The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021 – 2026 Passenger Cars and Light Trucks

Final Environmental Impact Statement

March 2020

Docket No. NHTSA-2017-0069

U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Final Environmental Impact Statement for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks

Lead Agency

National Highway Traffic Safety Administration (NHTSA)

Cooperating Agencies

U.S. Environmental Protection Agency (EPA), U.S. Department of Energy (DOE)

Overview

This Final Environmental Impact Statement (Final EIS) analyzes the environmental impacts of fuel economy standards and reasonable alternative standards for model years 2021 to 2026 for passenger cars and light trucks. NHTSA has proposed these new or amended Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act of 1975, as amended by the Energy Independence and Security Act of 2007. Environmental impacts analyzed in this Final EIS include those related to fuel and energy use, air quality, and climate change. In developing the final standards, NHTSA considered "technological feasibility, economic practicability, the effect of other vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy," as required by 49 United States Code (U.S.C.) § 32902(f).

Timing of Agency Action

NHTSA is issuing this Final EIS concurrently with the final rule (Record of Decision), which states and explains NHTSA's decision and describes NHTSA's consideration of applicable environmental laws and policies. *See* 49 U.S.C. § 304a(b) and U.S. Department of Transportation's *Guidance on the Use of Combined Final Environmental Impact Statements/Records of Decision and Errata Sheets in National Environmental Policy Act Reviews* (Apr. 25, 2019) (https://www.transportation.gov/sites/dot.gov/files/docs/mission/transportation-policy/permittingcenter/337371/feis-rod-guidance-final-04302019.pdf).

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Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter
AC	air conditioning
ACC	Advanced Clean Car
AEF	average emission factor
AEO	Annual Energy Outlook
AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation
AHS	American Housing Survey
AMOC	Atlantic Meridional Overturning Circulation
ANL	Argonne National Laboratory
AOGCM	atmospheric-ocean general circulation model
AR4	IPCC Fourth Assessment Report
AR5	IPCC Fifth Assessment Report
ASTM	American Society for Testing and Materials
BEV	battery electric vehicle
Btu	British thermal units
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CCSP	Climate Change Science Program
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CO_2SYS	CO_2 System Calculations
Diesel HAD	2002 Diesel Health Assessment Document
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
DOT	U. S. Department of Transportation
DPM	diesel particulate matter
E/GDP	energy-gross domestic product
eGRID	EPA Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration

EIS	environmental impact statement
EISA	Energy Independence and Security Act of 2007
ENSO	El-Niño-Southern Oscillation
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCA	Energy Policy and Conservation Act of 1975
ESA	Endangered Species Act
EV	electric vehicle
FCV	fuel cell electric vehicle
FHWA	Federal Highway Administration
FRIA	Final Regulatory Impact Analysis
g CO_2e/MJ	grams of carbon dioxide equivalent per megajoule of energy
g CO_2e/MMBtu	grams of carbon dioxide equivalent per million British thermal units
g/mi	gallons per mile
GCAM	Global Climate Change Assessment Model
GCM	general circulation model
GCRP	Global Change Research Program
GDP	gross domestic product
GGE	gasoline gallon equivalents
GHG	greenhouse gas
GIS	geographic information system
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
GSL	general service lamp
Gt	gigatons
GWP	global warming potential
HD	heavy-duty
HEV	hybrid-electric vehicle
HFCs	hydrofluorocarbons
IARC	International Agency for Research on Cancer
ICE	internal combustion engine
IEO	International Energy Outlook
IPCC	Intergovernmental Panel on Climate Change
IPCC WG1 AR5	IPCC Working Group I Fifth Assessment Report Summary for Policymakers
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
km^2	kilometers squared
kWh	kilowatt-hour
LABs	lead-acid batteries

LCA	life-cycle assessment
LFP	LiFePO4
Li-ion	lithium ion
LMO	LiMn2O4
LPG	liquefied petroleum gas
MAGICC	Model for the Assessment of Greenhouse-Gas Induced Climate Change
MEF	marginal emission factor
mg/m^3	milligrams per cubic meter of air
mm	millimeters
MMbtu	million British thermal units
$MMTCO_2$	million metric tons of carbon dioxide
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
MOVES	Motor Vehicle Emission Simulator
mpg	miles per gallon
MPGe	miles-per-gallon equivalent
MPGGE	miles per gallon of gasoline-equivalent
mph	miles per hour
MSAT	mobile source air toxics
MY	model year
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NCA	National Climate Assessment
NEI	National Emissions Inventory
NEMS	National Energy Modeling System
NEPA	National Environmental Policy Act
NERC	National Electricity Reliability Commission
NETL	National Energy Technology Laboratory
NHTSA	National Highway Traffic Safety Administration
NMC	LiNi0.4Mn0.4Co0.2O2
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NPRM	Notice of Proposed Rulemaking
NRC	National Research Council
NREL	National Renewable Energy Laboratory
NSPS	New Source Performance Standards
objECTS	Object-Oriented Energy, Climate, and Technology Systems
ODS	Ozone-Depleting Substance

PEV	plug-in electric vehicle
pH	potential of hydrogen
PHEV	plug-in hybrid electric vehicle
PM	particulate matter
PM10	particulate matter 10 microns or less in diameter
PM2.5	particulate matter 2.5 microns or less in diameter
ppm	parts per million
Preferred Alternative	Alternative 3
PRIA	Preliminary Regulatory Impact Analysis
quads	quadrillion Btu
RCP	Representative Concentration Pathway
RF	radiative forcing
RFS2	Renewable Fuel Standard 2
RGGI	Regional Greenhouse Gas Initiative
RIA	Regulatory Impact Analysis
SAFE	Safer Affordable Fuel-Efficient
SAPs	synthesis and assessment products
$SC-CH_4$	social cost of methane
$SC-CO_2$	social cost of carbon
$SC-N_2O$	social cost of nitrous oxide
SF_6	sulfur hexafluoride
SIP	State Implementation Plan
SO_2	sulfur dioxide
SO_X	oxides of sulfur
SPR	Strategic Petroleum Reserve
TS&D	transportation, storage, and distribution
TTI	travel time index
UNFCCC	United Nations Framework Convention on Climate Change and the annual Conference of the Parties
U. S. C.	U. S. Code
UV	ultraviolet
VMT	vehicle miles traveled
VOCs	volatile organic compounds
VRFBs	Vanadium redox flow batteries
WG1	Working Group 1

Glossary

The glossary provides the following definitions of technical and scientific terms, as well as plain English terms used differently in the context of this EIS.

Term	Definition
adaptation	Measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.
aerodynamic design	Features of vehicle design that can increase fuel efficiency by reducing drag.
albedo	Capacity of surfaces on Earth to reflect solar radiation back to space. High albedo has a cooling effect because the surface reflects, rather than absorbs most solar radiation.
anthropogenic	Resulting from or produced by human beings.
Atlantic Meridional Overturning Circulation (AMOC)	Mechanism for heat transport in the North Atlantic Ocean, by which warm waters are carried north and cold waters are carried toward the equator.
attainment area	Regions where concentrations of criteria pollutants meet National Ambient Air Quality Standards (NAAQS).
attribute-based standards	Each vehicle's performance standard (fuel economy or GHG emissions) is based on the model's attribute, which NHTSA classifies as the vehicle's footprint.
biofuel	Energy sources, such as biodiesel or ethanol, made from living things or the waste that living things produce.
black carbon (elemental carbon)	Most strongly light-absorbing component of particulate matter, formed by the incomplete combustion of fossil fuels, biofuels, and biomass.
CAFE Model	Model that estimates fuel consumption and tailpipe emissions under various technology, regulatory, and market scenarios.
carbon dioxide equivalent (CO_2e)	Measure that expresses total greenhouse gas emissions in a single unit. Calculated using global warming potentials of greenhouse gases and usually measured over 100 years.
carbon sink	Reservoir in which carbon removed from the atmosphere is stored, such as a forest.
carbon storage, sequestration	The removal and storage of a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol from the atmosphere.
compound events	Simultaneous occurrence of two or more events that collectively lead to extreme impacts.
conformity regulations, General Conformity Rule	Requirement that federal actions do not interfere with a state's ability to implement its State Implementation Plan and meet the National Ambient Air Quality Standards (NAAQS).
cooling degree days	The annual sum of the daily difference between the daily mean temperature and 65°F, when the daily mean temperature exceeds 65°F.
coordinated rulemaking	Joint rulemaking that addresses both fuel economy standards (NHTSA) and greenhouse gas emission standards (U.S. Environmental Protection Agency [EPA]).

Term	Definition
criteria pollutants	Six common pollutants for which the U.S. Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards (NAAQS): carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), fine particulate matter (PM) and airborne lead (Pb). Potential impacts of an action on ozone are evaluated based on the emissions of the ozone precursors nitrogen oxides (NO_X) and volatile organic compounds (VOCs).
cumulative impacts	Impacts caused by the action when added to other past, present, and reasonably foreseeable actions in the study area.
direct impacts	Impacts caused by the action that occur at the same time and place.
downstream emissions	Emissions related to vehicle life-cycle stages after vehicle production, including vehicle use and disposal.
dry natural gas	Gas that is removed from natural gas liquids.
El Niño-Southern Oscillation (ENSO)	Changes in atmospheric mass or pressure between the Pacific and Indo–Australian regions that affect both sea-surface temperature increases and decreases. El Niño is the warm phase of ENSO, in which sea surface temperatures along the central and eastern equatorial Pacific are warmer than normal, while La Niña is the cold phase of ENSO.
electric vehicle (EV)	Vehicle that runs partially, primarily, or completely on electricity. These include hybrid electric vehicles (HEVs), battery-powered electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs).
energy intensity	Ratio of energy inputs to gross domestic product. Also a common term used in life-cycle assessment to express energy consumption per functional unit (e.g., kilowatt hours per mile).
energy security	Regular availability of affordable energy.
eutrophication	Enrichment of a water body with plant nutrients as a result of phosphorus and nitrogen inputs.
evapotranspiration	Evaporation of water from soil and land and transpiration of water from vegetation.
fuel efficiency	Amount of fuel required to perform a certain amount of work. A vehicle is more fuel-efficient if it can perform more work while consuming less fuel.
fuel pathway	Supply chain characteristics of refined gasoline and other transportation fuels, whether sourced or refined in the United States or elsewhere.
global warming potential	A greenhouse gas's contribution to global warming relative to carbon dioxide (CO_2) emissions.
greenhouse gas (GHG) emissions	Emissions including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) that affect global temperature, precipitation, sea level, and ocean pH.
Greenhouse Gas Regulated Emissions, and Energy Use in Transportation (GREET) model	Model developed by Argonne National Laboratories that provides estimates of the life-cycle energy use, greenhouse gas emissions, and criteria air pollutant emissions of fuel production and vehicle use.
hazardous air pollutants	Pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. The U.S. Environmental Protection Agency (EPA) is required to control 187 hazardous air pollutants, also known as toxic air pollutants or air toxics.
heating degree days	Annual sum of the daily difference between daily mean temperature and 65°F, when the daily mean temperature is below 65°F.

Term	Definition
hydraulic fracturing	Method of releasing gas from shale formations by forcing water at high pressure into a well, thereby cracking the shale.
hydrocarbon	Organic compound consisting entirely of hydrogen and carbon.
indirect impacts	Impacts caused by the action that are later in time or farther in distance.
life-cycle assessment (LCA)	Evaluation of all of the inputs and outputs over the lifetime of a product.
lithium-ion (Li-ion) battery	Batteries that use lithium in cathode chemistries; a common battery technology for electric vehicles.
maintenance area	Former nonattainment area now in compliance with the National Ambient Air Quality Standards (NAAQS).
marginal emission factor (MEF)	Factors that reflect variations in electricity emission factors from power sources with time and location; compared with average emission factors (AEF), which average these emissions over annual periods and broad regions.
maximum feasible standard	Highest achievable fuel economy standard for a particular model year.
maximum lifetime of vehicles	Age after which less than 2% of the vehicles originally produced during a model year remain in service.
mitigation	Measures that avoid, minimize, rectify, reduce, or compensate for the impacts of an action.
mobile source air toxics (MSATS)	Hazardous air pollutants emitted from vehicles that are known or suspected to cause cancer or other serious health and environmental effects. MSATs included in this analysis are acetaldehyde, acrolein, benzene, 1,3-butadiene, diesel particulate matter, and formaldehyde.
morphology	Structural or anatomical features of a species, which may be affected by climate change.
Motor Vehicle Emissions Simulator (MOVES) model	U.S. Environmental Protection Agency (EPA) model used to calculate tailpipe emissions.
National Ambient Air Quality Standards (NAAQS)	Standards for ambient concentrations of six criteria air pollutants established by the U.S. Environmental Protection Agency (EPA) pursuant to the Clean Air Act.
NEPA scoping process	Early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.
nonattainment area	Regions where concentrations of criteria pollutants exceed National Ambient Air Quality Standards (NAAQS). These areas are required to implement plans to comply with the standards within specified periods.
ocean acidification	Decrease in the pH of sea water due to the uptake of anthropogenic carbon dioxide (CO_2).
ozone (O_3)	Criteria pollutant formed by reactions among nitrogen oxides (NO_X) and volatile organic compounds (VOCs).
passenger cars and light trucks	Motor vehicles with a gross vehicle weight rating of less than 8,500 pounds and medium-duty passenger vehicles with a gross vehicle weight rating of less than 10,000 pounds. Also referred to as *light-duty vehicles*.
particulate matter (PM)	Discrete particles that include dust, dirt, soot, smoke, and liquid droplets directly emitted into the air.
primary fuel	Energy sources consumed in the initial production of energy; primarily dry natural gas, petroleum, renewables, coal, nuclear, and liquefied natural gas or petroleum.

Term	Definition
radiative forcing	Change in energy fluxes caused by a specific driver that can alter the Earth's energy budget. Positive radiative forcing leads to warming while a negative radiative forcing leads to cooling.
rebound effect	Situation in which improved fuel economy would reduce the cost of driving and, hypothetically, lead to additional driving, thus increasing emissions of air pollutants.
saltwater intrusion	Displacement of fresh surface water or groundwater by saltwater in coastal and estuarine areas.
sea-ice extent	Area of the ocean where there is at least some sea ice.
shale gas, shale oil	Natural gas or oil that is trapped in fine-grained shale formations.
thermal expansion (of water)	Change in volume of water in response to a change in temperature; a cause of sea-level rise.
tipping point	Point at which a disproportionately large or singular response in a climate-affected system occurs as a result of only a moderate additional change in the inputs to that system.
transmission efficiency technology	Technology to improve engine efficiency such as increasing gears, dual clutch, and continuously variable transmissions.
unavoidable adverse impact	Impact of the action that cannot be mitigated.
upstream emissions	Emissions associated with crude-petroleum (feedstock) recovery and transportation, and with the production, refining, transportation, storage, and distribution of transportation fuels.
vanadium redox flow battery (VRFB)	Emerging battery technology in which energy is stored in an electrolyte, which is replenished during charging, thereby accelerating the recharge rate relative to existing battery technologies.
vehicle mass reduction	A means of increasing fuel efficiency by reducing vehicle weight (e.g., laser welding, hydroforming, tailor-welded blanks, aluminum casting and extrusion), and substituting lighter-weight materials for heavier materials.
vehicle miles traveled (VMT)	Total number of miles driven, typically reported annually.

SUMMARY

Foreword

The National Highway Traffic Safety Administration (NHTSA) prepared this environmental impact statement (EIS) to analyze and disclose the potential environmental impacts of the Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks for model years (MYs) 2021 to 2026. NHTSA prepared this document pursuant to Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) implementing regulations, U.S. Department of Transportation (DOT) Order 5610.1C, and NHTSA regulations.

This Final EIS compares the potential environmental impacts of eight alternatives for setting fuel economy standards for MY 2022–2026 passenger cars and light trucks (seven action alternatives and the No Action Alternative). Additionally, some of the action alternatives would revise the currently existing CAFE standards for MY 2021. This EIS analyzes the direct, indirect, and cumulative impacts of each action alternative relative to the No Action Alternative.

Background

The Energy Policy and Conservation Act of 1975 (EPCA) mandated that NHTSA establish and implement a regulatory program for motor vehicle fuel economy, known as the CAFE program, to reduce national energy consumption. As codified in Chapter 329 of Title 49 of the U.S. Code (U.S.C.) and, as amended by the Energy Independence and Security Act of 2007 (EISA), EPCA sets forth specific requirements concerning the establishment of average fuel economy standards for passenger cars and light trucks, which are motor vehicles with a gross vehicle weight rating less than 8,500 pounds and medium-duty passenger vehicles with a gross vehicle weight rating less than 10,000 pounds. The Secretary of Transportation has delegated responsibility for implementing the CAFE program to NHTSA.

EISA, enacted by Congress in December 2007, amended the EPCA CAFE program requirements by providing DOT additional rulemaking authority and responsibilities. Consistent with its statutory authority, in a rulemaking to establish CAFE standards for MY 2017 and beyond passenger cars and light trucks, NHTSA developed two phases of standards. The first phase included final standards for MYs 2017–2021. The second phase, covering MYs 2022–2025, included standards that were not final, due to the statutory requirement that NHTSA set average fuel economy standards not more than five model years at a time. Rather, NHTSA wrote that those standards were *augural*, meaning that they represented its best estimate, based on the information available at that time, of what levels of stringency might be maximum feasible in those model years.

On July 26, 2017, NHTSA published a Notice of Intent to prepare an EIS for new CAFE standards, which stated that NHTSA intended to publish a Notice of Proposed Rulemaking (NPRM) for MY 2022–2025 passenger cars and light trucks. The NPRM was issued together with the Draft EIS on August 2, 2018.

To inform its development of the final CAFE standards, NHTSA prepared this EIS, which analyzes, discloses, and compares the potential environmental impacts of a reasonable range of alternatives, including a Preferred Alternative, and discusses impacts in proportion to their significance. NHTSA is issuing this Final EIS concurrently with the final rule (Record of Decision), pursuant to 49 U.S.C. 304a (Pub. L. 114-94, 129 Stat. 1312, Section 1311(a)) and U.S. Department of Transportation *Guidance on the*

Use of Combined Final Environmental Impact Statements/Records of Decision and Errata Sheets in National Environmental Policy Act Reviews.

Purpose and Need for the Action

In accordance with EPCA, as amended by EISA, the purpose of NHTSA's rulemaking is to set fuel economy standards for MY 2021–2026 passenger cars and light trucks at "the maximum feasible average fuel economy level that the Secretary of Transportation decides the manufacturers can achieve in that model year." Specifically, in addition to establishing new standards for MY 2022–2026 vehicles, NHTSA also considers whether the current MY 2021 CAFE standards are "maximum feasible" and, if not, how to amend them as appropriate. When determining the maximum feasible levels that manufacturers can achieve in each model year, EPCA requires that NHTSA consider the four statutory factors of technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy. In addition, when determining the maximum feasible levels, the agency considers relevant safety and environmental factors.

For MYs 2021–2030, NHTSA must establish separate average fuel economy standards for passenger cars and light trucks for each model year. Standards must be "based on one or more vehicle attributes related to fuel economy" and "express[ed]…in the form of a mathematical function." EISA includes another requirement, which mandates that NHTSA "prescribe annual fuel economy standard increases that increase the applicable average fuel economy standard ratably," for MYs 2011–2020. This requirement does not apply for MY 2021 and later model years.

Proposed Action and Alternatives

NHTSA's action is setting fuel economy standards for passenger cars and light trucks in accordance with EPCA, as amended by EISA. NHTSA has selected a reasonable range of alternatives within which to set CAFE standards and to evaluate the potential environmental impacts of the final CAFE standards and alternatives under NEPA. In any single rulemaking under EPCA, fuel economy standards may be established for not more than five model years. For this reason, NHTSA is establishing CAFE standards for MY 2022–2026 passenger cars and light trucks. In addition, some of the action alternatives would revise the current CAFE standards for MY 2021.

NHTSA has analyzed a range of action alternatives with fuel economy stringencies that increase annually, on average, 0.0 to 3.0 percent from the MY 2020 or MY 2021 standards for passenger cars and for light trucks (depending on alternative). This range of action alternatives, as well as the No Action Alternative, encompasses a spectrum of possible standards NHTSA could determine is maximum feasible based on the different ways the agency could weigh EPCA's four statutory factors.

The No Action Alternative (also referred to as Alternative 0 in tables and figures) assumes that NHTSA would not amend the CAFE standards for MY 2021 passenger cars and light trucks. In addition, the No Action Alternative assumes that NHTSA would finalize the MY 2022–2025 augural CAFE standards that were described in the 2012 joint final rule. Finally, for purposes of its analysis, NHTSA assumes that the MY 2025 CAFE standards would continue indefinitely. The No Action Alternative provides an analytical baseline against which to compare the environmental impacts of the other alternatives presented in the EIS. NHTSA also considers seven action alternatives, Alternatives 1 through 7, which would require average annual increases in fuel economy ranging from 0.0 percent for passenger cars and light trucks

(Alternative 1) to 2.0 percent (passenger cars) and 3.0 percent (light trucks) (Alternative 7) from year to year. These action alternatives are as follows:

- **Alternative 1.** Alternative 1 would require a 0.0 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MYs 2021–2026. This alternative revises the MY 2021 standards to the MY 2020 levels and carries those numbers forward for MYs 2021–2026. Alternative 1 was identified as NHTSA's Preferred Alternative in the NPRM and Draft EIS; however, Alternative 3 is now NHTSA's Preferred Alternative.
- **Alternative 2**. Alternative 2 would require a 0.5 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MYs 2021–2026.
- **Alternative 3 (Preferred Alternative/Proposed Action).** Alternative 3, which NHTSA has identified as the Preferred Alternative, would require a 1.5 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MYs 2021–2026.
- **Alternative 4.** Alternative 4 would require a 1.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent average annual increase in fuel economy for light trucks for MYs 2021–2026.
- **Alternative 5.** Alternative 5 would require a 1.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent average annual increase in fuel economy for light trucks for MYs 2022–2026. Alternative 5 would make no changes to the current CAFE standards for MY 2021.
- **Alternative 6.** Alternative 6 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent average annual increase in fuel economy for light trucks for MYs 2021–2026.
- **Alternative 7.** Alternative 7 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent average annual increase in fuel economy for light trucks for MYs 2022–2026. Alternative 7 would make no changes to the current CAFE standards for MY 2021.

NHTSA eliminated from further consideration two alternatives that were considered in the Draft EIS and added a new alternative (Alternative 3) in this Final EIS. For purposes of its analysis, NHTSA assumes that the MY 2026 CAFE standards for each alternative would continue indefinitely. Table S-1 shows the estimated average required fleet-wide fuel economy forecasts by model year for each alternative.

Table S-1. Projected Average Required Fleet-Wide Fuel Economy (mpg) for Combined U.S. Passenger Cars and Light Trucks by Model Year and Alternative

Model Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Projected required mpg								
MY 2021	38.8	36.8	37.0	37.3	37.4	38.8	37.7	38.8
MY 2022	40.6	36.8	37.2	37.9	37.9	39.4	38.7	39.8
MY 2023	42.5	36.8	37.4	38.5	38.6	40.0	39.7	40.8
MY 2024	44.5	36.9	37.6	39.1	39.2	40.7	40.8	41.9
MY 2025	46.6	36.9	37.8	39.8	39.8	41.3	41.9	43.0
MY 2026	46.6	36.9	38.0	40.4	40.5	42.0	43.0	44.2

Notes:
mpg = miles per gallon; MY = model year

The range under consideration in the alternatives encompass a spectrum of possible standards that NHTSA could select based on how the agency weighs EPCA's four statutory factors. By providing environmental analyses at discrete representative points, the decision-makers and the public can determine the projected environmental effects of points that fall between the individual alternatives. The alternatives evaluated in this EIS therefore provide decision-makers with the ability to select from a wide variety of other potential alternatives with stringencies that would increase annually at average percentage rates from 0.0 to 3.0 percent, or up to the No Action Alternative. This range includes, for example, alternatives with stringencies that would increase at different rates for passenger cars and for light trucks and stringencies that would increase at different rates in different years. These alternatives reflect differences in the degree of technology adoption across the fleet, in costs to manufacturers and consumers, and in conservation of oil and related reductions in greenhouse gas (GHG) emissions.

Environmental Consequences

This section describes how the Proposed Action and alternatives could affect energy use, air quality, and climate, as reported in Chapter 3, *Energy*, Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, of this EIS, respectively. Air quality and climate impacts are reported for the entire light-duty vehicle fleet (passenger cars and light trucks combined); results are reported separately for passenger cars and light trucks in an appendix. Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts,* describes the life-cycle environmental implications of some of the fuels, materials, and technologies that NHTSA forecasts vehicle manufacturers might use to comply with the Proposed Action. Chapter 7, *Other Impacts,* qualitatively describes potential additional impacts on hazardous materials and regulated wastes, historic and cultural resources, safety impacts on human health, noise, and environmental justice.

The impacts on energy use, air quality, and climate include *direct*, *indirect*, and *cumulative impacts*. Direct impacts occur at the same time and place as the action. Indirect impacts occur later in time and/or are farther removed in distance. Cumulative impacts are the incremental direct and indirect impacts resulting from the action added to those of other past, present, and reasonably foreseeable future actions. The cumulative impacts associated with the Proposed Action and alternatives are discussed in Chapter 8, *Cumulative Impacts.*

To derive the direct and indirect impacts of the action alternatives, NHTSA compares each action alternative to a No Action Alternative, which reflects baseline trends that would be expected in the absence of any regulatory action as discussed above. The No Action Alternative for this EIS reflects fuel use and emission trends that would be expected if there were no change in the joint MY 2017–2025 National Program standards issued in the 2012 final rule, which include the MY 2017–2021 CAFE standards and the augural MY 2022–2025 CAFE standards. All alternatives assume the MY 2025 (No Action Alternative) or MY 2026 (action alternatives) standards would continue indefinitely. Because EPCA, as amended by EISA, requires NHTSA to set CAFE standards for each model year, environmental impacts would also depend on future standards established by NHTSA, but which cannot be quantified at this time.

Energy

NHTSA's final standards would regulate fuel economy and, therefore, affect U.S. transportation fuel consumption. Transportation fuel accounts for a large portion of total U.S. energy consumption and energy imports and has a significant impact on the functioning of the energy sector as a whole. Although

U.S. energy efficiency has been increasing and the U.S. share of global energy consumption has been declining in recent decades, total U.S. energy consumption has been increasing over that same period. Until a decade ago, most of this increase came not from increased domestic energy production but from the increase in imports, largely for use in the transportation sector.

Petroleum is by far the largest source of energy used in the transportation sector. In 2018, petroleum supplied 91 percent of transportation energy demand, and in 2040, petroleum is expected to supply 85 percent of transportation energy demand. Transportation accounts for the largest share of total U.S. petroleum consumption. In 2018, the transportation sector accounted for 78 percent of total U.S. petroleum consumption. In 2040, transportation is expected to account for 72 percent of total U.S. petroleum consumption.[1]

With transportation expected to account for 72 percent of total petroleum consumption, U.S. net petroleum imports in 2040 are expected to result primarily from fuel consumption by light-duty and heavy-duty vehicles. The United States is poised to reverse the trend of the last four decades and achieve net energy exports starting in 2020 because of continuing increases in overall U.S. energy efficiency and recent developments in U.S. energy production.

In the future, the transportation sector will continue to be the largest consumer of U.S. petroleum and the second-largest consumer of total U.S. energy, after the industrial sector. NHTSA's analysis of fuel consumption in this EIS projects that fuel consumed by light-duty vehicles will consist predominantly of gasoline derived from petroleum for the foreseeable future.

Direct and Indirect Impacts

To calculate the impacts on fuel use for each action alternative, NHTSA subtracted projected fuel consumption under the No Action Alternative from the level under each action alternative. As the alternatives increase in stringency, total fuel consumption decreases. Table S-2 shows total 2020 to 2050 fuel consumption for each alternative and the direct and indirect fuel use impacts for each action alternative compared with the No Action Alternative through 2050. NHTSA used 2050 as the end year for its analysis as it is the year by which nearly the entire U.S. light duty vehicle fleet will be composed of MY 2021–2026 or later vehicles. This table reports total 2020 to 2050 fuel consumption in gasoline gallon equivalents (GGE) for diesel, gasoline, electricity, hydrogen, and biofuel for cars and light trucks. Gasoline accounts for approximately 99 percent of car and light truck fuel use.

Table S-2. Fuel Consumption and Increase in Fuel Use by Alternative (billion gasoline gallon equivalent total for calendar years 2020–2050)

	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Fuel Consumption								
Cars	1,482	1,594	1,591	1,583	1,584	1,564	1,560	1,537
Light trucks	1,889	2,004	2,000	1,988	1,977	1,950	1,932	1,919
All light-duty vehicles	3,371	3,598	3,591	3,571	3,561	3,514	3,492	3,456

[1] This Summary references pertinent data from the analysis in the EIS. Sources of such data are appropriately cited and referenced in those chapters.

	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Increase in Fuel Use Compared to the No Action Alternative								
Cars		112	108	101	101	82	78	55
Light trucks		115	111	98	88	61	43	29
All light-duty vehicles		226	220	200	189	142	120	85

Total light-duty vehicle fuel consumption from 2020 to 2050 under the No Action Alternative is projected to be 3,371 billion GGE. Light-duty vehicle fuel consumption from 2020 to 2050 under the Proposed Action and alternatives is projected to range from 3,598 billion GGE under Alternative 1 to 3,456 billion GGE under Alternative 7. All of the action alternatives would increase fuel consumption compared to the No Action Alternative, with fuel consumption increases that range from 226 billion GGE under Alternative 1 to 85 billion GGE under Alternative 7.

Air Quality

Air pollution and air quality can affect public health, public welfare, and the environment. The Proposed Action and alternatives would affect air pollutant emissions and air quality, which, in turn, would affect public health and welfare and the natural environment. The air quality analysis in Chapter 4, *Air Quality*, assesses the impacts of the alternatives on emissions of pollutants of concern from mobile sources, and the resulting impacts on human health. The reductions and increases in emissions would vary by pollutant, calendar year, and action alternative.

Under the authority of the Clean Air Act and its amendments, EPA has established National Ambient Air Quality Standards (NAAQS) for six relatively common air pollutants known as *criteria pollutants*: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, sulfur dioxide (SO_2), lead, and particulate matter (PM) with an aerodynamic diameter equal to or less than 10 microns (PM10) and 2.5 microns (PM2.5, or fine particles). Ozone is not emitted directly from vehicles but is formed in the atmosphere from emissions of ozone precursor pollutants such as nitrogen oxides (NO_X) and volatile organic compounds (VOCs).

Criteria pollutants have been shown to cause the following adverse health impacts at various concentrations and exposures: damage to lung tissue, reduced lung function, exacerbation of existing respiratory and cardiovascular diseases, difficulty breathing, irritation of the upper respiratory tract, bronchitis and pneumonia, reduced resistance to respiratory infections, alterations to the body's defense systems against foreign materials, reduced delivery of oxygen to the body's organs and tissues, impairment of the brain's ability to function properly, cancer, and premature death.

In addition to criteria pollutants, motor vehicles emit some substances defined by the 1990 Clean Air Act amendments as toxic air pollutants. Toxic air pollutants from vehicles are known as mobile-source air toxics (MSATs). The MSATs included in this analysis are acetaldehyde, acrolein, benzene, 1,3-butadiene, diesel particulate matter (DPM), and formaldehyde. DPM is a component of exhaust from diesel-fueled vehicles and falls almost entirely within the PM2.5 particle-size class. MSATs are also associated with adverse health impacts. For example, EPA classifies acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and certain components of DPM as either known or probable human carcinogens. Many MSATs are also associated with noncancer health impacts, such as respiratory irritation.

Contribution of U.S. Transportation Sector to Air Pollutant Emissions

The U.S. transportation sector is a major source of emissions of certain criteria pollutants or their chemical precursors. Emissions of these pollutants from on-road mobile sources have declined dramatically since 1970 because of pollution controls on vehicles and regulation of the chemical content of fuels, despite continuing increases in vehicle travel and fuel consumption. Nevertheless, the U.S. transportation sector remains a major source of emissions of certain criteria pollutants or their chemical precursors. On-road mobile sources are responsible for 17.9 million tons per year of CO (30 percent of total U.S. emissions), 133,000 tons per year (2 percent) of PM2.5 emissions, and 287,000 tons per year (1 percent) of PM10 emissions. Passenger cars and light trucks contribute 93 percent of U.S. highway emissions of CO, 40 percent of highway emissions of PM2.5, and 56 percent of highway emissions of PM10. Almost all of the PM in motor vehicle exhaust is PM2.5; therefore, this analysis focuses on PM2.5 rather than PM10. All on-road mobile sources emit 1.8 million tons per year (11 percent of total nationwide emissions) of VOCs and 3.6 million tons per year (34 percent) of NO_X, which are chemical precursors of ozone. Passenger cars and light trucks account for 90 percent of U.S. highway emissions of VOCs and 51 percent of NO_X. In addition, NO_X is a PM2.5 precursor, and VOCs can be PM2.5 precursors. SO_2 and other oxides of sulfur (SO_X) are important because they contribute to the formation of PM2.5 in the atmosphere; however, on-road mobile sources account for less than 0.68 percent of U.S. SO_2 emissions. With the elimination of lead in automotive gasoline, lead is no longer emitted from motor vehicles in more than negligible quantities and is therefore not assessed in this analysis.

Methods

To analyze air quality and human health impacts, NHTSA calculated the emissions of criteria pollutants and MSATs from passenger cars and light trucks that would occur under each alternative. NHTSA then estimated the resulting changes in emissions by comparing emissions under each action alternative to those under the No Action Alternative. The resulting changes in air quality and impacts on human health were assumed proportional to the changes in emissions projected to occur under each action alternative.

Key Findings for Air Quality

The EIS provides findings for air quality impacts for 2025, 2035, and 2050. In general, emissions of criteria air pollutants increase across all alternatives, with some exceptions. The changes in emissions reflect the complex interactions among the tailpipe emissions rates of the various vehicle types, the technologies assumed to be incorporated by manufacturers in response to the CAFE standards, upstream emissions rates, the relative proportions of gasoline and diesel in total fuel consumption reductions, and changes in vehicle miles traveled (VMT) from the rebound effect. In addition, the action alternatives would result in increased incidence of PM2.5-related adverse health impacts due to the emissions increases. Increases in adverse health outcomes include increased incidences of premature mortality, acute bronchitis, respiratory emergency room visits, and work-loss days.

Direct and Indirect Impacts

<u>Criteria Pollutants</u>

The air quality analysis identified the following impacts on criteria air pollutants:

- In 2025, emissions of CO, NO_X, and SO_2 decrease under the action alternatives compared to the No Action Alternative (except for SO_2 under Alternative 7, which has emissions slightly greater than under the No Action Alternative). For CO, the more stringent alternatives have the smallest decreases, while for NO_X the decreases vary across the action alternatives, and for SO_2 the more stringent alternatives generally have the largest decreases (except for Alternative 7). Emissions of PM2.5 and VOCs increase under the action alternatives compared to the No Action Alternative, with the more stringent alternatives generally having the smallest increases.

- In 2025, across all criteria pollutants and action alternatives, the smallest decrease in emissions is less than 0.1 percent and occurs for NO_X under Alternative 7; the largest decrease is 0.5 percent and occurs for SO_2 under Alternative 6. The smallest increase in emissions is 0.1 percent and occurs for SO_2 under Alternative 7; the largest increase is 0.7 percent and occurs for PM2.5 under Alternative 1.
- In 2035 and 2050, emissions of CO, NO_X, PM2.5, and VOCs increase under the action alternatives compared to the No Action Alternative, with the more stringent alternatives having the smallest increases. SO_2 emissions decrease under the action alternatives compared to the No Action Alternative, with the more stringent alternatives having the smallest decreases.
- In 2035 and 2050, across all criteria pollutants and action alternatives, the smallest decrease in emissions is 0.9 percent and occurs for SO_2 under Alternative 7; the largest decrease is 12 percent and occurs for SO_2 under Alternative 2. The smallest increase in emissions is 0.2 percent and occurs for CO under Alternative 7; the largest increase is 12 percent and occurs for VOCs under Alternative 1.

Toxic Air Pollutants

The air quality analysis identified the following impacts on toxic air pollutants:

- Under each action alternative in 2025 compared to the No Action Alternative, decreases in emissions would occur for all toxic air pollutants except for DPM, for which emissions would increase by as much as 2 percent. For 2025, the largest relative decreases in emissions would occur for 1,3-butadiene, for which emissions would decrease by as much as 0.5 percent. Percentage reductions in emissions of acetaldehyde, acrolein, benzene, and formaldehyde would be less.
- Under each action alternative in 2035 and 2050 compared to the No Action Alternative, increases in emissions would occur for all toxic air pollutants. The largest relative increases in emissions would occur for DPM, for which emissions would increase by as much as 9 percent. Percentage increases in emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde would be less.

Changes in criteria pollutant emissions in 2035 are shown by alternative in Figure S-1. Changes in toxic air pollutant emissions in 2035 are shown by alternative in Figure S-2.

Health Impacts

The air quality analysis identified the following health impacts:

- In 2025 and 2035, all action alternatives except for Alternative 6 would result in increased adverse health impacts (mortality, acute bronchitis, respiratory emergency room visits, and other health effects) nationwide compared to the No Action Alternative as a result of increases in emissions of NO_X, PM2.5, and DPM. The increases in adverse health impacts are largest for the least stringent alternative (Alternative 1). With some exceptions, the increases get smaller as stringency increases, while Alternative 6 would result in decreased adverse health impacts.
- In 2050, all action alternatives would result in decreased adverse health impacts nationwide compared to the No Action Alternative as a result of decreases in emissions of SO_X. The decreases in adverse health impacts get smaller from Alternative 1 to Alternative 7.

Figure S-1. Nationwide Criteria Pollutant Emissions (tons/year) from U.S. Passenger Cars and Light Trucks for 2035 by Alternative

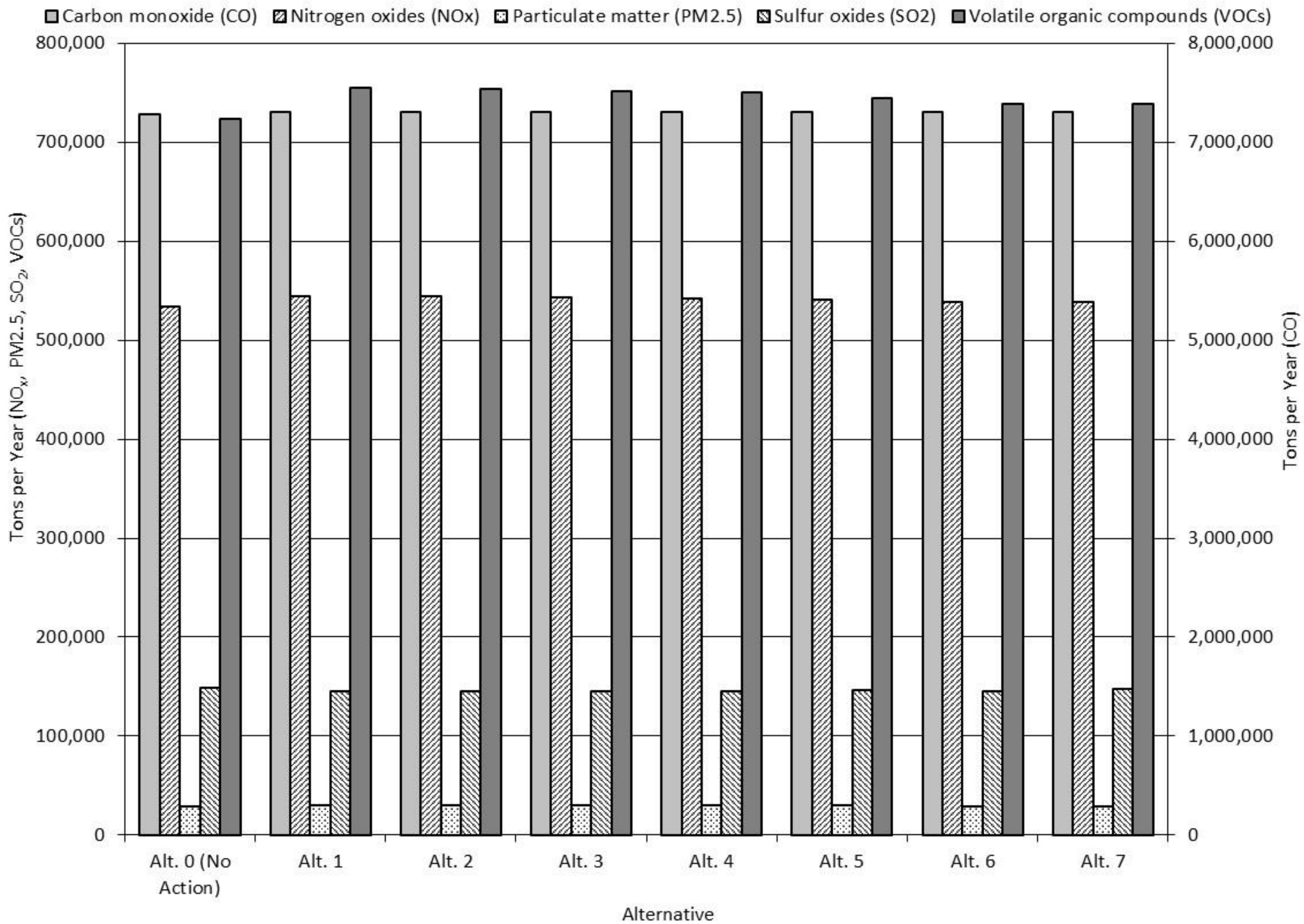
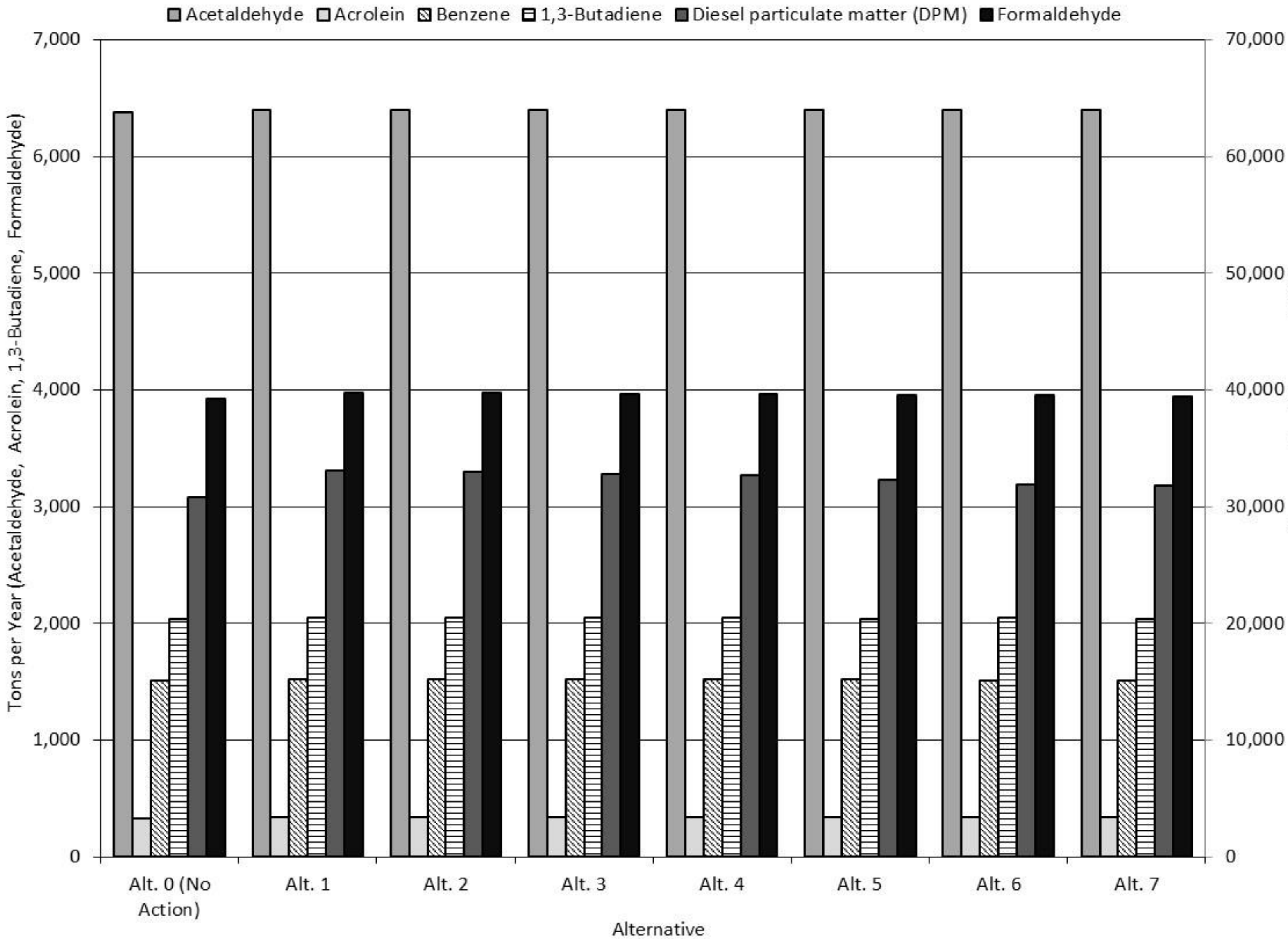


Figure S-2. Nationwide Toxic Air Pollutant Emissions (tons/year) from U.S. Passenger Cars and Light Trucks for 2035 by Alternative



Greenhouse Gas Emissions and Climate Change

This section describes how the Proposed Action and alternatives could affect the anticipated pace and extent of future changes in global climate. In this EIS, the discussion of climate change direct and indirect impacts focuses on impacts associated with increases in GHG emissions from the Proposed Action and alternatives as compared to projected GHG emissions under the No Action Alternative, including impacts on atmospheric carbon dioxide (CO_2) concentrations, global mean surface temperature, sea level, precipitation, and ocean pH.

Earth absorbs heat energy from the sun and returns most of this heat to space as terrestrial infrared radiation. GHGs trap heat in the lower atmosphere (the atmosphere extending from Earth's surface to approximately 4 to 12 miles above the surface), absorb heat energy emitted by Earth's surface and lower atmosphere, and reradiate much of it back to Earth's surface, thereby causing warming. This process, known as the *greenhouse effect*, is responsible for maintaining surface temperatures that are warm enough to sustain life. Human activities, particularly fossil-fuel combustion, have been identified by the Intergovernmental Panel on Climate Change (IPCC) as primarily responsible for increasing the concentrations of GHGs in the atmosphere; this buildup of GHGs is changing Earth's energy balance. Climate simulations have been used to support arguments that the warming experienced over the past century requires the inclusion of both natural GHGs and other climatic forcers (e.g., solar activity) as well as human-made climate forcers.

Global climate change refers to long-term (i.e., multi-decadal) trends in global average surface temperature, precipitation, ice cover, sea level, cloud cover, sea-surface temperatures and currents, ocean pH, and other climatic conditions. Average surface temperatures have increased since the Industrial Revolution (IPCC 2013a). From 1880 to 2016, Earth's global average surface temperature rose by more than 0.9°C (1.6°F) (GCRP 2017). Global mean sea level rose by about 1.0 to 1.7 millimeters per year from 1901 to 1990, a total of 11 to 14 centimeters (4 to 5 inches) (GCRP 2017). After 1993, global mean sea level rose at a faster rate of about 3 millimeters (0.12 inches) per year (GCRP 2017). Consequently, global mean sea level has risen by about 7 centimeters (3 inches) since 1990, and by 16 to 21 centimeters (7 to 8 inches) since 1900 (GCRP 2017).

Global atmospheric CO_2 concentration has increased 46.4 percent from approximately 278 parts per million (ppm) in 1750 (before the Industrial Revolution) (IPCC 2013a) to approximately 407 ppm in 2018 (NOAA 2019). Atmospheric concentrations of methane (CH_4) and nitrous oxide (N_2O) increased approximately 150 and 20 percent, respectively, over roughly the same period (IPCC 2013a). IPCC concluded, "[h]uman influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea-level rise, and in changes in some climate extremes. … This evidence for human influence has grown since [the IPCC *Working Group 1 (WG1) Fourth Assessment Report (AR4)*]. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC 2013a).

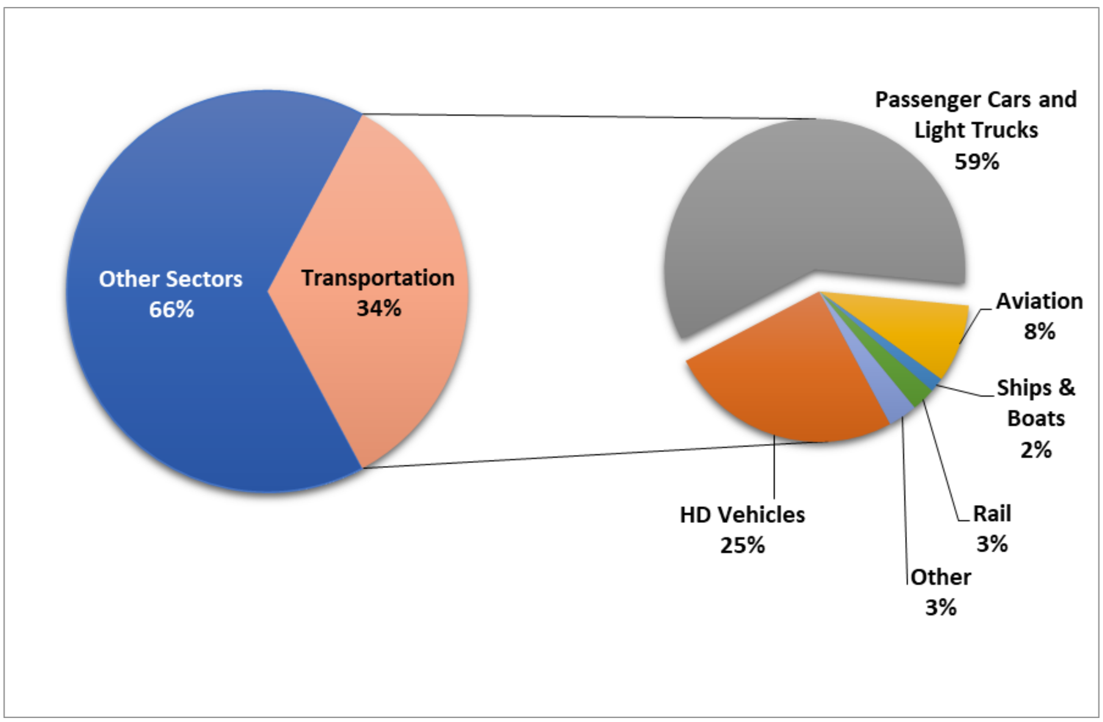
This EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and the U.S. Global Change Research Program (GCRP), supplemented with past reports from the U.S. Climate Change Science Program (CCSP), the National Research Council, and the Arctic Council.

Contribution of the U.S. Transportation Sector to U.S. and Global Carbon Dioxide Emissions

Human activities that emit GHGs to the atmosphere include fossil fuel production and combustion; industrial processes and product use; agriculture, forestry, and other land use; and waste management. Emissions of CO_2, CH_4, and N_2O account for approximately 98 percent of annual anthropogenic GHG emissions. Isotopic- and inventory-based studies have indicated that the rise in the global CO_2 concentration is largely a result of the release of carbon that has been stored underground through the combustion of fossil fuels (coal, petroleum, and natural gas) used to produce electricity, heat buildings, and power motor vehicles and airplanes, among other uses.

According to the World Resources Institute's Climate Watch, emissions from the United States account for approximately 15 percent of total global CO_2 emissions. EPA's National Greenhouse Gas Inventory for 1990 to 2017 indicates that, in 2017, the U.S. transportation sector contributed about 34 percent of total U.S. CO_2 emissions, with passenger cars and light trucks accounting for 59 percent of total U.S. CO_2 emissions from transportation. Therefore, approximately 20 percent of total U.S. CO_2 emissions are from passenger cars and light trucks, and these vehicles in the United States account for 3 percent of total global CO_2 emissions (based on comprehensive global CO_2 emissions data available for 2017).[2] Figure S-3 shows the proportion of U.S. CO_2 emissions attributable to the transportation sector and the contribution of each mode of transportation to those emissions.

Figure S-3. Contribution of Transportation to U.S. Carbon Dioxide Emissions and Proportion Attributable by Mode, 2017



Source: EPA 2019
HD = heavy duty

[2] The estimate for CO_2 emissions from fossil fuel combustion and industry is from the World Resources Institute. It excludes emissions and sinks from land use change and forestry.

Key Findings for Climate

The Proposed Action and alternatives would increase U.S. passenger car and light truck fuel consumption and CO_2 emissions compared with the No Action Alternative, resulting in minor increases to the anticipated increases in global CO_2 concentrations, temperature, precipitation, and sea level, and decreases in ocean pH that would otherwise occur. They could also, to a small degree, increase the impacts and risks of climate change. Uncertainty exists regarding the magnitude of impact on these climate variables, as well as to the impacts and risks of climate change.

Estimates of GHG emissions and increases are presented for each of the action alternatives. Key climate effects on atmospheric CO_2 concentration, global mean surface temperature, precipitation, sea level, and ocean pH, which result from changes in GHG emissions, are also presented for each of the action alternatives. These effects are gradual and increase over time. Changes to these climate variables are typically modeled to 2100 or longer because of the amount of time it takes to show the full extent of the effects of GHG emissions on the climate system.

The impacts of the Proposed Action and alternatives on global mean surface temperature, precipitation, sea level, and ocean pH would be extremely small in relation to global emissions trajectories. This is because of the global and multi-sectoral nature of climate change. These effects would be small, would occur on a global scale, and would not disproportionately affect the United States.

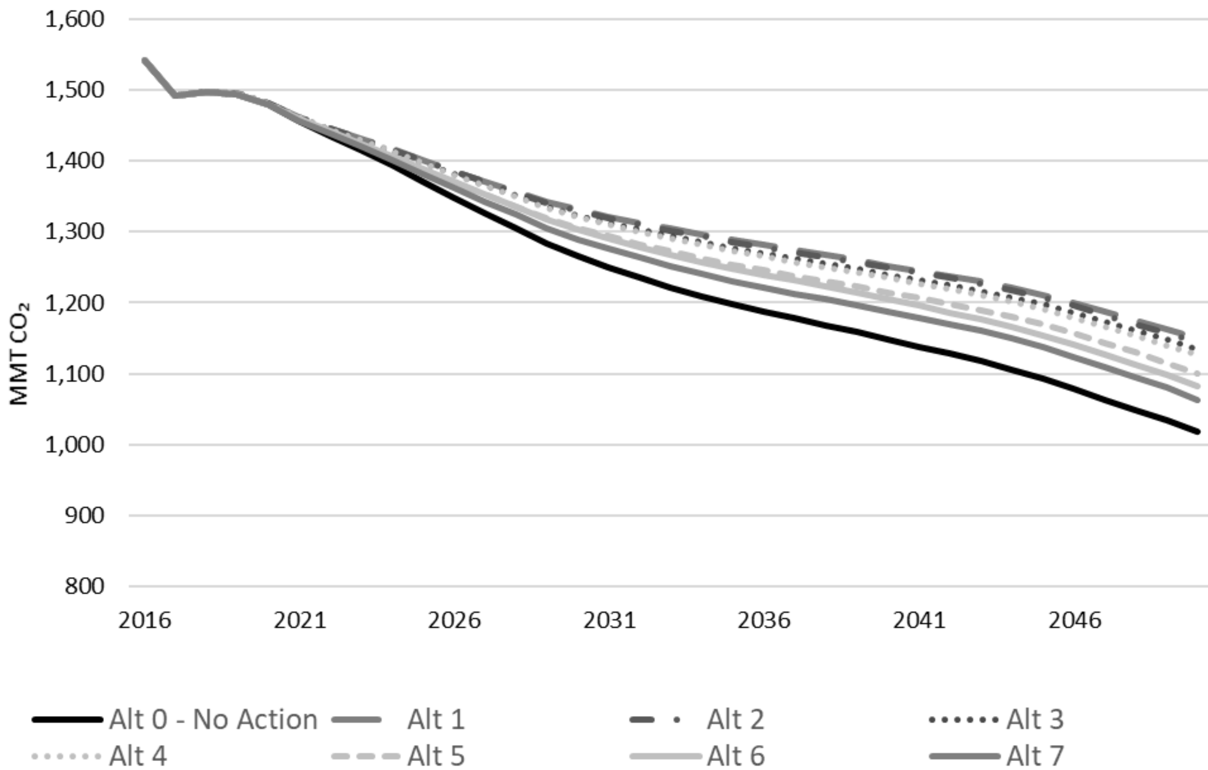
Direct and Indirect Impacts

Greenhouse Gas Emissions

The alternatives would have the following impacts related to GHG emissions:

- Figure S-4 shows projected annual CO_2 emissions from passenger cars and light trucks under each alternative. Passenger cars and light trucks are projected to emit 85,900 million metric tons of carbon dioxide ($MMTCO_2$) from 2021 through 2100 under the No Action Alternative. Alternative 1 would increase these emissions by 10 percent through 2100. Alternative 7 would increase these emissions by 4 percent through 2100. Emissions would be lowest under the No Action Alternative, while Alternatives 1 through 7 would have higher emissions than the No Action Alternative. Emissions increases would be highest under Alternative 1 and would decrease across the action alternatives.
- Compared with total projected CO_2 emissions of 935 $MMTCO_2$ from all passenger cars and light trucks under the No Action Alternative in the year 2100, the Proposed Action and alternatives are expected to increase CO_2 emissions from passenger cars and light trucks in the year 2100 from 4 percent under Alternative 7 to 13 percent under Alternative 1.
- Compared with total global CO_2 emissions from all sources of 4,950,865 $MMTCO_2$ under the No Action Alternative from 2021 through 2100, the Proposed Action and alternatives are expected to increase global CO_2 emissions between 0.06 (Alternative 7) and 0.17 (Alternative 1) percent by 2100.
- The emission increases in 2025 compared with emissions under the No Action Alternative are approximately equivalent to the annual emissions from 2,020,000 vehicles under Alternative 7 to 5,586,000 vehicles under Alternative 1. (A total of 254,969,000 passenger cars and light trucks vehicles are projected to be on the road in 2025 under the No Action Alternative.)

Figure S-4. Projected Annual Carbon Dioxide Emissions ($MMTCO_2$) from All U.S. Passenger Cars and Light Trucks by Alternative



$MMTCO_2$ = million metric tons of carbon dioxide

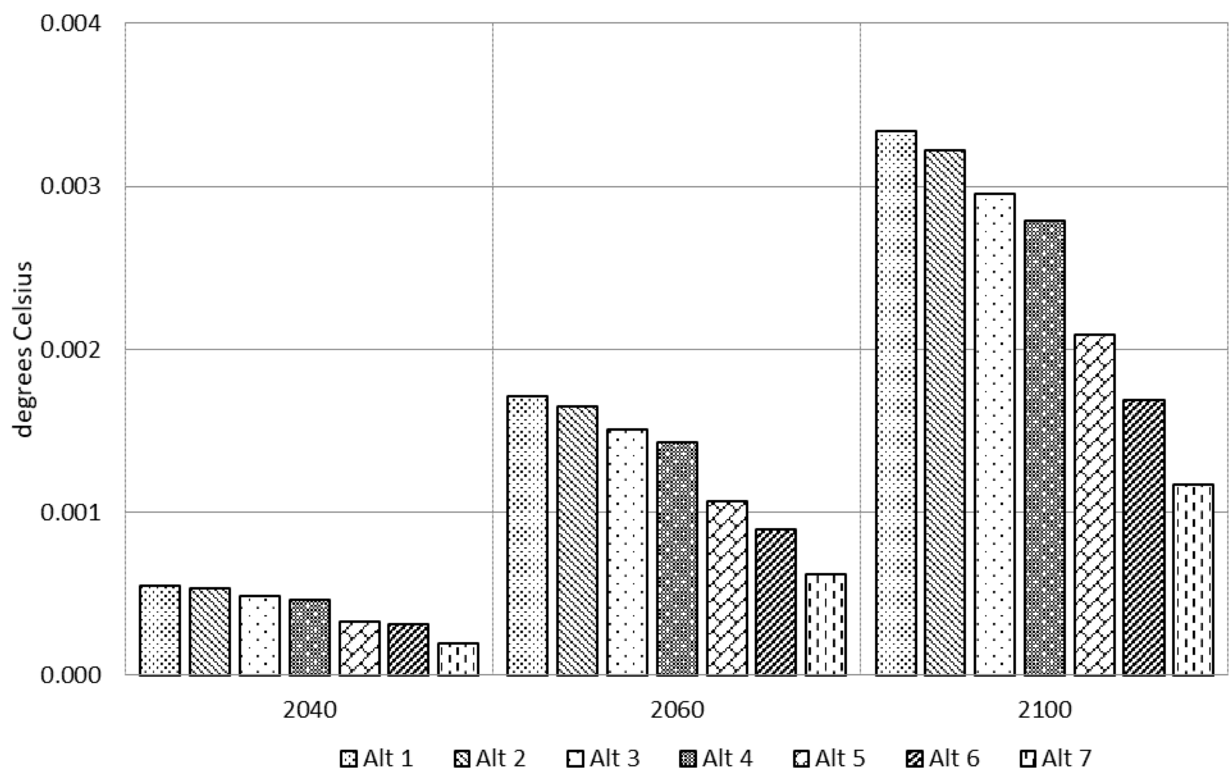
Carbon Dioxide Concentration, Global Mean Surface Temperature, Sea Level, Precipitation, and Ocean pH

CO_2 emissions affect the concentration of CO_2 in the atmosphere, which in turn affects global temperature, sea level, precipitation, and ocean pH. For the analysis of direct and indirect impacts, NHTSA used the Global Change Assessment Model Reference scenario to represent the Reference Case emissions scenario (i.e., future global emissions assuming no comprehensive global actions to mitigate GHG emissions):

- Estimated CO_2 concentrations in the atmosphere for 2100 would range from 789.89 parts per million (ppm) under Alternative 1 to approximately 789.11 ppm under the No Action Alternative, indicating a maximum atmospheric CO_2 increase of approximately 0.78 ppm compared to the No Action Alternative. Atmospheric CO_2 concentration under Alternative 7 would increase by 0.27 ppm compared with the No Action Alternative.
- Global mean surface temperature is projected to increase by approximately 3.48°C (6.27°F) under the No Action Alternative by 2100. Implementing the lowest emissions action alternative (Alternative 7) would increase this projected temperature rise by 0.001 degrees Celsius (°C) (0.002 degrees Fahrenheit [°F]), while implementing the highest emissions alternative (Alternative 1) would increase projected temperature rise by 0.003°C (0.005°F). Figure S-5 shows the increase in projected global mean surface temperature under each action alternative compared with temperatures under the No Action Alternative.

- Projected sea-level rise in 2100 ranges from a low of 76.28 centimeters (30.03 inches) under the No Action Alternative to a high of 76.35 centimeters (30.06 inches) under Alternative 1. Alternative 1 would result in an increase in sea level equal to 0.07 centimeter (0.03 inch) by 2100 compared with the level projected under the No Action Alternative compared to an increase under Alternative 7 of 0.02 centimeter (0.001 inch) compared with the No Action Alternative.
- Global mean precipitation is anticipated to increase by 5.85 percent by 2100 under the No Action Alternative. Under the action alternatives, this increase in precipitation would be increased further by 0.01 percent.
- Ocean pH in 2100 is anticipated to be 8.2175 under Alternative 7, about 0.0001 less than the No Action Alternative. Under Alternative 1, ocean pH in 2100 would be 8.2172, or 0.0004 less than the No Action Alternative.

Figure S-5. Increase in Global Mean Surface Temperature Compared with the No Action Alternative



Cumulative Impacts

The cumulative impact analysis evaluates the impact of the Proposed Action and alternatives in combination with other past, present, and reasonably foreseeable future actions that affect the same resource. The other actions that contribute to cumulative impacts can vary by resource and are defined independently for each resource. However, the underlying inputs, models, and assumptions of the CAFE model already take into account many past, present, and reasonably foreseeable future actions that affect U.S. transportation sector fuel use and U.S. mobile source air pollutant emissions. Therefore, the analysis of direct and indirect impacts of the Proposed Action and alternatives inherently incorporates projections about the impacts of past, present, and reasonably foreseeable future actions in order to develop a realistic baseline.

For energy and air quality, the focus of the cumulative impacts analysis is on trends in electric vehicle sales and use. For climate, the analysis reflects potential actions in global climate change policy to control GHG emissions. The cumulative impacts analysis for climate also includes qualitative discussions of the potential cumulative impacts of climate change on key natural and human resources and the potential nonclimate effects of CO_2.

Energy

The Presidential Executive Order on Promoting Energy Independence and Economic Growth (EO 13783, issued March 28, 2017) could substantively affect energy supply. EO 13783 requires that executive departments and agencies "review existing regulations that potentially burden the development or use of domestically produced energy resources and appropriately suspend, revise, or rescind those that unduly burden the development of domestic energy resources beyond the degree necessary to protect the public interest or otherwise comply with the law." The stated goal of this initiative is to "promote clean and safe development of our Nation's vast energy resources, while at the same time avoiding regulatory burdens that unnecessarily encumber energy production, constrain economic growth, and prevent job creation." EO 13783 also recognizes that "prudent development of these natural resources is essential to ensuring the Nation's geopolitical security."

The ongoing implementation of EO 13783 could affect cumulative energy impacts in many different ways. Eliminating unnecessary regulatory burdens that restrain oil exploration could increase U.S. oil production and thereby reduce the price of gasoline and diesel fuel. Lower-priced fuel may result in consumers purchasing a higher proportion of light trucks compared to passenger cars, resulting in lower overall new vehicle fuel economy. Alternatively, cheaper fuel prices may result in increased vehicle miles traveled (i.e., the rebound effect), resulting in increased U.S. vehicle use of these fuels. On the other hand, it is also possible that eliminating regulatory burdens that increase the cost of electricity could reduce electricity prices paid to operate electric vehicles and thereby increase demand for electric vehicles.

Although EO 13783 is expected to result in future actions that are likely to have substantive cumulative impacts on U.S. energy supply and associated impacts on U.S. light-duty vehicle fuel consumption, the variety of potential impacts on different energy sources and end-use sectors is too complex to support specific quantitative estimates of impacts on U.S. light-duty vehicle fuel consumption at this time.

In addition to U.S. energy policy, manufacturer investments in plug-in electric vehicle (PEV) technologies and manufacturing in response to government mandates (including foreign PEV quotas) may affect market trends and energy use over the long term if consumers actually choose to purchase such vehicles. Recent global trends show that PEV battery costs have declined, and vehicle manufacturers have announced more aggressive plans for global PEV production. Global efforts to comply with PEV requirements outside the United States, if enforced, could reduce the cost of PEVs, thereby reducing energy use if U.S. PEV demand increases. However, recent consumer demand for PEVs remains low compared to traditional internal combustion engine vehicles despite massive direct government subsidies, nonmonetary incentives, automaker price cross-subsidization, and future forecasts of PEV sales in the United States are subject to considerable uncertainty.

Air Quality

Market-driven changes in the energy sector are expected to affect U.S. emissions and could result in future increases or decreases in emissions. Trends in the prices of fossil fuels and the costs of renewable energy sources will affect the electricity generation mix and, consequently, the upstream emissions from energy production and distribution as well as electric vehicle use. Temporal patterns in charging of electric vehicles by vehicle owners would affect any increase in power plant emissions. Potential changes in federal regulation of emissions from power plants also could result in future increases or decreases in aggregate emissions from these sources.

The forecasts of upstream and downstream emissions that underlie the air quality impact analysis assume the continuation of existing emissions standards for vehicles, oil and gas development operations, and industrial processes such as fuel refining. These standards have become tighter over time as state and federal agencies have sought to reduce emissions to help bring nonattainment areas into attainment. To the extent that the trend toward tighter emissions standards could change in the future, total nationwide emissions from vehicles and industrial processes could change accordingly.

Cumulative changes in health impacts due to air pollution are expected to be consistent with trends in emissions. Higher emissions would be expected to lead to an overall increase in adverse health impacts while lower emissions would be expected to lead to a decrease in adverse health impacts, compared to conditions in the absence of cumulative impacts.

Greenhouse Gas Emissions and Climate Change

The global emissions scenario used in the cumulative impacts analysis differs from the global emissions scenario used for climate change modeling of direct and indirect impacts. In the cumulative impacts analysis, the Reference Case global emissions scenario used in the climate modeling analysis reflects reasonably foreseeable actions in global climate change policy.

Greenhouse Gas Emissions

The following cumulative impacts related to GHG emissions are anticipated:

- Projections of total emissions increases from 2021 to 2100 under the Proposed Action and alternatives and other reasonably foreseeable future actions compared with the No Action Alternative range from 3,100 $MMTCO_2$ (under Alternative 7) to 8,800 $MMTCO_2$ (under Alternative 1). The Proposed Action and alternatives would increase total vehicle emissions by between 4 percent (under Alternative 7) and 10 percent (under Alternative 1) by 2100.
- Compared with projected total global CO_2 emissions of 4,044,005 $MMTCO_2$ from all sources from 2021 to 2100, the incremental impact of this rulemaking is expected to increase global CO_2 emissions between 0.08 (Alternative 7) and 0.22 (Alternative 1) percent by 2100.

Climate Change Indicators

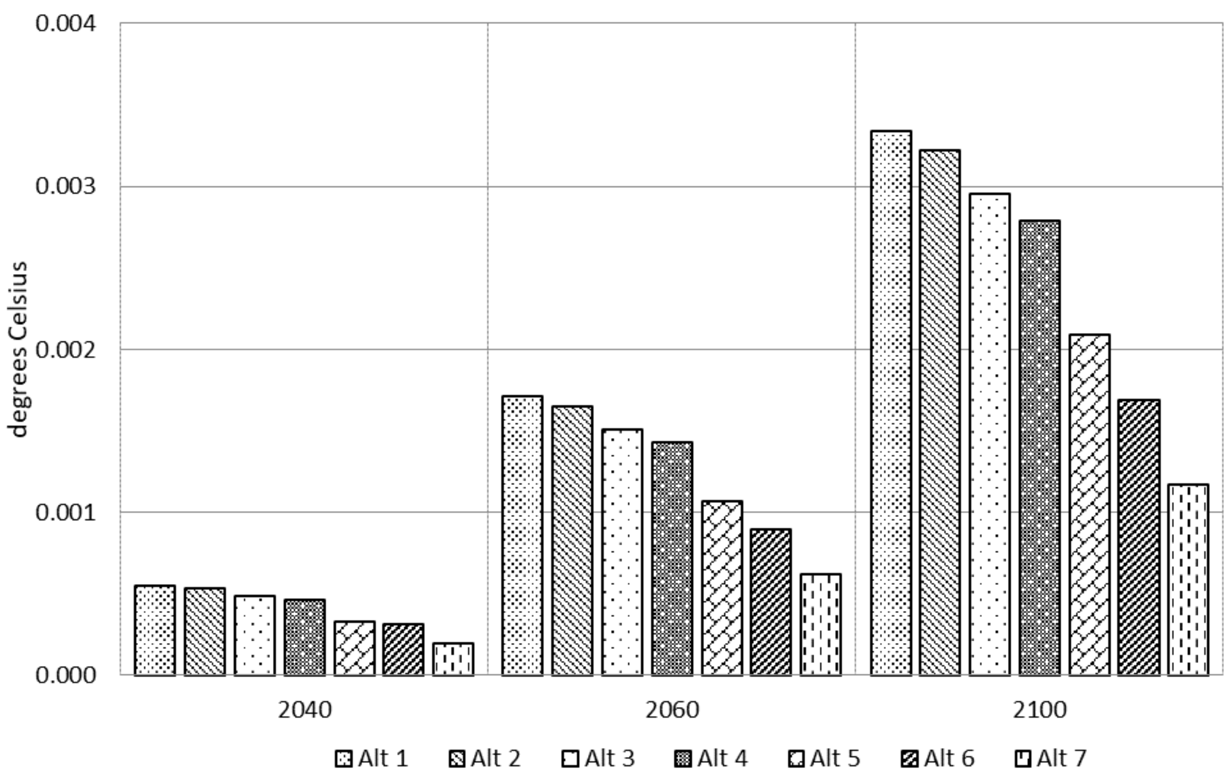
The following cumulative impacts related to the climate change indicators of atmospheric CO_2 concentration, global mean surface temperature, precipitation, sea level, and ocean pH are anticipated:

- Estimated atmospheric CO_2 concentrations in 2100 range from a low of 687.3 ppm under the No Action Alternative to a high of 688.04 ppm under Alternative 1. Alternative 7, the lowest CO_2

emissions alternative, would result in CO_2 concentrations of 687.55 ppm, an increase of 0.26 ppm compared with the No Action Alternative.

- Global mean surface temperature increases for the Proposed Action and alternatives compared with the No Action Alternative in 2100 range from a low of 0.001°C (0.002°F) under Alternative 7 to a high of 0.004°C (0.007°F) under Alternative 1. Figure S-6 illustrates the increases in global mean temperature under each action alternative compared with the No Action Alternative.
- Global mean precipitation is anticipated to increase by 4.77 percent by 2100 under the No Action Alternative. Under the action alternatives, this increase in precipitation would be increased further by 0.01 percent.
- Projected sea-level rise in 2100 ranges from a low of 70.22 centimeters (27.65 inches) under the No Action Alternative to a high of 70.30 centimeters (27.68 inches) under Alternative 1, indicating a maximum increase of sea-level rise of 0.07 centimeter (0.03 inch) by 2100. Sea-level rise under Alternative 7 would be 70.25 centimeters (27.66 inches), a 0.03-centimeter (0.01-inch) increase compared to the No Action Alternative.
- Ocean pH in 2100 is anticipated to be 8.2721 under Alternative 7, about 0.0001 less than the No Action Alternative. Under Alternative 1, ocean pH in 2100 would be 8.2719, or 0.0004 less than the No Action Alternative.

Figure S-6. Increase in Global Mean Surface Temperature Compared with the No Action Alternative, Cumulative Impacts



Health, Societal, and Environmental Impacts of Climate Change

The Proposed Action and alternatives could marginally increase the impacts of climate change that would otherwise occur under the No Action Alternative. The magnitude of the changes in climate effects that would be produced by the least stringent action alternative (Alternative 1) by the year 2100 is roughly a 0.8 ppm higher concentration of CO_2, four thousandths of a degree increase in temperature rise, a small percentage change in the rate of precipitation increase, about 0.07 centimeter (0.03 inch) of sea-level rise, and a decrease of 0.0004 in ocean pH. Because the projected increases in CO_2 and climate effects are extremely small compared with total projected future climate change, they would only marginally increase the potential risks associated with climate change.

Although NHTSA does quantify the increases in monetized damages that can be attributable to each action alternative (see CO_2 Damage Reduction Benefit metric in the Final Regulatory Impact Analysis (FRIA) benefits and net impacts tables), many specific impacts of climate change on health, society, and the environment cannot be estimated quantitatively. Therefore, NHTSA provides a qualitative discussion of these impacts by presenting the findings of peer-reviewed panel reports including those from IPCC, GCRP, the CCSP, the National Research Council, and the Arctic Council, among others. Because the impacts of the emissions increase under this rule would be marginal compared to global GHG emissions, the following climate impacts could be exacerbated but only to a marginal degree in proportion with the emissions increases reported. Uncertainty remains in the potential climate impacts reported, and emissions resulting from this rule cannot be directly attributed to any particular climate impact. Ultimately, climate impacts would vary by region, including in scope, intensity, and directionality (particularly for precipitation). The following types of long-term impacts were identified in the scientific literature and could be associated with climate change but would not likely be significantly affected by any of the alternatives:

- Impacts on freshwater resources could include changes in rainfall and streamflow patterns, changes in water availability paired with increasing water demand for irrigation and other needs, and decreased water quality from increased algal blooms. Inland flood risk could increase in response to increasing intensity of precipitation events, drought, changes in sediment transport, and changes in snowpack and the timing of snowmelt.
- Impacts on terrestrial and freshwater ecosystems could include shifts in the range and seasonal migration patterns of species, relative timing of species' life-cycle events, potential extinction of sensitive species that are unable to adapt to changing conditions, increases in the occurrence of forest fires and pest infestations, and changes in habitat productivity due to increased atmospheric concentrations of CO_2.
- Impacts on ocean systems, coastal regions, and low-lying areas could include the loss of coastal areas due to inundation, submersion or erosion from sea-level rise and storm surge, with increased vulnerability of the built environment and associated economies. Changes in key habitats (e.g., increased temperatures, decreased oxygen, decreased ocean pH, increased salinization) and reductions in key habitats (e.g., coral reefs) may affect the distribution, abundance, and productivity of many marine species.
- Impacts on food, fiber, and forestry could include increasing tree mortality, forest ecosystem vulnerability, productivity losses in crops and livestock, and changes in the nutritional quality of pastures and grazing lands in response to fire, insect infestations, increases in weeds, drought, disease outbreaks, or extreme weather events. Increased concentrations of CO_2 in the atmosphere can also stimulate plant growth to some degree, a phenomenon known as the CO_2 fertilization

effect, but the impact varies by species and location. Many marine fish species could migrate to deeper or colder water in response to rising ocean temperatures, and global potential fish catches could decrease. Impacts on food, including yields, food processing, storage, and transportation could affect food prices and food security globally.

- Impacts on rural and urban areas could affect water and energy supplies, wastewater and stormwater systems, transportation, telecommunications, provision of social services, incomes (especially agricultural), and air quality. The impacts could be greater for vulnerable populations such as lower-income populations, the elderly, those with existing health conditions, and young children.
- Impacts on human health could include increases in mortality and morbidity due to excessive heat and other extreme weather events, increases in respiratory conditions due to poor air quality and aeroallergens, increases in water and food-borne diseases, increases in mental health issues, and changes in the seasonal patterns and range of vector-borne diseases. The most disadvantaged groups such as children, the elderly, the sick, and low-income populations are especially vulnerable.
- Impacts on human security could include increased threats in response to adversely affected livelihoods, compromised cultures, increased or restricted migration, increased risk of armed conflicts, reduction in adequate essential services such as water and energy, and increased geopolitical rivalry.

In addition to the individual impacts of climate change on various sectors, compound events may occur more frequently. Compound events consist of two or more extreme weather events occurring simultaneously or in sequence when underlying conditions associated with an initial event amplify subsequent events and, in turn, lead to more extreme impacts. The effect of climate change on the frequency and severity of compound events remains uncertain, and the outcome of this rule on any of them would be minimal.

CHAPTER 1 PURPOSE AND NEED FOR THE ACTION

1.1 Introduction

The Energy Policy and Conservation Act of 1975 (EPCA)[1] established the Corporate Average Fuel Economy (CAFE) program as part of a comprehensive approach to federal energy policy. In order to reduce national energy consumption, EPCA directs the National Highway Traffic Safety Administration (NHTSA) within the U.S. Department of Transportation (DOT) to prescribe and enforce average fuel economy standards for passenger cars and light trucks sold in the United States.[2] As codified in Chapter 329 of Title 49 of the U.S. Code (U.S.C.), and as amended by the Energy Independence and Security Act of 2007 (EISA),[3] EPCA sets forth specific requirements concerning the establishment of average fuel economy standards for passenger cars and light trucks. These are motor vehicles with a gross vehicle weight rating of less than 8,500 pounds, and medium-duty passenger vehicles with a gross vehicle weight rating of less than 10,000 pounds.[4]

NHTSA has set fuel economy standards since the 1970s. In recent years, NHTSA issued final CAFE standards for model year (MY) 2011 passenger cars and light trucks,[5] MY 2012–2016 passenger cars and light trucks,[6] and MY 2017 and beyond passenger cars and light trucks.[7] NHTSA also established, pursuant to EISA, the first fuel efficiency standards for medium- and heavy-duty vehicles for MYs 2014–2018 (HD Fuel Efficiency Improvement Program Phase 1)[8] and MYs 2018–2027 (Phase 2).[9] Because of the direct relationship between fuel economy and greenhouse gas (GHG) emissions in motor vehicles, beginning with the MY 2012–2016 CAFE rulemaking, NHTSA has issued its light-duty fuel economy and medium- and heavy-duty fuel efficiency standards in joint rulemakings with the U.S. Environmental

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[1] Public Law (Pub. L.) No. 94-163, 89 Stat. 871 (Dec. 22, 1975). EPCA was enacted for the purpose of serving the nation's energy demands and promoting conservation methods when feasibly obtainable.

[2] The Secretary of Transportation has delegated the responsibility for implementing the CAFE program to the National Highway Traffic Safety Administration (NHTSA). 49 Code of Federal Regulations (CFR) § 1.95(a). Accordingly, the Secretary, U.S. Department of Transportation (DOT), and NHTSA are often used interchangeably in this environmental impact statement (EIS).

[3] Pub. L. No. 110–140, 121 Stat. 1492 (Dec. 19, 2007). EISA amends and builds on EPCA by setting out a comprehensive energy strategy for the 21st century, including the reduction of fuel consumption from all motor vehicle sectors.

[4] Passenger cars and light trucks that meet these criteria are also referred to as light-duty vehicles. The terms *passenger car, light truck,* and *medium-duty passenger vehicle* are defined in 49 CFR Part 523.

[5] NHTSA initially proposed standards for MY 2011–2015 passenger cars and light trucks (*see* Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015. Notice of Proposed Rulemaking, 73 *Federal Register* [FR] 24352 [May 2, 2008]); however, on January 7, 2009, DOT announced that the Bush Administration would not issue the final rule for that rulemaking (DOT 2009). Later that year, NHTSA issued a final rule only for MY 2011 passenger cars and light trucks (*see* Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011. Final Rule; Record of Decision, 74 FR 14196 [Mar. 30, 2009]).

[6] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 FR 25324 (May 7, 2010).

[7] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule, 77 FR 62624 (Oct. 15, 2012).

[8] Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles; Final Rule, 76 FR 57106 (Sept. 15, 2011).

[9] Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2; Final Rule, 81 FR 73478 (Oct. 25, 2016).

Protection Agency (EPA). Although the agencies' programs and standards are separate,[10] they have been closely coordinated.

Consistent with its statutory authority, in the MY 2017 and beyond rulemaking for passenger cars and light trucks, NHTSA developed two phases of standards. The first phase, covering MYs 2017–2021, included final standards that were projected at the time to require, on an average industry fleet-wide basis and based on the then-anticipated fleet mix, a range from 40.3 to 41.0 miles per gallon (mpg) in MY 2021. The second phase of the CAFE program, covering MYs 2022–2025, included standards that were not final, due to the statutory requirement that NHTSA set new average fuel economy standards not more than five model years at a time. Rather, NHTSA wrote that those standards were *augural*, meaning that they represented its best estimate, based on the information available at that time, of what levels of stringency might be maximum feasible in those model years. NHTSA projected that those standards could require, on an average industry fleet-wide basis, a range from 48.7 to 49.7 mpg in MY 2025.

As part of the final rulemaking, NHTSA and EPA committed to conducting a "comprehensive mid-term evaluation and agency decision-making process" for the MY 2022–2025 standards, which was to be completed by April 1, 2018. The mid-term evaluation process reflects the long period of the MY 2017–-2025 rule as well as NHTSA's statutory obligation to conduct a *de novo* rulemaking to establish final CAFE standards for MYs 2022–2025. This environmental impact statement (EIS) has been prepared as part of that *de novo* rulemaking process, which includes fresh inputs and a fresh consideration and balancing of all relevant factors, to establish final CAFE standards for those model years.

As the first step of the mid-term evaluation process, on July 18, 2016, NHTSA, EPA, and the California Air Resources Board (CARB) issued a Draft Technical Assessment Report, which examined a range of matters relevant to CAFE and GHG emissions standards for MYs 2022–2025 (NHTSA 2016a).[11] On December 6, 2016, EPA published in the *Federal Register* an announcement of its proposed determination for the mid-term evaluation, which consisted of almost 1,000 pages of analyses and technical information, and gave commenters less than 1 month to respond.[12] On January 12, 2017, less than 2 weeks after the comment period closed and well over a year earlier than anticipated, the EPA Administrator signed the Final Determination of the mid-term evaluation of light-duty GHG emissions standards for MYs 2022–2025 (EPA 2017f).[13] Subsequently, EPA Administrator Scott Pruitt and Transportation Secretary Elaine L. Chao issued a joint notice announcing EPA's conclusion that it would reconsider its Final Determination in order to allow additional consultation and coordination with NHTSA in support of a national

[10] NHTSA issues CAFE standards pursuant to its statutory authority under EPCA, as amended by EISA. EPA sets national carbon dioxide (CO_2) emissions standards for passenger cars and light trucks under section 202(a) of the Clean Air Act (CAA) (42 U.S.C. § 7521(a)). In addition, EPA has authority to measure passenger car and passenger car fleet fuel economy pursuant to EPCA (49 U.S.C. § 32904(c)).

[11] Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022–2025 (July 18, 2016). Available at: https://www.nhtsa.gov/corporate-average-fuel-economy/light-duty-cafe-midterm-evaluation (Accessed: Feb. 28, 2020).

[12] Proposed Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, 81 FR 87927 (Dec. 6, 2016).

[13] U.S. EPA, Final Determination on the Appropriateness of the Model Year 2022–2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (January 2017). Available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas#previoussteps (Accessed: Jan. 29, 2018).

harmonized program.[14] On April 2, 2018, EPA issued a new Final Determination announcing its intention to revise the MY 2022–2025 GHG emissions standards established in 2012, determining that those standards are based on outdated information and that more recent information suggests that the standards may be too stringent.[15] The notice also explained that EPA, in partnership with NHTSA, would initiate a notice-and-comment rulemaking to further consider appropriate standards for MY 2022–2025 light-duty vehicles. As part of its rulemaking to establish the next phase of CAFE standards, NHTSA considered a broad range of alternatives with varying levels of stringency for MY 2022–2026 passenger cars and light trucks. In addition, some of those alternatives (including the agency's Preferred Alternative, as discussed in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*) would revise the already finalized CAFE standards for MY 2021.[16]

To inform its development of the CAFE standards for MYs 2021–2026,[17] NHTSA prepared this EIS, pursuant to the National Environmental Policy Act (NEPA),[18] to evaluate the potential environmental impacts of these alternatives. NEPA directs that federal agencies proposing "major federal actions significantly affecting the quality of the human environment" must, "to the fullest extent possible," prepare "a detailed statement" on the environmental impacts of the proposed action (including alternatives to the proposed action).[19] Although NHTSA evaluated the impacts of the augural standards in its EIS accompanying the MY 2017–2025 rulemaking (NHTSA 2012),[20] NHTSA prepared this new EIS as part of the *de novo* rulemaking in order to provide fresh consideration of all available information. This EIS analyzes, discloses, and compares the potential environmental impacts of a reasonable range of action alternatives, including a no action alternative and a Preferred Alternative, pursuant to Council on Environmental Quality (CEQ) NEPA implementing regulations, DOT Order 5610.1C, and NHTSA regulations.[21] This EIS analyzes direct, indirect, and cumulative impacts, and discusses impacts in proportion to their significance. The Draft EIS was issued together with the joint NHTSA-EPA Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Notice of Proposed Rulemaking (NPRM)[22] on August 2, 2018.[23]

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[14] Notice of Intention to Reconsider the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light Duty Vehicles, 82 FR 14671 (Mar. 22, 2017).

[15] Notice; Withdrawal; Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles, 83 FR 16077 (Apr. 13, 2018).

[16] The range of alternatives under consideration by NHTSA is described more extensively in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and in the preamble to the final rule.

[17] For simplicity, the entire range of vehicles that may be regulated under NHTSA's proposed CAFE standards is referred to as MYs 2021–2026.

[18] 42 U.S.C. §§ 4321–4347.

[19] 42 U.S.C. § 4332.

[20] NHTSA, Final Environmental Impact Statement, Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2017–2025, Docket No. NHTSA–2011–0056 (July 2012).

[21] NEPA is codified at 42 U.S.C. §§ 4321–4347. CEQ NEPA implementing regulations are codified at 40 CFR Parts 1500–1508, DOT Order 5610.1C, 44 FR 56420 (Oct. 1, 1979), as amended (Available at: https://www.transportation.gov/office-policy/transportation-policy/procedures-considering-environmental-impacts-dot-order-56101c), and NHTSA's NEPA implementing regulations are codified at 49 CFR Part 520.

[22] *See* The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks; NPRM, 83 FR 42986 (Aug. 24, 2018) (hereinafter "SAFE Vehicles NPRM").

[23] NHTSA posted both the SAFE Vehicles NPRM and the Draft EIS on its fuel economy website (http://www.nhtsa.gov/fuel-economy).

1.2 Purpose and Need

NEPA requires that agencies develop alternatives to a proposed action based on the action's purpose and need. The purpose and need statement explains why the action is needed, describes the action's intended purpose, and serves as the basis for developing the range of alternatives to be considered in the NEPA analysis.[24] In accordance with EPCA/EISA, the purpose of the rulemaking is to establish CAFE standards for MY 2022–2026 passenger cars and light trucks at "the maximum feasible average fuel economy level that the Secretary of Transportation decides the manufacturers can achieve in that model year."[25] When determining the maximum feasible levels that manufacturers can achieve in each model year, EPCA requires that NHTSA consider the four statutory factors of "technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy."[26] In addition, the agency has the authority to—and traditionally does—consider other relevant factors, such as the effect of the CAFE standards on motor vehicle safety.[27] As part of this rulemaking, NHTSA is also considering whether the already finalized MY 2021 CAFE standards are maximum feasible and, if not, NHTSA would amend them as appropriate.

NHTSA has interpreted the four EPCA statutory factors as follows:[28]

- *Technological feasibility* refers to whether a particular method of improving fuel economy is available for widespread commercial application in the model year for which a standard is being established.
- *Economic practicability* refers to whether a standard is one within the financial capability of the industry, but not so stringent as to lead to adverse economic consequences, such as significant job losses, unreasonable limitation of consumer choice, or negative safety impacts.
- *The effect of other motor vehicle standards of the Government on fuel economy* involves analysis of the effects of compliance with federal emission, safety, noise, or damageability standards on fuel economy capability and therefore on average fuel economy.
- *The need of the United States to conserve energy* means the consumer cost, national balance of payments, environmental, and foreign policy implications of the nation's need for large quantities of petroleum, especially imported petroleum.

[24] *See* 40 CFR § 1502.13.

[25] 49 U.S.C. § 32902(a).

[26] 49 U.S.C. §§ 32902(a), 32902(f). *See also Ctr. for Biological Diversity v. NHTSA,* 538 F.3d 1172, 1195 (9th Cir. 2008) ("The EPCA clearly requires the agency to consider these four factors, but it gives NHTSA discretion to decide how to balance the statutory factors—as long as NHTSA's balancing does not undermine the fundamental purpose of the EPCA: energy conservation."); *Ctr. for Auto Safety v. NHTSA,* 793 F.2d 1322, 1340 (D.C. Cir. 1986) ("It is axiomatic that Congress intended energy conservation to be a long term effort that would continue through temporary improvements in energy availability. Thus, it would clearly be impermissible for NHTSA to rely on consumer demand to such an extent that it ignored the overarching goal of fuel conservation.") (footnote omitted).

[27] *See*, *e.g.*, *Competitive Enterprise Inst. v. NHTSA*, 956 F.2d 321, 322 (D.C. Cir. 1992) (citing *Competitive Enterprise Inst. v. NHTSA*, 901 F.2d 107, 120 n.11 (D.C. Cir. 1990)) ("NHTSA has always examined the safety consequences of the CAFE standards in its overall consideration of relevant factors since its earliest rulemaking under the CAFE program.").

[28] *See* SAFE Vehicles NPRM, *supra* note 22. The four EPCA statutory factors are discussed in greater detail in the preamble to the final rule.

For MYs 2021–2030, NHTSA must establish separate average fuel economy standards for passenger cars and light trucks for each model year.[29] Standards must be "based on one or more vehicle attributes related to fuel economy" and "express[ed]…in the form of a mathematical function."[30] Two other EISA requirements, that NHTSA "prescribe annual fuel economy standard increases that increase the applicable average fuel economy standard ratably" and that the combined U.S. passenger car and light truck fleet achieves an average fuel economy level of not less than 35 mpg by MY 2020, apply only for MYs 2011–2020 and therefore do not apply for MY 2021 and later.[31]

1.3 Corporate Average Fuel Economy Rulemaking Process

NHTSA and EPA are announcing rules to establish or amend CAFE standards and carbon dioxide (CO_2) emission standards, respectively, for light-duty vehicles for MYs 2021–2026. This EIS informs NHTSA and the public during the development of the standards as part of the rulemaking process. NHTSA and EPA have proposed coordinated standards for passenger cars, light trucks, and medium-duty passenger vehicles.

1.3.1 Corporate Average Fuel Economy and Greenhouse Gas Emissions Programs

Coordination between NHTSA fuel economy and EPA CO_2 emission standards rulemakings is both needed and possible because the relationship between improving fuel economy and reducing CO_2 tailpipe emissions is direct and close. The amount of CO_2 emissions is essentially constant per gallon combusted of a given type of fuel. Therefore, the more fuel-efficient a vehicle, the less fuel it burns to travel a given distance. The less fuel it burns, the less CO_2 it emits in traveling that distance. While emissions control technologies can reduce the pollutants (e.g., carbon monoxide) produced by imperfect combustion of fuel by capturing or destroying them, there is no such technology for CO_2. Further, while some of those pollutants can also be reduced by achieving a more complete combustion of fuel, doing so only increases the tailpipe emissions of CO_2. Therefore, the same technologies are generally used to address motor vehicle fuel economy and tailpipe CO_2 emissions.

1.3.1.1 Corporate Average Fuel Economy Program (U.S. Department of Transportation)

In 1975, Congress enacted EPCA, mandating that NHTSA establish and implement a regulatory program for motor vehicle fuel economy to meet the various facets of the need to conserve energy, including those with energy independence and security, environmental, and foreign policy implications. Fuel economy gains since 1975, due to both standards and market factors, have saved billions of barrels of oil. In December 2007, Congress enacted EISA, amending EPCA to provide additional rulemaking authority and responsibilities, as well as to set a combined average fuel economy target for MY 2020.

[29] 49 U.S.C. § 32902(a), (b)(2)(B).

[30] 49 U.S.C. § 32902(b)(3)(A).

[31] 49 U.S.C. § 32902(b)(2)(C).

1.3.1.2 Greenhouse Gas Standards for Light-Duty Vehicles (U.S. Environmental Protection Agency)

Under the Clean Air Act (CAA), EPA is responsible for addressing air pollutants from motor vehicles. In 2007, the U.S. Supreme Court issued a decision on *Massachusetts v. Environmental Protection Agency*,[32] a case involving a 2003 EPA order denying a petition for rulemaking to regulate GHG emissions from motor vehicles under CAA Section 202(a).[33] The Court held that GHGs were air pollutants for purposes of the CAA and further held that the EPA Administrator must determine whether emissions from new motor vehicles cause or contribute to air pollution that might reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. The Court further ruled that, in making these decisions, the EPA Administrator is required to follow the language of CAA Section 202(a). The Court rejected the argument that EPA cannot regulate CO_2 from motor vehicles because to do so would *de facto* tighten fuel economy standards, authority over which Congress has assigned to DOT. The Court held that the fact "that DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities. EPA has been charged with protecting the public's 'health' and 'welfare', a statutory obligation wholly independent of DOT's mandate to promote energy efficiency." The Court concluded that "[t]he two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency."[34]

EPA has since found that emissions of GHGs from new motor vehicles and motor vehicle engines do cause or contribute to air pollution that can reasonably be anticipated to endanger public health and welfare.[35] The NHTSA and EPA joint final rulemakings for MY 2012–2016 and MY 2017 and beyond passenger cars and light trucks issued in 2010 and 2012, respectively, as well as EPA's final standards issued concurrently with this Final EIS, are part of EPA's response to the U.S. Supreme Court decision.[36]

1.3.2 Proposed Action

For this EIS, NHTSA's action is to set fuel economy standards for passenger cars and light trucks, in accordance with EPCA, as amended by EISA. In the MY 2017 and beyond rulemaking, NHTSA set final CAFE standards for MY 2017–2021 passenger cars and light trucks and augural CAFE standards for MYs 2022–2025. The MY 2022–2025 standards were augural (i.e., projected and nonbinding) because the agency's statutory authority requires it to "issue regulations . . . prescribing average fuel economy standards for at least 1, but not more than 5, model years."[37] As part of the current rulemaking, NHTSA considered a range of alternatives for prescribing CAFE standards for MYs 2022–2026, or five model

[32] 549 U.S. 497 (2007).

[33] Notice of Denial of Petition for Rulemaking, Control of Emissions from New Highway Vehicles and Engines, 68 FR 52922 (Sept. 8, 2003).

[34] 549 U.S. at 531-32. For more information on *Massachusetts v. Environmental Protection Agency,* see the July 30, 2008, Advance Notice of Proposed Rulemaking, Regulating Greenhouse Gas Emissions under the Clean Air Act, 73 FR 44354 at 44397. This includes a comprehensive discussion of the litigation history, the U.S. Supreme Court findings, and subsequent actions undertaken by the Bush Administration and EPA from 2007 through 2008 in response to the Supreme Court remand.

[35] Final Rule, Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 FR 66496 (Dec. 15, 2009).

[36] Light-Duty Vehicles Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 FR 25324 (May 7, 2010). 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule, 77 FR 62624 (Oct. 15, 2012).

[37] 49 U.S.C. § 32902(b)(3)(B).

years. Some of the alternatives the agency considered also would amend the final CAFE standards for MY 2021.[38] The Proposed Action, also known as the Preferred Alternative, and alternatives considered in this EIS are discussed in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*.[39]

1.3.2.1 Level of the Standards

NHTSA and EPA are promulgating separate but coordinated standards for passenger cars and light trucks under each agency's respective statutory authority. All the alternatives under consideration by NHTSA would set CAFE standards for MYs 2022–2026, although some would also amend the MY 2021 standards. While all action alternatives would be less stringent than the No Action Alternative, all but one alternative would increase in stringency from the beginning of the regulatory period through MY 2026.[40] Under NHTSA's action alternatives, the agency currently estimates that the combined average of manufacturers' required fuel economy levels would be 36.8 to 38.8 mpg in MY 2021 and 36.9 to 44.2 mpg in MY 2026. This compares to estimated average required fuel economy levels of 38.8 mpg and 46.6 mpg in MY 2021 and MY 2026, respectively, under the No Action Alternative. Under NHTSA's Proposed Action, the agency currently estimates that the combined average of manufacturers' required fuel economy levels would be 37.3 mpg in MY 2021, 37.9 mpg in MY 2022, 38.5 mpg in MY 2023, 39.1 mpg in MY 2024, 39.8 mpg in MY 2025, and 40.4 mpg in MY 2026. EPA's standards, which are coordinated with NHTSA's standards, are estimated to require that manufacturers, on average, meet a combined average emissions level of approximately 205 grams per mile of CO_2 in MY 2026. Because the standards are attribute-based and apply separately to each manufacturer and separately to passenger cars and light trucks, actual average required fuel economy levels will depend on the mix of vehicles manufacturers produce for sale in future model years. While NHTSA estimates the future composition of the fleet based on current market forecasts of future sales to compute the estimated average required fuel economy levels under each regulatory alternative, any estimates of future sales are subject to considerable uncertainty. Therefore, the average future required fuel economy under each regulatory alternative is also subject to considerable uncertainty.

The NHTSA and EPA standards are coordinated even though they are not identical. Many differences are rooted in differences in NHTSA's and EPA's respective statutory authorities. In the NPRM, NHTSA and EPA invited public comments on several potential changes in the programs to improve harmonization. For example, in the NPRM, EPA proposed excluding air conditioning refrigerants and leakage, as well as nitrous oxide and methane emissions, for compliance with CO_2 standards after MY 2020, in an effort to better align the programs. However, as described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and the preamble to the final rule, the agencies have not adopted these changes.

[38] NHTSA's authority to amend previously issued standards (49 U.S.C. § 32902(c)) is distinct from its authority to prescribe new average fuel economy standards for MYs 2021–2030 (49 U.S.C. § 32902(b)). As a result, the limitation on prescribing new standards for more than 5 model years (49 U.S.C. § 32902(b)(3)(B)) does not apply when the agency prescribes regulations amending previously issued standards. For more information, please see the final rule.

[39] NHTSA uses the terms *Proposed Action* and *Preferred Alternative* interchangeably in this EIS. Unless otherwise specified, these terms refer to the CAFE standards established in the SAFE Vehicles final rule issued concurrently with this Final EIS, not to the CAFE standards proposed in the SAFE Vehicles NPRM. The Proposed Action/Preferred Alternative is described in greater detail in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*.

[40] For a more complete description of the alternatives under consideration, see Chapter 2, *Proposed Action and Alternatives and Analysis Methods*.

1.3.2.2 Form of the Standards

In this rulemaking, NHTSA again proposed attribute-based standards based on vehicle footprint for passenger cars and light trucks. NHTSA adopted an attribute standard based on vehicle footprint in its Reformed CAFE program for light trucks for MYs 2008–2011[41] and extended this approach to passenger cars in the CAFE rule for MY 2011, as required by EISA.[42] NHTSA and EPA also used an attribute standard for the joint rules establishing standards for MY 2012–2016 and MY 2017–2025 passenger cars and light trucks.[43]

Under an attribute-based standard, each vehicle model has a performance target (fuel economy for the CAFE standards; CO_2 grams per mile for the CO_2 emissions standards), the level of which depends on the vehicle's attribute. As in the previous CAFE rulemaking, NHTSA used vehicle footprint as the attribute for CAFE standards. Vehicle footprint is one measure of vehicle size and is defined as a vehicle's wheelbase multiplied by the vehicle's track width. NHTSA believes that the footprint attribute is the most appropriate attribute on which to base the standards under consideration, as discussed in Section V.A.2 of the final rule preamble.

Under the final rule, each manufacturer will have separate standards for cars and for trucks, based on the footprint target curves promulgated by the agency and the mix of vehicles that each manufacturer produces for sale in a given model year. Generally, larger vehicles (i.e., vehicles with larger footprints) will be subject to less stringent standards (i.e., higher CO_2 gram-per-mile standards and lower CAFE standards) than smaller vehicles. This is because, typically, smaller vehicles are more capable of achieving more stringent standards than larger vehicles. The shape and stringency of the proposed curves reflect, in part, NHTSA's analysis of the technological and economic capabilities of the industry within the rulemaking timeframe.

After using vehicle footprint as the attribute to determine each specific vehicle model performance target, the manufacturers' fleet average performance is then determined by the production-weighted[44] average (for CAFE, harmonic average[45]) of those targets. The manufacturer's ultimate compliance obligation is based on that average; no individual vehicle or nameplate is required to meet or exceed its specific performance target level, but the manufacturer's fleet (either domestic passenger car, import passenger car, or light truck) on average must meet or exceed the average required level for the entire fleet in order to comply. In other words, a manufacturer's individual CAFE standards for cars and trucks would be based on the target levels associated with the footprints of its particular mix of cars and trucks manufactured in that model year. Because of the curves that represent the CAFE standard for each model year, a manufacturer with a relatively high percentage of smaller vehicles would have a higher standard than a manufacturer with a relatively low percentage of smaller vehicles.

[41] Final Rule, Average Fuel Economy Standards for Light Trucks Model Years 2008–2011, 71 FR 17566 (Apr. 6, 2006).

[42] Final Rule, Record of Decision, Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 FR 14196 (Mar. 30, 2009).

[43] *See* Chapter 2 of previous CAFE EISs (NHTSA 2010, 2012).

[44] Production for sale in the United States.

[45] The harmonic average is the reciprocal of the arithmetic mean of the reciprocals of the given set of observations and is generally used when averaging units like speed or other rates and ratios.

Therefore, although a manufacturer's fleet average standard could be estimated throughout the model year based on the projected production volume of its vehicle fleet, the standard with which the manufacturer must comply would be based on its final model year vehicle production. Compliance would be determined by comparing a manufacturer's harmonically averaged fleet fuel economy level in a model year with a required fuel economy level calculated using the manufacturer's actual production levels and the targets for each vehicle it produces.[46] A manufacturer's calculation of fleet average emissions at the end of the model year would, therefore, be based on the production-weighted average (for CAFE, harmonic average) emissions of each model in its fleet.

In Section V of the preamble to the final rule, NHTSA included a full discussion of the equations and coefficients that define the passenger car and light truck curves established for each model year by each agency.

1.3.2.3 Program Flexibilities for Achieving Compliance

As with previous model-year rules, NHTSA is establishing standards that include several program flexibilities for achieving compliance. The following flexibility provisions are discussed in Section IX of the final rule preamble:

- CAFE credits generated based on fleet average over-compliance.
- Air conditioning efficiency fuel consumption improvement values.
- Off-cycle fuel consumption improvement values.
- Special fuel economy calculations for dual and alternative fueled vehicles.
- Incentives for game-changing technologies performance for full-size pickup trucks, including hybridization.

Additional flexibilities are discussed in NHTSA and EPA's joint final rule. Some of these flexibilities will be available to manufacturers in aiding compliance under both NHTSA and EPA standards, but some flexibilities, such as incentives for electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles, will only be available under the EPA standard because of differences between the CAFE and CAA legal authorities. The CAA provides EPA broad discretion to create incentives for certain technologies, but NHTSA's authority under EPCA, as amended by EISA is more constrained.

1.3.2.4 Compliance

The MY 2017 and beyond final rule, which was issued in 2012, established detailed and comprehensive regulatory provisions for compliance and enforcement under the CAFE and CO_2 emissions standards programs. In the joint final rule, NHTSA and EPA have made minor modifications to these provisions, as they would apply for model years beyond MY 2020. These changes are described in Section IX of the preamble to the final rule.

[46] While manufacturers may use a variety of flexibility mechanisms to comply with CAFE, including credits earned for over-compliance, NHTSA is statutorily prohibited from considering manufacturers' ability to use statutorily provided flexibility mechanisms in determining what level of CAFE standards would be maximum feasible. 49 U.S.C. § 32902(h).

NHTSA makes its ultimate determination of a manufacturer's CAFE compliance obligation based on official reported and verified CAFE data received from EPA.[47] The EPA-verified data is based on any considerations from NHTSA testing, its own vehicle testing, and final model year data submitted by manufacturers to EPA pursuant to 40 CFR § 600.512. EPA test procedures are contained in 40 CFR Part 600 and 40 CFR Part 86.

1.4 Cooperating Agencies

Section 1501.6 of the CEQ NEPA implementing regulations emphasizes agency cooperation early in the NEPA process and authorizes a lead agency (in this case, NHTSA) to request the assistance of other agencies that have either jurisdiction by law or special expertise regarding issues considered in an EIS.[48] NHTSA invited EPA and the U.S. Department of Energy (DOE) to become cooperating agencies with NHTSA in the development of this EIS.

EPA and DOE accepted NHTSA's invitation and agreed to become cooperating agencies.[49] EPA and DOE personnel were asked to review and comment on the Draft and Final EISs prior to publication.

1.5 Public Review and Comment

On July 26, 2017, NHTSA published a notice of intent to prepare an EIS for new CAFE standards for MY 2022–2025 passenger cars and light trucks.[50] The notice described the statutory requirements for the standards, provided initial information about the NEPA process, and initiated the scoping process by requesting public input on the scope of the environmental analysis.[51] NHTSA invited the public to submit scoping comments on the notice by posting to the NHTSA EIS docket (Docket No. NHTSA-2017-0069). NHTSA summarized the public comments received during the scoping period in Section 1.5 of the Draft EIS.

NHTSA submitted to EPA the Draft EIS to disclose and analyze the potential environmental impacts of the agency's Proposed Action and reasonable alternative standards pursuant to CEQ NEPA implementing regulations, DOT Order 5610.1C, and NHTSA regulations. The Draft EIS was posted to the NHTSA EIS docket (Docket No. NHTSA-2017-0069) on August 3, 2018, and EPA published a Notice of Availability in the *Federal Register* on August 10, 2018.[52] The Draft EIS requested public input on the agency's environmental analysis by September 24, 2018; publication of the Notice of Availability in the *Federal Register* triggered the Draft EIS public comment period. On August 24, 2018, NHTSA and EPA

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[47] EPA is responsible for calculating manufacturers' CAFE values so that NHTSA can determine compliance with its CAFE standards. 49 U.S.C. § 32904(e).

[48] 40 CFR § 1501.6.

[49] While NEPA requires NHTSA to complete an EIS for this rulemaking, EPA does not have the same statutory obligation. EPA actions under the CAA, including EPA's proposed vehicle CO_2 emission standards for light-duty vehicles under the joint rulemaking, are not subject to NEPA requirements. See Section 7(c) of the Energy Supply and Environmental Coordination Act of 1974 (15 U.S.C. § 793(c)(1)). EPA's environmental review of its proposed rule is part of the Regulatory Impact Analysis and other rulemaking documents.

[50] Notice of Intent to Prepare an Environmental Impact Statement for Model Year 2022–2025 Corporate Average Fuel Economy Standards, 82 FR 34740 (July 26, 2017).

[51] Scoping, as defined under NEPA, is an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action. 40 CFR § 1501.7.

[52] Environmental Impact Statements, Notice of Availability, 83 FR 39750 (Aug. 10, 2018).

published the NPRM,[53] and opened a 60-day comment period. The agencies invited the public to submit comments on the NPRM on or before October 23, 2018, by posting to either the NHTSA or EPA docket (NHTSA-2018-0067 or EPA-HQ-OAR-2018-0283). The comment periods for the NPRM and the Draft EIS were subsequently extended to October 26, 2018.[54]

Consistent with NEPA and its implementing regulations, NHTSA mailed a copy of the Draft EIS to:

- Contacts at federal agencies with jurisdiction by law or special expertise regarding the environmental impacts involved, or authorized to develop and enforce environmental standards, including other agencies within DOT.
- The Governors of every state and U.S. territory.
- Organizations representing state and local governments.
- Native American tribes and tribal organizations.
- Individuals and contacts at other stakeholder organizations that NHTSA reasonably expected to be interested in the NEPA analysis for the MY 2021–2026 CAFE standards, including advocacy, industry, and other organizations.

NHTSA and EPA also held public hearings on the Draft EIS and the proposed rule on September 24, 2018, in Fresno, California; on September 25, 2018, in Dearborn, Michigan; and on September 26, 2018, in Pittsburgh, Pennsylvania. NHTSA received statements from 109 individuals at the hearing in Fresno, of which 70 provided only oral statements, 3 provided only written statements, and 36 provided both oral and written statements. At the Dearborn hearing, NHTSA received statements from 115 individuals, of which 60 provided only oral statements, 4 provided only written statements, and 51 provided both oral and written statements. The Pittsburgh hearing collected statements from 107 individuals, of which 27 provided oral statements only, one provided only a written statement, and 79 provided both oral and written statements.

The agency also received more than 173,600 comments in the dockets for the Draft EIS and the NPRM. NHTSA reviewed the oral and written submissions for comments relevant to the EIS. Several commenters referenced or submitted studies, research, and other information that supported or added to their comments. NHTSA carefully reviewed these references to determine if they were appropriate for inclusion in this EIS. See Appendix B, *Sources Identified in Public Comments*.

As described in Chapter 10, *Responses to Public Comments*, of this Final EIS, comments that raised issues central to the rule or the rulemaking process are addressed in the preamble to the final rule, the Final Regulatory Impact Analysis (FRIA), or associated documents in the public docket.

[53] *See* SAFE Vehicles NPRM, *supra* note 22.

[54] *See* Extension of Comment Period for The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 83 FR 48578 (Sept. 26, 2018).

1.6 Next Steps in the National Environmental Policy Act and Joint Rulemaking Process

NHTSA is issuing this Final EIS concurrent with the final rule, which serves as the Record of Decision. It states and explains NHTSA's decision and describes NHTSA's consideration of applicable environmental laws and policies.[55] NHTSA has determined that concurrent issuance of the Final EIS and Record of Decision is not precluded by statutory criteria[56] or practicability considerations. EPA will announce the availability of this Final EIS in the *Federal Register*.[57]

[55] *See* 49 U.S.C. § 304a (Pub. L. No. 114-94, 129 Stat. 1312, Section 1311(a)) and U.S. Department of Transportation, Office of Transportation Policy, *Guidance on the Use of Combined Final Environmental Impact Statements/Records of Decision and Errata Sheets in National Environmental Policy Act Reviews* (Apr. 25, 2019), available at https://www.transportation.gov/sites/dot.gov/files/docs/mission/transportation-policy/permittingcenter/337371/feis-rod-guidance-final-04302019.pdf.

[56] 49 U.S.C. § 304a(b)(1)-(2).

[57] *See* 40 CFR § 1506.10(a).

CHAPTER 2 PROPOSED ACTION AND ALTERNATIVES AND ANALYSIS METHODS

2.1 Introduction

NEPA requires that, when an agency prepares an EIS, it must evaluate the environmental impacts of its proposed action and alternatives to the proposed action.[1] An agency must rigorously explore and objectively evaluate all reasonable alternatives, including the alternative of taking no action. For alternatives that an agency eliminates from detailed study, the agency must "briefly discuss the reasons for their having been eliminated."[2] The purpose of and need for the agency's action provides the foundation for determining the range of reasonable alternatives to be considered in its NEPA analysis.[3]

This chapter describes the Proposed Action and alternatives, explains the methods and assumptions applied in the analysis of environmental impacts, and summarizes environmental impacts in the following subsections:

- Section 2.2, *Proposed Action and Alternatives*
- Section 2.3, *Standard-Setting and EIS Methods and Assumptions*
- Section 2.4, *Resource Areas Affected and Types of Emissions*
- Section 2.5, *Comparison of Alternatives*

2.2 Proposed Action and Alternatives

NHTSA's action is to set fuel economy standards for MY 2021–2026 passenger cars and light trucks (also referred to as the light-duty vehicle fleet) in accordance with Energy Policy and Conservation Act of 1975 (EPCA),[4] as amended by the Energy Independence and Security Act of 2007 (EISA).[5] Specifically, in addition to establishing new standards for MY 2022–2026 vehicles, NHTSA also considered whether the current MY 2021 CAFE standards are "maximum feasible" and, if not, how to amend them as appropriate. In developing the Proposed Action and alternatives, NHTSA considered the four EPCA statutory factors that guide the agency's determination of maximum feasible standards: technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy.[6] In addition, NHTSA considered relevant safety and environmental factors.[7] During the process of developing the fuel economy standards, NHTSA consulted with EPA and the U.S. Department of Energy (DOE) regarding a variety of

[1] 40 CFR § 1502.14.

[2] 40 CFR § 1502.14(a), (d).

[3] 40 CFR § 1502.13. See City of Carmel-By-The-Sea v. U.S. Dept. of Transp., 123 F.3d 1142,1155 (9th Cir. 1997); City of Alexandria v. Slater, 198 F.3d 862, 867-69 (D.C. Cir. 1999), cert. denied sub nom., 531 U.S. 820 (2000).

[4] 49 U.S.C. § 32901 et seq.

[5] Pub. L. No. 110–140, 121 Stat. 1492 (Dec. 19, 2007).

[6] 49 U.S.C. § 32902(f).

[7] As noted in Chapter 1, NHTSA interprets the statutory factors as including environmental issues and permitting the consideration of other relevant societal issues, such as safety. *See*, e.g., *Competitive Enterprise Inst. v. NHTSA*, 956 F.2d 321, 322 (D.C. Cir. 1992) (citing *Competitive Enterprise Inst. v. NHTSA*, 901 F.2d 107, 120 n.11 (D.C. Cir. 1990)); and Average Fuel Economy Standards, Passenger Cars and Light Trucks; MYs 2011–2015, 73 FR 24352 (May 2, 2008).

matters, as required by EPCA.[8] Consistent with CEQ NEPA implementing regulations, this EIS compares a reasonable range of action alternatives to the No Action Alternative (Alternative 0). This analysis assumes under the No Action Alternative that new MY 2021–2025 light-duty vehicles would comply with the current CAFE standards for MY 2021 and the augural CAFE standards for MYs 2022–2025, which NHTSA evaluated in the 2012 joint final rule, and that manufacturers would continue to comply with the MY 2025 augural CAFE standards indefinitely (Section 2.2.1, *Alternative 0: No Action Alternative*).[9] NHTSA has selected Alternative 3, which is described below, as the Preferred Alternative.

Under EPCA, as amended by EISA, NHTSA is required to set separate average fuel economy standards for passenger cars and light trucks. Because NHTSA intends to set standards both for cars and for trucks, and because evaluating the environmental impacts of this proposal requires consideration of the impacts of the standards for both vehicle classes, the main analyses presented in this EIS reflect the combined environmental impacts associated with the proposed standards for passenger cars and light trucks. Appendix D, *U.S. Passenger Car and Light Truck Results Reported Separately*, shows separate results for passenger cars and light trucks under each alternative.

2.2.1 Alternative 0: No Action Alternative

The No Action Alternative assumes that NHTSA would not amend the CAFE standards for MY 2021 passenger cars and light trucks. In addition, the No Action Alternative assumes that NHTSA would finalize the MY 2022–2025 augural CAFE standards that were described in the 2012 joint final rule. Finally, NHTSA assumes that the MY 2025 CAFE standards would continue indefinitely.

Currently, there are no enforceable CAFE standards for MY 2022 and beyond. However, the augural standards reflect where NHTSA last indicated it would set CAFE standards for MYs 2022–2025. In addition, this approach reflects NHTSA's most recent CAFE EIS analysis, where it assumed the augural standards for MYs 2022–2025 would be enforceable. Finally, these augural standards serve as a proxy for EPA's greenhouse gas (GHG) emission standards for MYs 2022–2025, which were finalized in the 2012 joint final rule. The NHTSA MY 2022–2025 augural CAFE standards were set in the 2012 joint final rule at levels that coordinated with the EPA MY 2022–2025 GHG emissions standards such that manufacturers would be able to build a single fleet that satisfies all requirements under both programs. Therefore, the No Action Alternative assumes that new MY 2022–2025 light-duty vehicles would be subject to the augural CAFE standards and that manufacturers would continue to be subject to the MY 2025 augural CAFE standards for MY 2026 and beyond. Although in the absence of any rulemaking activity the augural CAFE standards are not enforceable, consistent with public comments received on the scoping notice for this EIS (as described in Draft EIS Chapter 1, *Purpose and Need for the Proposed Action*), NHTSA believes that they are the most appropriate baseline from which to analyze impacts in this EIS.

The No Action Alternative provides an analytical baseline against which to compare the environmental impacts of the other alternatives presented in the EIS.[10] NEPA expressly requires agencies to consider a

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[8] 49 U.S.C. § 32902(i).

[9] 40 CFR § 1502.14(d).

[10] 40 CFR §§ 1502.2(e), 1502.14(d). CEQ has explained that "[T]he regulations require the analysis of the no action alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. [40 CFR § 1502.14(c).] * * * Inclusion of such an analysis in the EIS is necessary to inform Congress, the public, and the President as intended by NEPA. [40 CFR §

‘‘no action’’ alternative in their NEPA analyses and to compare the impacts of not taking action with the impacts of action alternatives to demonstrate the environmental impacts of the action alternatives. The environmental impacts of the action alternatives are calculated in relation to the baseline of the No Action Alternative.

Table 2.2.1-1 shows the estimated average required fleet-wide fuel economy NHTSA forecasts under the No Action Alternative. The values reported in that table do not apply strictly to manufacturers in those model years. Both the augural MY 2022–2025 standards and the alternatives considered in this EIS are attribute-based standards based on vehicle footprint. Under the footprint-based standards, a curve defines a fuel economy performance target for each separate car or truck footprint. Using the curves, each manufacturer would therefore have a CAFE standard that is unique to each of its fleets, depending on the footprints and production volumes of the vehicle models produced by that manufacturer. A manufacturer would have separate footprint-based standards for cars and for trucks. Although a manufacturer’s fleet average standards could be estimated throughout the model year based on projected production volume of its vehicle fleet, the standards with which the manufacturer must comply would be based on its final model year production figures. A manufacturer’s calculation of its fleet average standards and its fleet’s average performance at the end of the model year would therefore be based on the production-weighted average target and performance of each model in its fleet. The values in Table 2.2.1-1 reflect NHTSA’s estimate based on application of the mathematical function defining the alternative (i.e., the curves that define the augural MY 2022–2025 CAFE standards) to the market forecast defining the estimated future fleets of new passenger cars and light trucks across all manufacturers. The fuel economy numbers presented here do not include a fuel economy adjustment factor to account for real-world driving conditions (see Section 2.2.5, *Gap between Compliance Fuel Economy and Real-World Fuel Economy*, for more discussion about the difference between adjusted and unadjusted mile-per-gallon [mpg] values).

Table 2.2.1-1. No Action Alternative: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	45.4	47.6	49.8	52.1	54.6	54.6
Light trucks	33.2	34.8	36.5	38.2	40.0	40.0
Combined cars and trucks	38.8	40.6	42.5	44.5	46.6	46.6

Notes:
mpg = miles per gallon

2.2.2 Action Alternatives

In addition to the No Action Alternative, NHTSA analyzed a range of action alternatives with fuel economy stringencies that increase, on average, 0.0 percent to 3.0 percent annually from either the MY 2020 or MY 2021 standards for passenger cars and light trucks. For purposes of its analysis, NHTSA assumes that the MY 2026 CAFE standards for each alternative would continue indefinitely.[11] As NHTSA

1500.1(a).]” Forty Most Asked Questions Concerning CEQ’s National Environmental Policy Act Regulations, 46 FR 18026 (Mar. 23, 1981).

[11] All alternatives assume the MY 2025 (No Action Alternative) or MY 2026 (action alternatives) standards would continue indefinitely. Because EPCA, as amended by EISA, requires NHTSA to set CAFE standards for each model year, environmental impacts reported in this EIS would also depend on future standards established by NHTSA, but which cannot be quantified at this time.

stated in the Notice of Intent to Prepare an EIS,[12] the agency believes that, based on the different ways the agency could weigh EPCA's four statutory factors, the maximum feasible level of CAFE stringency falls within the range of alternatives under consideration.[13]

Throughout this EIS, estimated impacts are shown for seven action alternatives that illustrate the following range of average annual percentage increases in fuel economy for both passenger cars and light trucks:

- 0.0 percent annual average increase for both passenger cars and light trucks for MYs 2021–2026 (Alternative 1)
- 0.5 percent average annual increase for both passenger cars and light trucks for MYs 2021–2026 (Alternative 2)
- 1.5 percent annual average increase for both passenger cars and light trucks for MYs 2021–2026 (Alternative 3—NHTSA's Preferred Alternative)
- 1.0 percent average annual increase for passenger cars and a 2.0 percent annual average increase for light trucks for MYs 2021–2026 (Alternative 4)
- 1.0 percent average annual increase for passenger cars and a 2.0 percent annual average increase for light trucks for MYs 2022–2026 (Alternative 5)
- 2.0 percent annual average increase for passenger cars and a 3.0 percent annual average increase for light trucks for MYs 2021–2026 (Alternative 6)
- 2.0 percent annual average increase for passenger cars and a 3.0 percent annual average increase for light trucks for MYs 2022–2026 (Alternative 7)

As noted, NHTSA reasonably believes the maximum feasible standards fall within the range of alternatives presented in this EIS. This range encompasses a spectrum of possible standards that NHTSA could select, based on how the agency weighs EPCA's four statutory factors. By providing environmental analyses at discrete representative points, the decision-makers and the public can determine the environmental impacts of points that fall between those individual alternatives. The alternatives evaluated in this EIS therefore provide decision-makers with the ability to select from a wide variety of other potential alternatives with stringencies that would increase annually at average percentage rates from 0.0 to 3.0 percent, or up to the No Action Alternative. This range includes, for example, alternatives with stringencies that would increase at different rates for passenger cars and for light trucks and stringencies that would increase at different rates in different years.

Tables for each of the action alternatives show estimated average required fuel economy levels reflecting application of the mathematical functions defining the alternatives to the market forecast defining the estimated future fleets of new passenger cars and light trucks across all manufacturers. The actual standards under the alternatives are footprint-based and each manufacturer would have a CAFE standard that is unique to each of its fleets, depending on the footprints and production volumes of the vehicle models produced by that manufacturer. The required fuel economy values projected for each action alternative do not include a fuel economy adjustment factor to account for real-world driving

[12] Notice of Intent to Prepare an Environmental Impact Statement for Model Year 2022–2025 Corporate Average Fuel Economy Standards, 82 FR 34740 (July 26, 2017).

[13] For a full discussion of the agency's balancing of the statutory factors related to maximum feasible standards, consult the Notice of Proposed Rulemaking (NPRM). NHTSA balances the statutory factors for the final rule in Section VIII of the preamble to the final rule.

conditions. (See Section 2.2.5, *Gap between Compliance Fuel Economy and Real-World Fuel Economy,* for more discussion about the difference between adjusted and unadjusted fuel economy.)

This EIS assumes a weighted average of flexible fuel vehicles' fuel economy levels when operating on gasoline and on E85 (a blend of 15 percent gasoline and 85 percent ethanol, by volume). In particular, this EIS assumes that flexible fuel vehicles operate on gasoline 99 percent of the time and on E85 1 percent of the time.

2.2.2.1 Alternative 1: 0.0 Percent Annual Increase in Fuel Economy, MYs 2021–2026

Alternative 1 would require a 0.0 percent average annual fleet-wide increase in fuel economy for passenger cars and light trucks for MYs 2021–2026. This alternative revises the MY 2021 standards to the MY 2020 levels and carries those numbers forward for MYs 2022–2026. Alternative 1 was identified as NHTSA's Preferred Alternative in the NPRM and Draft EIS; however, Alternative 3 is now NHTSA's Preferred Alternative. Table 2.2.2-1 lists the estimated average required fleet-wide fuel economy under Alternative 1.

Table 2.2.2-1. Alternative 1: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	43.6	43.6	43.6	43.6	43.6	43.6
Light trucks	31.1	31.1	31.1	31.1	31.1	31.1
Combined cars and trucks	36.8	36.8	36.8	36.9	36.9	36.9

Notes:
mpg = miles per gallon

2.2.2.2 Alternative 2: 0.5 Percent Annual Increase in Fuel Economy, MYs 2021–2026

Alternative 2 would require a 0.5 percent average annual fleet-wide increase in fuel economy for passenger cars and light trucks for MYs 2021–2026. Table 2.2.2-2 lists the estimated average required fleet-wide fuel economy under Alternative 2.

Table 2.2.2-2. Alternative 2: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	43.8	44.0	44.2	44.5	44.7	44.9
Light trucks	31.3	31.4	31.6	31.8	31.9	32.1
Combined cars and trucks	37.0	37.2	37.4	37.6	37.8	38.0

Notes:
mpg = miles per gallon

2.2.2.3 Alternative 3 (Preferred Alternative): 1.5 Percent Annual Increase in Fuel Economy, MYs 2021–2026

Alternative 3 would require a 1.5 percent average annual fleet-wide increase in fuel economy for passenger cars and light trucks for MYs 2021–2026. Alternative 3 is NHTSA's Preferred Alternative.[14] Table 2.2.2-3 lists the estimated average required fleet-wide fuel economy under Alternative 3.

Table 2.2.2-3. Alternative 3: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	44.2	44.9	45.6	46.3	47.0	47.7
Light trucks	31.6	32.1	32.6	33.1	33.6	34.1
Combined cars and trucks	37.3	37.9	38.5	39.1	39.8	40.4

Notes:
mpg = miles per gallon

2.2.2.4 Alternative 4: 1.0 Percent Annual Increase in Passenger Car, 2.0 Percent Annual Increase in Light Truck Fuel Economy, MYs 2021–2026

Alternative 4 would require a 1.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent average annual increase for light trucks for MYs 2021–2026. Table 2.2.2-4 lists the estimated average required fleet-wide fuel economy under Alternative 4.

Table 2.2.2-4. Alternative 4: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	44.0	44.5	44.9	45.4	45.8	46.3
Light trucks	31.8	32.4	33.1	33.7	34.5	35.1
Combined cars and trucks	37.4	37.9	38.6	39.2	39.8	40.5

Notes:
mpg = miles per gallon

2.2.2.5 Alternative 5: 1.0 Percent Annual Increase in Passenger Car, 2.0 Percent Annual Increase in Light Truck Fuel Economy, MYs 2022–2026

Alternative 5 would require a 1.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent average annual increase for light trucks for MYs 2022–2026. This alternative would not revise the MY 2021 CAFE standards. Table 2.2.2-5 lists the estimated average required fleet-wide fuel economy under Alternative 5.

[14] In this EIS, Alternative 3 is also referred to as NHTSA's Proposed Action. This contrasts with the use of "proposal," which generally refers to NHTSA's NPRM and the Preferred Alternative in the Draft EIS (Alternative 1).

Table 2.2.2-5. Alternative 5: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	45.4	45.9	46.4	46.8	47.3	47.8
Light trucks	33.2	33.9	34.6	35.3	36.0	36.8
Combined cars and trucks	38.8	39.4	40.0	40.7	41.3	42.0

Notes:
mpg = miles per gallon

2.2.2.6 Alternative 6: 2.0 Percent Annual Increase in Passenger Car, 3.0 Percent Annual Increase in Light Truck Fuel Economy, MYs 2021–2026

Alternative 6 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent average annual increase for light trucks for MYs 2021–2026. Table 2.2.2-6 lists the estimated average required fleet-wide fuel economy under Alternative 6.

Table 2.2.2-6. Alternative 6: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	44.5	45.4	46.3	47.3	48.2	49.2
Light trucks	32.1	33.1	34.1	35.2	36.3	37.4
Combined cars and trucks	37.7	38.7	39.7	40.8	41.9	43.0

Notes:
mpg = miles per gallon

2.2.2.7 Alternative 7: 2.0 Percent Annual Increase in Passenger Car, 3.0 Percent Annual Increase in Light Truck Fuel Economy, MYs 2022–2026

Alternative 7 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent average annual increase for light trucks for MYs 2022–2026. This alternative would not revise the MY 2021 CAFE standards. Table 2.2.2-7 lists the estimated average required fleet-wide fuel economy under Alternative 7.

Table 2.2.2-7. Alternative 7: Estimated Average Required U.S. Passenger Car and Light Truck Fleet-Wide Fuel Economy (mpg) by Model Year

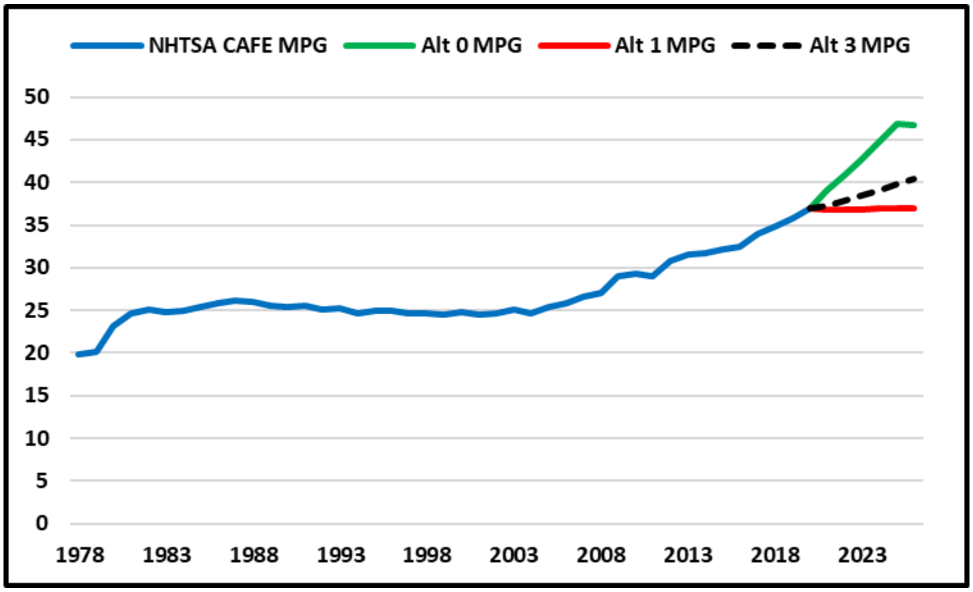
	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	45.4	46.4	47.3	48.3	49.3	50.3
Light trucks	33.2	34.2	35.3	36.4	37.5	38.7
Combined cars and trucks	38.8	39.8	40.8	41.9	43.0	44.2

Notes:
mpg = miles per gallon

2.2.3 No Action and Action Alternatives in Historical Perspective

NHTSA has set CAFE standards since 1978. Figure 2.2.3-1 illustrates unadjusted[15] required CAFE fuel economy (mpg) for combined passenger cars and light trucks from 1978 through 2020 (EPA 2018b). The figure extends these fuel economy levels out to their required average fuel economy levels under Alternative 1, Alternative 3 (Preferred Alternative), and the No Action Alternative (Alternative 0) to demonstrate the range of alternatives currently under consideration.

Figure 2.2.3-1. Historical CAFE Fuel Economy Requirements for Passenger Cars and Light Trucks through MY 2020 and Range of Projected EIS Alternative Standards through MY 2026



mpg = miles per gallon

As illustrated in the figure, light-duty vehicle fuel economy has moved through four phases since 1975: (1) a rapid increase from MYs 1975–1981, (2) a slower increase until MY 1987, (3) a gradual decrease until MY 2004, and (4) and a large increase since MY 2005. The MY 2018–2020 CAFE standards should extend this increase through 2020, and the MY 2021–2026 action alternatives would maintain or further increase fuel economy at historically high levels through 2026.

2.2.4 EPA's Carbon Dioxide Standards

In conjunction with NHTSA's Proposed Action, EPA is issuing amended or new carbon dioxide (CO_2) emissions standards under Section 202(a) of the Clean Air Act (CAA) for MYs 2021–2026. EPA will continue to allow manufacturers to make improvements relating to air conditioning refrigerants and leakage and will credit those improvements toward CO_2 compliance, and EPA is making no changes in the amounts of credits available. EPA is also not making any changes to the existing methane (CH_4) and

[15] Unadjusted fuel economy measures fuel economy as achieved by vehicles in the laboratory. Adjusted fuel economy, reported in EPA window stickers, includes adjustments to better estimate actual achieved on-road fuel economy, and is generally lower than its corresponding unadjusted fuel economy values. Figure 2.2.3-1 uses historical unadjusted fuel economy data as a basis to compare projected achieved fuel economy (based on Alternative 0, Alternative 1, and Alternative 3 CAFE standards) because projected achieved fuel economy data would also be derived from laboratory testing and would not include an adjustment factor. See Section 2.2.4, *Gap between Compliance Fuel Economy and Real-World Fuel Economy,* for more discussion about the difference between NHTSA laboratory test fuel economy and EPA adjusted fuel economy.

nitrous oxide (N_2O) standards. The joint standards represent a coordinated approach that allows industry to build a single national fleet that will satisfy both the GHG requirements under the CAA and CAFE requirements under EPCA (as amended by EISA). Table 2.2.4-1 lists EPA's estimates of its projected overall fleet-wide CO_2 emissions compliance targets under the final standards, as stated in Section I of the final rule.

Table 2.2.4-1. Projected U.S. Passenger Car and Light-Truck Fleet-Wide Emissions Compliance Targets under the Final Carbon Dioxide Standards (grams/mile)

	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	MY 2026
Passenger cars	187	184	181	178	175	173
Light trucks	264	260	255	251	248	243
Combined cars and trucks	222	219	215	211	208	205

2.2.5 Gap between Compliance Fuel Economy and Real-World Fuel Economy

Real-world fuel economy levels achieved by light-duty vehicles in on-road driving are lower than the corresponding levels measured under the laboratory-like test conditions used to determine CAFE compliance. This is because the city and highway tests used for compliance do not encompass the range of driver behavior and climatic conditions experienced by typical U.S. drivers and because CAFE ratings include certain adjustments and flexibilities (EPA 2012b). CAFE ratings are based on laboratory test *drive cycles* for city and highway driving conditions, and they reflect a weighted average of 55 percent city and 45 percent highway conditions. Beginning in MY 1985, to bring new vehicle window labels closer to the on-road fuel economy that drivers actually achieve, EPA adjusted window-sticker fuel economy ratings downward by 10 percent for the city test and 22 percent for the highway test. Since MY 2008, EPA has based vehicle labels on a five-cycle method that includes three additional tests (reflecting high speed/high acceleration, hot temperature/air conditioning, and cold temperature operation) as well as a 9.5 percent downward fuel economy adjustment for other factors not reflected in the five-cycle protocol (EPA 2018b). While these changes are intended to better align new vehicle window labels with on-road fuel economy, CAFE standards and compliance testing are still determined using the two-cycle city and highway tests.[16]

For more discussion of the on-road fuel economy gap (the difference between adjusted and unadjusted mpg), see final rule Section VI.B.

2.2.6 Alternatives Considered but Not Analyzed in Detail

Multiple comments on the Draft EIS and NPRM stated that NHTSA should consider an alternative that is more stringent than the MY 2022–2025 augural standards that NHTSA identified as maximum feasible in 2012. As discussed in Section V of the preamble to the final rule, the agencies carefully considered these comments to expand the range of stringencies to be considered as its final standards. To inform this consideration, the agencies used the CAFE model to examine a progression of stringencies extending outside the range presented in the proposal and Draft EIS, and as a point of reference, using a case that reverts to MY 2018 standards starting in MY 2021. Scenarios included in this initial screening exercise

[16] Except as noted, when fuel economy values are cited in this EIS, they represent standards compliance values. Real-world fuel economy levels are lower, and the environmental impacts are estimated based on real-world fuel economy rather than compliance ratings.

ranged as high as increasing annually at 9.5% during MYs 2021-2026, reaching average CAFE and CO_2 requirements of 66 mpg and 120 gallons per mile (g/mi), respectively. Among other conclusions discussed further in Section V of the preamble to the final rule, NHTSA determined that increases in stringency beyond the baseline augural standards show costs continuing to accrue much more rapidly than CAFE and CO_2 improvements. Considering that, as discussed further in the preamble, even the no action alternative is already well beyond levels that can be supported under EPCA. If further stringency increases appeared likely to yield more significant additional energy and environmental benefits, it is conceivable that these could outweigh these significant additional cost increases. However, the screening analysis showed no dramatic acceleration of energy and environmental benefits. Therefore, NHTSA did not analyze in detail alternatives that were more stringent than the No Action Alternative.

In addition, some of the action alternatives analyzed in the Draft EIS would have phased out air conditioning (AC) and off-cycle adjustments from MY 2022 through MY 2026. Some comments received on the Draft EIS urged NHTSA against phasing out AC and off-cycle adjustments in the CAFE program. For the reasons discussed in Section V of the final rule, the agency decided against further analysis of alternatives that would phase out AC and off-cycle adjustments.

NHTSA also received multiple comments on the Draft EIS that the agency should consider alternatives that retain California's Clean Air Act waiver of preemption under Section 209 (and, by implication, that NHTSA find that EPCA/EISA preemption under 49 U.S.C. § 32919 does not apply to California's program). The issues of California's Clean Air Act waiver under Section 209 and EPCA/EISA preemption under 49 U.S.C. § 32919 were the subject of a separate final action by the agencies in September 2019.[17] The agencies addressed and responded to comments received regarding those issues as part of that action. Because of EPA's withdrawal of California's waiver and NHTSA's conclusion that state or local laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy are expressly and impliedly preempted under 49 U.S.C. § 32919,[18] NHTSA has not considered alternatives that retained California's waiver in this EIS.

2.3 Standard-Setting and EIS Methods and Assumptions

Each of the alternatives considered here represents a different manner in which NHTSA could conceivably balance conflicting policies and considerations in setting the standards. For example, the most stringent action alternative in terms of required mpg (Alternative 7), which would not revise the MY 2021 CAFE standards and would increase passenger car CAFE standards by 2 percent per year and light-truck CAFE standards by 3 percent per year beginning in MY 2022, weighs energy conservation and climate change considerations more heavily and weighs economic practicability less heavily. In contrast, the least stringent action alternative (Alternative 1) would increase both car and truck fuel economy standards on average by 0.0 percent per year, and it places more weight on economic practicability.

NHTSA has assessed the effectiveness and costs of technologies as well as market forecasts and economic assumptions for fuel economy standards, as described in the Section VI of the final rule and Chapter VI of the Final Regulatory Impact Analysis (FRIA). NHTSA uses a modeling system to assess the technologies that manufacturers could apply to their fleet to comply with each alternative. Section

[17] *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program*, 84 FR 51310 (September 27, 2019).

[18] *See* Appendix B to 49 CFR part 531.

2.3.1, *CAFE Model*, describes this model and its inputs and provides an overview of the analytical pieces and tools used in the analysis of alternatives.

2.3.1 CAFE Model

Since 2002, as part of its CAFE analyses, NHTSA has employed a modeling system developed specifically to help the agency apply technologies to thousands of vehicles and develop estimates of the costs and benefits of potential CAFE standards. The CAFE model developed by the Volpe National Transportation Systems Center[19] enables NHTSA to evaluate efficiently, systematically, and reproducibly many regulatory options. The CAFE model is designed to simulate compliance with a given set of CAFE standards for each manufacturer that sells vehicles in the United States. For this final rule, the model begins with a representation of the MY 2017 offerings for each manufacturer that includes the specific engines and transmissions on each model variant, observed sales volumes, and all fuel economy improvement technology already present on those vehicles. From there it adds technology, in response to estimated future fuel prices, estimated willingness of new vehicle buyers to pay for fuel economy improvements, and the standards being considered, in ways estimated to be optimal when also accounting for many real-world constraints faced by automobile manufacturers. After simulating compliance, the model calculates a range of impacts of the simulated standards, such as changes in new vehicle sales, the rates at which older vehicles are removed from service, annual highway travel, technology costs, fuel usage and cost, emissions of air pollutants and GHGs, fatalities resulting from highway vehicle crashes, incidents of health impacts resulting from air pollution, and overall social costs and benefits.

For this EIS, NHTSA used the CAFE model to estimate annual fuel consumption for each calendar year from 2021, when the Proposed Action and some alternatives would first take effect, through 2050, when almost all passenger cars and light trucks in use would have been manufactured and sold during or after the model years for which NHTSA would set CAFE standards in this action.[20] This analysis reflects several changes made to the CAFE model since 2012, when NHTSA used the model to estimate the effects, costs, and benefits of final MY 2017–2021 CAFE standards and augural standards for MYs 2022–2025. A description of the key changes in the model since 2012, as well as a complete description of the software, is included in Sections IV and VI of the preamble to the final rule, as well as in separate model documentation located in NHTSA's docket for this rulemaking.

2.3.1.1 CAFE Model Inputs

The CAFE model requires estimates for the following types of inputs:

- A forecast of the future vehicle fleet.
- Availability, applicability, and effectiveness and cost of fuel-saving technologies.

[19] NHTSA has also sometimes referred to this model as the *Volpe model*.

[20] After running the CAFE model to produce emissions estimates to inform this Final EIS, Volpe Center staff made a range of further changes to the model and inputs. A memorandum to the docket lists these changes and demonstrates that their impacts on emissions estimates were inconsequential. In addition, NHTSA has changed its approach to setting the minimum CAFE standards for domestic passenger cars. As explained in a separate memorandum to the docket, while the CAFE model analyses underlying the final rule preamble, FRIA, and Final EIS do not reflect this change, a separate analysis that does reflect the change demonstrates that doing so does not change estimated impacts of any of the regulatory alternatives under consideration.

- Economic factors, including vehicle survival and mileage accumulation patterns, future fuel prices, the rebound effect (the increase in vehicle use that results from improved fuel economy), and the social cost of carbon.
- Fuel characteristics and vehicular emissions rates.
- Coefficients defining the shape and level of CAFE footprint-based curves, which use vehicle footprint (a vehicle's wheelbase multiplied by the vehicle's average track width) to determine the required fuel economy level or target.

NHTSA uses the model for analysis; the model makes no *a priori* assumptions regarding inputs such as fuel prices and available technologies and it does not dictate the stringency or form of the CAFE standards to be examined. NHTSA makes those selections based on the best currently available information and data.

Using selected inputs, the agency projects a set of technologies each manufacturer could apply to each of its vehicle models to comply with the various levels of CAFE standards to be examined for each fleet, for each model year. The model then estimates the costs associated with this additional technology utilization and accompanying changes in travel demand, fuel consumption, fuel outlays, emissions, and economic externalities related to petroleum consumption and other factors.

For more information about the CAFE model and its inputs, see final rule Sections IV and VI and Section VI of the FRIA. Model documentation, publicly available in the rulemaking docket and on NHTSA's website, explains how the model is installed, how the model inputs and outputs are structured, and how the model is used.

Although NHTSA has used the CAFE model as a tool to inform its consideration of potential CAFE standards, the CAFE model alone does not determine the CAFE standards NHTSA proposes or promulgates as final regulations. NHTSA considers the results of analyses using the CAFE model and external analyses, including this EIS and the analyses cited herein. NHTSA also considers consumer acceptance of new technologies and the extent to which changes in vehicle costs and fuel economy might affect vehicle production and sales. Using all this information, NHTSA considers the governing statutory factors, along with environmental issues and other relevant societal issues, such as safety, and promulgates the maximum feasible standards based on its best judgment on how to balance these factors.

Vehicle Fleet

To determine what levels of stringency are feasible in future model years, NHTSA must project what vehicles and technologies could be produced in those model years and then evaluate which of those technologies can feasibly be applied to those vehicles to raise their fuel economy. The agency therefore establishes an analysis fleet representing those vehicles against which they can analyze potential future levels of stringency and their costs and benefits based on the best available information and a reasonable balancing of various policy concerns. As for other recent CAFE rulemakings, the agency has developed the analysis fleet using information that can be made public, rather than constructing a market forecast using product planning provided by manufacturers on a confidential basis. More information about the vehicle market forecast used in this EIS is available in Section VI.B of the preamble to the final rule.

Technology Assumptions

The analysis of costs and benefits employed in the CAFE model reflects NHTSA's assessment of a broad range of technologies that can be applied to passenger cars and light trucks. The model considers technologies in four broad categories: engine, transmission, vehicle, and electrification/accessory and hybrid technologies. More information about the technology assumptions used in this EIS can be found in Section VI.C of the preamble to the final rule and Section VI of the FRIA. Table 2.3.1-1 lists the types of technologies considered in this analysis for improving fuel economy.

Table 2.3.1-1. Categories of Technologies Considered by the CAFE Model that Manufacturers Can Add to Their Vehicle Models and Platforms to Improve Fuel Economy

Engine Technologies	Transmission Technologies	Vehicle Technologies	Electrification/Accessory and Hybrid Technologies
Improved engine friction reduction	Manual six and seven-speed transmission	Low-rolling-resistance tires (two levels)	Electric power steering/electro-hydraulic power steering
Cylinder deactivation	Six, eight, and ten-speed automatic transmissions	Low-drag brakes	Improved accessories
Advanced cylinder deactivation	Advanced six, eight, and ten-speed automatic transmissions	Front or secondary axle disconnect for four-wheel drive systems	12-volt stop-start
Variable valve timing	Six and eight speed dual clutch transmissions	Aerodynamic drag reduction (four levels)	48-volt belt integrated starter generator
Variable valve lift	Continuous variable transmissions	Mass reduction (six levels)	Power split hybrids
Stoichiometric gasoline direct-injection technology	Advanced continuous variable transmissions	--	P2 hybrids
Turbocharging and downsizing	--	--	Plug-in hybrid electric vehicles (20-mile and 50-mile range)
Cooled exhaust-gas recirculation	--	--	Battery electric vehicles (200-mile and 300-mile range)
Variable turbo geometry	--	--	Fuel cell vehicles
Turbocharging and downsizing with cylinder deactivation	--	--	--
Advanced diesel engines	--	--	--
High-compression engines	--	--	--
Variable compression engines	--	--	--

Economic Assumptions

NHTSA's analysis of the energy savings, changes in emissions, and environmental impacts likely to result from the action alternatives relies on a range of forecasts, economic assumptions, and estimates of parameters used by the CAFE model. These economic values play a significant role in determining the impacts on fuel consumption, changes in emissions of criteria and toxic air pollutants and GHGs, and resulting economic costs and benefits of alternative standards. The CAFE model uses the following forecasts, assumptions, and parameters, which are described in Section VI of the preamble to the final rule and examples of which include:

- Estimates of ways in which the quantities of new passenger cars and light trucks could change in response to future vehicle prices and fuel economy levels, accounting also for future fuel prices.
- Estimates of the fraction of the on-road fleet that remains in service at different ages, and the average annual mileage accumulated by passenger cars and light trucks over their useful lives.
- Estimates of the rates of retirement for older vehicles in response to new vehicle prices and fuel economy levels.
- Estimates of future fuel prices.
- Forecasts of expected future growth in total passenger car and light-truck use, including vehicles of all model years in the U.S. vehicle fleet.
- The size of the gap between test and actual on-road fuel economy.
- The magnitude of the elasticity of annual travel with respect to the per-mile cost of fuel (also referred to as the rebound effect).
- Changes in emissions of criteria and toxic air pollutants and GHGs that result from saving each gallon of fuel and from each added mile of driving.
- Changes in the population-wide incidence of selected health impacts and changes in the aggregate value of health damage costs likely to result from the changes in emissions of criteria air pollutants.
- The value of increased driving range and less-frequent refueling that result from increases in fuel economy.
- The costs of increased congestion and noise caused by added passenger car and light-truck use.
- The costs of light-duty traffic fatalities, injuries, and property damage resulting from changes to vehicle exposure, vehicle retirement rates, and reductions in vehicle mass to improve fuel economy.
- The discount rate applied to future benefits.

NHTSA's analysis includes several assumptions about how vehicles are used. For example, this analysis recognizes that passenger cars and light trucks typically remain in use for many years, so even though NHTSA is issuing standards through MY 2026, changes in fuel use, emissions, and other environmental impacts will continue for many years beyond that. However, the contributions to these impacts by vehicles produced during a particular model year decline over time as those vehicles are gradually retired from service, while those that remain in use are driven progressively less as they age.

NHTSA's analysis incorporates modules added to the CAFE model in 2018—a sales and scrappage module and a safety module—that affect the retirement of the existing vehicle population in response to changes in new vehicle prices, relative cost per mile, and the gross domestic product growth rate. For example, the increase in the price of new vehicles as a result of manufacturers' compliance actions can result in increased demand for used vehicles, extending the expected age and lifetime vehicle miles traveled (VMT) of less efficient, more polluting, and, generally, less safe vehicles. Section VI of the FRIA describes these modules in detail. The extended usage of older vehicles results in incrementally fewer gallons of fuel saved, greater air pollutant emissions, and more on-road fatalities under more stringent regulatory alternatives, which has important implications for the evaluation of economic costs and benefits of alternative standards. The modules assume that vehicles are operated for up to 40 years after their initial sale, after which no vehicles produced in that model year are included in the modeling.

In addition, NHTSA's analysis continues the agency's long-standing practice of accounting for the fact that the amount of driving tends to increase as driving becomes less expensive—a market reality referred to in this context as the rebound effect. Specifically, when the fuel economy of a vehicle increases, the cost of fuel consumed per mile driven decreases, thereby creating an incentive for additional vehicle use. Any increase in vehicle use would therefore offset part of the fuel savings that would otherwise result from higher fuel economy. The total passenger car and light-truck VMT would increase slightly because of the rebound effect, and tailpipe emissions of pollutants strictly related to vehicle use would increase in proportion to increased VMT. Conversely, when the fuel economy of a vehicle decreases, the cost of fuel consumed per mile driven increases, resulting in decreased vehicle use. In this EIS, the rebound effect for light-duty vehicles is an estimated 20 percent. These VMT impacts are reflected in the estimates of emissions under each of the alternatives evaluated (Section 2.4.1, *Types of Emissions*).

The impacts of the alternatives evaluated in this EIS reflect a specific combination of economic inputs in the CAFE model. Detailed descriptions of the sources of forecast information, the rationale underlying each economic assumption, and the agency's choices of specific parameter values are included in Section VI of the FRIA.

Coefficients Defining the Shape and Level of CAFE Footprint-Based Curves

In the NPRM, NHTSA proposed CAFE standards for MYs 2021–2026 expressed as a mathematical function that defines a fuel economy target for each vehicle model and, for each fleet, establishes a required CAFE level determined by computing the sales-weighted harmonic average[21] of those targets. NHTSA has retained that approach in the final rule. NHTSA describes its methods for developing the coefficients defining the curves for the Proposed Action in Section V.A of the NPRM.

2.3.2 Constrained versus Unconstrained CAFE Model Analysis

NHTSA's CAFE model results presented in the final rule in Section VII and FRIA in Section VII differ slightly from those presented in this EIS. EPCA and EISA require that the Secretary determine the maximum feasible levels of CAFE standards in a manner that sets aside the potential use of CAFE credits or application of alternative fuels toward compliance with new standards. NEPA, however, does not impose such constraints on analysis; instead, its purpose is to ensure that "public officials make decisions that are based on [an] understanding of environmental consequences."[22] The EIS therefore presents results of an "unconstrained" analysis that considers manufacturers' potential use of CAFE credits and application of alternative fuels in order to disclose and allow consideration of the real-world environmental consequences of the Proposed Action and alternatives.

[21] The harmonic average is the reciprocal of the arithmetic mean of the reciprocals of the given set of observations and is generally used when averaging units like speed or other rates and ratios.

[22] 40 CFR § 1500.1(c).

2.3.3 Modeling Software

Table 2.3.3-1 provides information about the software that NHTSA used for computer simulation modeling of the projected vehicle fleet and its upstream and downstream emissions.

Table 2.3.3-1. Modeling Software

Model Title	Model Inputs	Model Outputs Used in this Analysis
DOE: NEMS (CAFE model outputs of analysis conducted using the 2019 EIA National Energy Modeling System)		
National Energy Modeling System	• Freeze fuel economy standards at 2020 levels • Set aside enforcement of state-level "Zero Emission Vehicle" mandates after 2019 • Reduce estimated future battery costs • Other inputs are default values for the AEO 2019 Reference Case	• Projected fuel prices for all fuels • U.S. average electricity-generating mix for future years
Argonne National Laboratory: GREET (2018 Version) Fuel-Cycle Model		
Greenhouse Gases and Regulated Emissions in Transportation	• Estimates for nationwide average electricity generating mix from NEMS 2018 • Other inputs are default GREET 2018 data	• Upstream emissions for EV electricity generation • Estimates of upstream emissions associated with production, transportation, and storage for gasoline, diesel, hydrogen and E85
EPA: MOVES (2014a)[23]		
Motor Vehicle Emissions Simulator	• Emissions data from in-use chassis testing; remote sensing; state vehicle inspection and maintenance; and other programs	• NO_X, SO_X, CO, VOCs, PM2.5, and toxic emission factors (tailpipe, evaporative, brake and tire wear) for CAFE model for cars and light-duty trucks, for four fuel types: gasoline, diesel, hydrogen and E85
Volpe: CAFE Model (2020 Version)		
CAFE Compliance and Effects Model	• Characteristics of analysis fleet • Availability, applicability, and effectiveness and cost of fuel-saving technologies • Fuel economy rebound effect • Future fuel prices, social cost of carbon, and other economic factors • Fuel characteristics and criteria pollutant emission factors	• Costs associated with utilization of additional fuel-saving technologies • Changes in travel demand, fuel consumption, fuel outlays, • Technology utilization scenarios • Estimated U.S. vehicle fleet size, criteria and toxic emissions (tons) for future years

[23] For the emissions factors informing the Final EIS, updating to MOVES 2014b would have produced values identical to those based on MOVES 2014a.

Model Title	Model Inputs	Model Outputs Used in this Analysis
Joint Global Change Research Institute: GCAM RCP Scenario Results		
Global Change Assessment Model's simulations of the representative concentration pathway radiative forcing targets	• Regional population estimates • Labor productivity growth • Energy demand • Agriculture, land cover, and land-use models • Atmospheric gas concentrations	• GCAMReference, GCAM6.0, and RCP4.5 global GHG emission scenarios (baselines)
Brookhaven National Laboratory and Oak Ridge National Laboratory: CO2SYS (v.2.3)		
CO_2 System Calculations Model	• Atmospheric gas concentrations from MAGICC model output • Natural sea water observations prepared at the Scripps Institution of Oceanography • Constants from the CO2SYS model	• Projected ocean pH in 2040, 2060, and 2100 under GHG emission scenarios
National Center for Atmospheric Research: MAGICC6		
Model for the Assessment of Greenhouse-gas Induced Climate Change	• Adjusted GCAMReference, GCAM6.0, and RCP4.5 climate scenarios to reflect projected emissions from the car and light-duty vehicle fleet in the US from the action alternatives.	• Projected global CO_2 concentrations, global mean surface temperature from 2017 through 2100

Notes:
NEMS = National Energy Modeling System; AEO = Annual Energy Outlook; DOE = U.S. Department of Energy;
GREET = Greenhouse Gases, Emissions, and Energy Use in Transportation; EV = electric vehicle; E85 = ethanol fuel blend of 85% denatured ethanol; EPA = U.S. Environmental Protection Agency; NO_X = nitrogen oxides; SO_X = sulfur oxides;
CO = carbon monoxide; VOCs = volatile organic compounds; PM2.5 = particulate matter with an aerodynamic diameter equal to or less than 2.5 microns; GCAM = global change assessment model; RCP = representative concentration pathway;
GHG = greenhouse gas; CO_2 = carbon dioxide

2.3.4 Energy Market Forecast Assumptions

In this EIS, NHTSA uses projections of energy prices, demand, and supply derived from the U.S. Department of Energy (DOE) Energy Information Administration (EIA), which collects and provides official energy statistics for the United States. EIA is the primary source of data that government agencies and private firms use to analyze and model energy systems. Every year, EIA issues projections of energy consumption and supply for the United States (Annual Energy Outlook [AEO]) and the world (International Energy Outlook [IEO]). EIA reports energy forecasts through 2050 for a range of fuels, sectors, and geographic regions. To develop projections reported in AEOs, EIA uses its National Energy Modeling System (NEMS), which incorporates all federal and state laws and regulations in force at the time of modeling. Potential legislation and laws under debate in Congress are not included in AEO Reference case projections.

In this EIS, NHTSA uses NEMS-based projections in two ways: (1) by modifying NEMS, incorporating its outputs as inputs into NHTSA's CAFE model, and using the CAFE model to project the environmental impacts reported in this Final EIS, and (2) by citing directly to unmodified projections published by EIA as part of the AEO. Regarding the first use, NHTSA addresses how it modified NEMS and incorporates its outputs in NHTSA's CAFE model in the preamble to the final rule. The following discussion relates to the second use, NHTSA's direct reference to published AEO reports, and not how NEMS was used for purposes of developing the CAFE model.

References to the AEO 2019 (and AEO 2018) in this EIS refer to the published annual AEO, and the agency is citing directly to the AEO Reference case. As published by EIA, recent editions of the AEO assume that NHTSA's and EPA's vehicle standards announced in the 2012 final rule, including both the MY 2017–2021 CAFE standards and the MY 2022–2025 augural CAFE standards, are fully enforced and that manufacturers generally comply with those standards. Recent editions of the AEO also assume states will enforce any adopted zero-emissions vehicle mandates, despite the fact that EPCA preempts states from adopting regulations related to fuel economy standards. Still, NHTSA relies on the AEO in this EIS as it is widely used and publicly available.

In the Draft EIS, NHTSA frequently referenced AEO 2018. In this Final EIS, NHTSA has updated these references to AEO 2019 to provide the most recent projections available for the decision-maker. However, NHTSA does not believe that these updates reflect a significant change in the environmental impacts reported. For example, the 2018 and 2019 AEO projections of fuel prices are similar. Compared to the 2018 AEO, projected gasoline prices in the 2019 AEO are about 4 percent higher in 2020, lower between 2020 and 2050, and about 2.7 percent lower in 2050. Similarly, compared to the 2018 AEO, projected diesel fuel prices in the 2019 AEO are about 5.5 percent higher in 2020, generally within 2 percent higher or lower between 2020 and 2050, and about 2 percent lower in 2050. In addition, the 2018 and 2019 AEO projections of electricity-generating mix also are similar, with both projections showing continuation of recent trends toward proportionally less generation with coal and greater generation with natural gas. The 2018 AEO projects that the share of coal will decrease from about 28 percent in 2020 to about 22 percent in 2050, while the 2019 AEO projects that the coal share will decrease by slightly more, from about 25 percent in 2020 to about 17 percent in 2050. The 2018 AEO projects that the natural gas share will increase from about 32 percent in 2020 to about 36 percent in 2050, while the 2019 AEO projects that the natural gas share will increase by slightly less, from about 36 percent in 2020 to about 39 percent in 2050. The 2018 and 2019 AEO both project that the nuclear share will decrease from about 18 percent in 2020 to about 12 percent in 2050, while the renewables share will increase from about 20 percent in 2020 to about 31 percent in 2050.

2.3.5 Approach to Scientific Uncertainty and Incomplete Information

CEQ regulations recognize that many federal agencies encounter limited information and substantial uncertainties when analyzing the potential environmental impacts of their actions. Accordingly, the regulations provide agencies with a means of formally acknowledging incomplete or unavailable information in NEPA documents. Where "information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known," the regulations require an agency to include the following elements in its NEPA document:[24]

- A statement that such information is incomplete or unavailable.
- A statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment.
- A summary of existing credible scientific evidence relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment.

[24] 40 CFR § 1502.22(b).

- The agency's evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

In this EIS, NHTSA acknowledges incomplete, uncertain, or unavailable information where it is relevant to the agency's analysis of the potential environmental impacts of the alternatives. For example, NHTSA recognizes that scientific information about the potential environmental impacts of changes in emissions of CO_2 and associated changes in temperature, including those expected to result from the final rule, is uncertain and incomplete. NHTSA relies on the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013a, 2013b, 2014b,) and the U.S. Global Change Research Program (GCRP) Fourth National Climate Assessment (GCRP 2017) as a recent "summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment."[25] Some discussions, such as in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, address general potential effects of climate change, but these impacts are not attributable to any particular action, such as the Proposed Action and alternatives.

2.4 Resource Areas Affected and Types of Emissions

The major resource areas affected by the action alternatives are energy, air quality, and climate. Chapter 3, *Energy*, describes the affected environment for energy and energy impacts under each alternative. Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, describe the affected environments and direct and indirect impacts for air quality and climate change, respectively. Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, describes the impacts on the energy, material, and technology aspects of the vehicle lifecycle. The action alternatives also would affect the following resource areas (although to a lesser degree than energy, air quality, and climate): land use and development, hazardous materials and regulated waste, historical and cultural resources, noise, and environmental justice. These resource areas are discussed in Chapter 7, *Other Impacts*. Chapter 8, *Cumulative Impacts*, describes the cumulative impacts of the action alternatives on all resource areas.

2.4.1 Types of Emissions

Emissions, including GHGs, criteria pollutants, and toxic air pollutants, are categorized for purposes of this analysis as either *downstream* or *upstream*. Downstream emissions are released from a vehicle while it is in operation, parked, or being refueled, and consist of tailpipe exhaust, evaporative emissions of volatile organic compounds from the vehicle's fuel storage and delivery system, and particulates generated by brake and tire wear. All downstream emissions were estimated using the CAFE model, which uses emissions factors from EPA's Motor Vehicle Emission Simulator (MOVES2014a) model (EPA 2017h). Upstream emissions related to the action alternatives are those associated with crude-petroleum extraction and transportation, and with the refining, storage, and distribution of transportation fuels. Upstream emissions from electric vehicles (EVs) also include emissions associated with using primary feedstocks (e.g., coal, natural gas, nuclear) to generate the electricity needed to run these vehicles. The amount of emissions created when generating electricity depends on the composition of fuels used for generation, which varies regionally. NHTSA estimated domestic upstream emissions of CO_2, criteria air pollutants, and toxic air pollutants. Upstream emissions considered in this EIS include those that occur within the United States during the recovery, extraction, and transportation

[25] 40 CFR § 1502.22(b)(3).

of crude petroleum, as well as during the refining, storage, and distribution of transportation of fuels. Emissions from each of these phases of fuel supply are estimated using factors obtained from Argonne National Laboratory's Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation (GREET) model. A portion of finished motor fuels is refined within the United States using imported crude petroleum as a feedstock and GREET's emissions factors are used to estimate emissions associated with transporting imported petroleum from coastal port facilities to U.S. refineries, refining it to produce transportation fuels, and storing and distributing those fuels. GREET's emissions factors are also used to estimate domestic emissions from transportation, storage, and distribution of motor fuels that are imported to the United States in refined form.

Estimates of upstream emissions were based on the GREET, version 2018 model developed by the DOE Argonne National Laboratory (ANL) 2018.[26] Section 2.4.1.1, *Downstream Emissions*, and Section 2.4.1.2, *Upstream Emissions*, describe analytical methods and assumptions used in this EIS for emissions modeling, including the impact of the rebound effect. Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, discuss modeling issues related specifically to the air quality and climate change analyses, respectively.

2.4.1.1 Downstream Emissions

Most downstream emissions are exhaust (tailpipe) emissions. The basic method used to estimate tailpipe emissions entails multiplying the estimated total miles driven by their estimated emissions rates per vehicle-mile of each pollutant. These emissions rates and annual VMT differ between cars and light trucks, between gasoline and diesel vehicles, and by model year that is used to calculate vehicle age. With the exception of sulfur dioxide (SO_2), NHTSA and EPA calculated the increase in emissions of these criteria pollutants from added car and light truck use by multiplying the estimated increases in vehicle use during each year over their expected lifetimes by per-mile emission rates appropriate to each vehicle type, fuel used, model year, and age as of that future year.

The CAFE model uses emission factors developed by EPA using the Motor Vehicle Emission Simulator (MOVES2014a) (EPA 2017h). MOVES incorporates EPA's updated estimates of real-world emissions from passenger cars and light trucks and accounts for emission control requirements on exhaust emissions and evaporative emissions, including the Tier 2 Vehicle & Gasoline Sulfur Program (EPA 2011) and the mobile source air toxics (MSAT) rule (EPA 2007). The MOVES database includes national default distributions by vehicles type and age, activity levels, regulatory class, fuel composition and supply, and other key parameters used to generate emission estimates. In modeling downstream emissions of particulate matter 2.5 microns or less in diameter (PM2.5), EPA included emissions from brake and tire wear in addition to exhaust. MOVES defaults were used for all other parameters to estimate tailpipe and other components of downstream emissions under the No Action Alternative.

NHTSA's and EPA's emissions analysis method assumes that no additional reduction in tailpipe emissions of criteria pollutants or toxic air pollutants will occur as a consequence of improvements in fuel economy that are not already accounted for in MOVES. In its emissions calculations, MOVES accounts for power required of the engine under different operating conditions, such as vehicle weight, speed, and acceleration. Changes to the vehicle that result in reduced engine load, such as from more efficient drivetrain components, vehicle weight reduction, improved aerodynamics, and lower rolling-resistance tires, are therefore reflected in the MOVES calculations of both fuel economy and emissions. Because

[26] On October 7, 2019, Argonne National Laboratory released the 2019 version of GREET. The upstream emissions analysis for this EIS was completed using GREET 2018 prior to the release of GREET 2019.

the final standards are not intended to dictate the design and technology choices manufacturers must make to comply, a manufacturer could employ technologies that increase fuel economy (and therefore reduce CO_2 and SO_2 emissions) while at the same time increasing emissions of other criteria pollutants or toxic air pollutants, as long as the manufacturer's production still meets both the fuel economy standards and prevailing EPA regulated pollutant standards. Depending on which strategies are pursued to meet the increased fuel economy standards, emissions of other pollutants, both regulated and unregulated, could increase or decrease.

In calculating emissions, two sets of units can be used depending on how activity levels are measured:

- Activity expressed as VMT and emission factors expressed as grams emitted per mile.
- Activity expressed as fuel consumption in gallons and emission factors expressed as grams emitted per gallon of fuel.

Considering both sets of units provides insight into how emissions of different GHGs and air pollutants vary with fuel economy and VMT.

Almost all of the carbon in fuels that are combusted in vehicle engines is oxidized to CO_2, and essentially all of the sulfur content of the fuel is oxidized to SO_2. As a result, emissions of CO_2 and SO_2 are constant in terms of grams emitted per gallon of fuel; their total emissions vary directly with the total volume of chosen fuel used, and inversely with fuel economy (mpg). Therefore, emissions factors for CO_2 and SO_2 are not constant in terms of grams emitted per mile of a specific vehicle, because fuel economy—and therefore the amount of fuel used per mile—varies with vehicle operating conditions.

In contrast to CO_2 and SO_2, downstream emissions of the other criteria pollutants and the toxic air pollutants are given in terms of grams emitted per mile. This is because the formation of these pollutants is affected by the continually varying conditions of engine and vehicle operation dictated by the amount of power required and by the type and efficiency of emission controls with which a vehicle is equipped.[27] For other criteria pollutants and air toxics, MOVES calculates emission rates individually for specific combinations of inputs, including various vehicle types, fuels, ages, and other key parameters as noted previously.

Emissions factors in the MOVES database are initially expressed in the form of grams per vehicle-hour of operation. To convert these emission factors to grams per mile, MOVES was run for the year 2050, and was programmed to report aggregate emissions from vehicle start, running, brake and tire wear, and crankcase exhaust operations. EPA selected 2050 in order to generate emission factors that were representative of lifetime average emission rates for vehicles meeting the Tier 3 emissions and fuel standards.[28] Separate estimates were developed for each vehicle type and model year, which also included effects to reflect regional and temporal variation in temperature and other relevant variables on emissions.

[27] The CAFE model's new sales and scrappage module accounts for the deferred retirement of older vehicles as a result of changes in new vehicle prices. Higher new vehicle prices due to more stringent CAFE standards would result in increased demand for used vehicles, which would result in higher levels of downstream criteria and toxic air pollutant emissions than otherwise anticipated without accounting for this effect.

[28] Because all light-duty emissions rates in MOVES2014b are assumed invariant after MY 2022, a calendar-year 2050 run produced a full set of emissions rates that reflect anticipated deterioration in the effectiveness of vehicles' emissions-control systems with increasing age and accumulated mileage for post-MY 2022 vehicles.

The MOVES emissions estimates were then summed across all model years and divided by total VMT in that year in order to produce per-mile emissions factors by vehicle type, fuel type, and pollutant. The resulting emissions rates represent average values across the nation, and incorporate typical variation in temperature and other operating conditions affecting emissions over an entire calendar year.[29] These national average rates also embody county-specific differences in fuel composition, as well as in the presence and type of vehicle inspection and maintenance programs.[30]

Emissions rates for the criteria pollutant SO_2 were calculated by using average fuel sulfur content estimates supplied by EPA, together with the simplifying assumption that the entire sulfur content of fuel is emitted in the form of SO_2. These calculations assumed that national average gasoline and diesel sulfur levels would remain at current levels for the foreseeable future,[31] because there are currently no open regulatory actions that consider fuel sulfur content. Therefore, unlike many emissions of other criteria pollutants that are affected by exhaust after-treatment devices (e.g., a catalytic converter), SO_2 emissions from vehicle use are effectively proportional to fuel consumption.

The agencies assume that, as a result of the rebound effect, total VMT would decrease slightly with decreases in fuel economy, thereby causing tailpipe emissions of each air pollutant generated by vehicle use (rather than by fuel consumption) to decrease in proportion to this decrease in VMT. However, emissions on a per-mile basis as calculated by MOVES could decline because of increased fuel economy, as discussed above.[32] If the increases in fuel consumption and emissions associated with VMT rebound effect are small compared to the decrease in fuel consumption due to increased fuel economy, then the net result can be a reduction in total emissions.

2.4.1.2 Upstream Emissions

NHTSA also estimated the impacts of the action alternatives on upstream emissions associated with petroleum extraction and transportation, and the refining, storage, and distribution of transportation fuels, as well as upstream emissions associated with generation of electricity used to power EVs. When average fuel economy decreases, NHTSA anticipates increases in upstream emissions from fuel production and distribution, because the total amount of fuel used by passenger cars and light trucks

[29] The emissions rates calculated by EPA for this analysis using MOVES2014a include only those components of emissions expected to vary in response to changes in vehicle use. These include exhaust emissions associated with starting and operating vehicles, and particulate emissions resulting from brake and tire wear. However, they *exclude* emissions associated with activities such as vehicle storage, because those do not vary directly with vehicle use. Therefore, the estimates of aggregate emissions reported for the No Action Alternative and action alternatives do not represent total emissions of each pollutant under any of those alternatives. However, the difference in emissions of each pollutant between any action alternative and the No Action Alternative does represent the agency's best estimate of the change in total emissions of that pollutant that would result from adopting that action alternative.

[30] The national mix of fuel types includes county-level market shares of conventional and reformulated gasoline, as well as county-level variation in sulfur content, ethanol fractions, and other fuel properties. Inspection and maintenance programs at the county level account for detailed program design elements such as test type, inspection frequency, and program coverage by vehicle type and age.

[31] These are 30 and 15 parts per million (ppm, measured on a mass basis) for gasoline and diesel, respectively, which produces emissions rates of 0.17 gram of SO_2 per gallon of gasoline and 0.10 gram per gallon of diesel.

[32] However, NHTSA notes that increased use of EVs might not reduce average emissions on a per-mile basis, because producers of EVs could allow the per-mile emissions rates of their conventionally fueled vehicles to increase to levels that still enable them to comply with EPA regulations on manufacturers' fleet average emissions rates. Such a response would leave each manufacturer's average emissions per mile unchanged, regardless of the extent to which it produced EVs as a compliance strategy.

would increase. To the extent that any action alternative would lead to increased EVs adoption and use, upstream emissions associated with charging EVs could increase because of adopting that alternative. These increases would offset at least part of the reduction in upstream emissions resulting from reduced production of motor vehicle fuels due to EV adoption. The net effect on national upstream emissions would depend on the relative magnitudes of the reductions in motor fuel production and the increases in electric power production to meet EV charging demand, and would vary by pollutant. (See Section 6.2, *Energy Sources*, for a discussion of emissions differences between conventional vehicles and EVs.)

Although the rebound effect is assumed to result in percentage increases in VMT and downstream emissions from vehicle use that are uniform in all regions of the United States, the associated changes in upstream emissions are expected to vary among regions because fuel refineries, storage facilities, and electric power plants are not uniformly distributed across the country. Therefore, an individual geographic region could experience either a net increase or a net decrease in emissions of each pollutant due to the final fuel economy standards. Net emissions changes depend on the relative magnitudes of the increase in emissions from additional vehicle use due to the rebound effect and electric power production tied to EV charging and the decline in emissions resulting from reduced fuel production and distribution in that geographic region.

The National Energy Modeling System (NEMS) is an energy-economy modeling system from the EIA. For the CAFE model analyses presented throughout this EIS, NHTSA used the NEMS AEO 2019 version to project the U.S. average electricity-generating fuel mix (e.g., coal, natural gas, and petroleum) for the reference year 2020 and used the GREET model (2018 version) (ANL 2017) to estimate upstream emissions. The analysis assumed that the vehicles would be sold and operated (refueled or charged) during the 2017 to 2060 timeframe. The analysis presented throughout this EIS assumes that the future EV fleet would charge from a nationally representative grid mix. As with gasoline, diesel, and E85, emission factors for electricity were calculated in 5-year increments from 1985 to 2050 in GREET to account for projected changes in the national grid mix. GREET contains information on the energy intensities (amount of pollutant emitted per unit of electrical energy generated) that extend to 2040.

For the action alternatives in this EIS, NHTSA assumed that decreased fuel economy affects upstream emissions by increasing volumes of gasoline and diesel produced and consumed,[33] and by causing changes in emissions related to electricity generation due to the different EV deployment levels projected under each action alternative. NHTSA calculated the impacts of increased fuel production on total emissions of each pollutant using the volumes of petroleum-based fuels estimated to be produced and consumed under each action alternative, together with emission factors for individual phases of the fuel production and distribution process derived from GREET. The emission factors derived from GREET (in grams of pollutant per million British thermal units of fuel energy content) for each phase of the fuel production and distribution process were multiplied by the volumes of different types of fuel produced and distributed under each action alternative to estimate the resulting changes in emissions during each phase of fuel production and distribution. Emissions were added together to derive the total emissions from fuel production and distribution resulting from each action alternative. This process was repeated for each alternative, and the change in upstream emissions of each pollutant from each action alternative was estimated as the difference between upstream emissions of that pollutant under the action alternative and its upstream emissions under the No Action Alternative.

[33] NHTSA assumed that the proportions of total fuel production and consumption represented by ethanol and other renewable fuels (such as biodiesel) under each of the action alternatives would be identical to those under the No Action Alternative.

2.5 Comparison of Alternatives

The CEQ NEPA implementing regulations direct federal agencies to present in an EIS "the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision-maker and the public."[34] NHTSA has presented the environmental impacts of the alternatives in comparative form through each of the substantive chapters that follow in this EIS. To supplement that information, this section summarizes and compares the direct, indirect, and cumulative impacts of all the alternatives on energy, air quality, and climate, as presented in Chapter 3, *Energy*, Chapter 4, *Air Quality*, Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*. No quantifiable, alternative-specific impacts were identified for the other resource areas discussed in Chapters 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impact*s, and Chapter 7, *Other Impacts*, so they are not summarized here.

Under the alternatives analyzed in this EIS, fuel economy is expected to improve compared to current levels under each action alternative, more than offsetting the growth in the number of passenger cars and light trucks in use throughout the United States and in the annual VMT by these vehicles. This would result in projected decreases in total fuel consumption by passenger cars and light trucks compared to current conditions. Because CO_2 emissions are a direct consequence of total fuel consumption, the same result is projected for total CO_2 emissions from passenger cars and light trucks. However, NHTSA estimates that the final CAFE standards and each of the action alternatives would increase fuel consumption and CO_2 emissions from the future levels that would otherwise occur under the No Action Alternative.

2.5.1 Direct and Indirect Impacts

This section compares the direct and indirect impacts of the No Action Alternative and the seven action alternatives on energy, air quality, and climate (Table 2.5.1-1). Under NEPA, direct impacts "are caused by the action and occur at the same time and place."[35] Indirect impacts "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable."[36] For detailed discussions of the assumptions and methods used to estimate the direct and indirect impacts, see Section 2.3, *Standard-Setting and EIS Methods and Assumptions*, Section 3.4, *Environmental Impacts* (energy), Section 4.1.2, *Methods*, (air quality), and Section 5.3, *Analysis Methods* (climate). Table 2.5.1-1 summarizes the direct and indirect impacts on each resource.

2.5.2 Cumulative Impacts

Table 2.5.2-2 summarizes the cumulative impacts of the action alternatives on energy, air quality, and climate, as presented in Chapter 8, *Cumulative Impacts*.

2.5.3 Comparison to the Draft EIS

The CEQ NEPA implementing regulations direct an agency to prepare a supplement to a draft or final EIS if: "(i) the agency makes substantial changes in the proposed action that are relevant to environmental

[34] 40 CFR § 1502.14.

[35] 40 CFR § 1508.8.

[36] Ibid.

concerns; or (ii) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts."[37] In this Final EIS, NHTSA is considering a new alternative (Alternative 3, the Preferred Alternative); however, this alternative falls well within the range of alternatives already considered in the Draft EIS. NHTSA has not fundamentally changed its proposed action, as it is continuing to set CAFE standards using the same methodology and approach described in the NPRM and the Draft EIS.[38] The agency has not made substantial changes in the proposed action that are relevant to environmental concerns.

Furthermore, the agency is not aware of significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. With regard to the impacts described in Chapter 3, *Energy*, NHTSA has updated its analysis based on AEO 2019. However, as described in Section 2.3.4, *Energy Market Forecast Assumptions*, AEO 2019 does not significantly differ from AEO 2018. Moreover, with regard to the impacts described in Chapters 4 through 8, NHTSA has updated its discussions to reflect more current scientific information based on studies the agency identified through additional literature review or material referenced or provided by commenters on the Draft EIS. For example, NHTSA has updated its discussion of climate change impacts to reflect new material published by the IPCC and Volume 2 of the 4th National Climate Assessment. In all cases, the studies reinforced the conclusions reached in the Draft EIS or were not significant as to materially impact the agency's decision.[39]

As a result of revising and updating the CAFE model, the environmental impacts reported in this Final EIS differ from those reported in the Draft EIS. However, NHTSA has carefully reviewed these differences and conclude that they do not result in significant new information relevant to environmental concerns. With regard to energy, the range of combined U.S. passenger car and light truck increases in fuel consumption across alternatives is within the scope of impacts reported in the Draft EIS. With regard to air quality, emissions levels and trends across alternatives did change from those impacts reported in the Draft EIS. However, most of these changes remain very small on an absolute basis, especially when considered in association with other sources of similar emissions across other sectors. Furthermore, the potential health impacts associated with those emissions were smaller in the Final EIS as compared to the Draft EIS. Finally, with regard to climate change impacts, differences across alternatives remained small and within the scope of those reported in the Draft EIS. Based on this review, NHTSA concludes that a supplement to the Draft EIS is not required and that issuance of this Final EIS is appropriate.

[37] 40 CFR § 1502.9(c)(1).

[38] Although the CAFE model has been revised and updated, as described in the preamble to the final rule, the agency continues to balance the statutory factors, define standards based on vehicle footprint curves, etc.

[39] NHTSA has considered this new material as part of its decision-making process, as described in the preamble to the final rule. However, no single study provided significant new information as to require the agency to significantly alter its approach to setting CAFE standards.

Table 2.5.3-1. Direct and Indirect Impacts

Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Energy: Combined U.S. Passenger Car and Light Truck Fuel Consumption for 2020–2050 (billion gasoline gallon equivalent)							
3371	3,598	3,591	3,571	3,561	3,514	3,492	3,456
Energy: Combined U.S. Passenger Car and Light Truck Increase in Fuel Consumption for 2020–2050 (billion gallons)							
--	226	220	200	189	142	120	85
Air Quality: Criteria Air Pollutant Emissions Changes in 2035							
--	Decrease: SO_2. Increase: CO, NO_X, PM2.5, and VOCs.	Decrease: SO_2, less than Alt. 1. Increase: CO, more than Alt. 1. NO_X, PM2.5, and VOCs, less than Alt. 1.	Decrease: SO_2, less than Alts. 1 and 2. Increase: CO, more than Alts. 1 and 2. NO_X, PM2.5, and VOCs, less than Alts. 1 and 2.	Decrease: SO_2, more than Alts. 1 and 2 but less than Alt. 3. Increase: CO, more than Alts. 1 through 3. NO_X, PM2.5, and VOCs, less than Alts. 1 through 3.	Decrease: SO_2, more than Alts. 1 through 4. Increase: CO, NO_X, PM2.5, and VOCs, less than Alts. 1 through 4.	Decrease: SO_2, more than Alts. 1 through 4 but less than Alt. 5. Increase: CO, NO_X, PM2.5, and VOCs, less than Alts. 1 through 5.	Decrease: SO_2, more than Alts. 1 through 6. Increase: CO, NO_X, PM2.5, and VOCs, less than Alts. 1 through 6.
Air Quality: Toxic Air Pollutant Emissions Changes in 2035							
--	Decrease: None. Increase: Acetaldehyde, acrolein, benzene, 1,3-butadiene, DPM, and formaldehyde.	Decrease: None. Increase: Acetaldehyde, acrolein, benzene, 1,3-butadiene, more than Alt. 1. DPM and formaldehyde, less than Alt. 1.	Decrease: None. Increase: Acetaldehyde, more than Alts. 1 and 2. 1,3-butadiene, more than Alt. 1 but less than Alt. 2. Acrolein, benzene, DPM, and formaldehyde, less than Alts. 1 and 2.	Decrease: None. Increase: Acetaldehyde, more than Alts. 1 through 3. 1,3-butadiene, more than Alt. 1 but less than Alts. 2 and 3. Acrolein, benzene, DPM, and formaldehyde, less than Alts. 1 through 3.	Decrease: None. Increase: Acetaldehyde, acrolein, benzene, 1,3-butadiene, DPM, and formaldehyde, less than Alts. 1 through 4.	Decrease: None. Increase: 1,3-butadiene, less than Alts. 1 through 4 but more than Alt. 5. Acetaldehyde, acrolein, benzene, DPM, and formaldehyde, less than Alts. 1 through 5.	Decrease: None. Increase: Acetaldehyde, acrolein, benzene, 1,3-butadiene, DPM, and formaldehyde, less than Alts. 1 through 6.

Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Air Quality: Increases in Premature Mortality Cases and Work-Loss Days in 2035							
--	Premature mortality: 11–22 cases Work-loss: 1,400 days	Premature mortality: 9–19 cases Work-loss: 1,194 days	Premature mortality: 9–18 cases Work-loss: 1,127 days	Premature mortality: 6–12 cases Work-loss: 819 days	Premature mortality: 8–18 cases Work-loss: 1,103 days	Premature mortality: decrease by 7–16 cases Work-loss: decrease by 813 days	Premature mortality: 9–20 cases Work-loss: 1,188 days
Climate: Total Greenhouse Gas Emissions from U.S. Passenger Cars and Light Trucks for 2021–2100 ($MMTCO_2$)							
85,900	94,700	94,400	93,700	93,200	91,400	90,400	89,000
Climate: Atmospheric Carbon Dioxide Concentrations in 2100 (ppm)							
789.11	789.89	789.86	789.80	789.76	789.59	789.50	789.38
Climate Increase in Global Mean Surface Temperature by 2100 in °C (°F)							
3.484°C (6.271°F)	3.487°C (6.277°F)	3.487°C (6.277°F)	3.487°C (6.277°F)	3.487°C (6.276°F)	3.486°C (6.275°F)	3.486°C (6.274°F)	3.485°C (6.273°F)
Climate: Global Sea-Level Rise by 2100 in centimeters (inches)							
76.28 (30.03)	76.35 (30.06)	76.35 (30.06)	76.34 (30.05)	76.34 (30.05)	76.32 (30.05)	76.32 (30.05)	76.31 (30.04)
Climate: Global Mean Precipitation Increase by 2100							
5.85%	5.86%	5.86%	5.86%	5.86%	5.86%	5.86%	5.86%
Climate: Ocean Acidification in 2100 (pH)							
8.2176	8.2172	8.2172	8.2172	8.2173	8.2173	8.2174	8.2175

Notes:
The numbers in this table have been rounded for presentation purposes. Therefore, the reductions might not reflect the exact difference of the values in all cases.
°C = degrees Celsius; °F = degrees Fahrenheit; DPM = diesel particulate matter; $MMTCO_2$ = million metric tons of carbon dioxide; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns in diameter or less; ppm = parts per million; SO_2 = sulfur dioxide; VOCs = volatile organic compounds

Table 2.5.3-2. Cumulative Impacts

Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Energy: Total Combined Gasoline, Diesel, Biofuel, Hydrogen, and Electricity Fuel Consumption by All U.S. Cars and Light Trucks for 2020–2050							
Fuel consumption could change due to a Presidential Executive Order on Promoting Energy Independence and Economic Growth (EO 13783, issued March 28, 2017) that could substantively affect energy supply. Recent market trends also indicate that global EV market share targets and quotas and associated manufacturer investments to improve EV technologies and increase the scale of EV manufacturing may affect U.S. transportation sector fuel use in the future.							
Energy: Total Change in Fuel Use by All U.S. Cars and Light Trucks for 2020–2050							
The magnitude and direction of reasonably foreseeable cumulative impacts cannot be quantified with precision.							
Air Quality: Criteria Air Pollutant (CO, NO_X, PM2.5, SO_2, and VOCs) Emissions Changes for 2018–2050							
Under all alternatives, cumulative impacts on air quality from criteria pollutants could increase or decrease depending on trends in the electric power sector, growth in EV usage, and potential changes in emissions standards and regulations for stationary and mobile sources.							
Air Quality: Toxic Air Pollutant (Acetaldehyde, Acrolein, Benzene, 1,3-Butadiene, DPM, and Formaldehyde) Emissions Changes for 2018–2050							
Under all alternatives, cumulative impacts on air quality from toxic air pollutants could increase or decrease depending on trends in the electric power sector, growth in EV usage, and potential changes in emissions standards and regulations for stationary and mobile sources.							
Air Quality: Changes in Premature Mortality Cases and Work-Loss Days in 2035 (Values within Range Depend on Assumptions Used)							
Under all alternatives, cumulative impacts on human health, as indicated by changes in premature mortality cases and work-loss days, could increase or decrease depending on trends in the electric power sector, growth in EV usage, and potential changes in emissions standards and regulations for stationary and mobile sources.							
Climate: Total Greenhouse Gas Emissions from U.S. Passenger Cars and Light Trucks for 2021–2100 ($MMTCO_2$)[a]							
85,900	94,700	94,400	93,700	93,200	91,400	90,400	89,000
Climate: Atmospheric Carbon Dioxide Concentrations in 2100 (ppm)							
687.29	688.04	688.01	687.95	687.91	687.76	687.67	687.55
Climate Increase in Global Mean Surface Temperature by 2100 in °C (°F)							
2.838°C (5.108°F)	2.841°C (5.115°F)	2.841°C (5.114°F)	2.841°C (5.114°F)	2.841°C (5.142°F)	2.840°C (5.112°F)	2.840°C (5.111°F)	2.839°C (5.110°F)
Climate: Global Sea-Level Rise by 2100 in centimeters (inches)							
70.22 (27.65)	70.30 (27.68)	70.29 (27.67)	70.29 (27.67)	70.28 (27.67)	70.27 (27.66)	70.26 (27.66)	70.25 (27.66)
Climate: Global Mean Precipitation Increase by 2100							
4.77%	4.77%	4.77%	4.77%	4.77%	4.77%	4.77%	4.77%
Climate: Ocean pH in 2100							
8.2723	8.2719	8.2719	8.2719	8.2719	8.2720	8.2721	8.2721

Notes:

[a] Total greenhouse gas emissions from U.S. passenger cars and light trucks are the same as in the direct and indirect impacts analysis. However, results differ for atmospheric CO_2 concentrations, surface temperature, sea-level rise, precipitation, and ocean pH. These differences are due to the fact that the cumulative impacts analysis uses a medium-high global emissions scenario (GCAM6.0) as opposed to the high emissions scenario (GCAMReference Scenario) used in the direct and indirect impacts analysis. NHTSA chose the GCAM6.0 scenario as a plausible global emissions baseline for the cumulative analysis, as this scenario is more aligned with reasonably foreseeable global actions that will result in a moderate level of emission reductions (although it does not explicitly include any particular policy or program).

EV = electric vehicles; CO = carbon monoxide; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns in diameter or less; SO_2 = sulfur dioxide; VOCs = volatile organic compounds; DPM = diesel particulate matter; $MMTCO_2$ = million metric tons of carbon dioxide; °C = degrees Celsius; °F = degrees Fahrenheit; DPM = diesel particulate matter

CHAPTER 3 ENERGY

NHTSA's light-duty vehicle standards regulate fuel economy and thereby affect U.S. transportation fuel consumption. The *Annual Energy Outlook* (AEO) 2019 forecasts that transportation fuel will account for 72.4 percent of U.S. petroleum consumption in 2040 (EIA 2019a).[1] (The AEO 2019 is the source for the Section 3.2, *Affected Environment*, discussion.) Improvements in vehicle fuel economy, combined with increases in U.S. petroleum production, have substantially reduced U.S. oil imports, the overall U.S. trade deficit, and U.S. vulnerability to foreign oil supply disruptions. Transportation fuel also accounts for a large portion of total U.S. energy consumption and has a significant impact on the overall balance of U.S. energy supply and demand. The AEO 2019 forecasts that the United States will become a net energy exporter starting in 2020, as net petroleum imports fall, net exports of natural gas increase, and the United States continues to have net exports of coal. The last time the United States was a net energy exporter was in 1952 (EIA 2017f).

The AEO 2019 forecast reflects enacted legislation and final regulations, including the NHTSA CAFE standards and greenhouse gas emissions standards for U.S. passenger cars and light trucks that were published in 2012.[2] The NHTSA 2012 EIS for the CAFE standards addressed impacts of fuel economy standards for MYs 2017–2021 and the augural standards set forth for MYs 2022–2025. Fuel economy standards for MYs 2022–2025 were not finalized in that 2012 rule, but it was assumed for purposes of analysis in the 2012 EIS that the values set forth for MYs 2022–2025 would be required in the future. The NHTSA EIS referred to CAFE "standards" for the full MY 2017–2025 period, coordinated and harmonized with EPA standards for carbon dioxide (CO_2) emissions in MYs 2017–2025, but the EIS noted that CAFE standards for MYs 2022–2025 would be determined in a subsequent rulemaking.

This chapter examines the energy impacts of the Proposed Action and alternatives, some of which would revise downward the MY 2021 CAFE standards and all of which would establish required CAFE standards for MYs 2022–2026. For the purpose of this analysis, the impacts of the Proposed Action and alternatives are measured relative to a No Action Alternative that assumes that the MY 2021 standards remain unchanged, the agency finalizes the augural MY 2022–2025 standards, and the augural MY 2025 standards continue indefinitely (Chapter 2, Section 2.2, *Proposed Action and Alternatives*). In light of the important role of the transportation sector in overall U.S. energy supply and demand, this chapter discusses past, present, and forecast U.S. energy production and consumption by sector and source to characterize the affected energy environment. This chapter also quantifies energy impacts under the Proposed Action and alternatives in relation to the No Action Alternative. The chapter is organized as follows:

- Section 3.1, *Energy Intensity*, describes past and forecast trends in U.S. energy intensity. The section addresses how these trends have changed the relationship between U.S. energy use and economic growth trends.
- Section 3.2, *Affected Environment*, describes the affected environment for U.S. energy production and consumption by primary fuel source (e.g., coal, natural gas, and petroleum) and consumption

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[1] This chapter uses 2040 as NHTSA's analysis year because it is sufficiently far in the future to have almost the entire light-duty vehicle fleet composed of MY 2026 or later vehicles.

[2] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule, 77 FR 62624 (Oct. 15, 2012).

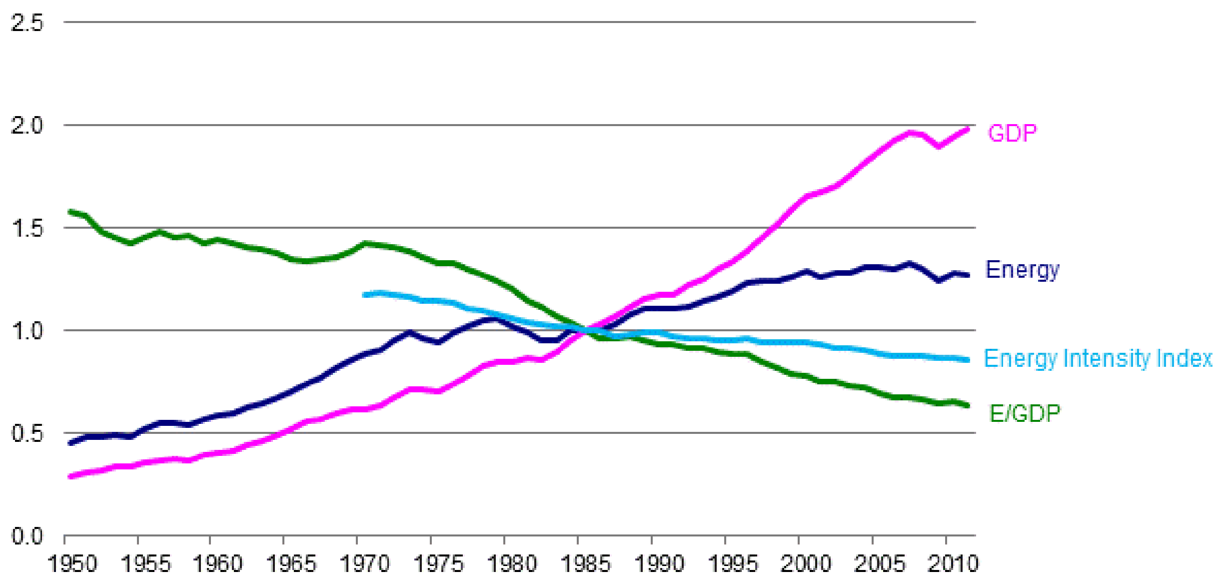
sectors (residential, commercial, industrial, and transportation). The section addresses how the passenger cars and light trucks vehicle sector affects overall energy use.

- Section 3.3, *Petroleum Imports and U.S. Energy Security*, describes how improvements in the fuel economy of vehicles and increasing energy production together affect U.S. energy security by reducing the overall U.S. trade deficit and the macroeconomic vulnerability of the United States to foreign oil supply disruptions.
- Section 3.4, *Environmental Consequences*, describes the direct and indirect energy impacts of the Proposed Action and alternatives.

3.1 Energy Intensity

Energy intensity is often calculated as the sum of all energy supplied to an economy (in thousand British thermal units [Btu]) divided by its real (inflation-adjusted) gross domestic product (GDP, the combined market price of all the goods and services produced in an economy at a given time). This energy-GDP ratio (E/GDP) can decline due to improvements in energy efficiency and/or shifts from more to less energy-intensive sectors of the economy (e.g., an increasing percentage of GDP from the services sector and a decreasing percentage of GDP from energy-intensive manufacturing). The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy has developed an economy-wide energy intensity index that estimates how the amount of energy needed to produce the same basket of goods has changed over time. Figure 3.1-1 shows that this index fell by 14 percent from 1985 to 2011, as the E/GDP ratio fell 36 percent, illustrating that the decline in energy use per dollar of GDP has come from energy efficiency improvements and shifts in the composition of GDP. The AEO 2019 forecasts ongoing declines in U.S. energy intensity, with the E/GDP forecast of energy intensity falling 33 percent from 2018 through 2040 (EIA 2019a). This forecast reflects energy efficiency improvements in all sectors of the U.S. economy, including among passenger cars and light trucks.

Figure 3.1-1. U.S. Energy Intensity, 1950–2011



Source: DOE 2019
GDP = gross domestic product; E/GDP = energy-GDP ratio

Figure 3.1-1 also shows that the relationship between growth in GDP and total energy consumption has changed over the past six decades. From 1950 through the mid-1970s, GDP growth was associated with nearly parallel growth in energy consumption, with little change in energy intensity. From 1970 to 2000, the DOE energy intensity index and E/GDP measures of energy intensity both declined, but total energy consumption still increased as GDP growth more than offset improvements in energy efficiency and shifts in GDP composition, which reduced energy intensity. From 2000 to 2011, the United States recorded substantial GDP growth with almost no increase in energy consumption, due to reductions in energy intensity.

3.2 Affected Environment

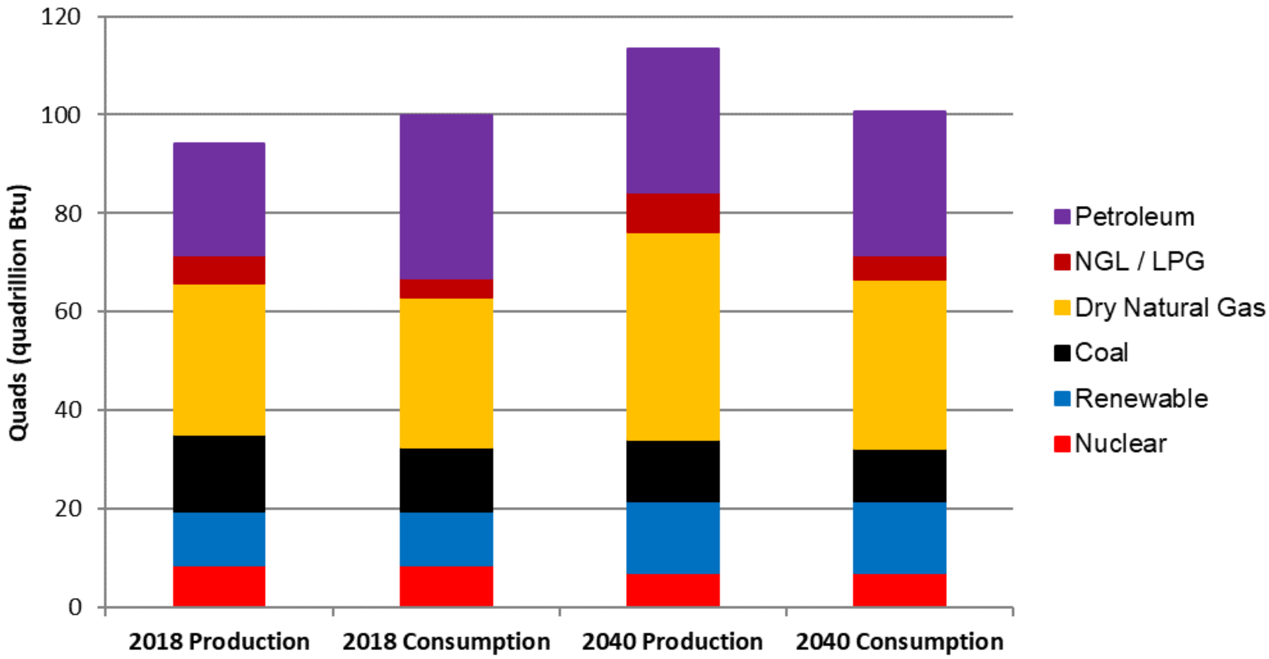
Although petroleum is overwhelmingly the primary source of energy for passenger cars and light trucks, these vehicles can use other fuels (e.g., electricity and natural gas). The Proposed Action and alternatives would affect demand for these fuels and thereby affect the availability and use of fuels consumed by other economic sectors. Understanding how primary fuel markets are expected to evolve in the coming years also provides context for considering energy impacts of the Proposed Action and alternatives. Therefore, the affected environment for energy encompasses current and projected U.S. energy consumption and production across all fuels and sectors. Section 3.2.1, *U.S. Production and Consumption of Primary Fuels*, discusses U.S. energy production and consumption by primary fuel source (e.g., petroleum, coal, and natural gas). Section 3.2.2, *U.S. Energy Consumption by Sector*, discusses U.S. energy consumption by stationary and transportation sectors.

3.2.1 U.S. Production and Consumption of Primary Fuels

Primary fuels are energy sources consumed in the initial production of energy. Energy sources used in the United States include nuclear power, coal, natural gas, crude oil (converted to petroleum products for consumption), and natural gas liquids (converted to liquefied petroleum gases [LPG] for consumption). These five energy sources accounted for 89 percent of U.S. energy consumption in 2018, whereas hydropower, biomass, solar, wind, and other renewable energy accounted for 11 percent of U.S. energy consumption in 2018 (EIA 2019a).

By 2040, the top five aforementioned energy sources are forecast to account for 85.5 percent of U.S. energy consumption, a reduction of 3.5 percent from their previous share, while the share of energy from renewable sources is forecast to rise to 14.5 percent (EIA 2019a). Forecast gains in U.S. oil and natural gas production, additional electricity generation from renewables, and energy efficiency improvements are expected to make the United States a net energy exporter starting in 2020. The change in U.S. energy production and consumption from 2018 through 2040 is shown in Figure 3.2.1-1.

Figure 3.2.1-1. U.S. Energy Production and Consumption by Source in 2018 and 2040



Source: EIA 2019a
Btu = British thermal unit; NGL = natural gas liquid; LPG = liquefied petroleum gas

From 2018 to 2040, production and consumption of nuclear power is forecast to decrease from 8.5 to 6.9 quadrillion Btu (quads), and production and consumption of renewable fuel is forecast to increase from 11.1 quads in 2018 to 14.6 quads in 2040. The forecast growth in renewable energy includes a decrease in hydropower production and consumption from 2.6 quads in 2018 to 2.5 quads in 2040. EIA also projects increases in biomass energy (e.g., ethanol and other liquid fuel from crops, and grid-connected electricity from wood and other biomass) and other renewable energy (e.g., wind and solar), from 8.5 quads in 2018 to 12.2 quads in 2040. Electric power generation accounts for 65 percent of forecast renewable fuel use in 2040, and the industrial sector accounts for another 21 percent. Because production and consumption are roughly equivalent for nuclear and renewable energy, there are essentially no net imports associated with these energy sources.[3] These fuels supplied 19 percent of U.S. energy consumption in 2018, and their combined share of consumption is forecast to increase to 21 percent by 2040.

U.S. coal production is forecast to decline from 15.7 quads in 2018 to 12.4 quads in 2040, as coal consumption is expected to decline from 13.2 quads in 2018 to 10.6 quads in 2040. The United States is currently, and is expected to remain, a net exporter of coal energy through 2040.

[3] There are virtually no U.S. net imports of nuclear power in the sense that U.S. consumption of electricity generated by nuclear power is supplied by U.S. nuclear power plants. Supply and consumption of nuclear fuel at different stages of processing is more complex, encompassing a nuclear fuel cycle that includes mining of uranium ore, conversion into uranium hexafluoride (UF6), and enrichment to increase the concentration of uranium-235. Uranium quantities are expressed in the unit of measure U3O8e (equivalent). U3O8e is uranium oxide (or uranium concentrate) and the equivalent uranium-component of UF6 and enriched uranium. U.S. nuclear plants in 2015 purchased 94 percent of their total delivered U3O8e (equivalent) from foreign suppliers (EIA 2016d).

U.S. production of dry natural gas (separated from natural gas liquids, discussed below) is forecast to increase from 30.6 quads in 2018 to 42.2 quads in 2040, while consumption of natural gas is expected to rise from 30.4 quads in 2018 to 34.5 quads in 2040, making the United States a net exporter of natural gas in 2018 through 2040. The forecast growth in natural gas is due to new production technologies that have enabled increases in U.S. shale gas production that far more than offset declines in conventional natural gas production.

Production of natural gas liquid (a similar but heavier hydrocarbon than dry natural gas) is forecast to increase from 5.9 quads in 2018 to 8.1 quads in 2040. After extraction, natural gas liquid is separated from dry natural gas in processing plants and sold as ethane, propane, and other LPGs. LPG consumption is forecast to increase from 3.8 quads in 2018 to 4.7 quads in 2040. Therefore, the increase in LPG production is expected to outpace the growth in LPG consumption, resulting in net exports from 2018 through 2040.

U.S. production of crude oil is forecast to increase from 22.4 quads in 2018 to 29.2 quads in 2040. Crude oil is refined into petroleum products (which includes gasoline and diesel, but excludes non-petroleum liquid fuels, such as biofuels and LPG). U.S. consumption of petroleum is forecast to decline from 33.0 quads in 2018 to 29.4 quads in 2040. Therefore, U.S. net imports of petroleum are forecast to decline from 10.6 quads (1.83 billion barrels) in 2018 to 0.2 quad (0.03 billion barrel) in 2040.

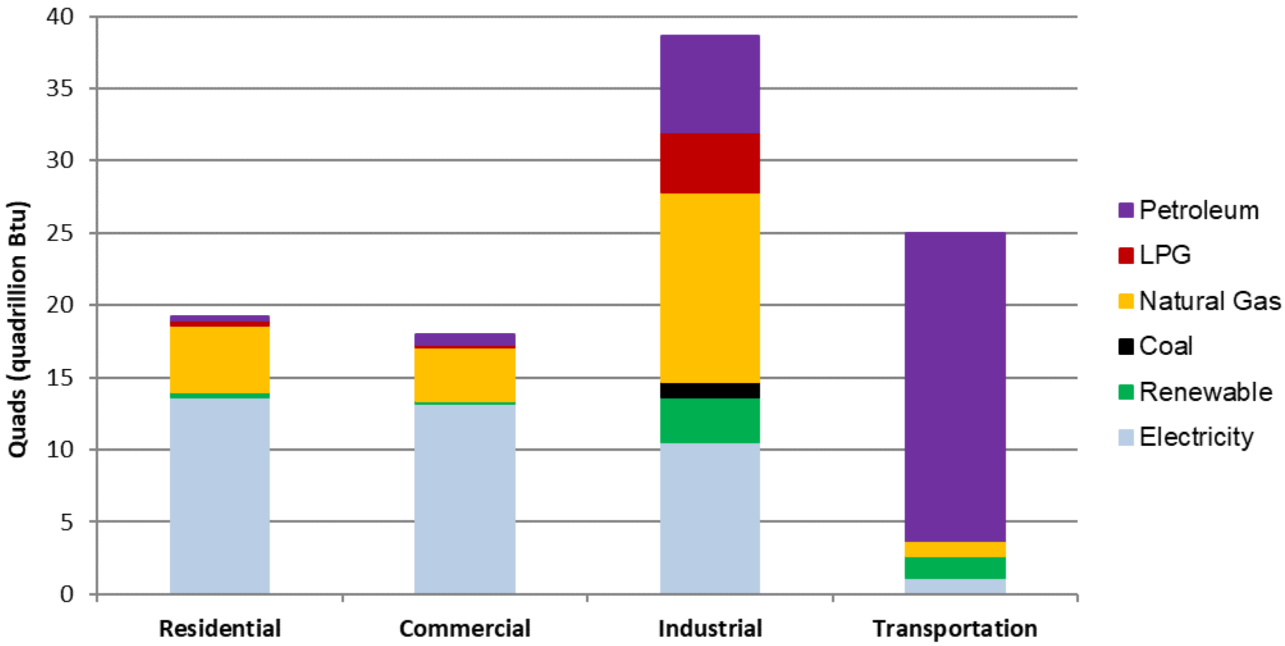
The primary fuel projections demonstrate that there are likely to be essentially no U.S. net imports of nuclear power and renewable energy, with U.S. net exports expected for coal, natural gas, and natural gas liquid from 2018 through 2040. U.S. net imports of petroleum are also expected to decline to a level that is less than net exports of other primary fuels, resulting in a forecast of net energy exports from 2020 through 2040 (EIA 2019a).

3.2.2 U.S. Energy Consumption by Sector

This section discusses the use of primary fuels by sector. Energy consumption occurs in four broad economic sectors: industrial, residential, commercial, and transportation. These sectors can be categorized as stationary (industrial, residential, and commercial sectors) or mobile (transportation). Stationary and transportation sectors consume the primary fuels previously described (e.g., natural gas, coal, and petroleum) and electricity. Electric power generation consumes primary fuel to provide electricity to the industrial, residential, commercial, and transportation sectors. Total primary energy consumption for electric power generation is forecast to increase from 38.2 quads in 2018 to 38.5 quads in 2040. In 2018, nuclear power supplied 22 percent of electric power generation source fuel, coal 32 percent, natural gas 28 percent, and renewable energy 17 percent. In 2040, nuclear power is expected to supply 18 percent of electric power generation source fuel, coal 25 percent, natural gas 32 percent, and renewable energy 25 percent. The petroleum share of electric power fuel supply is anticipated to decline from 0.5 percent in 2018 to just 0.2 percent in 2040 (EIA 2019a).

Figure 3.2.2-1 illustrates sharply contrasting profiles for 2040 fuel consumption forecasts for stationary and transportation sectors, with stationary sectors consuming more electricity and natural gas, and the transportation sector consuming primarily petroleum. Sections 3.2.2.1, *Stationary-Sector Fuel Consumption*, and 3.2.2.2, *Transportation-Sector Fuel Consumption*, discuss the specifics of fuel use by those sectors, respectively.

Figure 3.2.2-1. Forecast U.S. Energy Consumption by End-Use Sector and Source Fuel in 2040



Source: EIA 2019a
Btu = British thermal unit; LPG = liquefied petroleum gas

3.2.2.1 Stationary-Sector Fuel Consumption

This section provides background information on stationary-sector fuel consumption, which could be affected by the Proposed Action and alternatives either by increased use of plug-in electric vehicles or by changes in upstream energy use related to energy production, refining, storage, and distribution. Because forecast deployment rates of plug-in electric vehicles are anticipated to be low and upstream energy use related to energy production, refining, storage, and distribution constitute only a small percentage of national energy consumption, the Proposed Action and alternatives would likely have a negligible impact on this sector. Section 3.2.2.2, *Transportation-Sector Fuel Consumption*, discusses transportation fuel consumption, on which the Proposed Action and alternatives would be expected to have a larger impact.

Electricity (including energy losses during generation and transmission) and natural gas used on site (for heat, cooking, and hot water) are the principal forms of energy used by the residential and commercial sectors, accounting for 94 percent of 2018 energy use and 95 percent of forecast 2040 energy use in these two sectors. The industrial sector has more diverse energy consumption patterns, including coal, LPG, petroleum, and renewable energy, but electricity and natural gas still accounted for 62 percent of 2018 industrial sector energy use, and account for 61 percent of forecast 2040 energy use. New energy technologies that supply stationary energy to consumers must compete with an existing infrastructure that delivers electricity and natural gas reliably and at a relatively low cost, but energy efficiency improvements are expected to restrain total energy consumption growth in these sectors.

Residential-sector energy consumption is forecast to decline from 21.1 quads in 2018 to 19.2 quads in 2040, with this sector accounting for 21 percent of U.S. energy consumption in 2018 and 19 percent of forecast U.S. energy consumption in 2040. Residential consumption of liquid fuel (propane, kerosene, and distillate fuel oil) is expected to fall from 1.0 quad in 2018 to 0.6 quad in 2040. Residential use of natural gas is expected to decline from 5.0 quads in 2018 to 4.6 quads in 2040. Residential electricity use is expected to decline from 14.7 quads in 2018 to 13.6 quads in 2040, and renewable fuel use (primarily wood for heating) is expected to fall from 0.44 quad in 2018 to 0.38 quad in 2040.

Commercial-sector energy consumption is forecast to fall from 18.3 quads in 2018 to 17.9 quads in 2040, with this sector accounting for 18 percent of U.S. energy consumption in 2018 and 18 percent of forecast U.S. energy consumption in 2040. Commercial use of liquid fuel, renewable energy, and coal, are all expected to be essentially the same in 2016 and 2040, at 0.9 quad for liquid fuel, 0.14 quad for renewable energy, and 0.02 quad for coal. Commercial use of electricity is expected to decrease from 13.8 quads in 2018 to 13.2 quads in 2040. Commercial use of natural gas is expected to increase from 3.4 quads in 2018 to 3.7 quads in 2040.

Industrial-sector energy consumption is projected to rise from 32.3 quads in 2018 to 38.6 quads in 2040, with this sector accounting for 32 percent of U.S. energy consumption in 2018 and 38 percent of forecast energy consumption in 2040. Industrial consumption of LPG is expected to increase from 3.1 quads in 2018 to 4.2 quads in 2040, petrochemical feedstock consumption is forecast to increase from 0.7 quad in 2018 to 1.2 quads in 2040, and other petroleum product liquid fuel use is expected to increase from 5.0 quads in 2018 to 5.4 quads in 2040. Industrial coal use is expected to decrease from 1.12 quads in 2018 to 1.06 quads in 2040. Industrial consumption of renewable energy is expected to increase from 2.4 quads in 2018 to 3.1 quads in 2040. Industrial electricity use is forecast to increase from 9.5 quads in 2018 to 10.6 quads in 2040, and natural gas consumption is forecast to increase from 10.5 quads in 2018 to 13.1 quads in 2040.

3.2.2.2 Transportation-Sector Fuel Consumption

Transportation sector fuel consumption is forecast to decline from 28.1 quads in 2018 to 25.0 quads in 2040. In 2018, petroleum supplied 91.2 percent of transportation energy use, biofuel (mostly ethanol used in gasoline blending) 5.5 percent, natural gas 2.8 percent, LPG (propane) 0.03 percent, and electricity 0.5 percent. In 2040, petroleum is expected to supply 85.2 percent of transportation energy use, biofuel 5.9 percent, natural gas 4.3 percent, hydrogen 0.15 percent (up from 0.004 percent in 2018), LPG 0.04 percent, and electricity 4.5 percent.

In 2018, passenger cars and light trucks accounted for 55 percent of transportation energy consumption, medium- and heavy-duty (HD) vehicles accounted for 24 percent, air travel accounted for 9 percent, and other transportation (e.g., boats, rail, pipeline) accounted for 12 percent. In 2040, passenger cars and light trucks are expected to account for 46 percent of transportation energy consumption, HD vehicles 28 percent, air travel 13 percent, and other transportation 13 percent. The forecast decline in the percentage of transportation energy used by passenger cars and light trucks reflects the fuel economy improvements that are expected under the No Action Alternative.

In 2018, the transportation sector accounted for 77.6 percent of total U.S. petroleum consumption. In 2040, transportation is expected to account for 72.4 percent of U.S. petroleum use, with the industrial sector accounting for 22.5 percent. The residential and commercial sectors, unspecified sector consumption, and electricity generation combined are expected to account for just 5.0 percent of U.S. petroleum consumption in 2040. With petroleum expected to be the only U.S. primary fuel with net imports in 2040 and transportation expected to account for 72.4 percent of U.S. petroleum use in 2040, U.S. net petroleum imports through 2040 are expected to result primarily from fuel consumption by the transportation sector.

The forecast decline in transportation energy use is led by a 27.7 percent forecast decline from 2018 to 2040 in energy used by passenger cars and light trucks, despite a 13.4 percent forecast increase in vehicle miles traveled (VMT) by passenger cars and light trucks. The forecast decline in energy use by passenger cars and light trucks reflects the impacts under the No Action Alternative. The EPA CO_2 emissions standards and NHTSA CAFE standards in the 2019 AEO forecast (and, thus, the No Action Alternative) contribute to a 56.9 percent forecast increase from 2018 to 2040 in the average miles per gallon achieved by all passenger cars and light trucks in use, as older, less efficient vehicles are replaced by more efficient vehicles.[4] The forecast decline in energy use by passenger cars and light trucks is reflected in a 28.0 percent forecast decline from 2018 to 2040 in transportation sector gasoline use, with gasoline expected to account for 92 percent of energy consumption by passenger cars and light trucks in 2040.

The AEO 2019 also forecasts a 0.3 percent decline from 2018 to 2040 in energy used by HD vehicles despite a 34 percent forecast increase in VMT for HD trucks, reflecting impacts of Phase 1 and Phase 2 standards for HD vehicle fuel efficiency. The small forecast decline in energy used by HD vehicles is associated with a 5.0 percent forecast decline from 2018 to 2040 in transportation sector diesel use, with diesel expected to account for 78.4 percent of HD vehicle fuel in 2040.

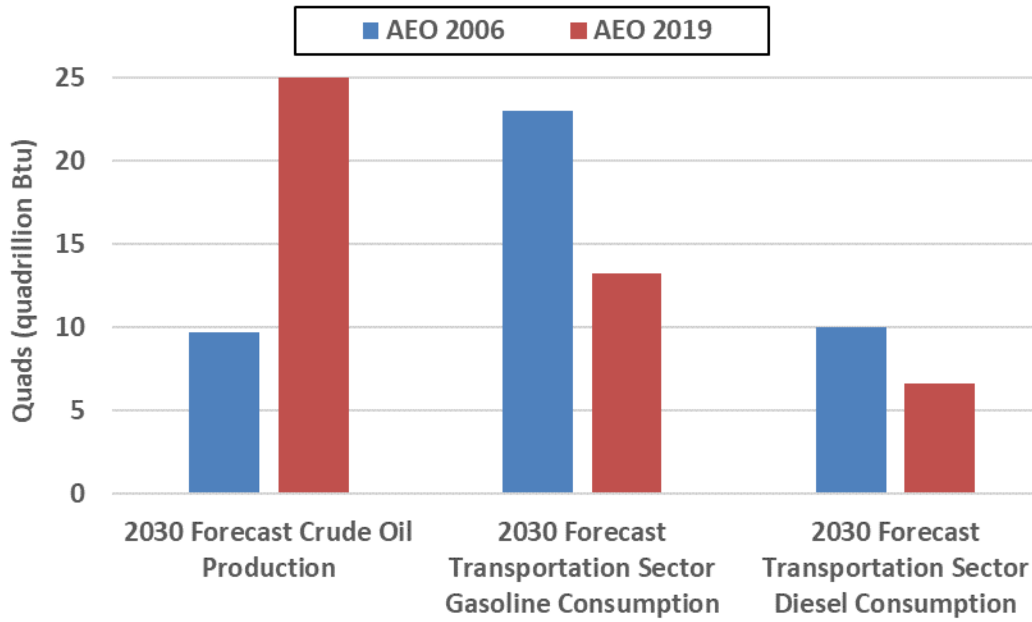
3.3 Petroleum Imports and U.S. Energy Security

Section 3.2, *Affected Environment,* shows that the United States is expected to have net energy exports from 2018 through 2040 for the combination of all source fuels, except for petroleum. Petroleum net imports are also expected to decline to a level that is less than net exports of other primary fuels, resulting in U.S. net energy exports from 2020 through 2040. In 2040, the transportation sector is expected to account for 72.4 percent of all U.S. petroleum use, with passenger cars and light trucks accounting for 46 percent of transportation energy consumption. Therefore, fuel economy improvements required by previously promulgated CAFE standards for passenger cars and light trucks have had a substantial impact on the forecast extent of U.S. dependence on petroleum imports.

The forecast decline in U.S. net petroleum imports reflects stark changes in forecasts for both petroleum production and transportation sector petroleum consumption between the time of the AEO 2006 and the AEO 2019, as shown in Figure 3.3-1. The AEO 2006 forecast U.S. crude oil production of 9.7 quads in 2030, but the AEO 2019 forecasts production of 30.0 quads in 2030, an increase of 20.3 quads. The AEO 2006 also forecast transportation sector gasoline consumption of 23.0 quads and diesel consumption of 10.0 quads in 2030, but the AEO 2019 forecasts transportation sector gasoline consumption of 13.3 quads and diesel consumption of 6.6 quads in 2030, a decrease of 13.1 quads. (Figure 3.3-1 compares forecasts for 2030 because this was the last year of the AEO 2006 forecast.)

[4] AEO is an energy forecast, not a rulemaking analysis. AEO uses the EIA's National Energy Modeling System (NEMS), which represents fleets and standards at a highly generalized level that, while appropriate for economy-wide energy forecasting, is too generalized to be usable for rulemaking analysis. NHTSA's analysis supporting the Final EIS and final rule uses DOT's CAFE model, which is designed to support rulemaking analysis. Since 2012, DOT, working with EPA, has significantly expanded and refined the CAFE model, and has updated many accompanying input data and estimates. Some model inputs are considerably different from those used in 2012.

Figure 3.3-1. Changes in 2030 Annual Energy Outlook Forecasts with Large Impacts on U.S. Net Petroleum Imports

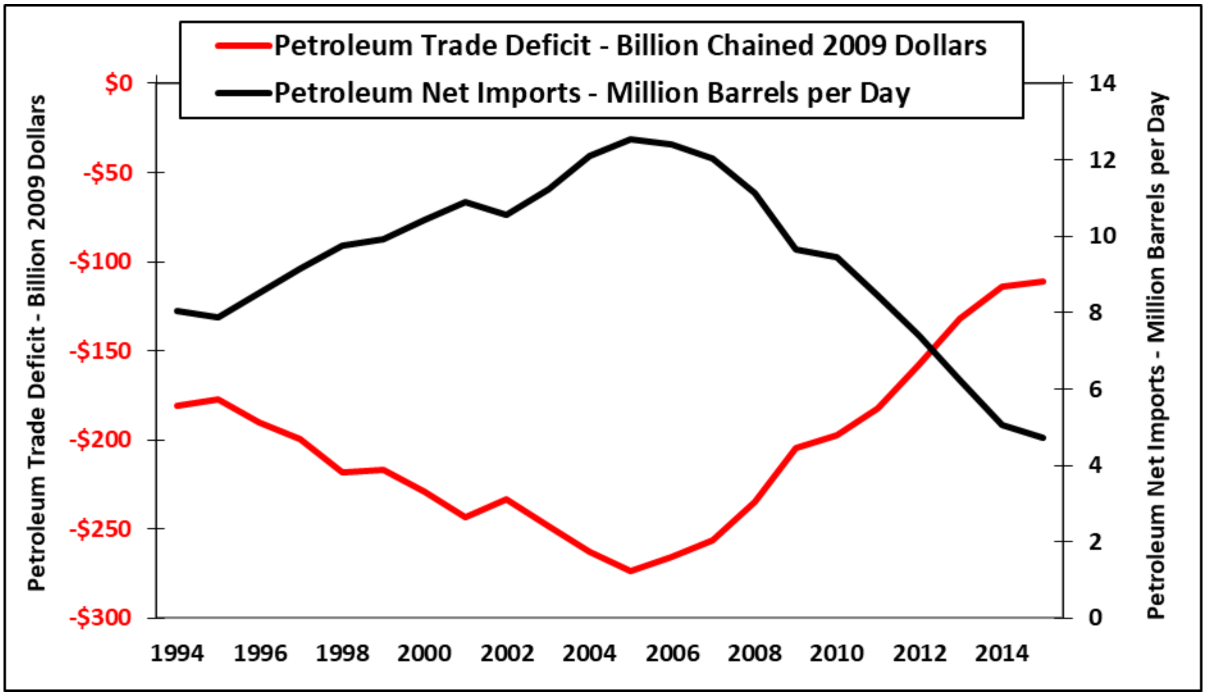


Source: EIA 2006 and EIA 2019a
AEO = Annual Energy Outlook; Btu = British thermal unit

As noted in Section 3.2, *Affected Environment,* the forecast trend in diesel use is mostly associated with HD vehicles, and the forecast trend in gasoline use is mostly associated with passenger cars and light trucks. About half of the difference between AEO 2006 and AEO 2019 forecasts for gasoline and diesel use in 2030 reflects slower forecast growth in VMT, while improvements in vehicle efficiency account for the other half of this change. The AEO 2019 also forecasts another 9.0 percent fall in gasoline use from 2030 to 2040 (a decline of 1.3 quads) as older vehicles are replaced by more efficient passenger cars and light trucks. Furthermore, the change in the gasoline forecast from AEO 2006 to AEO 2019 understates the decline in petroleum used in gasoline because the amount of petroleum consumed has been reduced by ethanol blending. As recently as 2000, U.S. gasoline consumption was almost entirely associated with petroleum content, but ethanol is now blended into nearly all U.S. gasoline as E10, which is 10 percent ethanol by volume, thereby reducing the petroleum content of gasoline.

Figure 3.3-2 shows the 1994–2015 rise and fall of U.S. net imports of petroleum (in million barrels per day) and the associated trend in the U.S. petroleum trade deficit (in billion dollars per year). The petroleum trade deficit reflects the physical volume of petroleum net imports and the prevailing price of crude oil that determines the dollar value of petroleum net imports. However, Figure 3.3-2 shows that the petroleum trade deficit trend (in 2009 chained dollars) has been a near mirror image of the petroleum net import trend despite changes in oil prices from 1994 to 2015. From 2000 through 2005 the U.S. petroleum trade deficit accounted for almost 40 percent of the total U.S. trade deficit, but the petroleum trade deficit declined from $273 billion in 2005 to $111 billion in 2015, as petroleum net imports fell from 12.5 million barrels per day in 2005 to 4.7 million barrels per day in 2015.

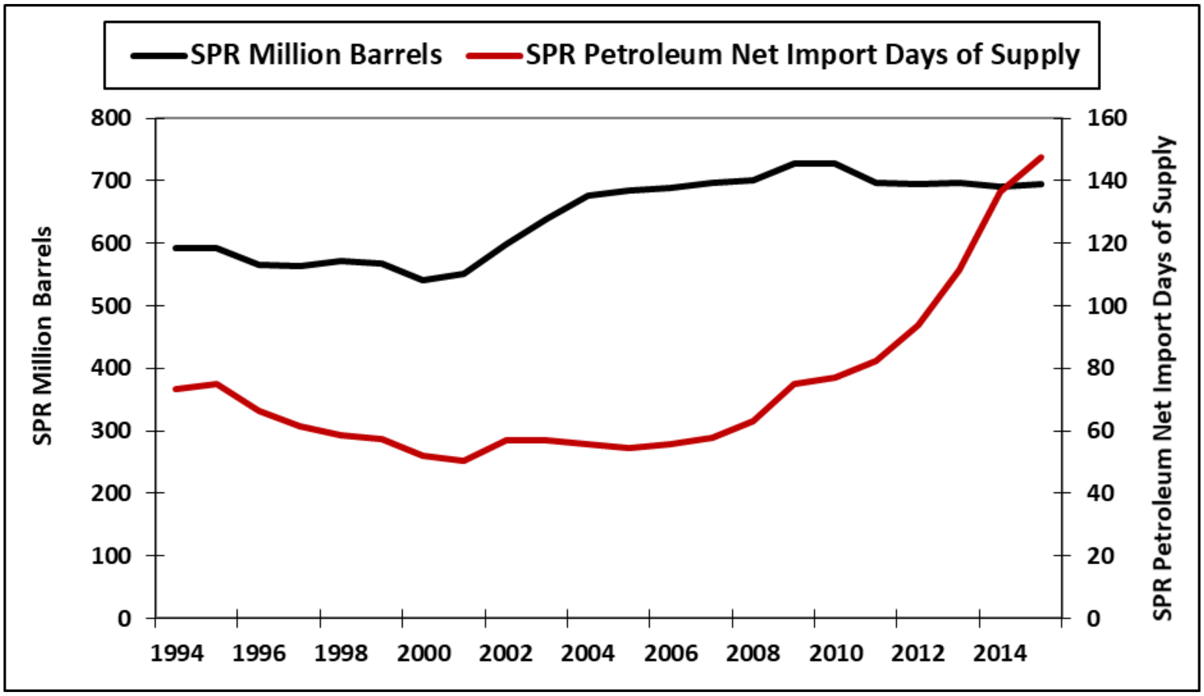
Figure 3.3-2. 1994–2015 Petroleum Net Imports (barrels) and Net Petroleum Trade Deficit (dollars)



Source: EIA 2019a, U.S. Census 2017

In addition to reducing the overall U.S. trade deficit, declines in U.S. net imports of petroleum also reduce the economic vulnerability of the United States to foreign oil supply disruptions. The Strategic Petroleum Reserve (SPR) was created in the 1970s after the 1973–74 embargo of oil flowing into the United States from many oil exporters caused severe U.S. economic disruptions. The strategic and economic protection provided by the SPR can be measured by the *days of petroleum net import supply* that the SPR could provide in the event of a complete halt to foreign oil supplies. This days of petroleum net import supply measure is determined by both the total amount oil held in the SPR and by the extent to which the United States is dependent on net petroleum imports. Figure 3.3-3 shows that the amount of crude oil held in the SPR increased by 17 percent from 1994 through 2005 but the days of petroleum net import supply in the SPR fell by 29 percent over those years because average daily petroleum net imports increased substantially from 1994 through 2005 (Figure 3.3-2). From 2005 through 2015, Figure 3.3-3 shows that the amount of crude oil held in the SPR was almost unchanged (up 1.5 percent) but the days of petroleum net import supply in the SPR increased by 170 percent during the same period because average daily petroleum net imports declined substantially from 2005 through 2015 (Figure 3.3-2). Ongoing forecast declines in U.S. net imports of petroleum will continue to increase the days of petroleum net import supply associated with any given amount of crude oil held in the SPR.

Figure 3.3-3. 1994–2015 Strategic Petroleum Reserve—Million Barrels vs. Days of Petroleum Net Import Supply



SPR = Strategic Petroleum Reserve

3.4 Environmental Consequences

All of the action alternatives would contribute to projected ongoing declines in U.S. energy intensity through 2050, but to a smaller extent than the No Action Alternative. Under the No Action Alternative, the average fuel economy of all light duty vehicles in use would increase by 67 percent from 2020 through 2050. Under Alternative 3 (NHTSA's Preferred Alternative), the average fuel economy of all light duty vehicles in use would increase by 46 percent from 2020 through 2050, as older, less efficient vehicles are replaced by new vehicles that achieve much better fuel economy. Gasoline accounts for 92 percent to 96 percent of total gasoline gallon equivalent (GGE) use in 2050 under all of the alternatives, so improvements in fuel economy would reduce net petroleum imports. Energy impacts on stationary energy sectors would be negligible due to the limited use of petroleum in those sectors.

Table 3.4-1 shows the direct and indirect impacts of each alternative on combined fuel consumption for 2020 through 2050, by which time almost the entire light-duty vehicle fleet will be composed of MY 2026 or later vehicles. Light-duty vehicle fuel consumption is shown in GGE, which includes consumption of gasoline, diesel, biofuel, hydrogen, and electricity used to power the light-duty vehicle fleet. Table 3.4-1 shows 2020 to 2050 fuel use resulting from the Proposed Action and alternatives compared to the No Action Alternative.

Table 3.4-1. Fuel Consumption and Increase in Fuel Consumption by Alternative (billion gasoline gallon equivalent total for calendar years 2020–2050)

	Alt 0 No Action	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Fuel Consumption								
Cars	1,482	1,594	1,591	1,583	1,584	1,564	1,560	1,537
Light trucks	1,889	2,004	2,000	1,988	1,977	1,950	1,932	1,919
All light-duty vehicles	3,371	3,598	3,591	3,571	3,561	3,514	3,492	3,456
Increase in Fuel Use Compared to the No Action Alternative								
Cars	--	112	108	101	101	82	78	55
Light trucks	--	115	111	98	88	61	43	29
All light-duty vehicles	--	226	220	200	189	142	120	85

Total light-duty vehicle fuel consumption from 2020 to 2050 under the No Action Alternative is projected to be 3,371 billion GGE. Light-duty vehicle fuel consumption from 2020 to 2050 under the Proposed Action and alternatives is projected to range from 3,598 billion GGE under Alternative 1 to 3,456 billion GGE under Alternative 7. All of the action alternatives would increase fuel consumption compared to the No Action Alternative, with increases that range from 226 billion GGE under Alternative 1 to 85 billion GGE under Alternative 7.

CHAPTER 4 AIR QUALITY

4.1 Affected Environment

4.1.1 Relevant Pollutants and Standards

Many human activities cause gases and particles to be emitted into the atmosphere. These activities include driving cars and trucks; burning coal, oil, and other fossil fuels; manufacturing chemicals and other products; and smaller, everyday activities such as dry-cleaning, degreasing, painting operations, and the use of consumer household and grooming products. When these gases and particles accumulate in the air in high enough concentrations, they can harm humans—especially children, the elderly, the ill, and other sensitive individuals—and can damage crops, vegetation, buildings, and other property. Many air pollutants remain in the environment for long periods and are carried by the wind hundreds of miles from their origins. People exposed to high enough levels of certain air pollutants can experience burning in their eyes, an irritated throat, breathing difficulties, or other respiratory symptoms. Long-term exposure to air pollution can cause cancer, heart and lung diseases, and damage to the immune, neurological, reproductive, and respiratory systems. In extreme cases, it can even cause death (EPA 2012a).

To reduce air pollution levels, the Federal Government and state agencies have passed legislation and established regulatory programs to control sources of emissions. The Clean Air Act (CAA) is the primary federal legislation that addresses air quality. Under the CAA, as amended, EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants.[1] The criteria pollutants discussed in this EIS are carbon monoxide (CO), nitrogen dioxide (NO_2) (one of several oxides of nitrogen), ozone, sulfur dioxide (SO_2), particulate matter (PM) with a diameter equal to or less than 10 microns (PM10) and 2.5 microns (PM2.5, or fine particles), and lead. Vehicles do not directly emit ozone, but this pollutant is evaluated based on emissions of the ozone precursor pollutants nitrogen oxides (NO_X) and volatile organic compounds (VOCs). This air quality analysis assesses the impacts of the No Action Alternative and action alternatives in relation to these criteria pollutants. It also assesses how the alternatives would affect the emissions of certain hazardous air pollutants.

Total emissions from on-road mobile sources (highway vehicles) have declined dramatically since 1970 because of pollution controls on vehicles and regulation of the chemical content of fuels, despite continuing increases in vehicle miles traveled (VMT). From 1970 to 2016, emissions from on-road mobile sources declined 89 percent for CO, 71 percent for NO_X, 59 percent for PM2.5, 40 percent for PM10, 93 percent for SO_2, and 90 percent for VOCs. Nevertheless, the U.S. transportation sector remains a major source of emissions of certain criteria pollutants or their chemical precursors. On-road mobile sources are responsible for emitting 17.9 million tons per year of CO (30 percent of total U.S. emissions), 133,000 tons per year (2 percent) of PM2.5, and 287,000 tons per year (1 percent) of PM10 (EPA 2016a). Passenger cars and light trucks contribute 93 percent of U.S. highway emissions of CO, 57 percent of highway emissions of PM2.5, and 55 percent of highway emissions of PM10 (EPA 2014g). Almost all of the PM in motor vehicle exhaust is PM2.5 (Gertler et al. 2000, EPA 2014g); therefore, this analysis

[1] *Criteria pollutants* is a term used to describe the six common air pollutants for which the CAA requires EPA to set NAAQS. EPA calls these pollutants criteria air pollutants because it regulates them by developing human health-based or environmentally based criteria (science-based guidelines) for setting permissible levels. *Hazardous air pollutants* refer to substances defined as hazardous by the 1990 CAA amendments. These substances include certain VOCs, compounds in particulate matter (PM), pesticides, herbicides, and radionuclides that present tangible hazards based on scientific studies of human (and other mammal) exposure.

focuses on PM2.5 rather than PM10. On-road mobile sources also emit 1.8 million tons per year (11 percent of total U.S. emissions) of VOCs and 3.6 million tons per year (34 percent) of NO_X, which are chemical precursors of ozone (EPA 2016a). Passenger cars and light trucks emit 90 percent of U.S. highway emissions of VOCs and 51 percent of NO_X (EPA 2014g). In addition, NO_X is a PM2.5 precursor and VOCs can be PM2.5 precursors.[2] SO_2 and other oxides of sulfur (SO_X) contribute to the formation of PM2.5 in the atmosphere; however, on-road mobile sources account for less than 0.68 percent of U.S. SO_2 emissions. With the elimination of lead in automotive gasoline, lead is no longer emitted from motor vehicles in more than negligible quantities. Therefore, this analysis does not address lead.

Table 4.1.1-1 lists the primary and secondary NAAQS for each criteria pollutant. Under the CAA, EPA sets primary standards at levels intended to protect against adverse impacts on human health; secondary standards are intended to protect against adverse impacts on public welfare, such as damage to agricultural crops or vegetation and damage to buildings or other property. Because each criteria pollutant has different potential impacts on human health and public welfare, NAAQS specify different permissible levels for each pollutant. NAAQS for some pollutants include standards for short- and long-term average levels. Short-term standards are intended to protect against acute health impacts from short-term exposure to higher levels of a pollutant; long-term standards are established to protect against chronic health impacts resulting from long-term exposure to lower levels of a pollutant.

NAAQS are most commonly used to help assess the air quality of a geographic region by comparing the levels of criteria air pollutants found in the atmosphere to the levels established by NAAQS. Concentrations of criteria pollutants in the air mass of a region are measured in parts of a pollutant per million parts of air (parts per million or ppm) or in micrograms of a pollutant per cubic meter of air (micrograms per cubic meter or $\mu g/m^3$) present in repeated air samples taken at designated monitoring locations. These ambient concentrations of each criteria pollutant are compared to the permissible levels specified by NAAQS to assess whether the region's air quality could be unhealthful.

When the measured concentrations of a criteria pollutant in a geographic region are less than those permitted by NAAQS, EPA designates the region as an attainment area for that pollutant; regions where concentrations of criteria pollutants exceed federal standards are called nonattainment areas. Former nonattainment areas that are now in compliance with NAAQS are designated as maintenance areas. Each state with a nonattainment area is required to develop and implement a State Implementation Plan (SIP) documenting how the region will reach attainment levels within periods specified in the CAA. For maintenance areas, the SIP must document how the state intends to maintain compliance with NAAQS. When EPA changes a NAAQS, each state must revise its SIP to address how it plans to attain the new standard.

[2] NO_X can undergo chemical transformations in the atmosphere to form nitrates. VOCs can undergo chemical transformations in the atmosphere to form other various carbon compounds. Nitrates and carbon compounds can be major constituents of PM2.5. Highway vehicle emissions are large contributors to nitrate formation nationally (EPA 2004b).

Table 4.1.1-1. National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level[a]	Averaging Time	Level[a]	Averaging Time
Carbon monoxide (CO)	9 ppm (10 mg/m^3)	8 hours[b]	None	
	35 ppm (40 mg/m^3)	1 hour[b]		
Lead	0.15 µg/m^3	Rolling 3-month average	Same as primary standards	
Nitrogen dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual (arithmetic mean)	Same as primary standards	
	0.100 ppm (188 µg/m^3)	1 hour[c]	None	
Particulate matter (PM10)	150 µg/m^3	24 hours[d]	Same as primary standards	
Particulate matter (PM2.5)	12.0 µg/m^3	Annual (arithmetic mean)[e]	15.0 µg/m^3	Annual (arithmetic mean)[e]
	35 µg/m^3	24 hours[f]	Same as primary standards	
Ozone	0.070 ppm	8 hours[g]	Same as primary standards	
Sulfur dioxide (SO_2)	0.075 ppm (200 µg/m^3)	1 hour[h]	0.5 ppm (1,300 µg/m^3)	3 hours[b]

Notes:
[a] Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter (µg/m^3) of air.
[b] Not to be exceeded more than once per year.
[c] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average NO_2 concentrations at each monitor within an area must not exceed 0.100 ppm (effective January 22, 2010).
[d] Not to be exceeded more than once per year on average over 3 years.
[e] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 12.0 µg/m^3 for the primary standard and 15.0 µg/m^3 for the secondary standard.
[f] To attain this standard, the 3-year average of the 98th percentile of 24-hour PM2.5 concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).
[g] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor in an area over each year must not exceed 0.070 ppm (effective December 28, 2015).
[h] To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average SO_2 concentrations must not exceed 0.075 ppm.
Source: 40 CFR § 50, as presented in EPA 2016a
ppm = parts per million; mg/m^3 = milligrams per cubic meter; µg/m^3 = micrograms per cubic meter; CFR = Code of Federal Regulations; EPA = U.S. Environmental Protection Agency; PM10 = particulate matter with a diameter equal to or less than 10 microns; PM2.5 = particulate matter with a nominal aerodynamic diameter equal to or less than 2.5 microns

NAAQS have not been established for hazardous air pollutants. Hazardous air pollutants emitted from vehicles that are known or suspected to cause cancer or other serious health and environmental impacts are referred to as mobile source air toxics (MSATs).[3] The MSATs included in this analysis are acetaldehyde, acrolein, benzene, 1,3-butadiene, diesel particulate matter (DPM), and formaldehyde. EPA and the Federal Highway Administration (FHWA) have identified these air toxics as the MSATs that typically are of greatest concern for impacts from highway vehicles (EPA 2007, FHWA 2012). DPM is a component of exhaust from diesel-fueled vehicles and falls almost entirely within the PM2.5 particle-size class. On-road mobile sources are responsible for 28,475 tons per year (3 percent of total U.S.

[3] A list of all MSATs identified by EPA to date can be found in the *Regulatory Impact Analysis for Final Rule: Control of Hazardous Air Pollutants from Mobile Sources* (signed February 9, 2007), EPA420-R-07-002, Tables 1.1-1 and 1.1-2 (EPA 2007).

emissions) of acetaldehyde emissions, 2,560 tons per year (5 percent) of acrolein emissions, 59,428 tons per year (28 percent) of benzene emissions, 9,484 tons per year (21 percent) of 1,3-butadiene emissions, and 38,941 tons per year (3 percent) of formaldehyde emissions (EPA 2018i).[4]

Vehicle-related sources of air pollutants include exhaust emissions, evaporative emissions, resuspension of road dust, and tire and brake wear. Locations close to major roadways generally have elevated concentrations of many air pollutants emitted from motor vehicles. Hundreds of studies published in peer-reviewed journals have concluded that concentrations of CO, nitric oxide, NO_2, benzene, aldehydes, PM, black carbon, and many other compounds are elevated in ambient air within approximately 300 to 600 meters (about 1,000 to 2,000 feet) of major roadways. Studies that focused on measurements during meteorological conditions that tend to inhibit the dispersion of emissions have found that concentrations of traffic-generated air pollutants can be elevated for as much as 2,600 meters (about 8,500 feet) downwind of roads under such meteorological conditions (Hu et al. 2009, 2012). The highest concentrations of most pollutants emitted directly by motor vehicles are found at locations within 50 meters (about 165 feet) of the edge of a roadway's traffic lanes.

Air pollution near major roads has been shown to increase the risk of adverse health impacts in populations who live, work, or attend school near major roads.[5] A 2013 study estimated that 19 percent of the U.S. population (more than 59 million people) lived within 500 meters (about 1,600 feet) of major roads (those with at least 25,000 annual average daily traffic) while about 3.2 percent of the population (10 million people) lived within 100 meters (about 300 feet) of such roads (Rowangould 2013). Another 2013 study estimated that 3.7 percent of the U.S. population (about 11 million people) lived within 150 meters (about 500 feet) of interstate highways, or other freeways and expressways (Boehmer et al. 2013). Because of the large number of people who live near major roads, it is important to understand how traffic-generated pollutants collectively affect the health of exposed populations (EPA 2014d).

In the past 15 years, many studies have reported that populations who live, work, or go to school near high-traffic roadways experience higher rates of numerous adverse health impacts, compared to populations far away from major roads.[6] Numerous studies have found adverse health impacts associated with spending time in traffic, such as commuting or walking along high-traffic roadways (Laden et al. 2007, Peters et al. 2004, Zanobetti et al. 2009, Dubowsky Adar et al. 2007). The health outcomes with the strongest evidence of linkages with traffic-associated air pollutants are respiratory effects, particularly in asthmatic children, and cardiovascular effects.

Numerous reviews of this body of health literature have been published as well. In 2010, an expert panel of the Health Effects Institute published a review of hundreds of exposure, epidemiology, and toxicology studies (HEI 2010). The panel rated how the evidence for each type of health outcome supported a conclusion of a causal association with traffic-associated air pollution as either "sufficient," "suggestive but not sufficient," or "inadequate and insufficient." The panel categorized evidence of a causal association for exacerbation of childhood asthma as "sufficient," and categorized evidence of a causal association for new onset asthma as between "sufficient" and "suggestive but not sufficient." The

[4] Nationwide total emissions data are not available for DPM.

[5] Most of the information in the remainder of this section appeared originally in the EPA 2014 Final Rule establishing Tier 3 motor vehicle emissions and fuel standards. Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards; Final Rule, 79 FR 23414 (April 28, 2014).

[6] The Tier 3 Final Rule reported that in the widely used PubMed database of health publications, between January 1, 1990 and August 18, 2011, 605 publications contained the keywords "traffic, pollution, epidemiology," with approximately half the studies published after 2007.

panel categorized evidence linking traffic-associated air pollutants with exacerbation of adult respiratory symptoms and lung function decrement as "suggestive of a causal association." It categorized as "inadequate and insufficient" evidence of a causal relationship between traffic-related air pollution and health care utilization for respiratory problems, new onset adult asthma, chronic obstructive pulmonary disease, nonasthmatic respiratory allergy, and cancer in adults and children. Other literature reviews have published conclusions generally similar to the HEI panel conclusions (Boothe and Shendell 2008, Sun et al. 2014). However, researchers from the U.S. Centers for Disease Control and Prevention recently published a systematic review and meta-analysis of studies evaluating the risk of childhood leukemia associated with traffic exposure and reported positive associations between "postnatal" proximity to traffic and leukemia risks but no such association for "prenatal" exposures (Boothe et al. 2014).

Other possible adverse health impacts resulting from high-traffic exposure are less studied and lack sufficient evidence to draw definitive conclusions. Among these less-studied potential outcomes are neurological impacts (e.g., autism and reduced cognitive function) and reproductive outcomes (e.g., preterm birth and low birth weight) (Volk et al. 2011, Franco-Suglia et al. 2007, Power et al. 2011, Wu et al. 2011).

In addition to reporting health outcomes, particularly cardiopulmonary effects, numerous studies suggest mechanisms by which traffic-related air pollution affects health and leads to those reported outcomes. Numerous studies indicate that near-roadway exposures may increase systemic inflammation, affecting organ systems, including blood vessels and lungs (Riediker 2007, Alexeef et al. 2011, Eckel et al. 2011, Zhang et al. 2009). Long-term exposures in near-road environments have been associated with inflammation-associated conditions, such as atherosclerosis and asthma (Adar et al. 2010, Kan et al. 2008, McConnell et al. 2010).

Sections 4.1.1.1, *Health Effects of Criteria Pollutants,* and 4.1.1.2, *Health Effects of Mobile Source Air Toxics*, discuss specific health effects associated with each of the criteria and hazardous air pollutants analyzed in this EIS. Section 5.4, *Environmental Consequences*, addresses the impacts of major greenhouse gases (GHGs)—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); this air quality analysis does not include these GHGs. Section 7.5, *Environmental Justice*, addresses the impacts of air pollution and climate change on minority and low-income populations.

4.1.1.1 Health Effects of Criteria Pollutants

The following sections describe the health effects of the five criteria pollutants addressed in this analysis. This information is adapted from EPA (2012b). The most recent EPA technical reports and *Federal Register* notices for NAAQS reviews provide more information on the health effects of criteria pollutants (EPA 2013d, 2015f).

Ozone

Ozone is a photochemical oxidant and the major component of smog. Ozone is not emitted directly into the air, but is formed through complex chemical reactions among precursor emissions of VOCs and NO_X in the presence of the ultraviolet component of sunlight. Ground-level ozone causes health problems because it irritates the mucous membranes, damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Ozone-related health effects also include respiratory symptoms and related effects, aggravation of asthma, increased hospital and emergency room visits, and increased asthma medication usage. Exposure to ozone for several hours at relatively low concentrations has been found to substantially reduce lung function and induce respiratory inflammation in normal, healthy people during exercise. There is also evidence that short-term exposure to ozone directly or indirectly contributes to nonaccidental and cardiopulmonary-related mortality.

In addition to its human health impacts, ozone has the potential to affect the health of vegetation and ecosystems. Ozone in the atmosphere is absorbed by plants and disturbs the plant's carbon sequestration process, thereby limiting its available energy supply. Consequently, exposed plants can lose their vigor, become more susceptible to disease and other environmental stressors, and demonstrate reduced growth, visual abnormalities, or accelerated aging. According to the United States Department of Agriculture (USDA 2016), ozone affects crops, vegetation, and ecosystems more than any other air pollutant. Ozone can produce both acute and chronic injury in sensitive species, depending on the concentration level, the duration of the exposure, and the plant species under exposure. Because of the differing sensitivities among plants to ozone, ozone pollution can also exert a selective pressure that leads to changes in plant community composition. Given the range of plant sensitivities and the fact that numerous other environmental factors modify plant uptake and response to ozone, it is not possible to identify threshold values above which ozone is consistently toxic for all plants.

VOCs, a chemical precursor to ozone, also can play a role in vegetation damage (NPS 2019). For some sensitive plants under exposure, VOCs have been demonstrated to affect seed production, photosynthetic efficiency, leaf water content, seed germination, flowering, and fruit ripening (Pinto et al. 2010). NO_X, the other chemical precursor to ozone, has also been demonstrated to affect vegetation health (Viskari 2000, Ugrekhelidze et al. 1997, Kammerbauer et al. 1987). Most of the studies of the impacts of VOCs and NO_X on vegetation have focused on short-term exposure; few studies have focused on long-term impacts and the potential for the metabolites[7] of these compounds to affect herbivores or insects.

Particulate Matter

PM is a generic term for a broad class of chemically and physically diverse substances that exist as discrete particles. PM includes dust, dirt, soot, smoke, and liquid droplets directly emitted into the air, as well as particles formed in the atmosphere by condensation or by the transformation of emitted gases such as NO_X, SO_X, and VOCs. Fine particles are produced primarily by combustion processes and by these atmospheric transformations of emitted gases. The definition of PM also includes particles composed of elemental carbon (black carbon).[8] Gasoline-fueled and diesel-fueled vehicles emit PM. In general, the smaller the PM, the deeper it can penetrate into the respiratory system and the more damage it can cause. Depending on its size and composition, PM can damage lung tissue, aggravate existing respiratory and cardiovascular diseases, alter the body's defense systems against foreign materials, and cause cancer and premature death (EPA 2019d).

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[7] Metabolites are formed as the initial compounds break down and are transformed through metabolism.

[8] Elemental carbon and black carbon are similar forms of fine PM and are considered synonymous for purposes of this analysis. The term *elemental carbon* describes carbonaceous particles based on chemical composition rather than light-absorbing characteristics. The term *black carbon* describes particles of mostly pure carbon that absorb solar radiation at all wavelengths (EPA 2012g). The carbon content of a sample of PM can be described by either term depending on the test method used: typically, the result for a sample tested by thermal or wet chemical methods is termed *elemental carbon* while the result for a sample tested by optical methods is termed *black carbon* (Long et al. 2013).

PM also can contribute to poor visibility by scattering and absorbing light, consequently making the terrain appear hazy. To address visibility concerns, EPA developed the regional haze program,[9] which was put in place in July 1999 to protect the visibility in Mandatory Class I Federal Areas (national parks and wilderness areas). EPA has also set secondary NAAQS to regulate non-Class I areas outside the regional haze program. Deposition of PM (especially secondary PM formed from NO_X and SO_X) can damage materials, adding to the effects of natural weathering processes by potentially promoting or accelerating the corrosion of metals, degrading paints, and deteriorating building materials (especially concrete and limestone).

EPA classifies DPM as an MSAT, so it is addressed in Section 4.1.1.2, *Health Effects of Mobile Source Air Toxics, Diesel Particulate Matter*.

Carbon Monoxide

CO is a colorless, odorless, poisonous gas produced by incomplete combustion of carbon in fuels. Motor vehicles are the single largest source of CO emissions nationally.[10] When CO enters the bloodstream, it acts as an asphyxiant by reducing the delivery of oxygen to the body's organs and tissues. It can affect the central nervous system and impair the brain's ability to function properly. Health threats are most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Epidemiological studies show associations between short-term CO exposure and cardiovascular morbidity, particularly increased emergency room visits and hospital admissions for coronary heart disease. Some epidemiological studies suggest a causal relationship between long-term exposures to CO and developmental effects and adverse health impacts at birth, such as decreased birth weight.

Sulfur Dioxide

SO_2, one of various oxides of sulfur, is a gas formed from combustion of fuels containing sulfur. Most SO_2 emissions are produced by stationary sources such as power plants. SO_2 is also formed when gasoline is extracted from crude oil in petroleum refineries and in other industrial processes. High concentrations of SO_2 cause severe respiratory distress (difficulty breathing), irritate the upper respiratory tract, and aggravate existing respiratory and cardiovascular disease. The immediate effect of SO_2 on the respiratory system in humans is bronchoconstriction (constriction of the airways). Asthmatics are more sensitive to the effects of SO_2, likely because of preexisting bronchial inflammation. SO_2 also is a primary contributor to acidic deposition, or acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues.

Nitrogen Dioxide

NO_2, a reddish-brown, highly reactive gas, is one of the oxides of nitrogen formed by high-temperature combustion (as in vehicle engines) of nitrogen and oxygen. Most NO_X created in the combustion reaction consists of nitric oxide (NO), which oxidizes to NO_2 in the atmosphere. NO_2 can irritate the lungs and mucous membranes, aggravate asthma, cause bronchitis and pneumonia, and reduce resistance to respiratory infections. NO_2 has also been linked to other health outcomes, including all-cause

[9] Final Rule: Regional Haze Regulations, 64 FR 35714 (July 1, 1999).

[10] Highway motor vehicles overall accounted for approximately 29 percent of national CO emissions in 2018 (EPA 2019a). Passenger cars and light trucks account for approximately 93 percent of the CO emissions from highway motor vehicles (EPA 2014g) while heavy-duty vehicles account for the remaining 7 percent (EPA 2019a).

(nonaccidental) mortality, hospital admissions or emergency department visits for cardiovascular disease, and reductions in lung function growth associated with chronic exposure. Oxides of nitrogen are an important precursor to ozone and acid rain and can affect terrestrial and aquatic ecosystems.

4.1.1.2 Health Effects of Mobile Source Air Toxics

The following sections briefly describe the health effects of the six priority MSATs analyzed in this EIS. This information is adapted from the preamble to the EPA Tier 3 Motor Vehicle Emission and Fuel Standards Rule.[11]

Motor vehicle emissions contribute to ambient levels of air toxics known or suspected to be human or animal carcinogens or known to have noncancer health effects. These compounds include, but are not limited to, acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde. These five air toxics, plus DPM, are the six priority MSATs analyzed in this EIS. These compounds, plus polycyclic organic matter and naphthalene, were identified as national or regional risk drivers or contributors in the EPA 2014 National-Scale Air Toxics Assessment and have significant inventory contributions from mobile sources (EPA 2018g). This EIS does not analyze polycyclic organic matter separately, but this matter can occur as a component of DPM and is discussed in *Diesel Particulate Matter*. Naphthalene also is not analyzed separately in this EIS, but it is a member of the polycyclic organic matter class of compounds discussed in *Diesel Particulate Matter*.

Acetaldehyde

Acetaldehyde is classified in the EPA Integrated Risk Information System (IRIS) database as a probable human carcinogen, based on nasal tumors in rats, and is considered toxic by the inhalation, oral, and intravenous routes (EPA 1998). In its Fourteenth Report on Carcinogens (NTP 2016a), the U.S. Department of Health and Human Services “reasonably anticipates” acetaldehyde to be a human carcinogen, and the World Health Organization’s International Agency for Research on Cancer (IARC) classifies acetaldehyde as possibly carcinogenic to humans (Group 2B) (IARC 1999).

The primary noncancer effects of exposure to acetaldehyde vapors include eye, skin, and respiratory-tract irritation (EPA 1998). In short-term (4-week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure (National Research Council Committee on Emergency and Continuous Exposure Guidance Levels for Selected Submarine Contaminants 2009). EPA used data from these studies to develop an inhalation reference concentration. Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume and bronchoconstriction upon inhaling acetaldehyde (OEHHA 2008).

Acrolein

Acrolein is extremely acrid and is irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion, and congestion. The intense irritancy of this carbonyl compound has been demonstrated during controlled tests in human subjects, who suffer intolerable eye and nasal mucosal sensory reactions within minutes of exposure (EPA 2003b). The EPA 2003 IRIS human health risk assessment for acrolein (EPA 2003b) summarizes these data and additional studies regarding acute effects of human exposure to acrolein. Evidence from studies in humans indicate

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[11] Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards; Final Rule, 79 FR 23414 (April 28, 2014).

that levels as low as 0.09 ppm (0.21 milligram per cubic meter) for 5 minutes can elicit subjective complaints of eye irritation, with increasing concentrations leading to more extensive eye, nose, and respiratory symptoms (OEHHA 2008). Lesions to the lungs and upper respiratory tracts of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein (OEHHA 2008). Animal studies report acute exposure effects such as bronchial hyper-responsiveness (OEHHA 2008). In a recent study, the acute respiratory irritant effects of exposure to 4 ppm acrolein were more pronounced in mice with allergic airway disease compared to nondiseased mice, which also showed decreases in respiratory rate (Snow et al. 2017). Based on these animal data and demonstration of similar effects in humans (e.g., reduction in respiratory rate), individuals with compromised respiratory function (e.g., emphysema and asthma) are expected to be at increased risk of developing adverse responses to strong respiratory irritants such as acrolein.

IARC determined that acrolein was not classifiable as to its carcinogenicity in humans (IARC 1995), and EPA determined in 2003 that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans, and the animal data provided inadequate evidence of carcinogenicity (EPA 2003b).

Benzene

EPA's IRIS database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure and concludes that exposure is associated with additional health impacts, including genetic changes in both humans and animals and increased proliferation of bone marrow cells in mice (EPA 2000b, IARC 2018). Data indicate a causal relationship between benzene exposure and acute lymphocytic leukemia and suggest a relationship between benzene exposure and chronic nonlymphocytic leukemia and chronic lymphocytic leukemia. IARC and the U.S. Department of Health and Human Services have characterized benzene as a human carcinogen (IARC 2018, NTP 2016b).

Several adverse noncancer health effects, including blood disorders such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene (OEHHA 2008). The most sensitive noncancer effect observed in humans, based on current data, is depression of the absolute lymphocyte count in blood (OEHHA 2008, EPA 2002d). In addition, recent work, including studies sponsored by the Health Effects Institute, provides evidence that biochemical responses are occurring at lower levels of benzene exposure than previously known (OEHHA 2008).

1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans through inhalation (EPA 2002b, 2002c). IARC has determined that 1,3-butadiene is a probable human carcinogen, and the U.S. Department of Health and Human Services has characterized 1,3-butadiene as a known human carcinogen (IARC 2012, NTP 2016c). Numerous experiments have demonstrated that animals and humans metabolize 1,3-butadiene into compounds that are genotoxic (capable of causing damage to a cell's genetic material such as deoxyribonucleic acid [DNA]). The specific mechanisms of 1,3-butadiene-induced carcinogenesis are not known; however, scientific evidence strongly suggests that the carcinogenic effects are mediated by genotoxic metabolites. Animal data suggest that females could be more sensitive than males to cancer effects associated with 1,3-butadiene exposure. There are insufficient data on humans from which to draw conclusions about sensitive subpopulations. 1,3-butadiene also causes a variety of reproductive and developmental effects in mice; there are no available human data on these effects. The most sensitive effect was ovarian atrophy observed in a lifetime bioassay of female mice (EPA 2002c).

Diesel Particulate Matter

Diesel exhaust consists of a complex mixture of CO_2, oxygen, nitrogen, water vapor, CO, nitrogen compounds, sulfur compounds, and numerous low-molecular-weight hydrocarbons. A number of these gaseous hydrocarbon components are individually known to be toxic, including aldehydes, benzene, and 1,3-butadiene. The DPM present in diesel exhaust consists mostly of fine particles (smaller than 2.5 microns), of which a significant fraction is ultrafine particles (smaller than 0.1 micron). These particles have a large surface area, which makes them an excellent medium for adsorbing organics, and their small size makes them highly respirable. Many of the organic compounds present in the gases and on the particles, such as polycyclic organic matter, are individually known to have mutagenic and carcinogenic properties.

DPM also includes elemental carbon (black carbon) particles emitted from diesel engines. EPA has not provided a special status, such as a NAAQS or other health-protective measure, for black carbon, but addresses black carbon in terms of PM2.5 and DPM emissions.

Diesel exhaust varies significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, acceleration, deceleration), and fuel formulations (high/low sulfur fuel). Also, there are emissions differences between on-road and nonroad engines because the nonroad engines are generally older technology. After being emitted in the engine exhaust, diesel exhaust undergoes dilution, as well as chemical and physical changes in the atmosphere. The lifetime for some of the compounds present in diesel exhaust ranges from hours to days.

In EPA's 2002 *Diesel Health Assessment Document* (Diesel HAD) (EPA 2002a), exposure to diesel exhaust was classified as likely to be carcinogenic to humans by inhalation from environmental exposures, in accordance with the revised draft 1996–1999 EPA cancer guidelines (EPA 1999a). A number of other agencies (National Institute for Occupational Safety and Health, International Agency for Research on Cancer, World Health Organization, California EPA, and U.S. Department of Health and Human Services) had made similar hazard classifications prior to 2002.

Noncancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to EPA. EPA derived a diesel exhaust reference concentration from consideration of four well-conducted chronic rat inhalation studies showing adverse pulmonary effects. The reference concentration is 5 $\mu g/m^3$ for diesel exhaust measured as DPM. This reference concentration does not consider allergenic effects such as those associated with asthma or immunologic effects or the potential for cardiac effects. There was emerging evidence in 2002, discussed in the Diesel HAD, that exposure to diesel exhaust can exacerbate these effects, but the exposure-response data were lacking at that time to derive a reference concentration based on these then-emerging considerations. The EPA Diesel HAD states, "With [diesel particulate matter] being a ubiquitous component of ambient PM, there is an uncertainty about the adequacy of the existing [diesel exhaust] non-cancer database to identify all of the pertinent [diesel exhaust]-caused non-cancer health hazards." The Diesel HAD also notes "that acute exposure to [diesel exhaust] has been associated with irritation of the eye, nose, and throat, respiratory symptoms (cough and phlegm), and neurophysiological symptoms such as headache, lightheadedness, nausea, vomiting, and numbness or tingling of the extremities." The Diesel HAD notes that the cancer and noncancer hazard conclusions applied to the general use of diesel engines then on the market and as cleaner engines replace a substantial number of existing ones, the applicability of the conclusions would need to be reevaluated.

The Diesel HAD also briefly summarizes health effects associated with ambient PM and discusses EPA's then-annual PM2.5 NAAQS of 15 µg/m^3. In 2012, EPA revised the annual PM2.5 NAAQS to 12 µg/m^3. There is a large and extensive body of human data showing a wide spectrum of adverse health impacts associated with exposure to ambient PM, of which diesel exhaust is an important component. The PM2.5 NAAQS is designed to provide protection from the noncancer health effects and premature mortality attributed to exposure to PM2.5. The contribution of diesel PM to total ambient PM varies in different regions of the country, within a region, and from one area to another. The contribution can be high in near-roadway environments, for example, or in other locations where diesel engine use is concentrated.

Since 2002, several new studies continue to report increased lung cancer risk with occupational exposure to diesel exhaust from older engines. Of particular note since 2011, three new epidemiology studies have examined lung cancer in occupational populations; for example, in truck drivers, underground nonmetal miners, and other diesel-engine-related occupations (HEI 2015, Olsson et al. 2011). These studies reported increased risk of lung cancer with exposure to diesel exhaust with evidence of positive exposure-response relationships to varying degrees. These newer studies—along with others that have appeared in the scientific literature—add to the evidence EPA evaluated in the 2002 Diesel HAD and further reinforce the concern that diesel exhaust exposure likely poses a lung cancer hazard. The findings from these newer studies do not necessarily apply to newer technology diesel engines because the newer engines have large reductions in the emissions constituents compared to older-technology diesel engines.

In light of the growing body of scientific literature evaluating the health effects of exposure to diesel exhaust, in June 2012, IARC, a recognized international authority on the carcinogenic potential of chemicals and other agents, evaluated the full range of cancer-related health effects data for diesel engine exhaust. IARC concluded that diesel exhaust should be regarded as "carcinogenic to humans" (IARC 2014). This designation was an update from its 1988 evaluation, which considered the evidence indicative of a "probable human carcinogen."

Formaldehyde

In 1991, EPA concluded that formaldehyde is a carcinogen based on nasal tumors in animal bioassays (EPA 1989). EPA developed an inhalation unit risk for cancer and a reference dose for oral noncancer effects and posted them in the IRIS database. Since that time, the National Toxicology Program and IARC have concluded that formaldehyde is a known human carcinogen (NTP 2016d, IARC 2012).

The conclusions by IARC and the National Toxicology Program reflect the results of epidemiologic research published since 1991, in combination with previous animal, human, and mechanistic evidence. Research by the National Cancer Institute reported an increased risk of nasopharyngeal (nose and throat) cancer and specific lymphohematopoietic (lymph and blood) malignancies among workers exposed to formaldehyde (NCI 2011). A National Institute of Occupational Safety and Health study of garment workers also reported increased risk of death due to leukemia among workers exposed to formaldehyde. Extended follow-up of a cohort of British chemical workers did not report evidence of an increase in nasopharyngeal or lymphohematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported (Checkoway et al. 2015). Finally, a study of embalmers reported formaldehyde exposures to be associated with an increased risk of myeloid (bone marrow cell) leukemia but not brain cancer (Hauptmann et al. 2009).

Other health effects of formaldehyde were reviewed by the Agency for Toxics Substances and Disease Registry in 1999 (ATSDR 1999) and supplemented in 2010 (ATSDR 2010), and by the World Health Organization (World Health Organization 2002). These organizations reviewed the literature concerning effects on the eyes and respiratory system, the primary point of contact for inhaled formaldehyde, including sensory irritation of eyes, and respiratory tract, pulmonary function, nasal histopathology, and immune system effects. In addition, research on reproductive and developmental effects and neurological effects were discussed along with several studies that suggest formaldehyde may increase the risk of asthma, particularly in the young. EPA released a draft Toxicological Review of Formaldehyde Inhalation Assessment through the IRIS program for peer review by the National Research Council and public comment in June 2010 (EPA 2010e). The draft assessment reviewed more recent research from animal and human studies on cancer and other health effects. The National Research Council released their review report in April 2011 (NRC 2011a). As of April 2019, EPA has suspended this assessment (EPA 2019b).

4.1.1.3 Vehicle Emissions Standards

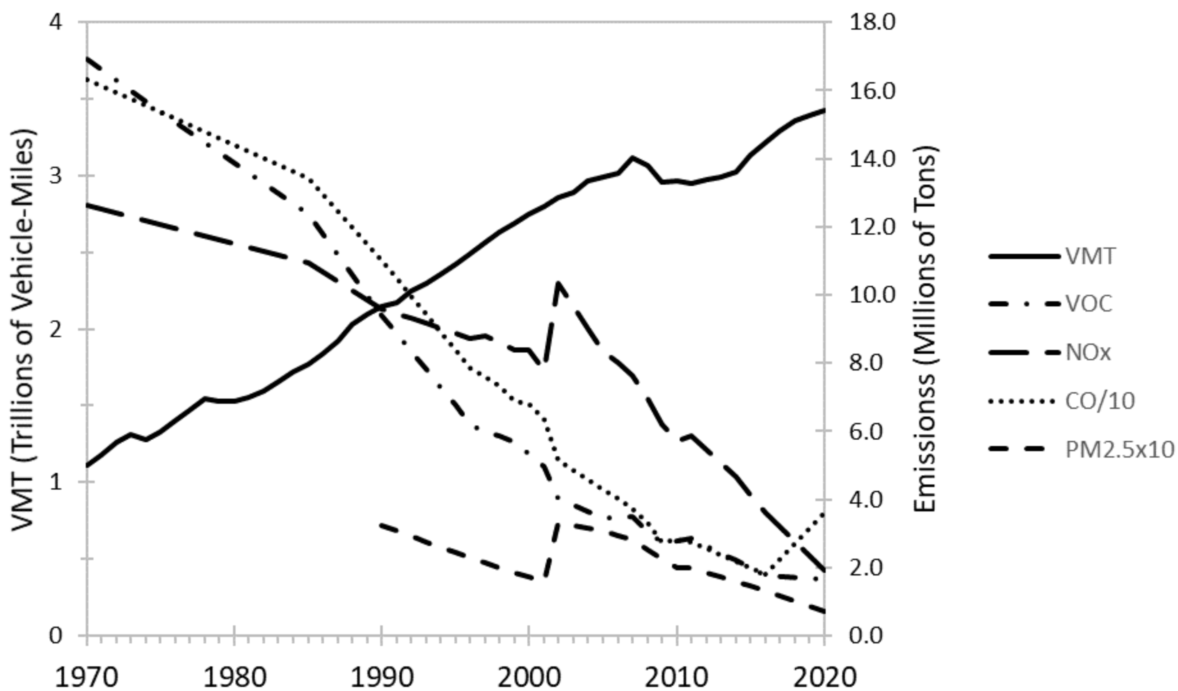
EPA has established criteria pollutant emissions standards for vehicles under the CAA. EPA has tightened these emissions standards over time as more effective emissions-control technologies have become available. These stricter standards for passenger cars and light trucks and for heavy-duty vehicles are responsible for the declines in total criteria pollutant emissions from motor vehicles, as discussed in Section 4.1.1, *Relevant Pollutants and Standards*. The EPA Tier 2 Vehicle & Gasoline Sulfur Program, which went into effect in 2004, established the CAA emissions standards that applied to MY 2004–2016 passenger cars and light trucks (EPA 2000a). Under the Tier 2 standards, manufacturers of passenger cars and light trucks were required to meet stricter vehicle emissions limits than under the previous Tier 1 standards. By 2006, U.S. refiners and importers of gasoline were required under the Tier 2 standards to manufacture gasoline with an average sulfur level of 30 ppm, a 90 percent reduction from earlier sulfur levels. These fuels enable post-MY 2006 vehicles to use emissions-control technologies that reduce tailpipe emissions of NO_X by 77 percent for passenger cars and by as much as 95 percent for pickup trucks, vans, and sport utility vehicles compared to 2003 levels. On April 28, 2014, EPA issued a Final Rule establishing Tier 3 motor vehicle emissions and fuel standards.[12] The Tier 3 vehicle standards reduce both tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and Classes 2b–3 heavy-duty vehicles. Starting in 2017, Tier 3 sets new vehicle emissions standards and lowers the sulfur content of gasoline, considering the vehicle and its fuel as an integrated system. The Tier 3 program phases out the Tier 2 vehicle emissions standards and replaces them with Tier 3 standards, which are being phased in over MYs 2017–2025 and will remain constant thereafter at the MY 2025 levels. The Tier 3 program will require emission reductions from new passenger cars and light trucks of approximately 80 percent for NO_X and VOCs, and 70 percent for PM. The Tier 3 gasoline sulfur standard will make emissions-control systems more effective for both existing and new vehicles and will enable more stringent vehicle emissions standards (EPA 2014b).

Figure 4.1.1-1 illustrates current trends in travel and emissions from highway vehicles, not accounting for the impacts of the Proposed Action and alternatives (Section 4.2, *Environmental Consequences*). Since 1970, aggregate emissions traditionally associated with vehicles have decreased substantially even as VMT increased by approximately 173 percent from 1970 to 2014, as shown in Figure 4.1.1-1. For example, NO_X emissions, due mainly to light trucks and heavy-duty vehicles, decreased by 71 percent between 1970

[12] Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards; Final Rule, 79 FR 23414 (April 28, 2014).

and 2016, despite increases in VMT (EPA 2016a). Future trends show that changes in VMT are having a smaller and smaller impact on emissions because of stricter EPA standards for vehicle emissions and the chemical composition of fuels, even with additional growth in VMT (Smith 2002). This general trend will continue, to a certain extent, with implementation of any of the action alternatives. MSAT emissions will likely decrease in the future because of recent EPA rules (EPA 2007). These rules limited the benzene content of gasoline beginning in 2011. They also limit exhaust emissions of hydrocarbons (many VOCs and MSATs are hydrocarbons) from passenger cars and light trucks when they are operated at cold temperatures. The cold-temperature standard was phased in from 2010 through 2015. EPA projects that these controls will substantially reduce emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Figure 4.1.1-1. Vehicle Miles Traveled Compared to Vehicle Emissions[a,b]



Notes:
[a] Because CO emissions are about 10 times higher than emissions of NO_X, SO_X, and VOCs and emissions of PM2.5 are about 10 times lower than emissions of NO_X, SO_X, and VOCs, the scales for CO and PM2.5 are proportionally adjusted to enable comparison of trends among pollutants.
[b] Apparent increases in NO_X and PM2.5 emissions in 2002 are due to a change in methods made by EPA in 2012 from the MOBILE6.2 model to the MOVES model to calculate emissions for years 2002 and later (EPA 2013f).
Sources: Davis et al. 2016, EPA 2016a, EIA 2017c, IEC 2011
VMT = vehicle miles traveled; VOC = volatile organic compound; NO_X = nitrogen oxides; CO = carbon monoxide; PM2.5 = particulate matter with a diameter of 2.5 microns or less; SO_X = sulfur oxides

4.1.1.4 Conformity Regulations

The CAA prohibits a federal agency from engaging in, supporting, licensing, or approving any activity that does not "conform" to a SIP or Federal Implementation Plan after EPA has approved or promulgated it, or that would affect a state's compliance with the NAAQS.[13] The purpose of the conformity requirement is to ensure that federally sponsored or conducted activities do not interfere with meeting the emissions targets in SIPs, do not cause or contribute to new violations of the NAAQS, and do not impede the ability of a state to attain or maintain NAAQS or delay any interim milestones. EPA has issued two sets of regulations to implement the conformity requirements.

The Transportation Conformity Rule[14] applies to transportation plans, programs, and projects that are developed, funded, or approved under 23 U.S.C. (Highways) or 49 U.S.C. Chapter 53 (Public Transportation). The General Conformity Rule[15] applies to all other federal actions not covered under transportation conformity. The General Conformity Rule establishes emissions thresholds for use in evaluating the conformity of an action that results in emissions increases.[16] If the net increases of direct and indirect emissions are lower than these thresholds, then the action is presumed to conform and no further conformity evaluation is required. If the net increases of direct and indirect emissions exceed any of these thresholds, and the action is not otherwise exempt, then a conformity determination is required. The conformity determination can entail air quality modeling studies, consultations with EPA and state air quality agencies, and commitments to revise the SIPs or to implement measures to mitigate air quality impacts.

The CAFE standards and associated program activities are not developed, funded, or approved under 23 U.S.C. or 49 U.S.C. Chapter 53. Further, the standards are not a highway or transit project funded, approved, or implemented by FHWA or the Federal Transit Administration. Accordingly, this action and associated program activities are not subject to the Transportation Conformity Rule. Under the General Conformity Rule, a conformity determination is required where a federal action would result in total direct and indirect emissions of a criteria pollutant or precursor originating in nonattainment or maintenance areas equaling or exceeding the rates specified in 40 CFR § 93.153(b)(1) and (2). As explained below, NHTSA's Proposed Action would result in neither direct nor indirect emissions as defined at 40 CFR § 93.152.

The General Conformity Rule defines direct emissions as "those emissions of a criteria pollutant or its precursors that are caused or initiated by the federal action and originate in a nonattainment or maintenance area and occur at the same time and place as the action and are reasonably foreseeable."[17] Because NHTSA's Proposed Action would set fuel economy standards for passenger cars and light trucks, it would cause no direct emissions consistent with the meaning of the General Conformity Rule.[18]

Indirect emissions under the General Conformity Rule are "those emissions of a criteria pollutant or its precursors (1) That are caused or initiated by the federal action and originate in the same nonattainment or maintenance area but occur at a different time or place as the action; (2) That are

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[13] 42 U.S.C. § 7506(c)(1)-(2).

[14] 40 CFR Part 51, Subpart T, and Part 93, Subpart A.

[15] 40 CFR Part 51, Subpart W, and Part 93, Subpart B.

[16] 40 CFR § 93.153(b).

[17] 40 CFR § 93.152.

[18] *Department of Transportation v. Public Citizen*, 541 U.S. 752, 772 (2004) ("[T]he emissions from the Mexican trucks are not 'direct' because they will not occur at the same time or at the same place as the promulgation of the regulations."). NHTSA's action is to establish fuel economy standards for MY 2021–2026 passenger car and light trucks; any emissions increases would occur well after promulgation of the final rule.

reasonably foreseeable; (3) That the agency can practically control; and (4) For which the agency has continuing program responsibility."[19] Each element of the definition must be met to qualify as indirect emissions. NHTSA has determined that, for purposes of general conformity, emissions that may result from the fuel economy standards would not be caused by NHTSA's action, but rather would occur because of subsequent activities the agency cannot practically control. "[E]ven if a Federal licensing, rulemaking, or other approving action is a required initial step for a subsequent activity that causes emissions, such initial steps do not mean that a Federal agency can practically control any resulting emissions."[20]

As the CAFE program uses performance-based standards, NHTSA cannot control the technologies vehicle manufacturers use to improve the fuel economy of passenger cars and light trucks. Furthermore, NHTSA cannot control consumer purchasing (which affects average achieved fleetwide fuel economy) and driving behavior (i.e., operation of motor vehicles, as measured by VMT). It is the combination of fuel economy technologies, consumer purchasing, and driving behavior that results in criteria pollutant or precursor emissions. For purposes of analyzing the environmental impacts of the Proposed Action and alternatives under NEPA, NHTSA has made assumptions regarding all of these factors. This NEPA analysis predicts that increases in air toxic and criteria pollutants would occur in some nonattainment areas under certain alternatives. However, the Proposed Action and alternatives do not mandate specific manufacturer decisions, consumer purchasing, or driver behavior, and NHTSA cannot practically control any of them.[21]

In addition, NHTSA does not have the statutory authority to control the actual VMT by drivers. As the extent of emissions is directly dependent on the operation of motor vehicles, changes in any emissions that result from NHTSA's standards are not changes the agency can practically control or for which the agency has continuing program responsibility. Therefore, the Proposed Action and alternatives would not cause indirect emissions under the General Conformity Rule, and a general conformity determination is not required. For more information on the analysis related to the General Conformity Rule, *see* Section X.E.2 of the preamble to the final rule.

4.1.2 Methods

This section describes the approaches and methods used to estimate the impacts of the Proposed Action and alternatives.

4.1.2.1 Overview

To analyze air quality and human health impacts, NHTSA calculated the emissions of criteria pollutants and MSATs from passenger cars and light trucks that would occur under each alternative. NHTSA then estimated the resulting changes in emissions under each action alternative by comparing emissions under that alternative to those under the No Action Alternative. The resulting changes in air quality and impacts on human health were assumed to be proportional to the changes in emissions projected to occur under each action alternative.

[19] 40 CFR § 93.152.

[20] 40 CFR § 93.152.

[21] *See*, e.g., *Department of Transportation v. Public Citizen*, 541 U.S. 752, 772-73 (2004); *South Coast Air Quality Management District v. Federal Energy Regulatory Commission*, 621 F.3d 1085, 1101 (9th Cir. 2010).

The air quality analysis accounted for downstream emissions, upstream emissions, the rebound effect, and changes in fleet age resulting from effects of vehicle price changes on vehicle sales[22] (where applicable). In summary, the change in emissions resulting from each alternative would be the sum of the following components:

- Changes in upstream emissions that result from (in this case) increases in fuel consumption and, therefore, higher volumes of fuel production and distribution.
- Decreases in per-vehicle downstream emissions from reductions in VMT due to rebound and from lower overall fleet age. (Newer vehicles have lower emissions per VMT.)
- Increases in per-vehicle downstream emissions from changes in the application of fuel economy technologies.

As discussed in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, the air quality results presented in this chapter, including impacts on human health, are based on assumptions about the type and rate of emissions from the combustion of fossil fuels. In addition to tailpipe emissions, this analysis accounts for upstream emissions from the production and distribution of fuels, including contributions from the power plants that generate the electricity used to recharge electric vehicles and from the production of the fuel burned in those power plants. Emissions and other environmental impacts from electricity production depend on the efficiency of the power plant and the mix of fuel sources used, sometimes referred to as the *grid mix*. In the United States, the current grid mix is composed of natural gas, coal, nuclear, hydroelectric, wind, other renewable energy sources, and oil with the largest single source of electricity being from natural gas, followed by coal (EIA 2019d).

To estimate upstream emissions changes resulting from changes in downstream fuel consumption, the analysis uses emissions factors from the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model (GREET) model (version 2018 developed by the U.S. Department of Energy, Argonne National Laboratory).[23] Upstream emission factors for gasoline, diesel, E85, and electricity in grams per million British thermal units (MMbtu) were taken from the GREET model in 5-year increments beginning in 1985 and ending in 2040. The agencies developed toxics upstream emission factors that are consistent with EPA's National Emission Inventory and emission factors from the Motor Vehicle Emissions Simulator (MOVES) model (EPA 2014d).[24] A spreadsheet model was developed to adjust upstream emission factors to account for the imported share of petroleum.

The analysis presented throughout this EIS assumes that the future electric vehicle fleet would charge from a grid whose mix is uniform across the country. As with gasoline, diesel, and E85, emission factors for electricity were calculated in 5-year increments from 1985 to 2050 in GREET to account for projected

[22] The scrappage model—an econometric survival model that captures the effect of increasing the price of new vehicles on the survival rate of used vehicles—works to quantify impacts on the registered vehicle fleet that exists when a set of new CAFE standards is implemented. It estimates changes in vehicle retirement rates that result from changes in the fuel economy and prices of new cars and light trucks produced during future model years, as well as from other variables that affect owners' decisions about when to retire used vehicles. These other influences include the fuel economy of vehicles produced during earlier model years, and macroeconomic conditions such as the rates of economic growth and fuel prices. Changes in the values of these factors affect the number of used vehicles of different ages that are kept in service rather than being retired, and their continued usage contributes to fuel consumption, emissions, and safety concerns in ways that offset some of the direct effects of changes in CAFE and CO_2 standards.

[23] On October 7, 2019, Argonne National Laboratory released the 2019 version of GREET. The upstream emissions analysis was completed using GREET 2018 prior to the release of GREET 2019.

[24] EPA's MOVES model, described in Section 2.4.1.1, *Downstream Emissions*, estimates emissions based on a variety of inputs, including vehicle type and age, fuel type and quality, operating conditions, and vehicle characteristics.

changes in the national grid mix. GREET contains information on the intensities (amount of pollutant emitted per unit of electrical energy generated) that extend to 2040. To project the U.S. average electricity-generating fuel mix, the analysis uses the National Energy Modeling System Annual Energy Outlook (AEO) 2019, an energy-economy modeling system from the U.S. Department of Energy.[25]

4.1.2.2 Regional Analysis

Over the course of the development of recent CAFE EISs (NHTSA 2010, 2012) and the medium- and heavy-duty fuel efficiency standards Phase 1 and 2 EISs (NHTSA 2011, 2016c), NHTSA received comments requesting that the agency consider the regional air quality impacts of these programs. NHTSA has included the following information about regional air quality impacts of the Proposed Action and alternatives in response to such comments and because the agency believes that such an analysis provides valuable information for the decision-maker, state and local authorities, and the public. Performing this analysis does not affect the agency's conclusion that a general conformity determination is not required. While a truly local analysis (i.e., at the individual roadway level) is impractical for a nationwide EIS, NHTSA believes a regional emissions analysis still provides valuable information and is feasible for the scope of this analysis.

To assess regional differences in the impacts of the alternatives, NHTSA estimated net emissions changes for individual nonattainment and maintenance areas. The distribution of emissions is not uniform nationwide, and either increases or decreases in emissions can occur within individual nonattainment and maintenance areas. NHTSA focused on nonattainment and maintenance areas because air quality problems have been the greatest in these areas. NHTSA assessed only areas that are in nonattainment or maintenance for ozone or PM2.5 because these are the criteria pollutant emissions from passenger cars and light trucks that are of greatest concern to human health. At present, there are no CO or NO_2 nonattainment areas. There are many areas designated as being in nonattainment for SO_2 or PM10. There are also maintenance areas for CO, NO_2, PM10, and SO_2. NHTSA did not quantify PM10 emissions separately from PM2.5 because almost all the PM in the exhaust from passenger cars and light trucks is PM2.5.[26] Appendix A, *Air Quality Nonattainment Area Results*, provides emissions estimates for all nonattainment and maintenance areas for all criteria pollutants (except lead, as explained in Section 4.1.1, *Relevant Pollutants and Standards*). On-road motor vehicles are a minor contributor to SO_2 emissions (less than 0.68 percent of national emissions, as noted above) (EPA 2016a) and are unlikely to affect the attainment status of SO_2 nonattainment and maintenance areas.

NHTSA's emissions analysis is national and regional but does not attempt to address the specific geographic locations of changes in emissions within nonattainment and maintenance areas. For example, there is limited evidence that EV use is disproportionately greater in areas with the worst traffic congestion (Section 8.3.3, *Other Past, Present, and Reasonably Foreseeable Future Actions*). Because hybrid electric vehicles and plug-in hybrid electric vehicles have lower tailpipe emissions compared to conventionally fueled vehicles, and battery electric vehicles have no tailpipe emissions, greater electric vehicle use in these areas could suggest that tailpipe emissions in urban nonattainment areas would be less than the analysis estimates. However, because of the complication and

[25] The Annual Energy Outlook (AEO) is the annual energy consumption forecast produced by the U.S. Energy Information Administration (EIA).

[26] In addition to exhaust PM2.5, the analysis included the brake wear and tire wear components of PM2.5.

uncertainties associated with these local variations, NHTSA's emissions analysis does not assume any variation by vehicle type or fuel in the geographic distribution of VMT.

Emissions changes due to the rebound effect would occur from passenger cars and light trucks operating on entire regional roadway networks; any emissions changes due to the rebound effect would be distributed throughout a region's entire road network and at any specific location would be uniformly proportional to VMT changes at that location. At any one location within a regional network, the resulting change in emissions would be small compared to total emissions from all sources surrounding that location (including existing emissions from traffic already using the road), so the localized impacts of the Proposed Action and alternatives on ambient concentrations and health impacts should also be small. The nationwide aggregated consequences of such small near-source impacts on ambient pollutant concentrations and health might be larger but are not feasible to quantify.

4.1.2.3 Analysis Periods

Ground-level concentrations of criteria and toxic air pollutants generally respond quickly to changes in emissions rates. The longest averaging period for measuring whether ambient concentrations of a pollutant comply with the NAAQS is 1 year.[27] This air quality analysis considers emissions that would occur over annual periods, consistent with the NAAQS. To evaluate impacts on air quality, specific years must be selected for which emissions are estimated and impacts on air quality are calculated.

NHTSA selected calendar years that are meaningful for the timing of likely effects of the alternatives, as follows:

- **2025:** An early forecast year; by 2025 about one-fourth of passenger car and light truck VMT would be accounted for by vehicles that meet fuel economy standards as set forth under the Proposed Action.
- **2035:** A midterm forecast year; by 2035 about three-fourths of passenger car and light truck VMT would be accounted for by vehicles that meet fuel economy standards as set forth under the Proposed Action.
- **2050:** By 2050, almost all passenger cars and light trucks in operation would meet fuel economy standards as set forth under the Proposed Action, and changes in year-over-year impacts would be determined primarily by VMT growth rather than by MY 2021–2026 passenger cars and light trucks replacing older, less fuel-efficient passenger cars and light trucks.

4.1.2.4 Incomplete or Unavailable Information

Where information in this analysis is incomplete or unavailable, NHTSA relies on Council on Environmental Quality regulations regarding incomplete or unavailable information.[28] As noted throughout this methods section, the estimates of emissions rely on models and forecasts that contain numerous assumptions and data that are uncertain. Examples of areas in which information is uncertain (and therefore may be incomplete or unavailable) include future emissions rates, vehicle manufacturers'

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[27] Compliance with the ozone NAAQS is based on the average of the fourth highest daily maximum 8-hour concentration over a 3-year period; compliance with the 24-hour PM2.5 NAAQS is based on the average of the daily 98th-percentile concentrations averaged over a 3-year period; compliance with the annual PM2.5 NAAQS is based on the 3-year average of the weighted annual mean concentrations.

[28] 40 CFR § 1502.22(b).

decisions about vehicle technology and design, the mix of vehicle types and model years in the passenger car and light truck fleet, VMT projections, emissions from fuel refining and distribution, the future composition of the grid mix, and economic factors.

To support the information in this EIS, NHTSA used the best available models and supporting data. The models used for the EIS were subjected to scientific review and were approved by the agencies that sponsored their development. Nonetheless, there are limitations to current modeling capabilities. For example, uncertainties can derive from model formulation (including numerical approximations and the definition of physical and chemical processes) and inaccuracies in the input data (e.g., emissions inventory estimates).

Additional limitations are associated with the estimates of health impacts. To approximate the health impacts associated with each alternative, NHTSA used screening-level estimates of health impacts in the form of cases per ton of criteria pollutant emissions change. Changes in emissions of toxic air pollutants should also result in health impacts, but scientific data that would support quantification and monetization of these impacts are not available.

4.1.2.5 Allocation of Exhaust Emissions to Nonattainment Areas[29]

For each alternative, the CAFE and MOVES models provided national emissions estimates for each criteria air pollutant (or its chemical precursors) and MSAT. National emissions were allocated to the county level using VMT data for each county. EPA provided estimated passenger cars and light truck VMT data for all counties in the United States, consistent with EPA’s National Emissions Inventory (NEI).[30] VMT data used in the NEI were estimated from traffic counts taken by counties and states on major roadways, and therefore are subject to some uncertainty. NHTSA used the estimates of county-level VMT from the NEI only to allocate nationwide total emissions to counties and not to calculate the county-level emissions directly. The estimates of nationwide total emissions are based on the national VMT data used in the CAFE and MOVES models.

NHTSA used the county-level VMT allocations, expressed as the fractions of national VMT that takes place within each county, to derive the county-level emissions from the estimates of nationwide total emissions. Emissions for each nonattainment area were then derived by summing the emissions for the counties included in each nonattainment area. Many nonattainment areas comprise one or more counties, and because county-level emissions are aggregated for each nonattainment area, uncertainties in the county-level emissions estimates carry over to estimates of emissions within each nonattainment area. Over time, some counties will grow faster than others will, and VMT growth rates will vary. EPA’s estimate of county-level VMT allocation is constant over time, which introduces some uncertainty into the nonattainment-area-level VMT estimates for future years. Additional uncertainties that affect county-level exhaust emissions estimates arise from differences among counties or nonattainment areas in factors other than VMT, such as ambient temperatures, vehicle age distributions, vehicle speed distributions, vehicle inspection and maintenance programs, and fuel composition requirements. Because of these uncertainties, emissions in a particular nonattainment area

[29] In Section 4.1.2.5, *Allocation of Exhaust Emissions to Nonattainment Areas,* and Section 4.1.2.6, *Allocation of Upstream Emissions to Nonattainment Areas*, the term *nonattainment* refers to both nonattainment areas and maintenance areas.

[30] The VMT data provided by EPA are based on data generated by the Federal Highway Administration.

may be overestimated or underestimated. The overall uncertainty increases as the projection period lengthens, such as for analysis years 2035 and 2050 compared with analysis year 2025.

The geographic definitions of nonattainment and maintenance areas that NHTSA uses in this document came from the current *Green Book Nonattainment Areas for Criteria Pollutants* (EPA 2019e). For nonattainment areas that include portions of counties, NHTSA calculated the proportion of county population that falls within the nonattainment area boundary as a proxy for the proportion of county VMT within the nonattainment area boundary. Partial county boundaries were taken from geographic information system (GIS) files based on 2018 nonattainment area definitions. The populations of these partial-county areas were calculated using U.S. Census data applied to the boundaries mapped by GIS. This method assumes that per-capita VMT is constant in each county so that the proportion of countywide VMT in the partial county area reflects the proportion of total county population residing in that same area. This technique for allocating VMT to partial counties involves some additional uncertainty because actual VMT per capita can vary according to the characteristics of land use and urban development. For example, VMT per capita can be lower than average in urban centers with mass transit, and higher than average in suburban and rural areas where people tend to drive more (Cook et al. 2006).

The method for allocation of emissions to nonattainment areas is the same for all geographic areas and pollutants. Table 4.1.2-1 lists the current nonattainment and maintenance areas for ozone and PM2.5 and their status and general conformity threshold. Areas for ozone and PM2.5 are listed because these are the pollutants for which nonattainment areas encompass the largest human populations. For the complete list of nonattainment and maintenance areas for all pollutants and standards, see Appendix A, *Air Quality Nonattainment Area Results*.

Table 4.1.2-1. Nonattainment and Maintenance Areas for Ozone and PM2.5

Nonattainment/Maintenance Area	Pollutant	Status[a]	General Conformity Threshold[b]
Allegan County, MI	Ozone	Marginal	100
Allegheny County, PA	PM2.5	Moderate	100
Allentown, PA	PM2.5	Maintenance	100
Allentown-Bethlehem-Easton, PA	Ozone	Marginal	50
Amador County, CA	Ozone	Marginal	100
Atlanta, GA	Ozone	Marginal	100
Baltimore, MD	Ozone	Moderate	50
Baton Rouge, LA	Ozone	Maintenance	100
Berrien County, MI	Ozone	Marginal	100
Birmingham, AL	PM2.5	Maintenance	100
Butte County, CA	Ozone	Marginal	100
Calaveras County, CA	Ozone	Marginal	100
Canton-Massillon, OH	PM2.5	Maintenance	100
Charleston, WV	PM2.5	Maintenance	100
Charlotte-Gastonia-Rock Hill, NC-SC	Ozone	Maintenance	100
Chicago-Naperville, IL-IN-WI	Ozone	Moderate	100

Nonattainment/Maintenance Area	Pollutant	Status[a]	General Conformity Threshold[b]
Chico (Butte County), CA	Ozone	Marginal	100
Chico, CA	PM2.5	Maintenance	100
Cincinnati-Hamilton, OH-KY-IN	Ozone	KY: Marginal OH, IN: Maintenance	100
Cleveland, OH	Ozone	Marginal	100
Cleveland, OH	PM2.5	Moderate	100
Cleveland-Akron-Lorain, OH	Ozone	Marginal	100
Cleveland-Akron-Lorain, OH	PM2.5	Maintenance	100
Columbus, OH	Ozone	Marginal	100
Dallas-Fort Worth, TX	Ozone	Moderate	100
Delaware County, PA	PM2.5	Moderate	100
Denver-Boulder-Greeley-Fort Collins-Loveland, CO	Ozone	Moderate	100
Detroit, MI	Ozone	Marginal	100
Detroit-Ann Arbor, MI	PM2.5	Maintenance	100
Doña Ana County (Sunland Park Area), NM	Ozone	Marginal	100
Door County, WI	Ozone	Marginal (Rural Transport)	100
Dukes County, MA	Ozone	Marginal	50
Fairbanks, AK	PM2.5	Serious	70
Greater Connecticut, CT	Ozone	Moderate	50
Harrisburg-Lebanon-Carlisle-York, PA	PM2.5	Maintenance	100
Houston-Galveston-Brazoria, TX	Ozone	Moderate	100
Imperial County, CA	Ozone	Moderate	100
Imperial County, CA	PM2.5	Moderate	100
Jamestown, NY	Ozone	Marginal	50
Johnstown, PA	PM2.5	Maintenance	100
Kern County (Eastern Kern), CA	Ozone	Serious	50
Klamath Falls, OR	PM2.5	Moderate	100
Knoxville, TN	Ozone	Maintenance	100
Knoxville-Sevierville-LaFollette, TN	PM2.5	Maintenance	100
Lancaster, PA	Ozone	Marginal	50
Lancaster, PA	PM2.5	Maintenance	100
Las Vegas, NV	Ozone	Marginal	100
Lebanon County, PA	PM2.5	Moderate	100
Liberty-Clairton, PA	PM2.5	Moderate	100
Logan, UT-ID	PM2.5	Moderate	100
Los Angeles, CA	PM2.5	Serious	70
Los Angeles-San Bernardino Counties (Western Mojave Desert), CA	Ozone	Severe-15	25

Nonattainment/Maintenance Area	Pollutant	Status[a]	General Conformity Threshold[b]
Los Angeles South Coast Air Basin, CA	Ozone	Extreme	10
Los Angeles South Coast Air Basin, CA	PM2.5	Moderate	100
Louisville, KY-IN	Ozone	Marginal	100
Manitowoc County, WI	Ozone	Marginal	100
Mariposa County, CA	Ozone	Moderate	100
Memphis, TN-MS-AR	Ozone	Maintenance	100
Milwaukee-Racine, WI	PM2.5	Maintenance	100
Morongo Band of Mission Indians, CA	Ozone	Serious	50
Muskegon County, MI	Ozone	Marginal	100
Nevada County (western part), CA	Ozone	Moderate	100
New York-N. New Jersey-Long Island, NY-NJ-CT	Ozone	Moderate	50
New York-N. New Jersey-Long Island, NY-NJ-CT	PM2.5	Maintenance	100
Nogales, AZ	PM2.5	Moderate	100
Northern Milwaukee/Ozaukee Shoreline, WI	Ozone	Marginal	100
Northern Wasatch Front, UT	Ozone	Marginal	100
Oakridge, OR	PM2.5	Moderate	100
Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation, CA	Ozone	Moderate	100
Philadelphia-Wilmington, PA-NJ-DE	PM2.5	Maintenance	100
Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE	Ozone	Marginal	50
Phoenix-Mesa, AZ	Ozone	Moderate	100
Pittsburgh-Beaver Valley, PA	Ozone	Marginal	50
Pittsburgh-Beaver Valley, PA	PM2.5	Moderate	100
Plumas County, CA	PM2.5	Moderate	100
Provo, UT	PM2.5	Serious	70
Reading, PA	Ozone	Marginal	50
Riverside County (Coachella Valley), CA	Ozone	Severe-15	25
Sacramento Metro, CA	Ozone	Severe-15	25
Sacramento Metro, CA	PM2.5	Moderate	100
Salt Lake City, UT	PM2.5	Serious	70
San Antonio, TX	Ozone	Marginal	100
San Diego County, CA	Ozone	Moderate	100
San Francisco Bay Area, CA	Ozone	Marginal	100
San Francisco Bay Area, CA	PM2.5	Moderate	100
San Joaquin Valley, CA	Ozone	Extreme	10
San Joaquin Valley, CA	PM2.5	Serious	70
San Luis Obispo (Eastern San Luis Obispo), CA	Ozone	Marginal	100
Seaford, DE	Ozone	Marginal	50

Nonattainment/Maintenance Area	Pollutant	Status[a]	General Conformity Threshold[b]
Seattle-Tacoma, WA	PM2.5	Maintenance	100
Sheboygan County, WI	Ozone	Moderate	100
Southern Wasatch Front, UT	Ozone	Marginal	100
St. Louis-St. Charles-Farmington, MO-IL	Ozone	Marginal	100
Steubenville-Weirton, OH-WV	PM2.5	Maintenance	100
Sutter Buttes, CA	Ozone	Marginal	100
Tuolumne County, CA	Ozone	Marginal	100
Tuscan Buttes, CA	Ozone	Marginal	100
Uinta Basin, UT	Ozone	Marginal	100
Upper Green River Basin Area, WY	Ozone	Marginal	100
Ventura County, CA	Ozone	Serious	50
Washington, DC-MD-VA	Ozone	Marginal	50
West Central Pinal County, AZ	PM2.5	Moderate	100
West Silver Valley, ID	PM2.5	Moderate	100
Yuba City-Marysville, CA	PM2.5	Maintenance	100
Yuma, AZ	Ozone	Marginal	100

Notes:
[a] Pollutants for which the area is designated in nonattainment or maintenance as of 2019. For nonattainment areas, the status given is the severity classification as defined in 40 CFR 1303. Classifications in order of increasing ozone concentration are Marginal, Moderate, Serious, Severe-15, Severe-17, and Extreme. Where an area is nonattainment for more than one standard for the same pollutant, the more restrictive severity classification is shown.
[b] Emissions thresholds in tons/year. In ozone nonattainment areas, the thresholds given are for the precursor pollutants VOC or NO_X; in PM2.5 nonattainment areas the thresholds represent primary PM2.5. Where an area is nonattainment for more than one standard for the same pollutant, the lowest applicable threshold is shown. Source: 40 CFR § 51.853. These thresholds are provided for information only; a general conformity determination is not required for the Proposed Action.
Source: EPA 2019e
NO_X = nitrogen oxides; PM2.5 = particulate matter with a nominal aerodynamic diameter equal to or less than 2.5 microns; VOC = volatile organic compounds

4.1.2.6 Allocation of Upstream Emissions to Nonattainment Areas

Upstream emissions are generated when fuels used by motor vehicles are produced, processed, and transported. Upstream emissions are typically divided into four categories: feedstock recovery, feedstock transportation, fuel refining, and fuel transportation, storage, and distribution (TS&D). Feedstock recovery refers to the extraction or production of fuel feedstocks—the materials (e.g., crude oil) that are the main inputs to the refining process. In the case of petroleum, this is the stage of crude-oil extraction. During the next stage, feedstock transportation, crude oil or other feedstocks are shipped to fuel refineries. Fuel refining refers to the processing of crude oil into gasoline and diesel fuel. Fuel refining is the largest source of upstream emissions of criteria pollutants. Depending on the specific fuel and pollutant, fuel refining accounts for between 9 percent and 86 percent of all upstream emissions per unit of fuel produced and distributed (based on GREET version 1.8c). TS&D refers to the movement of gasoline and diesel from refineries to bulk terminals, storage at bulk terminals, and transportation of fuel from bulk terminals to retail outlets.[31] Emissions of pollutants at each stage are associated with expenditure of energy and with leakage or spillage and evaporation of fuel products. NHTSA has allocated upstream emissions to individual nonattainment areas to provide additional information in its regional air quality analysis to the decision-maker and the public, consistent with previous CAFE EISs (NHTSA 2010, 2012) and the heavy-duty fuel efficiency standards EISs (NHTSA 2011, 2016c). NHTSA made a number of important assumptions for this analysis because of uncertainty over the accuracy of the allocation of upstream emissions.

To analyze the impacts of the alternatives on individual nonattainment areas, NHTSA allocated projected emissions data from the EPA 2011-based air quality modeling platform (EPA 2014f). These EPA data were projected for 2023, the most representative year available in the EPA dataset. NHTSA allocated changes in nationwide total emissions, for each of the four source categories separately, to individual nonattainment areas. The EPA modeling platform includes estimates of emissions of criteria and toxic pollutants by county and by source category. Because each of the four source categories represents a separate source category in the EPA modeling platform, it is possible to estimate the share of nationwide emissions from each category that occurs within each nonattainment area. This analysis assumes that the share of emissions from feedstock extraction and fuel refining allocated to each nonattainment area does not change over time, which means, in effect, that emissions for these two source categories are assumed to change uniformly (in percentage terms) across that category nationwide as a result of each alternative.[32] This analysis also assumes that the share of emissions from feedstock and fuel TS&D allocated to each nonattainment area can change over time based on the population forecast for each area.

4.1.2.7 Health Impacts

This section describes NHTSA's approach to providing quantitative estimates of adverse health impacts of conventional air pollutants associated with each alternative. In this analysis, NHTSA quantified the impacts on human health anticipated to result from the changes in pollutant emissions and related changes in human exposure to air pollutants under each alternative. NHTSA evaluated the changes to several health outcomes associated with criteria pollutant emissions. Table 4.1.2-2 lists the health outcomes NHTSA quantified. This method estimates the health impacts of each alternative for each analysis year, expressed as the number of additional or avoided adverse health outcomes per year. Health outcomes are calculated for each primary pollutant (NO_X, directly emitted PM2.5, and SO_2) and expressed as adverse health outcomes increased per ton of increased emissions or as adverse health outcomes avoided per ton of reduced emissions. Each primary pollutant has a specific factor related to its quantifiable health impacts (expressed as incidence of impacts per ton of emissions). The general approach to calculating the health outcomes associated with each alternative is to multiply these factors by the estimated annual change in emissions of that pollutant and to sum the results of these

[31] Emissions that occur while vehicles are being refueled at retail stations are included in estimates of emissions from vehicle operation.

[32] In the Draft EIS, NHTSA assumed that little to no extraction of crude oil occurs in nonattainment areas and that little to no crude oil is transported through nonattainment areas. Because NHTSA did not account for these stages, the assumptions produced conservative estimates of emissions reductions in nonattainment areas. As a result of public comments received on the Draft EIS, NHTSA incorporated the feedstock recovery and feedstock transportation stages in the Final EIS. Emissions from the feedstock recovery and feedstock transportation stages are small relative to total upstream and tailpipe emissions and do not have a substantial effect on the Final EIS results.

calculations for all pollutants. This calculation provides the total health impacts that would result under each alternative.

Table 4.1.2-2. Human Health and Welfare Impacts of PM2.5

Impacts Quantified	Impacts Excluded from Quantification[a]
Adult premature mortality	Chronic bronchitis (age >26)
Infant mortality	Emergency room visits for cardiovascular effects
Acute bronchitis (age 8-12)	Strokes and cerebrovascular disease (age 50–79)
Hospital admissions: respiratory (all ages) and cardiovascular (age >26)	Other respiratory effects (e.g., pulmonary function, non-asthma emergency room visits, nonbronchitis chronic diseases, other ages and populations)
Emergency room visits for asthma	Cardiovascular effects other than those listed
Nonfatal heart attacks (age >18)	Reproductive and developmental effects (e.g., low birth weight, preterm births)
Lower (age 7–14) and upper (age 9–11) respiratory symptoms	Cancer, mutagenicity, and genotoxicity effects
Minor restricted-activity days (age 18–65)	--
Lost work days (age 18–65)	--
Asthma exacerbations (asthmatics age 6–18)	--

Notes:
[a] EPA excluded these effects because of insufficient confidence in available data or methods, or because current evidence is only suggestive of causality or there are other significant concerns over the strength of the association.
Source: EPA 2018h. See this source for more information related to the affected ages included in the analysis.
PM2.5 = particulate matter 2.5 micrometers or less; EPA = U.S. Environmental Protection Agency

In calculating the health impacts of emissions increases, NHTSA estimated only the PM2.5-related human health impacts expected to result from increased population exposure to atmospheric concentrations of PM2.5. Two other pollutants—NO_X and SO_2—are included in the analysis as precursor emissions that contribute to PM2.5 not emitted directly from a source but instead are formed by chemical reactions in the atmosphere (secondary PM2.5). Increases in NO_X and VOC emissions would also increase ozone formation and the health effects associated with ozone exposure, but there are no incidence-per-ton estimates for NO_X and VOCs because of the complexity of the atmospheric air chemistry and nonlinearities associated with ozone formation. This analysis does not include any increases in health impacts resulting from greater population exposure to other criteria air pollutants and air toxics because there are not enough data available to quantify these impacts.

Quantified Health Impacts

The incidence-per-ton factors represent the total human health benefits due to a suite of PM-related health impacts for each ton of emissions reduced. The factors are specific to an individual pollutant and source. The PM2.5 incidence-per-ton estimates apply to directly emitted PM2.5 or its precursors (NO_X and SO_2). NHTSA followed the incidence-per-ton technique used in EPA's PM2.5 NAAQS Regulatory Impact Analysis (RIA) (EPA 2013d), Ozone NAAQS RIA (EPA 2010a), Portland Cement National Emission Standards for Hazardous Air Pollutants RIA (EPA 2010b), NO_2 NAAQS RIA (EPA 2010c), and most recently updated in *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors* (EPA2018h).[33] Updates from the 2006 PM NAAQS RIA in the 2012 PM2.5 NAAQS RIA include no longer assuming a concentration threshold in the concentration-response function for the PM2.5-related health effects; using incidence derived from two major cohort studies of PM2.5; and baseline incidence rates for hospital admissions, emergency department visits, and asthma prevalence rates. Revised health endpoints, sensitivity analyses, and new morbidity studies were also included.

Table 4.1.2-2 lists the quantified PM2.5-related benefits captured in those benefit-per-ton estimates, and potential PM2.5-related benefits that were not quantified in this analysis. The benefits estimates use the concentration-response functions[34] as reported in the epidemiology literature.[35]

EPA developed national per-ton estimates for selected pollutants emitted through stationary and mobile activity (EPA2018h). Because the per-ton values vary slightly between the two categories, the total health impacts were derived by multiplying the stationary per-ton estimates by total upstream emissions and the mobile per-ton estimates by total mobile emissions. NHTSA's estimate of PM2.5 benefits is, therefore, based on the total direct PM2.5 and PM2.5-related precursor emissions controlled by sector and multiplied by this per-ton value.

PM-related mortality reductions provide most of the benefit in each benefit-per-ton estimate. EPA calculated the premature mortality-related effect coefficients that underlie the benefits-per-ton estimates from epidemiology studies that examined two large population cohorts—the American Cancer Society cohort (Krewski et al. 2009) and the Harvard Six Cities cohort (Lepeule et al. 2012). These are logical choices for anchor points when presenting PM-related benefits because, although the benefit-per-ton results vary between the two studies, EPA considers both studies equal in terms of strengths and weaknesses and the quality of results. According to EPA, both studies should be used to generate benefits estimates (EPA 2013e). In this section, the mortality rates calculated from each of these studies are presented side by side.

For both studies, the benefits of mortality reductions do not occur in the year of analysis. Instead, EPA's method assumes that there is a cessation lag—that is, the benefits are distributed across 20 years following the year of exposure (the emissions analysis year). The benefits-per-ton estimates used in this analysis are based on the mortality health outcome factors given in Table 4.1.2-2. The benefit-per-ton estimates are subject to several assumptions and uncertainties, as follows:

- The benefit-per-ton estimates incorporate projections of key variables, including atmospheric conditions, source level emissions, population, health baselines, and incomes. These projections introduce some uncertainties to the benefit-per-ton estimates.
- The benefit-per-ton estimates do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an overestimate

[33] EPA refers to this technique as the "benefit per ton" method for estimating the health benefits of reduced emissions, and NHTSA follows this terminology below. However, this technique applies equally to estimating the additional health outcomes from increased emissions.

[34] Concentration-response functions measure the relationship between exposure to pollution as a cause and specific outcomes as an effect (e.g., the incremental number of hospitalizations that would result from exposure of a population to a specified concentration of an air pollutant over a specified period).

[35] The complete method for creating the benefit-per-ton estimates used in this analysis is provided in *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors* (EPA 2018h) and Fann et al. (2009). Note that since the publication of Fann et al. (2009), EPA no longer assumes that there is a threshold in PM-related models of health impacts.

or underestimate of the actual benefits of controlling fine particulates (PM2.5). Emissions changes and benefit-per-ton estimates alone are not a precise indication of local or regional air quality and health impacts because there could be localized impacts associated with the Proposed Action and alternatives. Because the atmospheric chemistry related to ambient concentrations of PM2.5, ozone, and air toxics is very complex, full-scale photochemical air quality modeling is necessary to control for local variability. Full-scale photochemical modeling provides the needed spatial and temporal detail to estimate changes in ambient levels of these pollutants and their associated impacts on human health and welfare. This modeling provides insight into the uncertainties associated with the use of benefit-per-ton estimates. NHTSA conducted a photochemical modeling analysis for the Final EIS using the same methods as in the CAFE Final EISs (NHTSA 2010, 2012) and the HD Fuel Efficiency Standards Phases 1 and 2 Final EISs (NHTSA 2011, 2016c). Appendix E, Air Quality Modeling and Health Impacts Assessment, provides the results of photochemical air quality modeling for the EIS.

- NHTSA assumed that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because PM2.5 produced via transported precursors emitted from stationary sources might differ significantly from direct PM2.5 released from diesel engines and other industrial sources. However, there are no clear scientific grounds to support estimating differential effects by particle type.
- NHTSA assumed that the health impact (concentration-response) function for fine particles is linear within the range of ambient concentrations under consideration. Therefore, the estimates include health benefits from reducing fine particles in areas with varied concentrations of PM2.5, including regions that are in attainment with the fine-particle standard and those that do not meet the standard, down to the lowest modeled concentrations.
- The following uncertainties, among others, are associated with the health impact functions: within-study variability (the precision with which a given study estimates the relationship between air quality changes and health impacts), across-study variation (different published studies of the same pollutant/health effect relationship typically do not report identical findings, and in some cases the differences are substantial), the application of concentration-response functions nationwide (does not account for any relationship between region and health impact to the extent that there is such a relationship), and extrapolation of impact functions across population (NHTSA assumed that certain health impact functions applied to age ranges broader than those considered in the original epidemiological study). These uncertainties could underestimate or overestimate benefits.
- NHTSA was unable to quantify several health-benefits categories because of limitations associated with using benefit-per-ton estimates, several of which could be substantial. Because NO_X and VOCs are also precursors to ozone, reductions in NO_X and VOC emissions would also reduce ozone formation and the health effects associated with ozone exposure. Unfortunately, there are no benefit-per-ton estimates because of the complexity of the atmospheric air chemistry and nonlinearities associated with ozone formation. The PM-related benefit-per-ton estimates also do not include any human welfare or ecological benefits because of limitations on the availability of data to quantify these impacts of pollutant emissions.

Because of these uncertainties, it is not possible to draw conclusions about whether the benefit-per-ton values are underestimated or overestimated. The RIA for the 2012 PM2.5 NAAQS (EPA 2013d) provides more information about the overall uncertainty in the estimates of the benefits of reducing PM2.5 emissions.

Table 4.1.2-3 lists the incidence-per-ton estimates for PM-related health impacts (derived by the process described above). For the analysis of direct and indirect impacts (Section 4.2, *Environmental Consequences*) NHTSA used the values for the 2025 analysis year (Section 4.1.2.3, *Analysis Periods*). NHTSA applied the values for 2030 to estimate impacts in 2035 and 2050.

Table 4.1.2-3. Incidence-per-Ton Values for Health Outcomes

Year	Upstream Emissions (Data for Refineries Sector)			Downstream Emissions (Data for On-Road Sources Sector)		
	Direct PM2.5	SO_2	NO_X	Direct PM2.5	SO_2	NO_X
Premature mortality (Krewski et al. 2009)						
2025	0.04100	0.00880	0.00087	0.04800	0.00260	0.00098
2030	0.04400	0.00950	0.00094	0.05100	0.00290	0.00100
Premature mortality (Lepeule et al. 2012)						
2025	0.09400	0.02000	0.00200	0.11000	0.00600	0.00220
2030	0.10000	0.02200	0.00210	0.12000	0.00650	0.00240
Emergency room visits: respiratory						
2025	0.02300	0.00470	0.00045	0.02700	0.00140	0.00052
2030	0.02400	0.00490	0.00047	0.02800	0.00150	0.00053
Acute bronchitis						
2025	0.06100	0.01300	0.00130	0.06700	0.00410	0.00130
2030	0.06600	0.01400	0.00140	0.07300	0.00450	0.00140
Lower respiratory symptoms						
2025	0.78000	0.16000	0.01600	0.86000	0.05200	0.01700
2030	0.84000	0.18000	0.01800	0.93000	0.05700	0.01800
Upper respiratory symptoms						
2025	1.10000	0.23000	0.02300	1.20000	0.07400	0.02500
2030	1.20000	0.25000	0.02500	1.30000	0.08200	0.02600
Minor Restricted Activity Days						
2025	32.00000	6.80000	0.67000	36.00000	2.10000	0.70000
2030	33.00000	7.00000	0.68000	37.00000	2.10000	0.71000
Work-loss days						
2025	5.40000	1.20000	0.11000	6.20000	0.35000	0.12000
2030	5.60000	1.20000	0.12000	6.30000	0.37000	0.12000
Asthma exacerbation						
2025	1.30000	0.28000	0.02700	1.40000	0.08700	0.02900
2030	1.40000	0.29000	0.02900	1.50000	0.09400	0.03100
Hospital admissions: cardiovascular						
2025	0.01000	0.00230	0.00022	0.01200	0.00062	0.00025
2030	0.01200	0.00260	0.00025	0.01400	0.00070	0.00027
Hospital admissions: respiratory						
2025	0.01000	0.00220	0.00021	0.01200	0.00060	0.00024
2030	0.01100	0.00250	0.00024	0.01300	0.00068	0.00026

Year	Upstream Emissions (Data for Refineries Sector)			Downstream Emissions (Data for On-Road Sources Sector)		
	Direct PM2.5	SO_2	NO_X	Direct PM2.5	SO_2	NO_X
Non-fatal heart attacks (Peters et al. 2001)						
2025	0.04100	0.00910	0.00088	0.04900	0.00250	0.00098
2030	0.04500	0.01000	0.00097	0.05400	0.00280	0.00110
Non-fatal heart attacks (All others)						
2025	0.00450	0.00099	0.00010	0.00530	0.00027	0.00011
2030	0.00490	0.00110	0.00010	0.00580	0.00030	0.00011

Source: EPA 2018h
EPA = U.S. Environmental Protection Agency; NO_X = nitrogen oxides; PM2.5 = particulate matter with a diameter equal to or less than 2.5 microns; SO_2 = sulfur dioxide

The EPA incidence-per-ton estimates shown in Table 4.1.2-3 are national averages and account for effects of upstream and downstream emissions separately. However, they do not reflect localized variations in emissions, population characteristics, or exposure to pollutants. Most upstream emissions are released from elevated points (for example, tall stacks at refineries and power plants) and disperse widely before reaching ground level. The population in a large geographic region could be affected, but pollutant concentrations generally would be relatively low at any one location. On the other hand, concentrations very near an upstream source that releases emissions at a relatively low elevation could be greater. The actual health impacts from human exposure at any particular location would vary with emissions, local meteorology and topography, and population characteristics.

Unlike most upstream emissions, downstream emissions occur across the roadway system and are released at or near ground level. Populations located near roadways could experience relatively greater pollutant levels because the short distance from the roadway allows less pollutant dispersion to occur. Populations located at greater distances from roadways would be larger than the populations near the roadways but would experience much lower pollutant levels. As with upstream emissions, the actual health effects from human exposure at any particular location would vary with emissions, local meteorology and topography, and population characteristics. Because of these variations, the actual change in health impacts per ton of emissions change could be larger or smaller at any particular location than the values in Table 4.1.2-3.

4.2 Environmental Consequences

This section examines the direct and indirect impacts on air quality associated with the Proposed Action and alternatives. NHTSA has identified Alternative 3 as the Preferred Alternative. The analysis shows that the action alternatives would result in different levels of emissions from passenger cars and light trucks when measured against projected trends under the No Action Alternative. These reductions and increases in emissions would vary by pollutant, calendar year, and action alternative. The more stringent action alternatives generally would result in larger emissions reductions or smaller emissions increases, compared to the No Action Alternative. Chapter 8, *Cumulative Impacts*, examines cumulative air quality impacts.

As described in Section 2.3.1, *CAFE Model*, NHTSA has revised certain inputs and assumptions in the CAFE Model that affect emissions projections. As a result, the emissions forecasts in this Final EIS differ from those in the Draft EIS, and the resulting health effects differ for the Final EIS as well. In the following sections, NHTSA describes these differences between the Draft EIS and Final EIS. In Section 2.5.3, NHTSA discusses why these differences are not significant new information relevant to environmental concerns that would require a Supplemental Draft EIS.

4.2.1 Criteria Pollutants

4.2.1.1 Emission Levels

Table 4.2.1-1 summarizes the total upstream and downstream[36] national emissions by alternative for each of the criteria pollutants and analysis years. Figure 4.2.1-1 illustrates this information for 2035, the forecast year by which a large proportion of passenger car and light truck VMT would be accounted for by vehicles that meet standards as set forth under the Proposed Action.

Figure 4.2.1-2 shows the changes over time in total national emissions of criteria pollutants under Alternative 1 (the least stringent and highest fuel use action alternative) and Alternative 7 (the lowest fuel use action alternative) to show the highest and lowest ends of the range of emissions impacts over time across action alternatives. Figure 4.2.1-2 shows a consistent time trend among the criteria pollutants except for SO_2. Emissions of CO, NOx, PM2.5, and VOC decline from 2025 to 2050 because of increasingly stringent EPA regulation of emissions from vehicles (Section 4.1.1, *Relevant Pollutants and Standards*) and from reductions in upstream emissions from fuel production, despite a growth in total VMT from 2025 to nearly 2050 (Table 4.2.1-1 and Figure 4.2.1-2). (Note that continued growth in VMT is projected to occur under all alternatives until 2042; a slight decline is projected to occur from 2042 to 2050.) Emissions of SO_2 decline from 2025 to 2035 but increase from 2035 to 2050. This increase reflects the projected increase in EV use in the later years, which would result in greater emissions from fossil-fueled power plants to generate the electricity for charging the EVs.

Total emissions consist of four components: two sources of emissions (downstream [i.e., tailpipe emissions] and upstream) for each of the two vehicle classes covered by the rule (passenger cars and light trucks). Table 4.2.1-2 shows the total emissions of criteria pollutants by component for calendar year 2035.

[36] Due to modeling limitations, downstream emissions do not include evaporative emissions from vehicle fuel systems.

Table 4.2.1-1. Nationwide Criteria Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks by Alternative, Direct and Indirect Impacts

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Carbon monoxide (CO)								
2025	12,417,383	12,360,373	12,363,024	12,367,168	12,368,879	12,381,995	12,384,943	12,391,066
2035	7,286,915	7,311,771	7,312,898	7,313,481	7,314,071	7,308,517	7,306,999	7,304,659
2050	4,739,300	4,999,260	4,987,297	4,980,660	4,977,083	4,921,747	4,871,534	4,857,136
Nitrogen oxides (NO_x)								
2025	990,975	990,397	990,450	990,404	990,472	990,596	990,173	990,754
2035	534,343	544,269	544,074	543,299	542,871	541,104	539,220	539,004
2050	363,020	380,729	380,041	378,993	378,308	374,710	371,843	370,155
Particulate matter (PM2.5)								
2025	35,459	35,694	35,687	35,668	35,667	35,608	35,563	35,570
2035	28,847	29,749	29,729	29,657	29,623	29,462	29,282	29,265
2050	24,048	25,546	25,487	25,392	25,332	25,032	24,782	24,645
Sulfur oxides (SO_2)								
2025	154,484	154,288	154,217	154,085	154,060	154,389	153,668	154,707
2035	148,708	145,032	144,959	145,278	145,201	146,284	145,728	147,383
2050	198,151	175,354	176,358	177,203	177,784	182,812	187,349	189,036
Volatile organic compounds (VOCs)								
2025	1,311,911	1,316,996	1,316,945	1,316,547	1,316,577	1,315,242	1,313,808	1,314,448
2035	723,438	755,238	754,661	752,122	750,905	745,266	738,857	738,507
2050	449,226	503,349	501,308	498,008	495,724	484,624	475,075	470,300

Figure 4.2.1-1. Nationwide Criteria Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks for 2035 by Alternative, Direct and Indirect Impacts

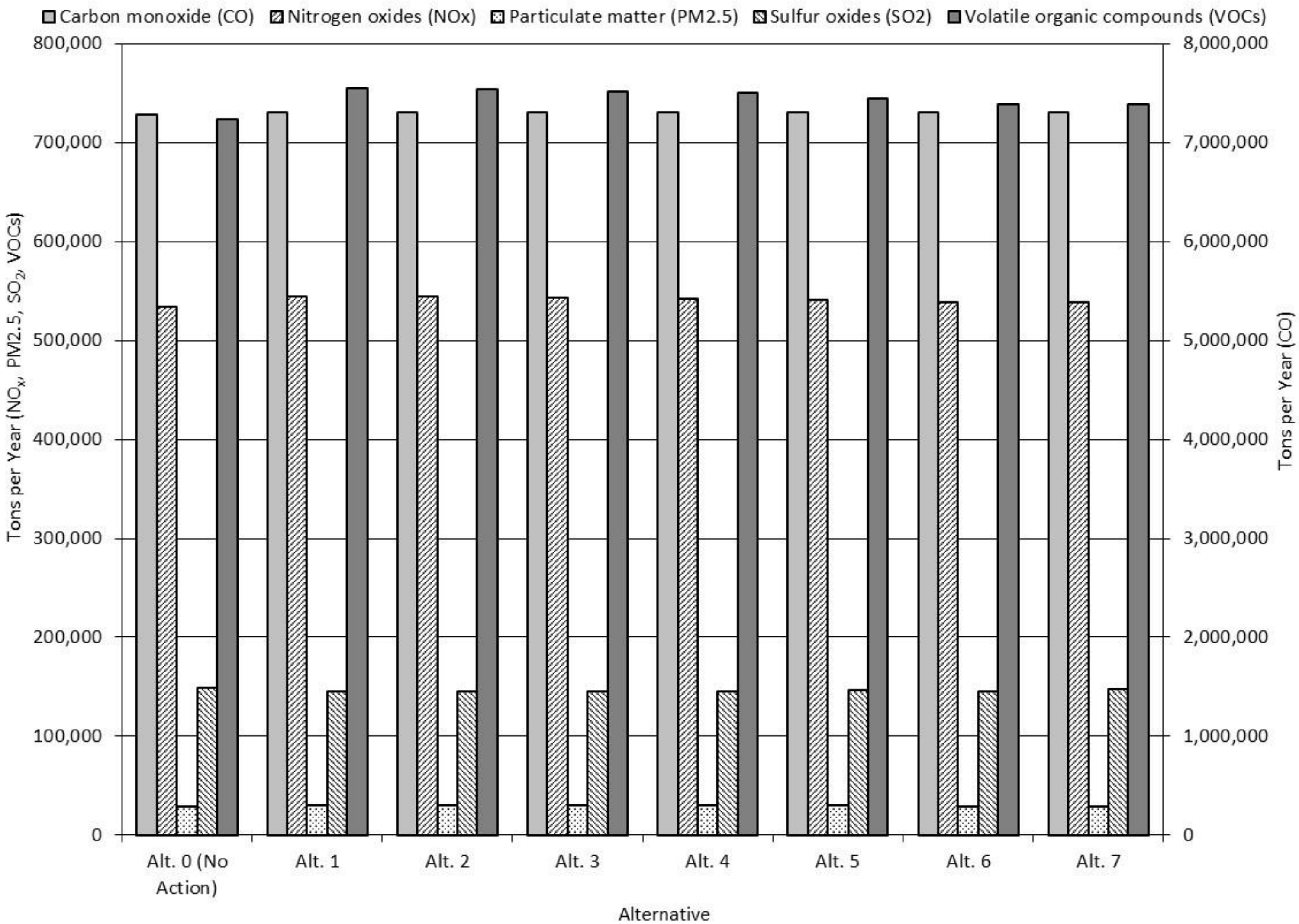


Figure 4.2.1-2. Nationwide Criteria Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks under Alternatives 1 and 7, Direct and Indirect Impacts

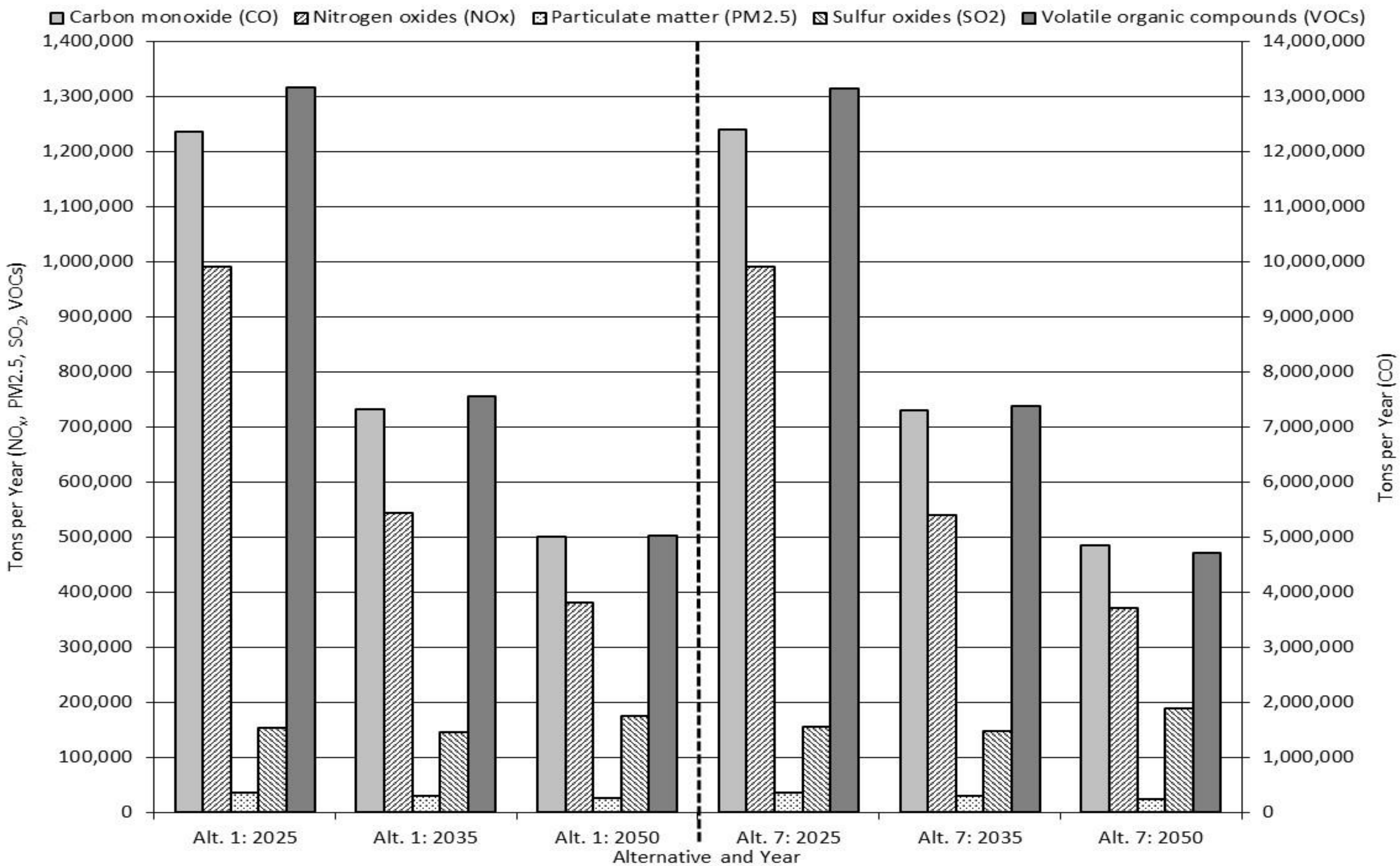


Table 4.2.1-2. Nationwide Criteria Pollutant Emissions (tons per year) in 2035 from U.S. Passenger Cars and Light Trucks by Vehicle Type and Alternative, Direct and Indirect Impacts

Vehicle Class	Alt 0 No Action	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Carbon monoxide (CO)								
Cars tailpipe	3,269,669	3,323,846	3,323,064	3,320,643	3,318,618	3,307,695	3,319,182	3,299,251
Cars upstream	41,692	44,583	44,528	44,282	44,176	43,569	43,407	42,746
Trucks tailpipe	3,923,909	3,890,225	3,892,271	3,895,661	3,898,514	3,904,610	3,892,537	3,910,148
Trucks upstream	51,645	53,116	53,035	52,896	52,763	52,643	51,874	52,514
Total	7,286,915	7,311,771	7,312,898	7,313,481	7,314,071	7,308,517	7,306,999	7,304,659
Nitrogen oxides (NO_x)								
Cars tailpipe	147,469	149,433	149,407	149,324	149,251	148,841	149,341	148,555
Cars upstream	76,237	82,090	81,967	81,482	81,337	80,218	79,952	78,631
Trucks tailpipe	215,302	213,259	213,362	213,543	213,679	214,049	213,667	214,443
Trucks upstream	95,336	99,488	99,337	98,951	98,604	97,996	96,260	97,374
Total	534,343	544,269	544,074	543,299	542,871	541,104	539,220	539,004
Particulate matter (PM2.5)								
Cars tailpipe	6,956	7,046	7,044	7,041	7,038	7,024	7,046	7,012
Cars upstream	5,843	6,327	6,316	6,277	6,268	6,182	6,163	6,055
Trucks tailpipe	8,708	8,630	8,635	8,642	8,652	8,663	8,630	8,674
Trucks upstream	7,341	7,746	7,735	7,697	7,664	7,594	7,442	7,523
Total	28,847	29,749	29,729	29,657	29,623	29,462	29,282	29,265
Sulfur oxides (SO_2)								
Cars tailpipe	2,878	3,181	3,173	3,150	3,151	3,107	3,101	3,035
Cars upstream	65,598	66,737	66,785	66,597	66,155	65,269	64,844	64,470
Trucks tailpipe	3,827	4,054	4,048	4,014	3,987	3,911	3,924	3,836
Trucks upstream	76,405	71,060	70,954	71,517	71,908	73,997	73,859	76,042
Total	148,708	145,032	144,959	145,278	145,201	146,284	145,728	147,383
Volatile organic compounds (VOCs)								
Cars tailpipe	172,467	173,983	173,975	173,912	173,848	173,506	174,089	173,311
Cars upstream	143,212	157,768	157,399	156,280	156,288	154,102	153,778	150,604
Trucks tailpipe	226,246	224,065	224,170	224,348	224,462	224,862	224,602	225,324
Trucks upstream	181,513	199,423	199,117	197,582	196,306	192,796	186,388	189,268
Total	723,438	755,238	754,661	752,122	750,905	745,266	738,857	738,507

Table 4.2.1-3 lists the net changes in nationwide criteria pollutant emissions for each action alternative for each criteria pollutant and analysis year compared to the No Action Alternative in the same year. Figure 4.2.1-3 shows these changes in percentages for 2035. As a general trend, total emissions of each pollutant follow one of two broad patterns of changes with the stringency of the alternatives:

- For CO (in 2025), NO_X (in 2025), and SO_2, emissions generally decrease under the action alternatives compared to the No Action Alternative. For CO in 2025, the largest decrease occurs under

Alternative 1 and the emissions decreases get smaller from Alternative 1 through Alternative 7 (the most stringent alternative in terms of required miles per gallon [mpg]). For NO_X in 2025, the largest decrease occurs under Alternative 6. For SO_2 in 2025, the largest decrease occurs under Alternative 6; however, emissions under Alternative 7 are greater than under the No Action Alternative. For SO_2 in 2035, the largest decrease occurs under Alternative 2. For SO_2 in 2050, the largest decrease occurs under Alternative 1 and the emissions decreases get smaller from Alternative 1 through Alternative 7.

- For CO (in 2035 and 2050), NO_X (in 2035 and 2050), PM2.5, and VOCs, emissions show increases across action alternatives compared to the No Action Alternative, with the largest increases occurring under Alternative 1 (except CO in 2035, for which the largest increase occurs under Alternative 4). The emissions increases get smaller from Alternative 1 through Alternative 7. Exceptions to this trend are for PM2.5 and VOCs in 2025, which show the smallest emissions increase under Alternative 6.

Table 4.2.1-3. Nationwide Changes in Criteria Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks by Alternative, Direct and Indirect Impacts[a,b]

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Carbon monoxide (CO)								
2025	0	-57,010	-54,359	-50,215	-48,504	-35,388	-32,440	-26,317
2035	0	24,856	25,984	26,567	27,157	21,602	20,085	17,744
2050	0	259,961	247,998	241,361	237,784	182,447	132,235	117,837
Nitrogen oxides (NO_x)								
2025	0	-579	-526	-571	-503	-379	-802	-221
2035	0	9,926	9,731	8,956	8,528	6,761	4,877	4,661
2050	0	17,708	17,021	15,973	15,288	11,690	8,823	7,135
Particulate matter (PM2.5)								
2025	0	235	228	209	208	149	104	111
2035	0	902	882	810	776	615	435	418
2050	0	1,498	1,439	1,344	1,284	984	734	597
Sulfur oxides (SO_x)								
2025	0	-196	-267	-399	-424	-95	-816	223
2035	0	-3,676	-3,749	-3,430	-3,507	-2,424	-2,980	-1,325
2050	0	-22,797	-21,793	-20,947	-20,367	-15,339	-10,802	-9,115
Volatile organic compounds (VOCs)								
2025	0	5,085	5,034	4,636	4,666	3,331	1,897	2,536
2035	0	31,800	31,223	28,684	27,467	21,829	15,419	15,069
2050	0	54,123	52,082	48,782	46,498	35,398	25,849	21,074

Notes:
[a] Changes for the No Action Alternative are shown as zero because the No Action Alternative is the baseline to which the action alternatives are compared.

For each combination of pollutant and year, the emissions changes generally decrease from Alternative 1 to Alternative 7 compared to the No Action Alternative, reflecting the generally increasing stringency of the alternatives and the fact that the No Action Alternative is the most stringent alternative. However, the directions and magnitudes of the changes in total emissions are not consistent across all pollutants, which reflects the complex interactions between tailpipe emissions rates of the various vehicle types, the technologies assumed to be incorporated by manufacturers in response to the standards, upstream emissions rates, the relative proportions of gasoline, diesel, and other fuels in total fuel consumption changes, and increases in VMT. Instances where downstream (tailpipe) emissions are predicted to increase[37] (on a per-VMT basis) in the action alternatives are attributable to shifts in modeled technology adoption from the baseline. Emissions of some criteria air pollutants in some years could increase compared to the No Action Alternative because the reductions in vehicle tailpipe emissions due to the rebound effect (from reduced VMT resulting from decreased vehicle fuel economy) would be offset by upstream emissions increases due to increases in fuel usage. Emissions of some criteria air pollutants in some years could decrease compared to the No Action Alternative where the reductions in vehicle emissions due to the rebound effect would not be offset by upstream emissions increases due to increases in fuel usage.

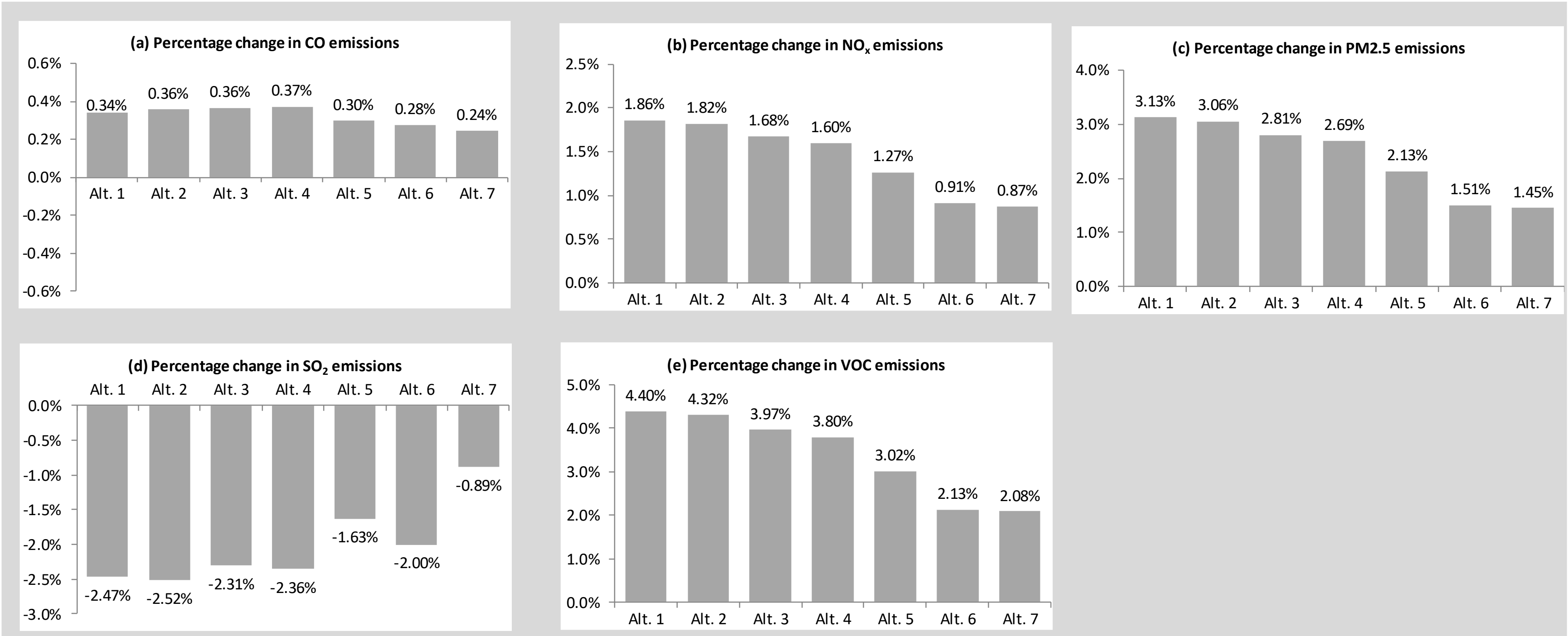
Under each action alternative compared to the No Action Alternative, the largest relative increases in emissions among the criteria pollutants would occur for VOCs, for which emissions would increase by as much as 12 percent by 2050. The largest relative decreases in emissions would occur for SO_2, for which emissions would decrease by as much as 12 percent by 2050 (Table 4.2.1-1). Percentage increases and reductions in emissions of CO, NO_X, and PM2.5 would be less.

The differences in national emissions of criteria air pollutants among the action alternatives compared to the No Action Alternative would range from less than 1 percent to 12 percent because of the interactions of the multiple factors described previously. The smaller differences are not expected to lead to measurable changes in concentrations of criteria pollutants in the ambient air. The larger differences in emissions could lead to changes in ambient pollutant concentrations.

These emissions trends differ in some respects from those presented in the Draft EIS. CO emissions increase under all action alternatives (except in 2025) compared to the No Action Alternative, whereas in the Draft EIS, CO emissions decreased under all action alternatives compared to the No Action Alternative. Trends for NO_X, PM2.5, and VOCs are generally similar between the Draft EIS and the Final EIS. SO_2 emissions decrease under all action alternatives (except in 2025 under Alternative 7) compared to the No Action Alternative, whereas in the Draft EIS, SO_2 emissions increased under all action alternatives compared to the No Action Alternative. Although emissions of criteria air pollutants differ compared to the Draft EIS, and some trends reverse direction (CO emissions increase compared to the No Action Alternative but had decreased in the Draft EIS, and SO_2 emissions decrease compared to the No Action Alternative but had increased in the Draft EIS), the changes are small in percentage terms, and the absolute differences in the emissions changes between the Draft EIS and Final EIS are not substantial.

[37] Criteria pollutant emissions on a per-VMT basis would not increase above the vehicle emissions standards but rather would increase within the allowable “headroom” of the standards.

Figure 4.2.1-3. Nationwide Percentage Changes in Criteria Pollutant Emissions from U.S. Passenger Cars and Light Trucks for 2035 by Action Alternative Compared to the No Action Alternative, Direct and Indirect Impacts



CO = carbon monoxide; NO_X = nitrogen oxides; PM2.5 = particulate matter less than 2.5 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compounds

4.2.1.2 Nonattainment Areas

Table 4.2.1-4 summarizes the criteria air pollutant analysis results by nonattainment area. For each pollutant, Table 4.2.1-4 lists the nonattainment areas in which the maximum increases and decreases in emissions would occur. Appendix A, *Air Quality Nonattainment Area Results*, lists the emissions changes for each nonattainment area. The increases and decreases would not be uniformly distributed to individual nonattainment areas. Appendix A indicates that for CO in 2025, most nonattainment areas would experience decreases in emissions across all alternatives, compared to the No Action Alternative. For NO_X (in 2025) and SO_2 (in 2035 and 2050), the majority of nonattainment areas would experience decreases in emissions across all alternatives, compared to the No Action Alternative. In 2025, for PM2.5, SO_2, and VOCs, the majority of nonattainment areas would experience increases in emissions across all alternatives, compared to the No Action Alternative. In 2035 and 2050, for CO, NO_X, PM2.5, and VOCs, most nonattainment areas would experience increases in emissions across all alternatives, compared to the No Action Alternative.

Table 4.2.1-4. Maximum Changes in Criteria Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks, Across All Nonattainment or Maintenance Areas, Alternatives, and Years, Direct and Indirect Impacts

Criteria Pollutant	Maximum Increase/ Decrease	Emission Change (tons per year)	Year	Alternative	Nonattainment or Maintenance Area [NAAQS Standard(s)]
Carbon monoxide (CO)	Maximum increase	11,965	2050	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO2 (1971 Annual)]
	Maximum decrease	-2,677	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO2 (1971 Annual)]
Nitrogen oxides (NO_x)	Maximum increase	1,072	2035	Alt. 1	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
	Maximum decrease	-145	2025	Alt. 1	New York, NY-NJ-CT [PM2.5 (2006 24-hour)]
Particulate matter (PM2.5)	Maximum increase	176	2050	Alt. 1	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
	Maximum decrease	-1	2025	Alt. 1	Atlanta, GA [Ozone (2008 8-hour)]
Sulfur oxides (SO_2)	Maximum increase	20	2025	Alt. 7	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
	Maximum decrease	-2,554	2050	Alt. 1	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
Volatile organic compounds (VOCs)	Maximum increase	2,201	2050	Alt. 1	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
	Maximum decrease	-152	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO2 (1971 Annual)]

Each nonattainment area implements emission controls and other requirements, in accordance with its SIP, that aim to reduce emissions so that the area will reach attainment levels under the schedule specified in the CAA. In a nonattainment area where emissions of a nonattainment pollutant or its precursors would increase under an action alternative, the increase would represent a slight decrease in the rate of reduction projected in the SIP. In response, the nonattainment area could revise its SIP to require greater emission reductions. Depending on the specific requirements in the SIP, the emissions increase under an action alternative could have the effect of shifting some of the responsibility to meet air quality requirements from the transportation sector to other sectors such as industry or electric utilities.

4.2.2 Toxic Air Pollutants

4.2.2.1 Emission Levels

Table 4.2.2-1 summarizes the total upstream and downstream[38] emissions of toxic air pollutants by alternative for each of the toxic air pollutants and analysis years. Figure 4.2.2-1 shows toxic air pollutant emissions for each alternative in 2035.

Table 4.2.2-1. Nationwide Toxic Air Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks by Alternative, Direct and Indirect Impacts

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Acetaldehyde								
2025	8,638	8,606	8,607	8,610	8,611	8,619	8,621	8,623
2035	6,377	6,401	6,402	6,402	6,403	6,397	6,395	6,393
2050	4,336	4,579	4,567	4,561	4,558	4,504	4,459	4,444
Acrolein								
2025	467	465	465	465	465	466	466	466
2035	333	335	335	335	335	335	335	334
2050	234	248	248	247	247	244	242	240
Benzene								
2025	30,849	30,729	30,735	30,743	30,747	30,774	30,777	30,794
2035	15,076	15,218	15,218	15,210	15,206	15,178	15,160	15,150
2050	8,530	9,137	9,111	9,089	9,073	8,941	8,833	8,785
1,3-Butadiene								
2025	3,654	3,637	3,638	3,639	3,640	3,643	3,645	3,646
2035	2,035	2,044	2,044	2,044	2,044	2,042	2,043	2,041
2050	1,305	1,381	1,378	1,376	1,375	1,357	1,344	1,338
Diesel particulate matter (DPM)								
2025	35,284	36,019	35,994	35,933	35,922	35,733	35,643	35,616
2035	30,839	33,052	32,997	32,801	32,700	32,297	31,924	31,792
2050	28,192	30,684	30,598	30,391	30,248	29,750	29,393	29,067
Formaldehyde								
2025	6,858	6,841	6,842	6,843	6,843	6,846	6,849	6,849
2035	3,924	3,973	3,973	3,969	3,968	3,957	3,955	3,945
2050	2,494	2,678	2,670	2,663	2,658	2,618	2,587	2,570

[38] Downstream emissions do not include evaporative emissions from vehicle fuel systems due to modeling limitations.

Figure 4.2.2-1. Nationwide Toxic Air Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks for 2035 by Alternative, Direct and Indirect Impacts

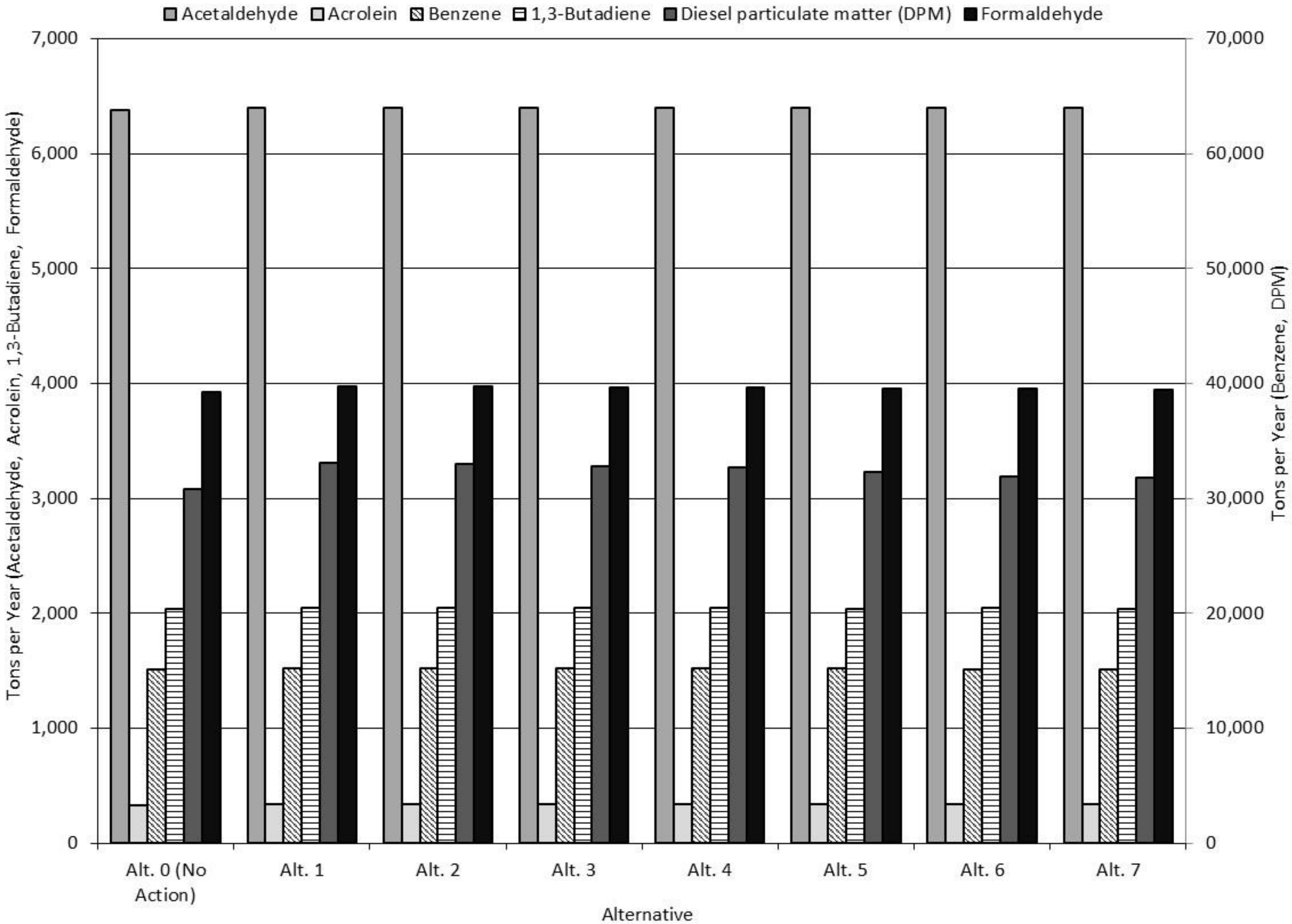


Figure 4.2.2-2 summarizes the changes over time in total national emissions of toxic air pollutants under Alternative 1 (the least stringent and highest fuel-use action alternative) and Alternative 7 (the lowest fuel-use action alternative) to show the highest and lowest ends of the range of emissions impacts. This figure indicates a consistent trend among the toxic air pollutants. Emissions decline from 2025 to nearly 2050 due to increasingly stringent EPA regulations (Section 4.1.1, *Relevant Pollutants and Standards*) and from reductions in upstream emissions from fuel production, despite a growth in total VMT from 2025 to nearly 2050 (Table 4.2.2-2 and Figure 4.2.2-3). (Note that continued growth in VMT is projected to occur under all alternatives until 2042; a slight decline is projected to occur from 2042 to 2050.)

As with criteria pollutant emissions, total toxic pollutant emissions consist of four components: two sources of emissions (downstream and upstream) for each of the two vehicle classes (passenger cars and light trucks). Table 4.2.2-2 shows the total emissions of air toxic pollutants by component for calendar year 2035.

Table 4.2.2-3 lists the net change in nationwide emissions for each of the toxic air pollutants and analysis years under the action alternatives compared to the No Action Alternative. Figure 4.2.2-3 shows these changes in percentages for 2035. The trends for toxic air pollutant emissions across the action alternatives generally show decreases in 2025 (except for DPM) and increases in 2035 and 2050 relative to the No Action Alternative for the same reasons as for criteria pollutants. In 2025, emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde would generally decrease under the action alternatives (compared to the No Action Alternative) with the largest decreases occurring under Alternative 1, and the decreases generally getting smaller from Alternative 1 through Alternative 7. In 2035 and 2050, emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde would increase under the action alternatives (compared to the No Action Alternative). In 2035, the largest increases occur under Alternative 1 for formaldehyde; Alternative 2 for acrolein, benzene, and 1,3-butadiene; and Alternative 4 for acetaldehyde. In 2050, the largest increases for these pollutants occur under Alternative 1. For DPM, emissions increase for all years and action alternatives (compared to the No Action Alternative), with the largest increases occurring under Alternative 1. These trends are accounted for by the extent of technologies assumed to be deployed under the different action alternatives to meet the different levels of fuel economy requirements.

Figure 4.2.2-2. Nationwide Toxic Air Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks under Alternatives 1 and 7, Direct and Indirect Impacts

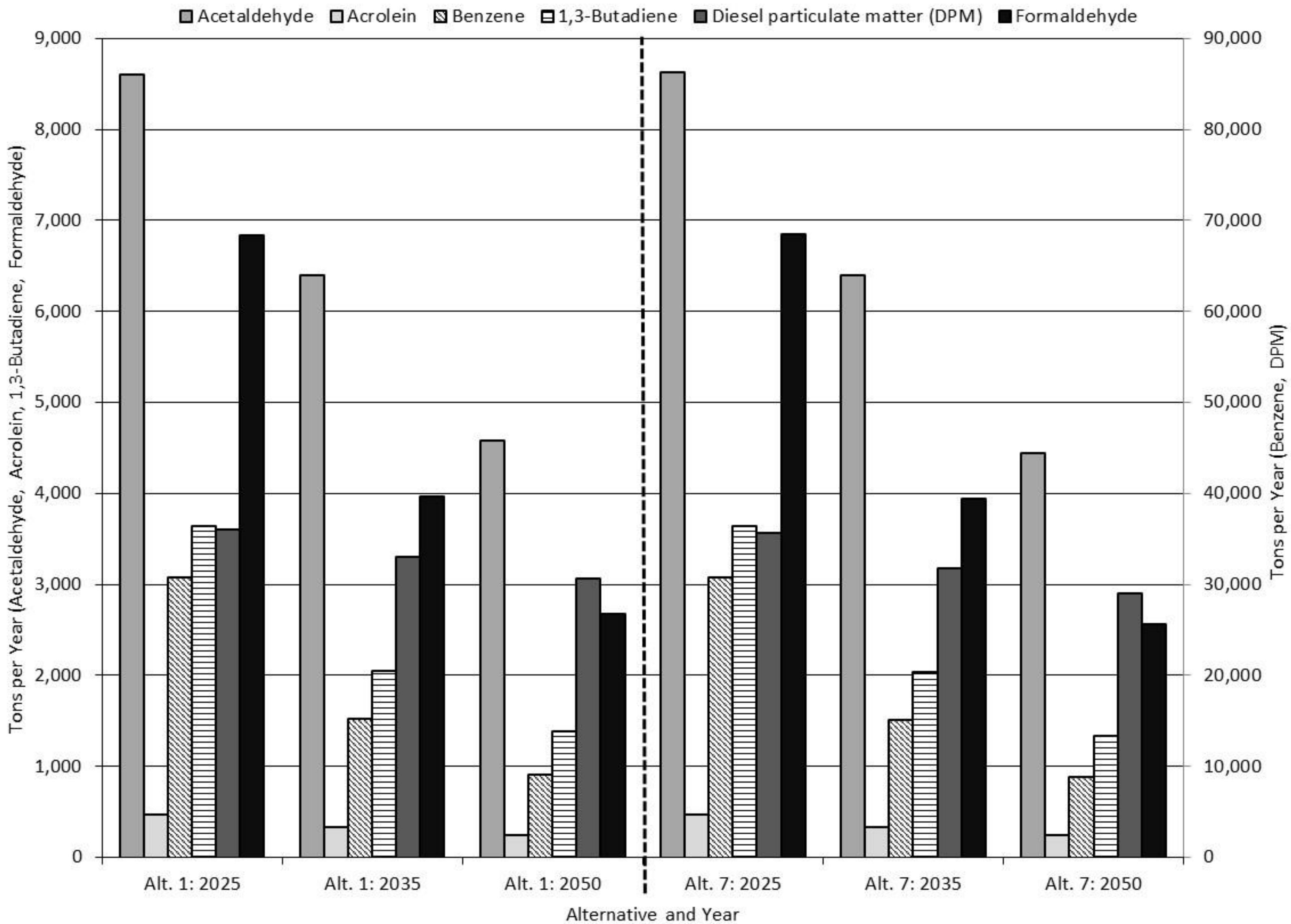


Table 4.2.2-2. Nationwide Toxic Air Pollutant Emissions (tons per year) in 2035 from U.S. Passenger Cars and Light Trucks, by Vehicle Type and Alternative, Direct and Indirect Impacts

Vehicle Class	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Acetaldehyde								
Cars tailpipe	2,863	2,911	2,910	2,908	2,907	2,897	2,908	2,890
Cars upstream	27	30	30	30	30	30	30	29
Trucks tailpipe	3,450	3,420	3,422	3,425	3,428	3,433	3,421	3,438
Trucks upstream	36	39	39	38	38	37	37	37
Total	6,377	6,401	6,402	6,402	6,403	6,397	6,395	6,393
Acrolein								
Cars tailpipe	157	160	160	160	160	159	160	159
Cars upstream	4	4	4	4	4	4	4	4
Trucks tailpipe	167	166	166	166	166	166	166	167
Trucks upstream	5	5	5	5	5	5	5	5
Total	333	335	335	335	335	335	335	334
Benzene								
Cars tailpipe	6,132	6,213	6,213	6,209	6,206	6,188	6,210	6,175
Cars upstream	558	616	615	610	611	602	601	588
Trucks tailpipe	7,675	7,605	7,609	7,615	7,619	7,632	7,618	7,646
Trucks upstream	711	783	782	776	770	755	732	740
Total	15,076	15,218	15,218	15,210	15,206	15,178	15,160	15,150
1,3-Butadiene								
Cars tailpipe	952	969	968	968	967	964	967	961
Cars upstream	6	7	7	7	7	7	6	6
Trucks tailpipe	1,069	1,060	1,061	1,062	1,062	1,064	1,061	1,066
Trucks upstream	8	8	8	8	8	8	8	8
Total	2,035	2,044	2,044	2,044	2,044	2,042	2,043	2,041
Diesel particulate matter (DPM)								
Cars tailpipe	3	3	3	3	3	3	3	3
Cars upstream	13,615	14,801	14,774	14,679	14,664	14,461	14,420	14,157
Trucks tailpipe	0	0	0	0	0	0	0	0
Trucks upstream	17,219	18,247	18,219	18,119	18,032	17,832	17,500	17,631
Total	30,839	33,052	32,997	32,801	32,700	32,297	31,924	31,792
Formaldehyde								
Cars tailpipe	1,562	1,587	1,586	1,585	1,584	1,579	1,585	1,575
Cars upstream	206	228	228	226	226	223	222	218
Trucks tailpipe	1,884	1,868	1,869	1,870	1,872	1,875	1,870	1,878
Trucks upstream	271	291	290	288	286	280	278	275
Total	3,924	3,973	3,973	3,969	3,968	3,957	3,955	3,945

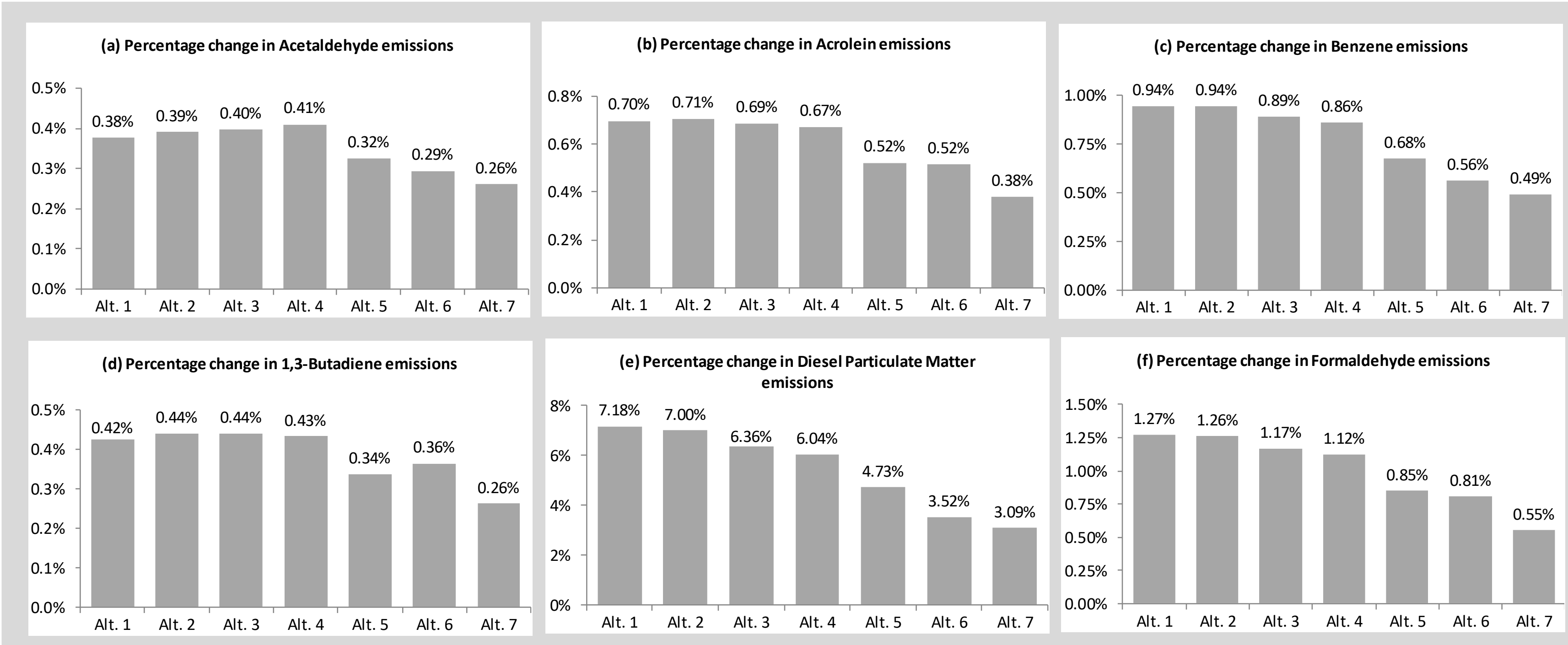
Table 4.2.2-3. Nationwide Changes in Toxic Air Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks by Alternative, Direct and Indirect Impacts[a,b]

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Acetaldehyde								
2025	0	-33	-31	-28	-27	-20	-18	-15
2035	0	24	25	25	26	21	19	17
2050	0	243	232	225	222	168	123	108
Acrolein								
2025	0	-1	-1	-1	-1	-1	-1	-1
2035	0	2	2	2	2	2	2	1
2050	0	14	13	13	13	10	7	6
Benzene								
2025	0	-120	-114	-107	-103	-75	-73	-56
2035	0	142	142	134	130	102	85	74
2050	0	607	582	559	544	412	303	256
1,3-Butadiene								
2025	0	-17	-16	-15	-14	-10	-9	-8
2035	0	9	9	9	9	7	7	5
2050	0	76	73	71	69	52	39	33
Diesel particulate matter (DPM)								
2025	0	735	710	649	638	450	359	332
2035	0	2,213	2,158	1,963	1,861	1,458	1,085	953
2050	0	2,492	2,406	2,199	2,056	1,558	1,201	875
Formaldehyde								
2025	0	-18	-17	-16	-15	-12	-9	-10
2035	0	50	49	46	44	33	32	22
2050	0	183	176	168	163	123	92	75

Notes:

[a] Changes for the No Action Alternative are shown as zero because the No Action Alternative is the baseline to which the action alternatives are compared.

Figure 4.2.2-3. Nationwide Percentage Changes in Toxic Air Pollutant Emissions from U.S. Passenger Cars and Light Trucks for 2035 by Action Alternative Compared to the No Action Alternative, Direct and Indirect Impacts



Under each action alternative in 2025 compared to the No Action Alternative, decreases in emissions would occur for all toxic air pollutants except for DPM, for which emissions would increase by as much as 2 percent. For 2025, the largest relative decreases in emissions would occur for 1,3-butadiene, for which emissions would decrease by as much as 0.5 percent (Table 4.2.2-3). Percentage reductions in emissions of acetaldehyde, acrolein, benzene, and formaldehyde would be less.

Under each action alternative in 2035 and 2050 compared to the No Action Alternative, increases in emissions would occur for all toxic air pollutants. The largest relative increases in emissions would occur for DPM, for which emissions would increase by as much as 9 percent (Table 4.2.2-3). Percentage increases in emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde would be less.

The differences in national emissions of toxic air pollutants among the action alternatives compared to the No Action Alternative would range from less than 1 percent to 9 percent due to the similar interactions of the multiple factors described for criteria pollutants. The smaller differences are not expected to lead to measurable changes in concentrations of toxic air pollutants in the ambient air. For such small changes, the impacts of those action alternatives would be essentially equivalent. The larger differences in emissions could lead to changes in ambient pollutant concentrations.

These emissions trends differ in some respects from those presented in the Draft EIS. Emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde increase (except in 2025) under all action alternatives compared to the No Action Alternative, whereas in the Draft EIS, these emissions decreased under all action alternatives compared to the No Action Alternative. Trends for DPM are similar between the Draft EIS and the Final EIS, with increases in DPM emissions under all action alternatives compared to the No Action Alternative. Although emissions of toxic air pollutants differ compared to the Draft EIS, and some trends reverse direction (emissions of all air toxics except DPM increase, except in 2025, compared to the No Action Alternative, but had decreased in the Draft EIS), the changes are small in percentage terms, and the absolute differences in the emissions changes between the Draft EIS and Final EIS are not substantial.

4.2.2.2 Nonattainment Areas

For each pollutant, Table 4.2.2-4 lists the nonattainment areas in which the maximum increases and decreases in emissions would occur.[39] Appendix A, *Air Quality Nonattainment Area Results*, lists the estimated emissions changes for each nonattainment area. The increases and decreases in upstream emissions would not be uniformly distributed to individual nonattainment areas. In 2025, compared to the No Action Alternative, all action alternatives could reduce emissions of most toxic air pollutants in most nonattainment areas but could increase emissions of DPM in most nonattainment areas. In 2035 and 2050, compared to the No Action Alternative, all action alternatives could increase emissions of all toxic air pollutants in most nonattainment areas.

[39] EPA has not established NAAQS for airborne toxics. Therefore, none of these areas is classified as a nonattainment area because of airborne toxics emissions. Toxic air pollutant emissions data for nonattainment areas are provided for information only.

Table 4.2.2-4. Maximum Changes in Toxic Air Pollutant Emissions (tons per year) from U.S. Passenger Cars and Light Trucks across All Nonattainment or Maintenance Areas, Alternatives, and Years, Direct and Indirect Impacts

Air Toxic	Maximum Increase/Decrease	Emission Change (tons per year)	Year	Alternative	Nonattainment or Maintenance Area [NAAQS Standard(s)]
Acetaldehyde	Maximum increase	11	2050	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
	Maximum decrease	-2	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
Acrolein	Maximum increase	0.6	2050	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
	Maximum decrease	-0.1	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
Benzene	Maximum increase	21	2050	Alt. 1	Los Angeles-South Coast Air Basin, CA [Ozone (2008 8-hour); Ozone (2015 8-hour)]
	Maximum decrease	-7	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
1,3-Butadiene	Maximum increase	3	2050	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
	Maximum decrease	-0.8	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]
Diesel particulate matter (DPM)	Maximum increase	413	2050	Alt. 1	Houston-Galveston-Brazoria, TX [Ozone (2008 8-hour)]
	Maximum decrease	-0.0003	2025	Alt. 1	Washoe County; Reno planning area, NV [PM10 (1987 24-hour)]
Formaldehyde	Maximum increase	7	2050	Alt. 1	Los Angeles-South Coast Air Basin, CA [Ozone (2008 8-hour); Ozone (2015 8-hour)]
	Maximum decrease	-1	2025	Alt. 1	Los Angeles-South Coast Air Basin Area, CA [CO (1971 8-hour); NO_2 (1971 Annual)]

4.2.3 Health Impacts

Adverse health impacts generally would increase nationwide in 2025 and 2035 under Alternatives 1 through 5 and Alternative 7 compared to the No Action Alternative (Table 4.2.3-1). Adverse health impacts would decrease nationwide in 2050 under all action alternatives. As discussed in Section 4.1.2.7, *Health Impacts*, the values in Table 4.2.3-1 are nationwide averages. These values account for effects of upstream and downstream emissions separately but do not reflect localized variations in emissions, meteorology and topography, and population characteristics. Although a number of the action alternatives would result in various criteria pollutant and air toxic decreases, emissions of PM2.5, DPM, and NO_X (except in 2025) would increase under all of the action alternatives, while emissions of SO_2 would decrease (except for Alternative 7 in 2025) under all of the action alternatives. As discussed in Section 4.1.2.7, *Health Impacts*, NHTSA's analysis quantifies the health impacts of PM2.5, DPM, and precursor emissions (NO_X and SO_2). However, sufficient data are not available for NHTSA to quantify the health impacts of exposure to other pollutants (EPA 2013e).

As described in Section 4.1.2.7, *Health Impacts*, the changes in premature mortality shown in these tables are measured in several ways. Benefits are measured under the Krewski method and the Lepeule method. While the number of premature mortalities varies between the two methods, the percent change in mortality when comparing any particular combinations of alternatives and years is equal for the two methods.

The adverse health impacts across all health outcomes generally would increase from 2025 to 2035, but health benefits (decreases in adverse health impacts) are predicted in 2050. In 2025 and 2035, the adverse health impacts would decrease from Alternative 1 to Alternative 5, reflecting the generally increasing stringency of the action alternatives, health benefits are predicted under Alternative 6, and increased adverse health impacts are predicted for Alternative 7. In 2050, health benefits are predicted for all action alternatives but would decrease (the decreases in adverse health impacts would be less) from Alternative 1 to Alternative 7.

These trends in health impacts for the Final EIS differ in some respects from those presented in the Draft EIS. In the Final EIS, adverse health impacts increase in 2025 and 2035 (except under Alternative 6) but decrease in 2050 and under Alternative 6, compared to the No Action Alternative. In contrast, in the Draft EIS, the adverse health impacts increased in all years and under all action alternatives, compared to the No Action Alternative. In the Final EIS, the increases in adverse health impacts are generally smaller than in the Draft EIS. The smaller adverse health impacts in the Final EIS are due primarily to the decrease in SO_2 emissions under the action alternatives compared to the No Action Alternative, whereas in the Draft EIS SO_2 emissions increased under the action alternatives. Although the changes in adverse health impacts differ for the Final EIS compared to the Draft EIS, the changes are small in percentage terms, and the absolute differences in the changes between the Draft EIS and the Final EIS are not substantial.

Under any alternative, total emissions from passenger cars and light trucks are expected to decrease over time compared to existing (2019) conditions (Table 4.2.1-1). As discussed in Section 4.1.1.3, *Vehicle Emissions Standards*, the phase-in of Tier 3 vehicle emissions standards will decrease the average per-VMT emissions as newer, lower-emitting vehicles replace older, higher-emitting vehicles over time. These decreases are expected to more than offset increases from VMT growth. As a result, under any alternative the total health effects of emissions from passenger cars and light trucks are expected to decrease over time compared to existing conditions. This time trend compared to existing conditions is consistent between the Draft EIS and the Final EIS.

Table 4.2.3-1. Nationwide Changes in Health Impacts (cases per year) from Criteria Pollutant Emissions from U.S. Passenger Cars and Light Trucks by Alternative, Direct and Indirect Impacts[a,b]

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Premature mortality (Krewski et al. 2009)								
2025	0	5	5	3	3	4	-5	6
2035	0	11	9	9	6	8	-7	9
2050	0	-135	-129	-126	-123	-92	-63	-53
Premature mortality (Lepeule et al. 2012)								
2025	0	12	11	7	6	9	-11	13
2035	0	22	19	18	12	18	-16	20
2050	0	-313	-299	-291	-285	-212	-145	-123
Emergency room visits: respiratory								
2025	0	3	3	2	2	2	-3	3
2035	0	7	6	5	4	5	-3	5
2050	0	-67	-64	-63	-62	-46	-31	-27
Acute bronchitis								
2025	0	9	8	5	5	6	-7	9
2035	0	17	15	14	10	13	-9	14
2050	0	-200	-190	-186	-182	-136	-93	-79
Lower Respiratory Symptoms								
2025	0	113	98	65	61	79	-81	108
2035	0	211	180	169	123	166	-122	178
2050	0	-2,583	-2,462	-2,402	-2,355	-1,754	-1,197	-1,022
Upper Respiratory Symptoms								
2025	0	156	135	87	82	109	-119	153
2035	0	324	280	263	198	251	-154	261
2050	0	-3,539	-3,374	-3,293	-3,230	-2,406	-1,639	-1,401
Minor Restricted Activity Days								
2025	0	4,517	3,912	2,498	2,342	3,171	-3,551	4,474
2035	0	8,232	7,032	6,637	4,842	6,488	-4,708	6,971
2050	0	-99,771	-95,122	-92,792	-90,976	-67,762	-46,213	-39,446
Work Loss Days								
2025	0	712	608	365	339	507	-664	750
2035	0	1,400	1,194	1,127	819	1,103	-813	1,188
2050	0	-17,165	-16,365	-15,963	-15,651	-11,659	-7,952	-6,789
Asthma Exacerbation								
2025	0	184	160	101	95	129	-146	183
2035	0	382	331	311	235	295	-175	306
2050	0	-4,095	-3,904	-3,811	-3,738	-2,784	-1,896	-1,622
Hospital Admissions: Cardiovascular								
2025	0	1	1	1	0	1	-1	1
2035	0	3	2	2	1	2	-2	2
2050	0	-37	-36	-35	-34	-25	-17	-15

Year	Alt. 0 No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Hospital Admissions: Respiratory								
2025	0	1	1	1	1	1	-1	1
2035	0	2	2	2	1	2	-2	2
2050	0	-36	-35	-34	-33	-25	-17	-14
Non-Fatal Heart Attacks (Peters et al. 2001)								
2025	0	5	4	2	2	4	-5	6
2035	0	10	8	8	5	8	-8	9
2050	0	-143	-136	-133	-130	-97	-66	-56
Non-Fatal Heart Attacks (All others)								
2025	0	1	0	0	0	0	-1	1
2035	0	1	1	1	0	1	-1	1
2050	0	-16	-15	-15	-15	-11	-7	-6

Notes:

[a] Negative changes indicate fewer health impacts; positive changes indicate additional health impacts.

[b] Changes for the No Action Alternative are shown as zero because the No Action Alternative is the baseline to which the action alternatives are compared.

CHAPTER 5 GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

This section describes how the Proposed Action and alternatives potentially would affect the pace and extent of future changes in global climate. One of the key matters about which federal agencies must use their own judgment is determining how to describe the direct and indirect climate change-related impacts of a proposed action.[1] In this EIS, the discussion compares projected increases in greenhouse gas (GHG) emissions from the Proposed Action and alternatives with GHG emissions from the No Action Alternative. The discussion of consequences of the Proposed Action and alternatives focuses on GHG emissions and their potential impacts on the climate system (atmospheric carbon dioxide [CO_2] concentrations, temperature, sea level, precipitation, and ocean pH). For purposes of this analysis, the standards are assumed to remain in place for model years after 2025 or 2026 (depending on alternative) at the level of the MY 2025 or MY 2026 standards set forth by the agency. This chapter presents results through 2100, the end of the climate change analysis period.

This chapter is organized as follows:

- Section 5.1, *Introduction,* introduces key topics on GHGs and climate change, including uncertainties in assessing climate change impacts.
- Section 5.2, *Affected Environment,* describes the affected environment in terms of current and anticipated trends in GHG emissions and climate.
- Section 5.3, *Analysis Methods*, outlines the methods NHTSA used to evaluate climate effects.
- Section 5.4, *Environmental Consequences*, describes the potential direct and indirect environmental impacts of the Proposed Action and alternatives. This information includes a projection of the direct and reasonably foreseeable indirect GHG emissions under each of the alternatives, as well as sector-wide and national GHG emissions estimates to provide context for understanding the relative magnitude of the Proposed Action and alternatives.

The cumulative impacts of the Proposed Action are discussed in Chapter 8, Cumulative Impacts. That chapter includes climate modeling that applies different assumptions about the effect of broader global GHG policies on emissions outside the U.S. passenger car and light truck fleets as well as qualitative discussions based on an appropriate literature review of the potential cumulative impacts of climate change on key natural and human resources.

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[1] On June 26, 2019, CEQ published draft guidance on consideration of GHG emissions in NEPA analyses and documentation. Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions; Request for Comments, 84 FR 30097 (June 26, 2019). According to the draft guidance, "As with all NEPA analyses, the rule of reason permits agencies to use their expertise and experience to decide how and to what degree to analyze particular effects." Furthermore, the draft guidance states that agencies may use a projection of an action's direct and reasonably foreseeable indirect GHG emissions as a proxy for assessing potential climate effects. This information may be presented along with local, regional, national, or sector-wide emissions estimates (if available) to provide context for understanding the relative magnitude of a proposed action's GHG emissions. Together with a qualitative summary discussion of the effects of GHG emissions based on an appropriate literature review, the draft guidance concluded this would satisfy NEPA's requirement that agencies analyze the cumulative effects of a proposed action because the potential effects of GHG emissions are inherently a global cumulative effect.

5.1 Introduction

The CEQ NEPA regulations require agencies to ensure the scientific integrity of the information included in an EIS.[2] Given that NHTSA's primary areas of technical and scientific expertise relate to the agency's primary mission to reduce deaths and injuries from motor vehicle crashes (including setting motor vehicle fuel economy standards), NHTSA has neither developed its own evidence nor drawn its own conclusions relating to climate change based on underlying scientific data. Rather, for its understanding of climate science and analysis of the potential impacts of the alternatives on climate change, NHSTA relies on existing expert panel- and peer-reviewed climate change studies and reports.[3] NHTSA draws conclusions on the potential impacts of the alternatives on the pace and extent of future changes in global climate based on the analysis and findings of these studies and reports.

This EIS draws primarily on panel-reviewed synthesis and assessment reports from the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Global Change Research Program (GCRP), supplemented with past reports from the U.S. Climate Change Science Program (CCSP), the National Research Council, and the Arctic Council. It also cites EPA's *Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act* (EPA 2009), which relied heavily on past major international or national scientific assessment reports. NHTSA relies on assessment reports because these reports assess numerous individual studies to draw general conclusions about the potential impacts of climate change. Even where assessment reports include consensus conclusions of expert authors, uncertainly still exists, as with all assessments of environmental impacts. See Section 5.1.1, *Uncertainty in the IPCC Framework*, on how uncertainty is communicated in the IPCC reports.

Like any analysis of complex, long-term changes to support decision-making, evaluating reasonably foreseeable impacts on the human environment involves many assumptions and uncertainties. For this reason, NHTSA relies on methods and data to analyze climate impacts that represent the best and most current information available on this topic and that have been subjected to extensive peer review and scrutiny. This EIS draws on peer-reviewed literature that has been published since the release of the IPCC and the GCRP panel-reviewed reports. Because this recent literature has not been assessed or synthesized by an expert panel, these sources supplement, but do not supersede, the findings of the panel-reviewed reports. In virtually every case, the recent literature corroborates the findings of the panel reports.

The level of detail regarding the science of climate change provided in this EIS, as well as NHTSA's consideration of other studies that demonstrate the potential impacts of climate change on health, society, and the environment, is provided to help inform the public and decision-makers. This approach is consistent with federal regulations and with NHTSA's approach in its EISs for the MY 2011–2015 CAFE standards, MY 2012–2016 CAFE standards, Phase 1 HD standards, MY 2017–2025 CAFE standards, and the Phase 2 HD standards.

[2] 40 CFR § 1502.24.

[3] NHTSA has conducted an appropriate literature review and applied its expertise to evaluate the available studies and reports to determine which are appropriate for inclusion in the EIS, as described in this section.

5.1.1 Uncertainty in the IPCC Framework

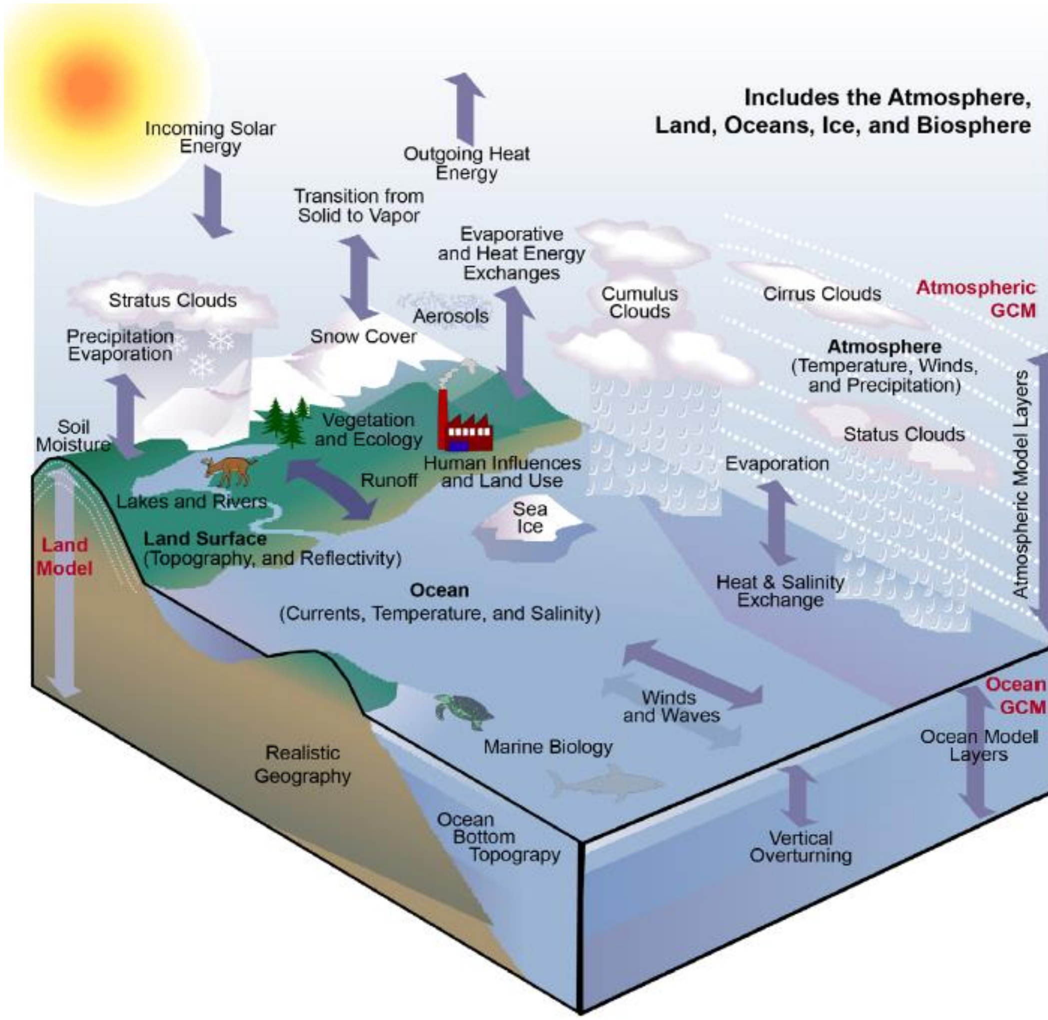
The CEQ regulations require agencies to make clear for reasonably foreseeable significant adverse environmental impacts when there is incomplete or unavailable information regarding that impact.[4] Assessing climate change impacts involves uncertainty, including with regard to discrete and localized impacts. Given the global nature of climate change and the need to communicate uncertainty to a variety of decision-makers, IPCC has focused considerable attention on developing a systematic approach to characterize and communicate this information. In this EIS, NHTSA uses the system developed by IPCC to describe uncertainty associated with various climate change impacts. Consequently, the meanings of these IPCC terms are different from the language used to describe uncertainty elsewhere in the EIS.

The IPCC reports communicate uncertainty and confidence bounds using commonly understood but carefully defined words in italics, such as *likely* and *very likely*, to represent likelihood of occurrence. The *IPCC Working Group I Fifth Assessment Report Summary for Policymakers* (*IPCC WG1 AR5*) (IPCC 2013b) briefly explains this convention. The IPCC Guidance Notes for Lead Authors of the *IPCC AR5 on Addressing Uncertainties* (IPCC 2010) provides a more detailed discussion of the IPCC treatment of uncertainty. This EIS uses the IPCC uncertainty language (noted in italics) when discussing qualitative environmental impacts on specific resources. The referenced IPCC documents provide a full understanding of the meaning of those uncertainty terms in the context of the IPCC findings. The *IPCC WG1 AR5* (IPCC 2013a) notes that the two primary uncertainties with climate modeling are model uncertainties and scenario uncertainties.

- **Model uncertainties.** These uncertainties occur when a climate model might not accurately represent complex phenomena in the climate system (see Figure 5.1.1-1 for a sample of processes generally represented in climate models). For some processes, the scientific understanding could be limited regarding how to use a climate model to "simulate" processes in the climate system.
- **Scenario uncertainties.** These uncertainties arise because of uncertainty in projecting future GHG emissions, concentrations, and forcings (e.g., from solar activity).

[4] 40 CFR § 1502.22.

Figure 5.1.1-1. Some Climate System Processes Included in Climate Models



Source: GCRP 2014
GCM = general circulation model

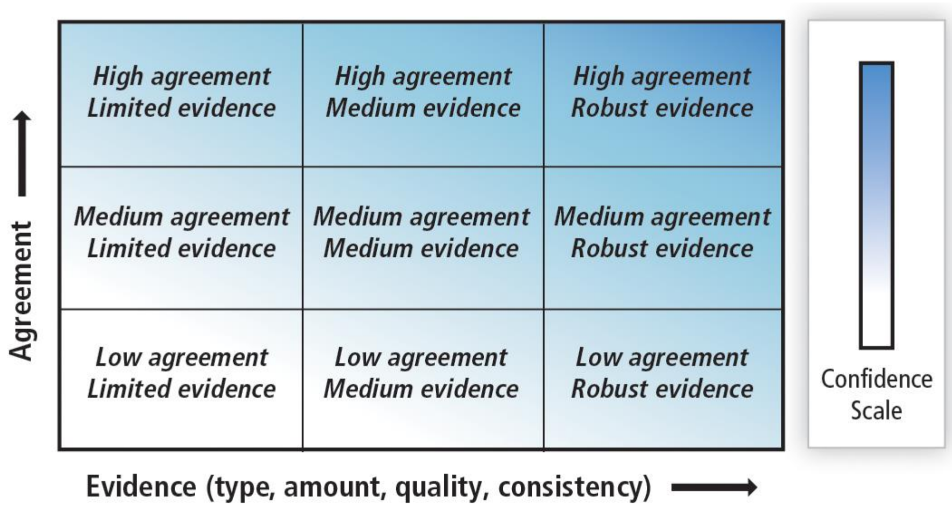
As stated in the *IPCC WG1 AR5*, these types of uncertainties are described by using two metrics for communicating the degree of certainty: confidence in the validity of findings, expressed qualitatively, and quantified measures of uncertainties, expressed probabilistically. The confidence levels synthesize the judgments about the validity of the findings, determined through evaluation of the evidence and the degree of scientific agreement. The qualitative expression of confidence ranges from *very low* to *very high*, with higher confidence levels assigned to findings that are supported by high scientific agreement. The quantitative expression of confidence ranges from *exceptionally unlikely* to *virtually certain*, with higher confidence representing findings supported by robust evidence (Table 5.1.1-1). Figure 5.1.1-2 shows that the degree of confidence increases as evidence becomes more robust and agreement is greater.

Table 5.1.1-1. Standard Terms to Define the Likelihood of a Climate-Related Event

Likelihood Terminology	Likelihood of the Occurrence/Outcome
Virtually certain	99–100% probability
Very likely	90–100% probability
Likely	66–100% probability
About as likely as not	33–66% probability
Unlikely	0–33% probability
Very unlikely	0–10% probability
Exceptionally unlikely	0–1% probability

Notes:
Additional terms that were used in limited circumstances in the IPCC Fourth Assessment Report (AR4) (*extremely likely* = 95−100% probability, *more likely than not* ≥ 50−100% probability, and *extremely unlikely* = 0−5% probability) were also used in *IPCC WG1 AR5* when appropriate, and in the *Fourth National Climate Assessment* (GCRP 2017).

Figure 5.1.1-2. Confidence Level as a Combination of Evidence and Agreement



Source: IPCC 2013a

5.1.2 Climate Change and Its Causes

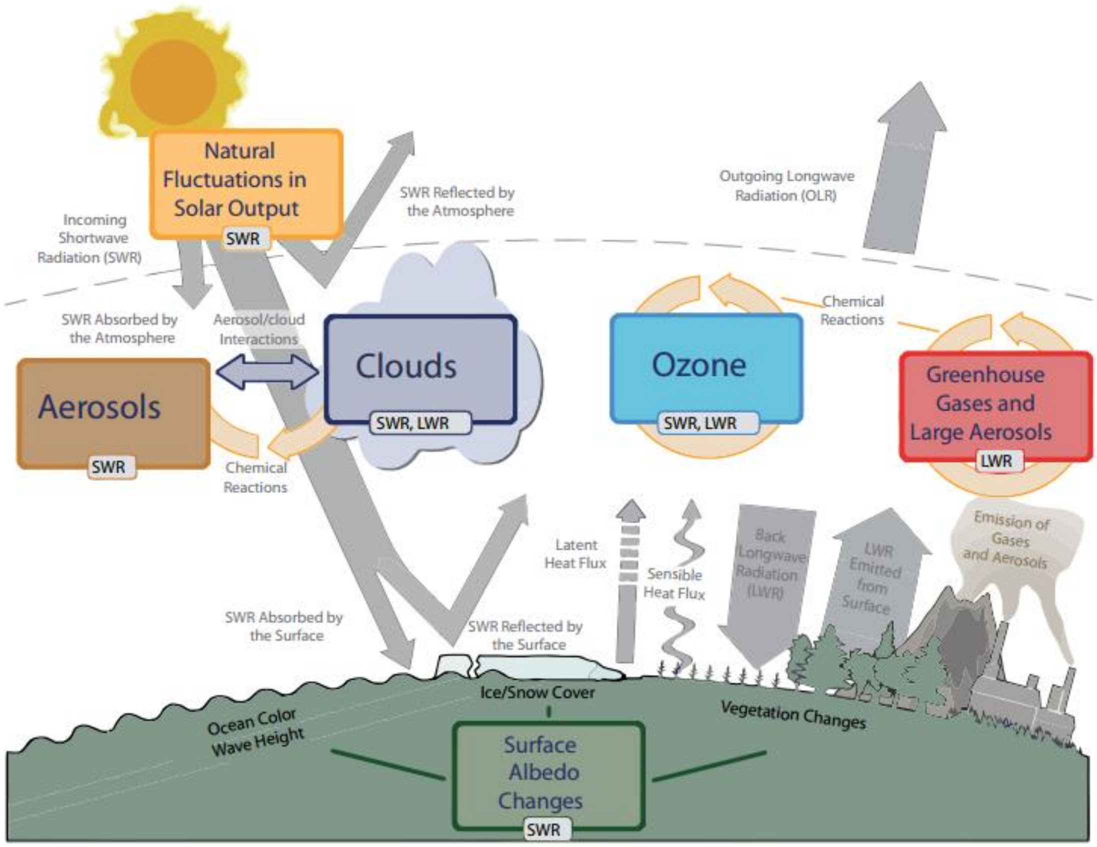
Earth absorbs heat energy from the sun and returns most of this heat to space as terrestrial infrared radiation. GHGs trap heat in the lower atmosphere (the atmosphere extending from Earth's surface to approximately 4 to 12 miles above the surface), absorb heat energy emitted by Earth's surface and lower atmosphere, and reradiate much of it back to Earth's surface, thereby causing warming. This process, known as the *greenhouse effect*, is responsible for maintaining surface temperatures that are warm enough to sustain life. Human activities, particularly fossil-fuel combustion, lead to the presence of increased concentrations of GHGs in the atmosphere; this buildup of GHGs is changing the Earth's energy balance. IPCC states the warming experienced since the mid-20th century is due to the combination of natural climatic forcers (e.g., natural GHGs, solar activity) and human-made climate forcers (IPCC 2013a). IPCC concluded, "[h]uman influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea-level rise, and in changes in some climate extremes. … This evidence for human influence has grown since [the IPCC *Working Group 1 (WG1) Fourth Assessment Report (AR4)*]. IPCC reports that it is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC 2013a).

Although the climate system is complex, IPCC has identified the following drivers of climate change (Figure 5.1.2-1):

- **GHGs**. Primary GHGs in the atmosphere are water vapor, CO_2, nitrous oxide (N_2O), methane (CH_4), and ozone (IPCC 2013a).
- **Aerosols.** Aerosols are natural (e.g., from volcanoes) and human-made particles in the atmosphere that scatter incoming sunlight back to space, causing cooling. Some aerosols are hygroscopic (i.e., attract water) and can affect the formation and lifetime of clouds. Large aerosols (more than 2.5 micrometers in size) modify the amount of outgoing long-wave radiation (IPCC 2013a). Other particles, such as black carbon, can absorb outgoing terrestrial radiation, causing warming. Natural aerosols have had a negligible cumulative impact on climate change since the start of the industrial era (IPCC 2013a).
- **Clouds**. Depending on cloud height, cloud interactions with terrestrial and solar radiation can vary. Small changes in the properties of clouds can have important implications for both the transfer of radiative energy and weather (IPCC 2013a).
- **Ozone.** Ozone is created through photochemical reactions from natural and human-made gases. In the troposphere, ozone absorbs and reemits long-wave radiation. In the stratosphere, the ozone layer absorbs incoming short-wave radiation (IPCC 2013a).
- **Solar radiation.** Solar radiation, the amount of solar energy that reaches the top of Earth's atmosphere, varies over time (IPCC 2013a). Solar radiation has had a negligible impact on climate change since the start of the industrial era compared to other main drivers (IPCC 2013a).
- **Surface changes**. Changes in vegetation or land surface properties, ice or snow cover, and ocean color can affect surface albedo.[5] The changes are driven by natural seasonal and diurnal changes (e.g., snow cover) as well as human influences (e.g., changes in vegetation type) (IPCC 2013a).

[5] Surfaces on Earth (including land, oceans, and clouds) reflect solar radiation back to space. This reflective characteristic, known as *albedo*, indicates the proportion of incoming solar radiation the surface reflects. High albedo has a cooling effect because the surface reflects rather than absorbs most solar radiation.

Figure 5.1.2-1. Main Drivers of Climate Change



Source: IPCC 2013a
SWR = shortwave radiation; LWR = longwave radiation; OLR = outgoing longwave radiation

5.2 Affected Environment

This section describes the affected environment in terms of current and anticipated trends in GHG emissions and climate. Effects of emissions and the corresponding processes that affect climate are highly complex and variable, which complicates the measurement and detection of change. However, an increasing number of studies conclude that anthropogenic GHG emissions are affecting climate in detectable and quantifiable ways (IPCC 2013b, GCRP 2017).

This section discusses GHG emissions and climate change both globally and in the United States. NHTSA references IPCC and GCRP sources of historical and current data to report trends in GHG emissions and changes in climate change attributes and phenomena.

5.2.1 Greenhouse Gas Emissions and Aerosols—Historical and Current Trends

5.2.1.1 Global Greenhouse Gas Emissions

Although humans have always contributed some level of GHG emissions to the atmosphere through activities like farming and land clearing, substantial anthropogenic contributions did not begin until the mid-1700s with the onset of the Industrial Revolution. People began burning coal, oil, and natural gas to light their homes, to power trains and cars, and to run factories and industrial operations.

GHGs are gaseous constituents in the atmosphere, both natural and anthropogenic, that absorb and reemit terrestrial infrared radiation. Primary GHGs in the atmosphere are water vapor, CO_2, N_2O, CH_4, and ozone. These GHGs occur naturally and because of human activity. Other GHGs, such as the fluorinated gases,[6] are almost entirely anthropogenic in origin and are used in commercial applications such as refrigeration and air conditioning and industrial processes such as aluminum production.

By far the GHG with the largest contribution to warming is CO_2. Global atmospheric CO_2 concentrations have increased 46.4 percent, from approximately 278 parts per million (ppm) in 1750 (IPCC 2013a) to approximately 407 ppm in 2018 (NOAA 2019). In 2016, CO_2 emissions[7] accounted for 74 percent of global GHG emissions on a global warming potential (GWP)-weighted basis,[8] followed by CH_4 (18 percent), N_2O (6 percent), and fluorinated gases (2 percent) (WRI 2020). Atmospheric concentrations of CH_4 and N_2O increased approximately 150 and 20 percent, respectively, over roughly the same period (IPCC 2013a).

GHGs are emitted from a wide variety of sectors, including energy, industrial processes, waste, agriculture, and forestry. The energy sector is the largest contributor of global GHG emissions, accounting for 78 percent of global emissions in 2016; other major contributors of GHG emissions are agriculture (13 percent) and industrial processes (6 percent) (WRI 2020). Transportation CO_2 emissions—from the combustion of petroleum-based fuels—have increased by 71 percent from 1990 to 2016 and account for roughly 17 percent of total global GHG emissions (WRI 2020).[9]

In general, global GHG emissions continue to increase, although annual increases vary according to factors such as weather, energy prices, and economics. Recent trends in observed carbon emissions are comparable to projected emissions from the most fossil fuel-intensive emissions scenario (A1Fi) in the *IPCC Special Report on Emissions Scenarios* (2000) and the highest emissions scenario representing unmitigated GHG concentration increases through the century (RCP8.5) as established by the more recent Representative Concentration Pathways (RCP)[10] (IPCC 2013a).

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[6] Fluorinated GHGs or gases include PFCs, HFCs, SF_6, and NF_3.

[7] These global GHG estimates *do not* include contributions from land-use change and forestry or international bunker fuels.

[8] Each GHG has a different radiative efficiency (the ability to absorb infrared radiation) and atmospheric lifetime. To compare their relative contributions, GHG emission quantities are converted to carbon dioxide equivalent (CO_2e) using the 100-year time horizon global warming potential (GWP) as reported in IPCC's *Second Assessment Report (AR2): The Science of Climate Change* in Sections B.7 Summary of Radiative Forcing and B.8 Global Warming Potential (GWP) (IPCC 1996).

[9] The energy sector is largely composed of emissions from fuels consumed in the electric power, transportation, industrial, commercial, and residential sectors. The 17 percent value for transportation is therefore included in the 78 percent value for energy.

[10] The Representative Concentration Pathways (RCPs) were developed for the IPCC AR5 report. They define specific pathways to emission concentrations and radiative forcing in 2100. The RCPs established four potential emission concentration futures, a business-as-usual pathway representing continued GHG concentration increases (RCP8.5), two stabilization pathways (RCP6.0, 4.5), and an aggressive reduction pathway (RCP2.6).

5.2.1.2 U.S. Greenhouse Gas Emissions

Most GHG emissions in the United States are from the energy sector, with the majority of those emissions being CO_2 emissions coming from the combustion of fossil fuels. Fossil fuel combustion CO_2 emissions alone account for 76 percent of total U.S. GWP-weighted emissions (EPA 2019d), with the remaining 24 percent contributed by other energy sources (e.g., energy production), industrial processes and product use, agriculture and forestry, and waste. CO_2 emissions due to combustion of fossil fuels are from fuels consumed in the transportation (37 percent of fossil fuel combustion CO_2 emissions), electric power (35 percent), industrial (16 percent), residential (6 percent), and commercial (5 percent) sectors (EPA 2019d). In 2017, U.S. GHG emissions were estimated to be 6,456.7 $MMTCO_2e$ (EPA 2019d),[11] or approximately 14 percent of global GHG emissions (WRI 2020).[12]

Similar to the global trend, CO_2 is by far the primary GHG emitted in the United States, representing 82 percent of U.S. GHG emissions in 2017 (EPA 2019d) (on a GWP-weighted basis) and accounting for 15 percent of total global CO_2 emissions (WRI 2020).[13] When U.S. CO_2 emissions are apportioned by end use, transportation is the single leading source of U.S. emissions from fossil fuels, causing over one-third of total CO_2 emissions from fossil fuels (EPA 2019d).[14] CO_2 emissions from passenger cars and light trucks have increased 14 percent since 1990 (EPA 2019d) and account for 59 percent of total U.S. CO_2 emissions from transportation (EPA 2019d). This increase in emissions is attributed to a 45-percent increase in vehicle miles traveled (VMT) because of population growth and expansion, economic growth, and low fuel prices. Additionally, the rising popularity of sport utility vehicles and other light trucks with lower fuel economy than passenger cars has contributed to higher emissions (EPA 2019d, DOT 2016a). Although emissions typically increased over this period, emissions declined from 2008 to 2009 because of decreased economic activity associated with the most recent recession (EPA 2019d). Figure 5.2.1-1 shows the proportion of U.S. CO_2 emissions attributable to the transportation sector and the contribution of each mode of transportation to those emissions.

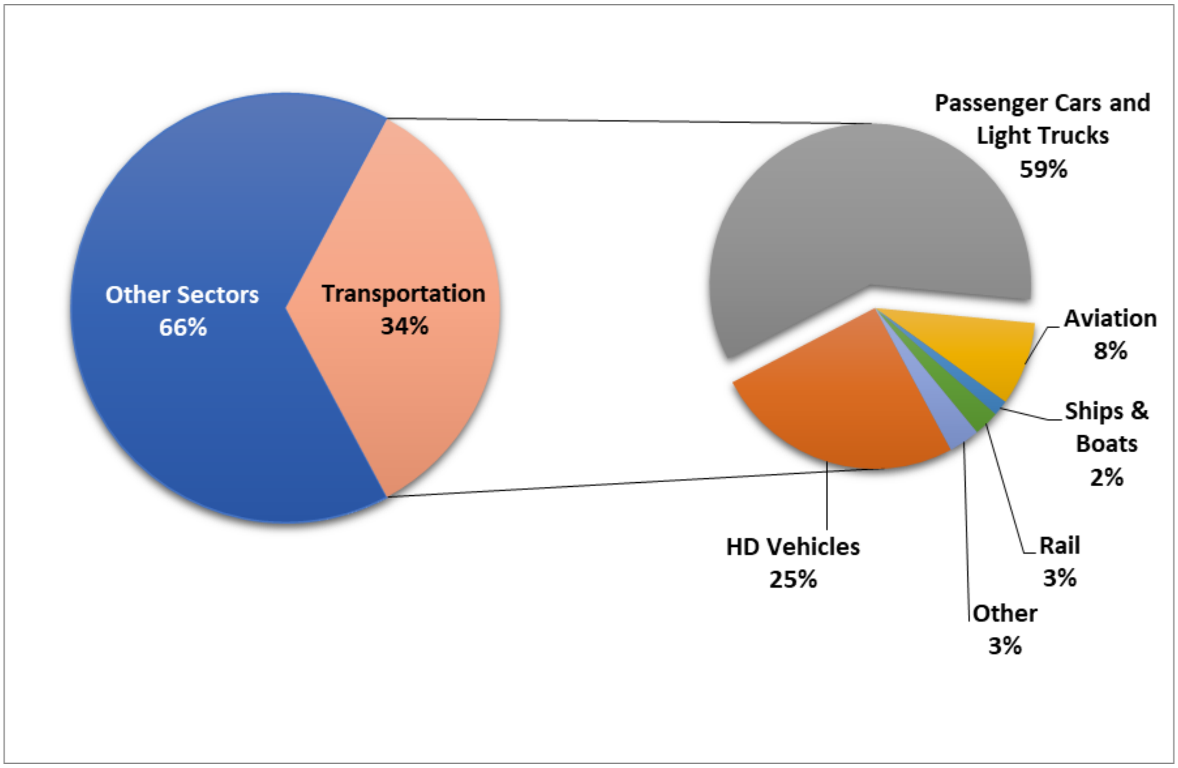
[11] Most recent year for which an official EPA estimate is available, excluding emissions and sinks from land-use change and forestry (EPA 2019d).

[12] Based on global and U.S. estimates for 2014, the most recent year for which a global estimate is available. Excluding emissions and sinks from land-use change and forestry.

[13] The estimate for global emissions from the World Resources Institute is for 2016, the most recent year with available data for all GHGs. It excludes emissions and sinks from land use change and forestry.

[14] Apportioning by end use allocates emissions associated with electricity generation to the sectors (residential, commercial, industrial, and transportation) where it is used.

Figure 5.2.1-1. Contribution of Transportation to U.S. Carbon Dioxide Emissions by Mode (2017)



Source: EPA 2019d
HD = heavy-duty

Although CO_2 is the GHG with by far the largest contribution to warming, CH_4 accounts for 10.2 percent of U.S. GHGs on a GWP-weighted basis, followed by N_2O (5.6 percent) and the fluorinated gases (2.6 percent) (EPA 2019d).

5.2.1.3 Black Carbon and Other Aerosols

Aerosols are solid or liquid particles suspended in Earth's atmosphere. The chemical composition of aerosols varies enormously and can include sulfates, nitrates, dust, black carbon, and other chemical species (IPCC 2013a, CCSP 2009). Aerosols are either emitted directly from a source (e.g., power plants, forest fires, and volcanoes) into Earth's atmosphere or chemically created in the atmosphere from gases (IPCC 2013a, CCSP 2009). Depending on meteorological conditions and other factors, aerosols typically remain in Earth's atmosphere from days to weeks (IPCC 2013a). Their relatively short lifetimes can create regional areas of high aerosol concentrations nearby as well as some distance downwind from emissions source(s) (IPCC 2013a).

An aerosol's impact on climate depends on its composition. Some aerosols, such as sulfates, reflect incoming sunlight back to space, causing a cooling effect; other aerosols, such as black carbon, absorb incoming sunlight, causing a warming effect (CCSP 2009, IPCC 2013a). In addition, some aerosols attract moisture or water vapor and can affect the lifetime and reflectivity of clouds. Overall, IPCC (2013a) states that there is *high confidence* that aerosols have offset a substantial portion of global mean forcing by cooling Earth's atmosphere from the reflection of incoming sunlight and their interaction with clouds, though large uncertainties exist. The overall effect of aerosols on precipitation is not known at the global scale, and this topic continues to be an active area of research (IPCC 2013a).

Among the aerosols, black carbon has recently attracted much attention because of its strong impact on Earth's energy balance. Black carbon is an aerosol that forms during incomplete combustion of certain fossil fuels (primarily coal and diesel) and biomass (primarily fuel wood and crop waste). There is no single accepted method for summarizing the range of effects of black carbon emissions on the climate or representing these effects and impacts in terms of carbon dioxide equivalent (CO_2e); significant scientific uncertainties remain regarding black carbon's total climate effect. The interaction of black carbon (and other co-emitted aerosols) with clouds is especially poorly quantified (IPCC 2013a), and this factor is key to any attempt to estimate the net climate impacts of black carbon. Although black carbon is likely to be a contributor to climate change, it is not feasible to quantify black carbon climate impacts in an analysis of the Proposed Action and alternatives.

Passenger cars and light trucks (especially those that are diesel-powered passenger cars and diesel-powered light trucks) contribute to U.S. emissions of black carbon, but there is no evidence to suggest that the alternatives would differ substantially in terms of their impact on black carbon and aerosol emissions. For further information on black carbon and aerosol emissions, climatic interactions, and net radiative effect, see Section 5.1.6 of the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c).

5.2.2 Climate Change Trends

In its most recent assessment of climate change (*IPCC WG1 AR5*), IPCC states that, "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased" (IPCC 2013a). IPCC concludes that, at continental and global scales, numerous long-term changes in climate have been observed. To be more specific, IPCC and the GCRP include the following trends observed over the 20th century as further supporting the evidence of climate-induced changes:

- Most land areas have *very likely* experienced warmer and/or fewer cold days and nights along with warmer and/or more frequent hot days and nights (IPCC 2014a, GCRP 2017).
- Cold-dependent habitats are shifting to higher altitudes and latitudes, and growing seasons are becoming longer (IPCC 2014a, GCRP 2017).
- Sea level is rising, caused by thermal expansion of the ocean and melting of snowcaps and ice sheets (IPCC 2013a, GCRP 2017).
- More frequent weather extremes such as droughts, floods, severe storms, and heat waves have been observed (IPCC 2013a, GCRP 2017).
- Oceans are becoming more acidic because of increasing absorption of CO_2 by seawater, which is driven by a higher atmospheric concentration of CO_2 (IPCC 2013a, UN 2016, GCRP 2017). There is *high confidence* that oceans have become increasingly more acidic (IPCC 2013a, UN 2016). A recent assessment found that the oceans have become about 30 percent more acidic over the last 150 years since the Industrial Revolution (GCRP 2017).

Developed countries, including the United States, have been responsible for the majority of GHG emissions since the mid-1800s and still have some of the highest GHG emissions per capita (WRI 2018). While annual emissions from developed countries have been relatively flat over the last few decades, world population growth, industrialization, and increases in living standards in developing countries are expected to cause global fossil-fuel use and resulting GHG emissions to grow substantially. Global GHG emissions since 2000 have been increasing nearly three times faster than in the 1990s (IPCC 2013a). Based on the current trajectory, IPCC projects that the atmospheric CO_2 concentration could rise to more than three times preindustrial levels by 2100 (IPCC 2013a). The effects of the CO_2 emissions that have accumulated in the atmosphere prior to 2100 will persist well beyond 2100. If current trends continue, this elevation in atmospheric CO_2 concentrations will persist for many centuries, with the potential for temperature anomalies continuing much longer (IPCC 2013a).

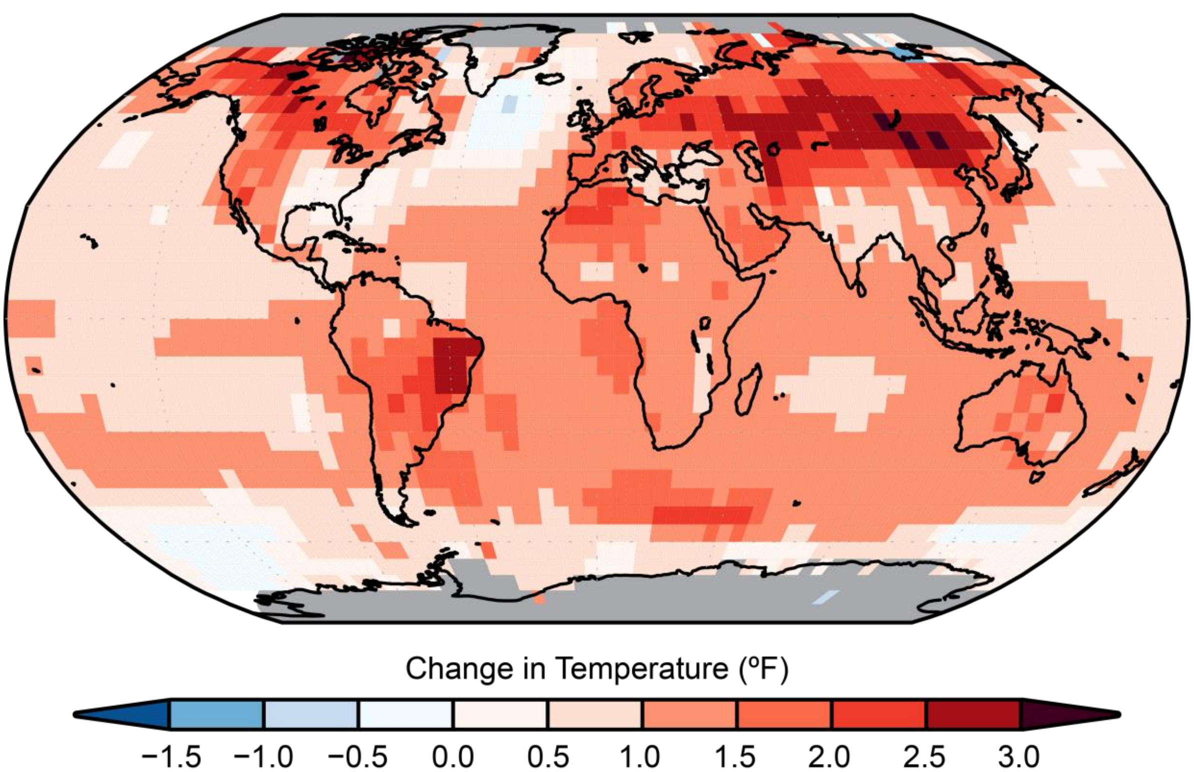
5.2.2.1 Climate Change Attributes

The climate change attributes of temperature, sea-level rise, precipitation, and ocean pH provide evidence of rapid climate change.

Temperature

Global warming is evidenced, in part, by the increase in surface temperatures over time. The last decade has been the warmest on record, and 2016 was the hottest year on record in the continental United States, at 0.94°C (1.69°F) above the 20th century average of 13.9°C (57.0°F).[15] This surpassed the previous global record set in 2015. In 2016, high temperatures were particularly evident in the Arctic (GCRP 2017). Ambient temperatures have increased across most of global lands and oceans in recent decades compared to earlier in the historical record. (Figure 5.2.2-1).

Figure 5.2.2-1. Global Surface Temperature Anomalies in Degrees Fahrenheit from 1986–2015 Relative to 1901–1960



Source: GCRP 2017
°F = degrees Fahrenheit

[15] The global temperatures in 2016 were influenced by strong El Niño conditions that prevailed at the beginning of the year.

Surface warming is projected to continue in the future, with estimates showing that average global surface temperatures will *very likely* increase by more than 2.7°F (1.5°C) by the end of the 21st century, relative to the 1850–1900 average (GCRP 2017).

The sections that follow discuss radiative forcing, average temperatures, and extreme temperatures as they relate to climate change.

Radiative Forcing

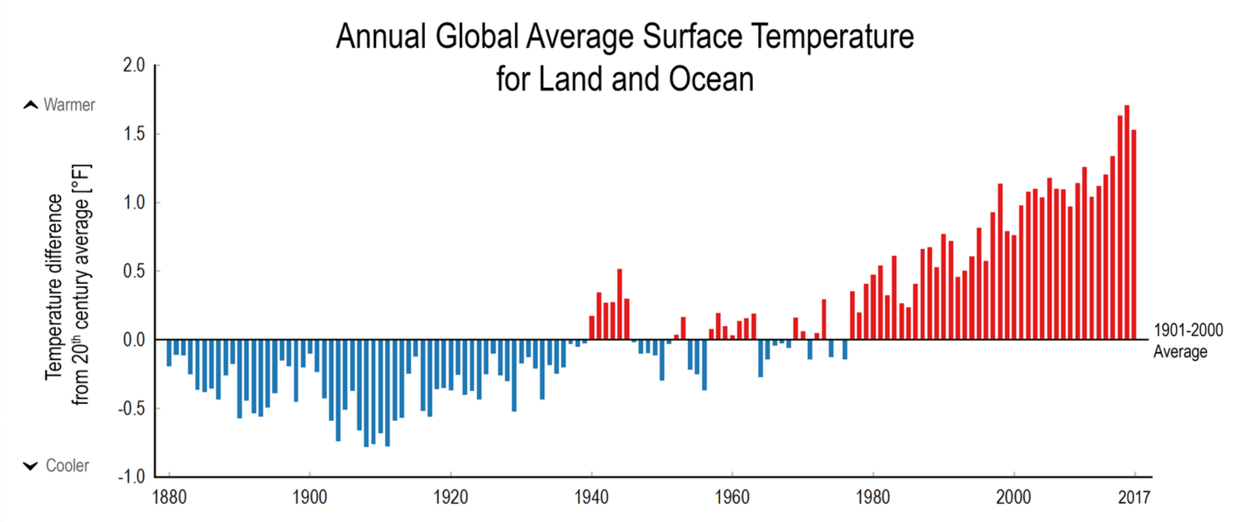
Radiative forcing (RF) describes the magnitude of change in energy fluxes caused by a specific driver—in this case, anthropogenic GHGs—that can alter the Earth's energy budget. Positive RF leads to warming while negative RF leads to cooling (IPCC 2013a). GHGs have a positive RF. Total anthropogenic RF has increased by 2.29 watts per square meter (W/m^2) (plus 1.04 or minus 1.16 W/m^2) and is responsible for the observed warming (IPCC 2013a). The RF from increased atmospheric CO_2 concentration alone is estimated to be 1.68 W/m^2 (plus or minus 0.35 W/m^2) (IPCC 2013a). Previous estimates of total anthropogenic RF had, in fact, underestimated recent changes in RF: "The total anthropogenic RF best estimate for 2011 is 43 percent higher than that reported in AR4 for the year 2005" (IPCC 2013a).

Future projections of RF are captured in the RCPs used to model future climate conditions. These RCPs are named according to the amount of change in RF in 2100 relative to preindustrial conditions (prior to 1750): +2.6, +4.5, +6.0, and +8.5 W/m^2 (GCRP 2017).

Average Temperatures

From 1880 to 2016, the global mean surface temperature increased by about 0.9°C (1.6°F) (Figure 5.2.2-2) (GCRP 2017). In addition, global temperatures are rising at an increasing rate. For example, 16 of the 17 warmest years in the instrumental record (dating to the late 1800s) occurred between 2001 and 2016 (GRCP 2017). The average Arctic temperature has increased at almost twice the global average rate over at least the past several decades (GCRP 2017). Air temperatures are warming more rapidly over land than over oceans (IPCC 2013a, GCRP 2017). Similar to the global trend, the U.S. average temperature is about 1.0°C (1.8°F) warmer than it was in 1895, and this rate of warming is increasing—most of the warming has occurred since 1970 (GCRP 2017).

Figure 5.2.2-2. Annual Global Average Surface Temperature Increases of About 0.9°C (1.6°F) from 1880 to 2016



Source: GCRP 2018b
°F = degrees Fahrenheit

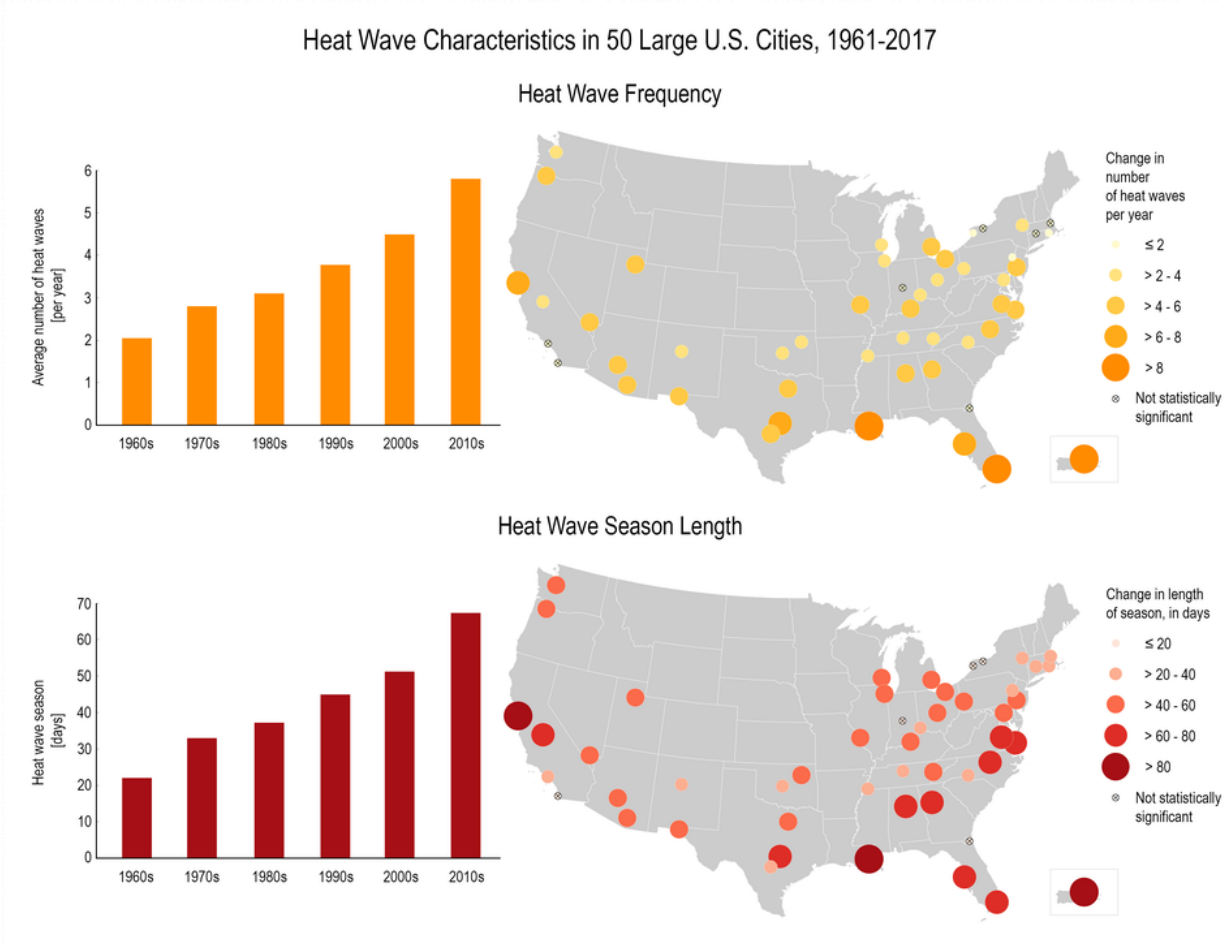
Surface temperatures are not rising uniformly around the globe. For example, some areas of the southeast region of the United States have experienced "warming holes" because temperature observations during the 20th century suggest minor to no warming trends since 1901 (GCRP 2017).

IPCC projects a continuing increase in surface temperature between 2081 and 2100, with a *likely* range between 0.3°C (0.5°F) and 4.8°C (8.6°F), compared with 1986 through 2005, where the lower value corresponds to substantial future mitigation of carbon emissions (IPCC 2013a). The oceans have a large heat capacity and have been absorbing more than 90 percent of warming caused by anthropogenic GHG emissions (GCRP 2017). Due to Earth's thermal inertia—whereby it takes a long time for the oceans to absorb heat and dissipate it to the atmosphere—warming could continue for centuries, even if atmospheric CO_2 is stabilized or reduced.

Extreme Temperatures

In many regions, extreme temperatures have changed substantially since about 1950. Hot days, hot nights, and heat waves have become more frequent; cold days, cold nights, and frost have become less frequent (Figure 5.2.2-3) (EPA 2009, IPCC 2013a, GCRP 2017). Since 1950, the frequency of heat waves in the United States has increased, although in many regions the heat waves recorded in the 1930s remain the most severe on record (one notable exception is that the drought in the western states for the last decade is the most severe on record) (GCRP 2017). Additionally, fewer unusually cold days occurred in the past few decades. The number of extreme cold waves peaked in the 1980s and reached a record low in the 2000s, with records dating back to at least 1895 (coincident with the expansion of the instrumental record) (GCRP 2017). Long-term warming driven by anthropogenic GHG emissions increases the likelihood of extreme temperatures and record warmth (Knutson 2017, Meehl et al. 2016, Vogel et al. 2019). According to IPCC, it is now considered *very likely* that humans have contributed to extreme heat events since the middle of the 20th century and it is *likely* that human activities have doubled the probability of extreme heat events in some regions (IPCC 2013a). For example, the likelihood of consecutive years with record-breaking annual average temperatures from 2014 to 2016 was negligible (less than 0.03 percent) in the absence of human influence (Mann et al. 2017). Additionally, the 2017 heat wave in southern Europe was found to be at least three times more likely today than it was in 1950 due to anthropogenic climate change (Kew et al. 2018).

Figure 5.2.2-3. Heat Waves Increasing in Frequency and Duration from 1961 to 2017



Source: GCRP 2018c

Multiple lines of evidence have recorded increasing temperatures, including weather balloons and more recently satellites (GCRP 2017). In addition, higher temperatures have also been independently confirmed by other global observations. For example, scientists have documented shifts to higher latitudes and elevations of certain flora and fauna habitat (GCRP 2017). In high and mid-northern latitudes, the growing season increased an average of approximately 2 weeks during the second half of the 20th century (IPCC 2014a, GCRP 2014), and plant flowering and animal spring migrations are occurring earlier (EPA 2009, IPCC 2014a, GCRP 2014).

According to the IPCC, "it is *virtually certain* that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales" and it is *very likely* that heat wave frequency and duration will also increase (IPCC 2014). Recent literature continues to support and strengthen such findings, projecting both geographic and temporal increases in extreme heat by the late century (Dahl et al. 2019). These projections result from the general warming trend, rather than a specific RCP scenario or timeframe.

Sea-Level Rise

Global temperature increases contribute to sea-level rise. The sections that follow discuss contributions to sea-level rise, observed global sea-level rise, and observed regional sea-level rise, respectively.

Contributions to Sea-Level Rise

Higher temperatures drive global sea level to rise due to both thermal expansion of ocean water and an increased transfer of water from glaciers and ice sheets to the ocean. Since the early 1970s, the majority of observed sea-level rise has come from these sources. Other factors, such as changing ocean currents and vertical land adjustments, also affect local sea-level rise. IPCC concludes that it is *very likely* that human contributions to sea-level rise are substantial (IPCC 2013a).

Between 1971 and 2010, global ocean temperature warmed by approximately 0.25°C (0.45°F) in the top 200 meters (approximately 660 feet) (IPCC 2013a). In the top 700 meters (approximately 2,300 feet) of the ocean column, warming contributed an average of 0.6 millimeter (plus or minus 0.2 millimeter) (0.024 inch plus or minus 0.008 inch) per year to sea-level rise (IPCC 2013a). IPCC concludes that mountain glaciers, ice caps, and snow cover have declined on average, further contributing to sea-level rise. Losses from the Greenland and Antarctic ice sheets *very likely* contributed to sea-level rise from 1993 to 2010, and satellite observations confirm that they have contributed to sea-level rise in subsequent years (IPCC 2013a). Dynamic ice loss (i.e., the transfer of ice from land-based ice sheets to the ocean, which can accelerate following the collapse of supporting ice shelves) explains most (up to 74 percent) of the Antarctic net mass loss and about half of the Greenland net mass loss (IPCC 2013a).

These contributions to sea-level rise are expected to continue throughout this century. According to the IPCC, ocean warming is projected to continue throughout the 21st century, and all RCP scenarios project year-round reductions in Arctic sea ice (IPCC 2014d). Global glacier volume (excluding the Greenland and Antarctic ice sheets and glaciers on the periphery of Antarctica) is projected to decrease from 15 to 85 percent by the end of the 21st century relative to the baseline period from 1986 to 2005 (between the low estimate for RCP2.6 and the high estimate for RCP8.5) (IPCC 2013a, 2014). While the Greenland Ice Sheet is currently contributing more to global sea-level rise, Antarctica could become the larger contributor by end of century due to rapid retreat of ice stream and glaciers draining the ice sheet (IPCC 2019a).

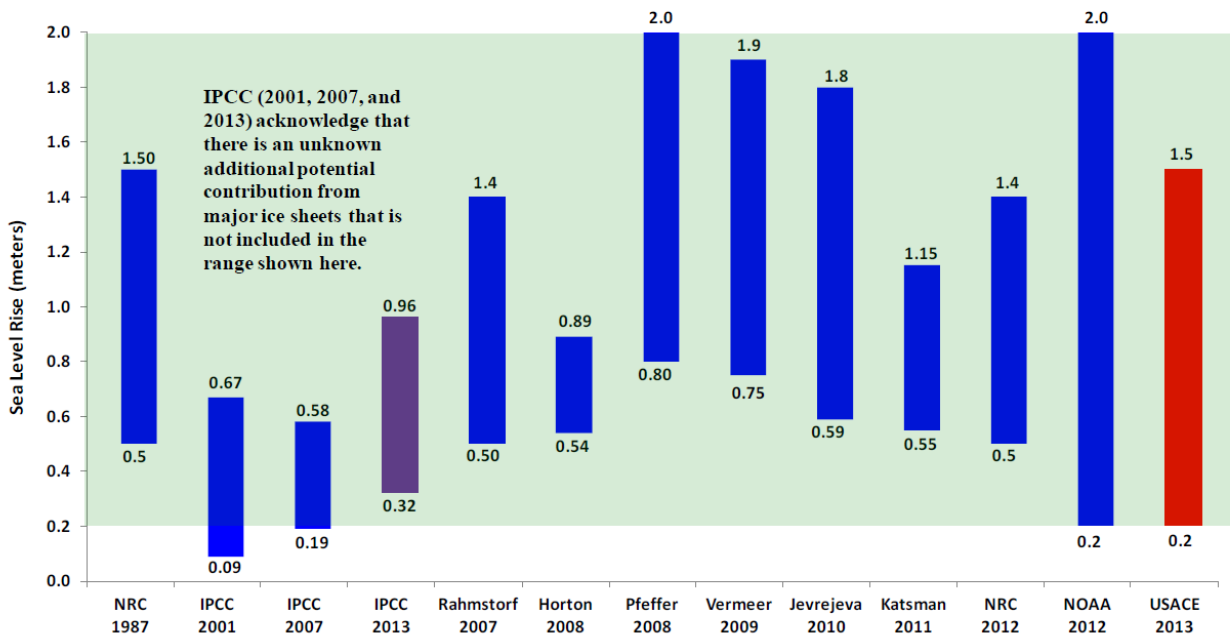
Ocean temperature and sea level affect ice sheet, glacier, and ice-shelf stability in places where the base of ice bodies is in direct contact with ocean water. The interconnectedness of the ocean and cryosphere (e.g., glaciers and ice streams that drain the Greenland and Antarctic Ice Sheets) can, thus, lead to compounding impacts, whereby ocean warming can trigger dramatic ice sheet instability through enhanced melting and calving at glacier and ice stream fronts. In turn, the nonlinear relationship between ocean warming and ice mass loss could be a large driver of future global sea-level rise (IPCC 2019a).

Global Sea-Level Rise

Global mean sea level rose by about 1.0 to 1.7 millimeters per year from 1901 to 1990, a total of 11 to 14 centimeters (4 to 5 inches) (GCRP 2017). After 1993, global mean sea level rose at a faster rate of about 3 millimeters (0.12 inch) per year (GCRP 2017). Consequently, global mean sea level has risen by about 7 centimeters (3 inches) since 1990, and by 16 to 21 centimeters (7 to 8 inches) since 1900 (GCRP 2017). Looking forward, IPCC projects that the global temperature increase will continue to affect sea level, causing a *likely* rise of 0.26 meter (0.85 foot) to 0.82 meter (2.7 feet) in the next century (IPCC 2013a).

In addition, other studies that consider dynamic mass loss from major ice sheets indicate that sea-level rise could be even greater (Figure 5.2.2-4) (Robel et al. 2019, Bamber et al. 2019). Most of these studies project a higher sea-level rise than the IPCC studies. In 2017, NOAA found that there is *very high confidence* (more than a 9 in 10 chance) that global mean sea level will rise 0.2 to 2.7 meters (7.9 inches to 8.9 feet) by 2100 (Sweet et al. 2017a). Increasing anthropogenic GHG emissions would increase the risks posed by greater warming and sea-level rise (IPCC 2014a). Records of paleo sea-level indicate that, when global mean temperatures increased to 2°C [3.6˚F] above preindustrial levels, global mean sea level was 5 meters (16.4 feet) higher than current levels (IPCC 2013a).

Figure 5.2.2-4. End-of-Century Estimates of Maximum and Minimum Global Mean Sea-Level Rise (2090–2100)



Source: USACE 2014

NRC = National Research Council; IPCC = Intergovernmental Panel on Climate Change; NOAA = National Oceanic and Atmospheric Administration; USACE = U.S. Army Corps of Engineers

Regional Sea-Level Rise

Sea-level rise is not uniform across the globe, primarily because dynamic ocean heights are adjusted by ocean currents and because coastline elevations change through time as a result of regional tectonics, subsidence, and isostatic rebound. The largest increases in sea level since 1992 have occurred in the western Pacific and eastern Indian Oceans; meanwhile, sea level in the eastern Pacific and western Indian Oceans has actually been falling (IPCC 2013a citing Beckley et al. 2010). This absence of uniformity in sea-level rise is projected to continue throughout the 21st century, though it is *very likely* that sea level will rise in more than 95 percent of the ocean area (IPCC 2014d).

Nationally, relative sea level has been rising at a rate of 0.8 to 1.2 inches per decade along most of the Atlantic and Gulf coasts and more than 3 inches per decade along portions of the Louisiana coast (where land subsidence is relatively rapid). Sea level is falling (due to tectonic uplift) at the rate of a few inches per decade in parts of Alaska (EPA 2009, National Science and Technology Council 2008). This pattern of relative sea-level rise along the U.S. coast is projected to continue throughout this century (GCRP 2017 citing Sweet et al. 2017). Tools such as the NOAA Seal Level Rise viewer can be used to understand the impact of coastal inundation under different sea-level rise scenarios along the coastal United States.[16]

Sea-level rise extends the zone of impact of storm surges and waves from tropical and other storms farther inland, causing coastal erosion and other damage. Resulting shoreline erosion is well documented. Since the 1970s, half of the coastal area in Mississippi and Texas has been eroding inland by an average of 2.6 to 3.1 meters (8.5 to 10.2 feet) per year (26 to 31 meters [85 to 102 feet] per decade). In Louisiana, a full 90 percent of the shoreline has been eroding inland at an average rate of more than 12.0 meters (39.4 feet) per year (EPA 2009, Nicholls et al. 2007).[17] As sea level continues to rise, so will the likelihood for extensive coastal erosion (GCRP 2017 citing Barnard et al. 2011, Theuerkauf and Rodriguez 2014, Serafin and Ruggiero 2014).

Precipitation

As the climate warms, evaporation from land and oceans increases and more moisture can be held in the atmosphere (GCRP 2017). Depending on atmospheric conditions, this evaporation causes some areas to experience increases in precipitation events, while other areas are left more susceptible to droughts (Fujita et al. 2019). Average atmospheric water vapor content has increased since at least the 1970s over land and the oceans, and in the upper troposphere, largely consistent with air temperature increases (IPCC 2013a). Because of changes in climate, including increased moisture content in the atmosphere, heavy precipitation events have increased in frequency over most land areas (IPCC 2013a, Min et al. 2011).

The sections that follow discuss global, regional, and national trends in precipitation, droughts, streamflow, and snow cover, respectively.

Precipitation

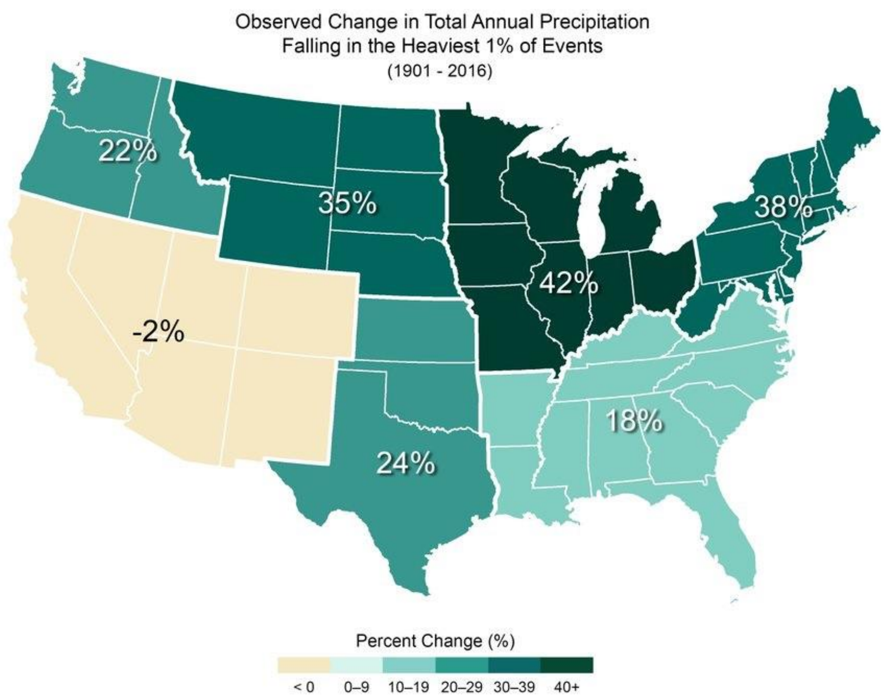
Long-term trends in global precipitation have been observed since 1901. Between 1901 and 2010, increases in precipitation have been observed in the middle and higher latitudes of both the Northern and Southern Hemispheres, specifically in northwestern and eastern parts of North America, parts of Europe and Russia, and southern South America. Drying has been observed in the Sahel region of Africa, the Mediterranean, southern Australia, and parts of Southeast Asia. Spatial and temporal variability for precipitation is high, and data are limited for some regions (IPCC 2013b).

Over the contiguous United States, total annual precipitation increased approximately 4 percent from 1901 to 2016, on average. The greatest increases from 1991 to 2015 (relative to 1901 to 1960) were noted in the Midwest, the Northeast, and the Great Plains, and there were notable decreases in areas of the Southwest (GCRP 2017). Heavy precipitation events also increased in all regions except the Southwest, primarily during the last 3 to 5 decades, with more than a 40 percent increase since 1901 in the Midwest (Figure 5.2.2-5) (GCRP 2017).

[16] NOAA, Office for Coastal Management, DigitalCoast, Sea Level Rise Viewer, https://coast.noaa.gov/digitalcoast/tools/slr.html.

[17] The shoreline erosion in Louisiana is also affected by human alterations and loss of sediment supply (EPA 2009).

Figure 5.2.2-5. Increased Heavy Precipitation Events from 1901 to 2016



Source: GCRP 2018d

In general, climate change is expected to reinforce global precipitation patterns. Under the RCP8.5 scenario, mean precipitation increases in wet regions at high and middle latitudes and the equatorial Pacific, and mean precipitation decreases in dry regions at subtropical and middle latitudes are *likely* by the end of the century (IPCC 2014d).

Drought

Observations of increased dryness since the 1950s suggest that some regions of the world have experienced longer, more intense droughts caused by higher temperatures and decreased precipitation, particularly in the tropics and subtropics (IPCC 2013a). Spatial variability for dryness is high and data availability is limited in some regions from which to draw global conclusions. IPCC concludes that, while there is *likely* increased dryness or drought in East Asia, the Mediterranean, and West Africa, there has *likely* been decreased dryness observed in central North America and Northwest Australia (IPCC 2013a).

Drought trends have been changing for some regions of the United States over the past 50 years (GCRP 2017). Most regions in the United States experienced decreases in drought severity and duration over the 20th century due to increasing average precipitation and the frequency of heavy precipitation events. There are exceptions to this trend, such as the severe drought in the Southwest from 1999 to 2008 (EPA 2009), and severe droughts in Texas and California in 2011 (GCRP 2017), the Midwest in 2012 (GCRP 2017), and California in 2014 and 2015 (USGS 2015). According to tree ring data, drought conditions in the western United States over the last decade could represent the driest conditions in 500 years (GCRP 2017).

By the end of the 21st century, it is *likely* that currently dry regions in the world will experience more frequent droughts under RCP8.5 (IPCC 2014d). In southwest North America, where long-term droughts have historically occurred because of natural causes, aridification is projected to increase due to climate change and concomitant general drying and poleward expansion of the subtropical dry zones (IPCC 2013a citing Held and Soden 2006, Seager et al. 2007, Seager and Vecchi 2010).

While current levels of climate change already manifest moderate risks of increased water scarcity, vegetation loss, and wildfire damage, these risks are projected to become more severe with future temperature increases (IPCC 2019b). In addition, increased warming is projected to shift climate zones poleward and increase the amount of land prone to drought (IPCC 2019b).

Streamflow

Melting snow and ice, increased evaporation, and changes in precipitation patterns all affect surface water. Previous assessments have indicated variable changes in streamflow and river discharge, with most increases observed at higher latitudes. Mean annual streamflow decreased approximately 2 percent per decade over the past century in the central Rocky Mountain region (IPCC 2007 citing Rood et al. 2005), while high streamflow increased 25 percent in the past 60 years in the eastern United States (IPCC 2013a citing Groisman et al. 2004). More recent assessments show even greater global variability in trends, where decreases in streamflow were observed in mainly low- and mid-latitude river basins, while increasing flow at higher latitudes could have resulted from possible permafrost thawing and increased snowmelt (IPCC 2013a). Changes in precipitation have also been identified as a major driver for changing discharge trends across regions (IPCC 2013a).

These streamflow drivers are expected to continue to change throughout the 21st century, with more frequent and intense heavy precipitation events (*high confidence*) and more precipitation falling as rain rather than snow, thereby decreasing snowpack and snowmelt (*high confidence*) in the United States (GCRP 2017). Changes in streamflow are also dominated by glacier-fed mountain basins, which are projected to experience increases in winter runoff and earlier spring peak flows (IPCC 2019a).

Snow Cover

Across the Northern Hemisphere, annual mean snow cover decreased 53 percent from 1967 to 2012 (IPCC 2013a). Changes in air temperature, decreased surface albedo, and increased atmospheric water vapor drove a downward trend in maximum snow cover per decade from 1961 to 2015 across North America (GCRP 2017). The amount of snow at the end of the winter season, which is important for water supply provided by snowmelt, has decreased because of springtime warming (GCRP 2017). In addition, North America, Europe, South Asia, and East Asia have experienced a decreasing number of snowfall events; according to IPCC, this is *likely* due to increasing winter temperatures (IPCC 2013a).

Spring snow cover area in the Northern Hemisphere is *likely* to decrease by 7 percent under RCP2.6 and up to 25 percent under RCP8.5 by the end of the 21st century relative to the historical baseline, based on the IPCC multimodel average (IPCC 2014d). Recent studies support these findings, and project that spring snow cover could decrease by as much as 35 percent relative to 1986–2005 by the end of the century under RCP8.5 (IPCC 2019a).

Ocean pH

With higher atmospheric CO_2 concentrations in recent decades, oceans have absorbed more CO_2, which lowers the potential of hydrogen (pH)—or increases the acidity—of the water. When CO_2 dissolves in seawater, the hydrogen ion concentration of the water increases; this is measured as a decrease in pH. Compared to the preindustrial period, the pH of the world's oceans has decreased by 0.1 unit (IPCC 2013a). Because pH is measured on a logarithmic scale, this decrease represents a 30 percent increase in the hydrogen ion concentration of seawater, a substantial acidification of the oceans. Although research on the ultimate impacts of declining ocean pH is limited, available observational, laboratory, and theoretical studies indicate that acidification could interfere with the calcification of coral reefs and inhibit the growth and survival of coral reef ecosystems (EPA 2009, GCRP 2017, IPCC 2013a). The Fourth National Climate Assessment (GCRP 2017) notes that, under the RCP8.5 emissions scenario, by 2100, nearly all coral reefs are projected to be surrounded by acidified seawater that will challenge coral growth (GCRP 2018a citing Ricke 2013). Further, IPCC projects that, when average global warming reaches 1.3°C above preindustrial levels, tropical coral reefs are *virtually certain* to experience high risks of impacts such as frequent mass mortalities, and at 2°C, most available evidence (*high agreement, robust evidence*) suggests that coral dominated ecosystems will be nonexistent (citing Alvarez-Filip et al. 2009).

The global average surface ocean acidity is projected to increase in acidity (decrease in pH) by 100 to 150 percent by the end of the century under RCP8.5 relative to historical conditions (*high confidence*) (GCRP 2017).

5.2.2.2 Increased Incidence of Severe Weather Events

Tropical cyclones appear to be increasing in intensity since 1970, but no clear trend in the frequency of tropical cyclones each year has been observed. Identifying long-term trends of tropical cyclones has been difficult because observations were limited prior to the satellite era (IPCC 2013a). However, there is observational evidence of an increase in intense tropical cyclone activity correlated with increases of sea-surface temperatures in the North Atlantic, which includes the Gulf Stream, since about 1970 (GCRP 2017). The tracks of tropical cyclones have shifted in a warming climate, migrating toward the poles (GCRP 2017). According to IPCC, while recent assessments indicate that it is *unlikely* that the annual frequency of tropical storms and hurricanes have increased over the past century in the North Atlantic, the increase in intensity since the 1970s in that region is *virtually certain* (IPCC 2013a). Additionally, recent projections indicate that climate change could increase the frequency of the most intense tropical cyclones by the end of the century, but it is still unclear how the overall frequency of events might change (GCRP 2017).

Climate change also causes hurricanes and tropical cyclones to produce heavier precipitation (GCRP 2017). Heavy precipitation events have increased globally since 1951, with some regional and subregional variability (IPCC 2013a). A warmer atmosphere holds more moisture and increases the energy available for convection, causing stronger storms and heavier precipitation (GCRP 2017, Gertler and O'Gorman 2019). The influence of climate change on recent storms is well documented. For example, the rainfall produced in Texas and Louisiana by Hurricane Harvey in 2014 was increased by about 15 to 19 percent due to climate change (Risser and Wehner 2017, van Oldenborgh et al. 2017) and could increase the probability of a similar extreme event by 17 percent through 2100 relative to the period from 1981 to 2000 under RCP8.5 (Emanuel 2017). Looking forward, tropical cyclone rainfall amounts in the eastern United States could increase by 8 to 17 percent relative to the 1980-to-2006 period as a result of a warmer climate (Wright et al. 2015). Evidence is insufficient to determine whether there are trends in large-scale phenomena such as the Atlantic meridional overturning circulation (AMOC), a mechanism for heat transport in the North Atlantic Ocean by which warm waters are carried north and cold waters are carried toward the equator or in small-scale phenomena such as tornadoes, hail, lightning, and dust storms (IPCC 2013a). However, the frequency of weather and climate disasters (including those causing more than $1 billion in damages) has increased in the United States (GCRP 2018a).

Changes in ocean heat content and freshwater-driven buoyancy could potentially weaken the AMOC and, in turn, drive dramatic changes to the regional climates of North America and Europe. However, there is currently *low confidence* in models that show AMOC weakening over the 21st century under a high emissions scenario (RCP8.5) (GCRP 2017). Similarly, confidence in future projections of severe thunderstorms (which includes tornadoes, hail, and winds) is *low* (GCRP 2017).

5.2.2.3 Changes in Ice Cover and Permafrost

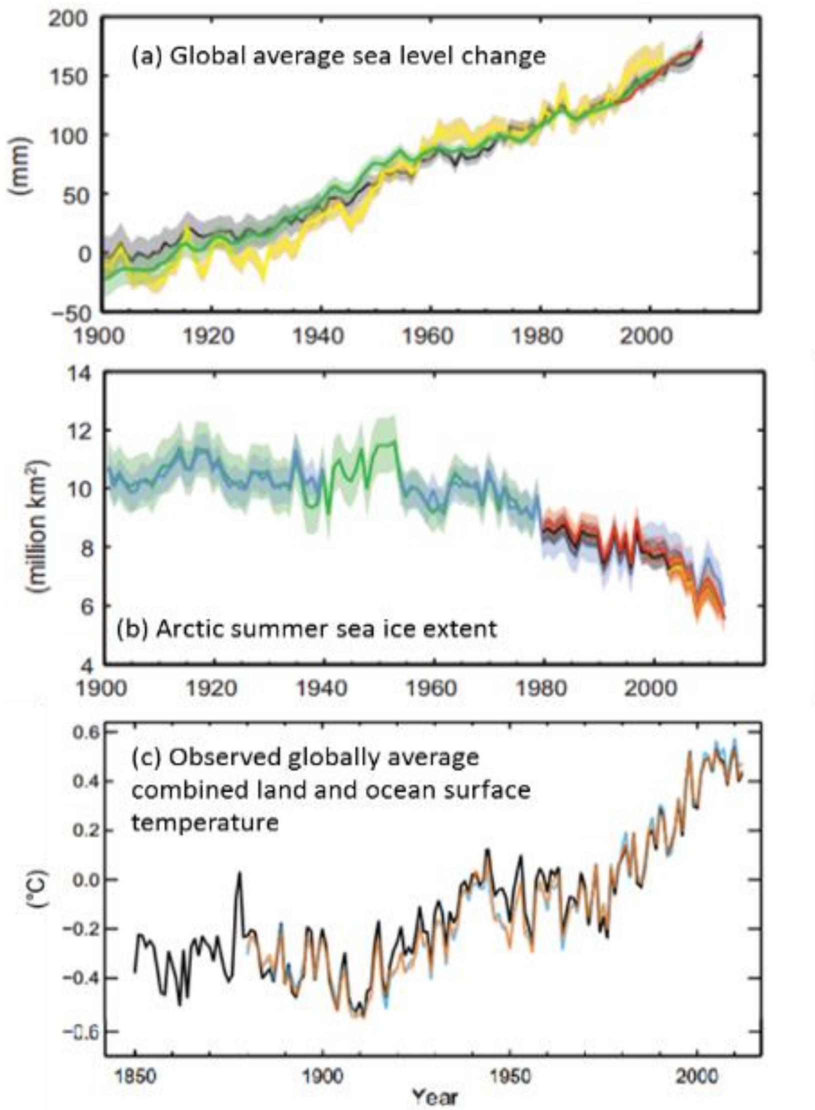
Changes in air and ocean temperatures, precipitation onto the ice mass, and water salinity are affecting glaciers, sea-ice cover, and ice sheets. Numerous studies have confirmed that glaciers and ice sheets have shrunk substantially in the past half century. Satellite images have documented the loss of mass from the Greenland ice sheet and the West Antarctic ice sheet (IPCC 2013a, GCRP 2017). Since 1979, the annual average Arctic sea-ice area has been declining at a rate of 3.5 to 4.1 percent per decade (IPCC 2013a). Warming in the Arctic has proceeded at about twice the rate as elsewhere, leading to decreases in summer sea-ice extent, glacier and ice sheet mass loss, coastal erosion, and permafrost thawing (IPCC 2013a).[18] Some Arctic ice that previously was thick enough to last through summer has now thinned enough to melt completely in summer. In March 2016, the Arctic experienced the lowest winter maximum ice extent in the satellite record (1979 to 2016), 7 percent below the 1981 to 2010 average (Perovich et al. 2017). Multiyear ice (more than 1 year old) and first-year ice were 22 percent and 78 percent of the ice cover, respectively, compared to 45 percent and 55 percent in 1985 (Perovich et al. 2017). In September 2016, the Arctic sea ice minimum extent was 33 percent lower than the 1981 to 2010 average minimum ice extent, 22 percent larger than the record minimum set in 2012, and tied with 2007 for the second lowest value in the satellite record (1979 to 2016) (Perovich et al. 2017). According to IPCC, average winter sea-ice thickness in the Arctic Basin *likely* decreased by approximately 1.3 and 2.3 meters (4.27 to 7.55 feet) from 1980 to 2008 (IPCC 2013a). The multiyear ice extent (ice that lasts at least two summers) has declined from about 7.9 million square kilometers (3.05 million square miles) in 1980 to as low as 3.5 million square kilometers (1.35 million square miles) in 2012 (IPCC 2013a). These area and thickness reductions allow winds to generate stronger waves, which have increased shoreline erosion along the Alaskan coast. Alaska has also experienced increased thawing of the permafrost base of up to 1.6 inches per year since 1992 (EPA 2009, National Science and Technology Council 2008).

Permafrost top layer temperatures have generally increased since the 1980s (approximately 3°C [5°F] in parts of Alaska and 2°C [4°F] in northern Russia), while the depth of seasonally frozen ground has, in some parts of the Eurasian continent, decreased since 1930 by approximately 0.3 meter (1 foot) (IPCC 2013a). The 4°F to 5°F warming in Alaska permafrost has been recorded at a depth of 65 feet (GCRP 2014 citing NRC 2011 and Hawkins and Sutton 2009); at a depth of about 3 feet, the warming has been recorded as 6°F to 8°F (GCRP 2014 citing Hansen and Sato 2012).

[18] Permafrost thawing releases CO_2 and CH_4 into the atmosphere.

The loss of Arctic sea ice is projected to continue throughout the 21st century, and could *very likely* result in nearly sea-ice-free late summers in the Arctic Ocean by the 2040s (*very high confidence*) (GCRP 2017). The Arctic is projected to have approximately a 1 percent chance of having sea-ice-free Septembers after mid-century based on stabilized warming of 1.5°C, and a 10 to 35 percent chance at 2°C (IPCC 2019a). At the same time, permafrost is projected to continue to decrease, with a switch from continuous to discontinuous permafrost expected over the 21st century (GCRP 2017 citing Vaughan et al. 2013, Grosse et al. 2016, and Schuur et al. 2015). Projections show that by end of century, near-surface (within 3 to 4 meters) permafrost could decrease by approximately 24 to 69 percent relative the 1986-to-2005 baseline time period, based on RCP2.6 and RCP8.5, respectively (IPCC 2019a). Figure 5.2.2-6 shows historical changes in sea level, Arctic summer sea-ice extent, and surface temperatures.

Figure 5.2.2-6. Changes in Sea Level, Arctic Summer Sea-Ice Extent, and Surface Temperature



Note:
Each line on the graphs above depicts mean values of one data set. Multiple data sets are displayed in each graph using different colors. Shaded areas in the graphs depict uncertainty in the data sets.
Source: IPCC 2013a
mm = millimeters; km^2 = kilometers squared; °C = degrees Celsius

5.3 Analysis Methods

The methods NHTSA used to characterize the effects of the alternatives on climate have three key elements:

- **Analyzing the impacts of each alternative on GHG emissions.** Many analyses of environmental and energy policies and regulations express their environmental impacts, at least in part, in terms of GHG emissions increases or decreases. This approach is also recommended by CEQ's draft guidance on consideration of GHG emissions in NEPA analyses.
- **Estimating the monetized damages associated with GHG emissions increases attributable to each alternative.** Economists have estimated the incremental effect of GHG emissions, and monetized those effects, to express the social costs of carbon, CH_4, and N_2O in terms of dollars per ton of each gas. By multiplying the emissions increases of each gas by estimates of their social cost, NHTSA derived a monetized estimate of the costs of the emissions increases associated with each action alternative. NHTSA has estimated the monetized damages associated with GHG emissions increases in its Final Regulatory Impact Analysis (FRIA), as indicated by the CO_2 Damage Reduction Benefit metric in the FRIA benefits and net impacts tables. See Section VI.D. of the FRIA for a description of the methods used for these estimates.
- **Analyzing how GHG emissions increases under each alternative would affect the climate system (climate effects).** Climate models characterize the relationship between GHG emissions and various climatic parameters in the atmosphere and ocean system, including temperature, precipitation, sea level, and ocean pH.[19] NHTSA translated the changes in GHG emissions associated with each action alternative to changes in temperature, precipitation, sea level, and ocean pH in relation to projections of these climatic parameters under the No Action Alternative.

In this EIS, impacts on GHG emissions and the climate system are expressed in terms of emissions, CO_2 concentrations, temperature, precipitation, sea level, and ocean pH for each of the alternatives.

Comparisons between the No Action Alternative and each action alternative are presented to illustrate the different environmental impacts of each alternatives. The impact of each action alternative is measured by the difference in the climate parameter (CO_2 concentration, temperature, sea level, precipitation, and ocean pH) under the No Action Alternative and the climate parameter under that action alternative. For example, the increase in CO_2 emissions attributable to an action alternative is measured by the difference in emissions under the No Action Alternative and emissions under that alternative.

The methods used to characterize emissions and climate impacts consider multiple sources of uncertainty. Sources of uncertainty include the following sources, in addition to many other factors:

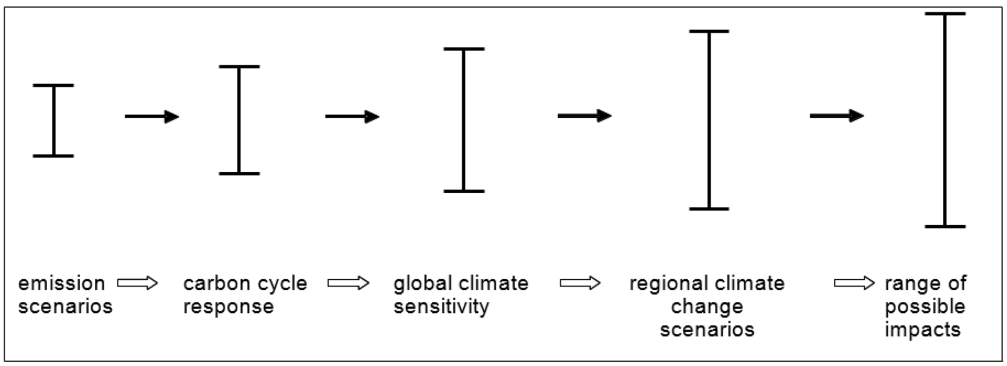
- The pace and effects of technology changes in the transportation sector and other sectors that emit GHGs.
- Changes in the future fuel supply and fuel characteristics that could affect emissions.
- Sensitivity of climate to increased GHG concentrations.

[19] In discussing impacts on ocean pH, this EIS uses both *changes to* and *reductions of* ocean pH to describe ocean acidification. The metric pH is a parameter that measures how acidic or basic a solution is. The increase in atmospheric concentration of CO_2 is causing acidification of the oceans, which can be measured by a decrease in ocean pH.

- The rate of change in the climate system in response to changing GHG concentrations.
- Potential existence of thresholds in the climate system (which cannot be predicted or simulated).
- Regional differences in the magnitude and rate of climate change.
- Sensitivity to natural variability, such as El Niño conditions.

Moss and Schneider (2000) characterize the "cascade of uncertainty" in climate change simulations (Figure 5.3-1). As indicated in Figure 5.3-1, the emissions estimates used in this EIS have narrower bands of uncertainty than global climate sensitivity, which is even less uncertain than regional climate change impacts. The impacts on climate are, in turn, less uncertain than the impacts of climate change on affected resources (such as terrestrial and coastal ecosystems, human health, and other resources discussed in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*). Although the uncertainty bands broaden with each successive step in the analytic chain, not all values within the bands are equally likely; the mid-range values have the highest likelihood.

Figure 5.3-1. Cascade of Uncertainty in Climate Change Simulations



Source: Moss and Schneider 2000

Scientific understanding of the climate system is incomplete; like any analysis of complex, long-term changes to support decision-making, evaluating reasonably foreseeable impacts on the human environment involves many assumptions and uncertainties. This EIS uses methods and data to analyze climate impacts that represent the best and most current information available on this topic and that have been subjected to extensive peer review and scrutiny. The information cited throughout this section, extracted from the most recent EPA, IPCC, and GCRP reports on climate change, has endured a more thorough and systematic review process than information on virtually any other topic in environmental science and policy. The tools used to perform the climate change impacts analysis, including the Model for the Assessment of Greenhouse Gas-Induced Climate Change (MAGICC) and the Object-Oriented Energy, Climate, and Technology Systems (objECTS) version of the Global Change Assessment Model (GCAM), are widely available and are commonly used in the scientific community.

The U.S. Climate Change Science Program Synthesis and Assessment Product 3.1 report on the strengths and limitations of climate models (CCSP 2008) provides a thorough discussion of the methodological limitations regarding modeling. Additionally, Chapter 9, Evaluation of Climate Models, of *IPCC WG1 AR5,* provides an evaluation of the performance of global climate models. Readers interested in a detailed treatment of this topic will find the Synthesis and Assessment 3.1 report and Chapter 9 of *IPCC WG1 AR5* useful in understanding the issues that underpin the modeling of environmental impacts of the Proposed Action and alternatives on climate change.

5.3.1 Methods for Modeling Greenhouse Gas Emissions

The emissions estimates in this EIS include GHG emissions from passenger car and light truck fuel combustion (tailpipe emissions) as well as upstream emissions from the production and distribution of fuel. GHG emissions were estimated by the DOT Volpe National Transportation Systems Center using the following models: the CAFE Compliance and Effects model (referred to as the CAFE model), described in Section 2.3.1, *CAFE Model*, to calculate tailpipe emissions, and the Greenhouse Gases and Regulated Emissions in Transportation (GREET) model, developed by the U.S. Department of Energy (DOE) Argonne National Laboratory, to estimate emissions associated with production, transportation, and storage of gasoline and diesel from crude oil as well as emissions associated with the generation of electricity. The CAFE model uses emissions factors (amount of pollutant emitted per unit of source activity (e.g., grams per VMT) derived from EPA's Motor Vehicle Emissions Simulator (MOVES).

Emissions under each action alternative were compared against those under the No Action Alternative. GHG emissions were estimated using the methods described in Section 2.3, *Standard-Setting and EIS Methods and Assumptions*. For the climate analysis, GHG emissions trajectories are projected through the year 2100. NHTSA estimated GHG emissions for the passenger car and light truck fleets for 2051 to 2100 by applying the projected rate of change in U.S. transportation fuel consumption over this period from GCAM.[20] For 2051 through 2100, the GCAM Reference and GCAM6.0 scenarios project that U.S. road transportation fuel consumption will decline slightly because of assumed improvements in efficiency of internal combustion engine-powered vehicles and increased deployment of noninternal combustion engine vehicles with higher drivetrain efficiencies. However, the projection of road transport fuel consumption beyond 2050 does not change substantially. Therefore, emissions remain relatively constant from 2050 through 2100. The assumptions and methods used to develop the GHG emissions estimates for this EIS are broadly consistent with those used in the *MY 2011–2015 CAFE Final EIS,* the *MY 2012–2016 CAFE Final EIS* (NHTSA 2010), *Phase 1 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2011), *MY 2017–2025 CAFE Final EIS* (NHTSA 2012), and the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c).

The emissions estimates include global CO_2, CH_4, and N_2O emissions resulting from direct fuel combustion and the production and distribution of fuel and electricity (upstream emissions).[21] The MOVES model also estimated the following non-GHG emissions, which are used as inputs in MAGICC6: sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), and volatile organic compounds (VOCs).

Higher fuel consumption from less stringent passenger car and light truck CAFE standards would result in higher emissions of CO_2 (the main GHG emitted) because of refining, distribution, and use of

[20] 2050 is the last year for which the CAFE model provides estimates of fleet CO_2 emissions for this analysis.

[21] Upstream emissions considered in this Final EIS include those that occur in the United States during the recovery, extraction, and transportation of crude petroleum, as well as during the refining, storage, and distribution of transportation fuels. Emissions from each of these phases of fuel supply are estimated using factors obtained from Argonne's GREET model. A portion of finished motor fuels are refined in the United States using imported crude petroleum as a feedstock, and GREET's emissions factors are used to estimate emissions associated with transporting imported petroleum from coastal port facilities to U.S. refineries, refining it to produce transportation fuels, and storing and distributing those fuels. GREET's emissions factors are also used to estimate domestic emissions from transportation, storage, and distribution of motor fuels that are imported to the United States in refined form.

transportation fuels.[22] There is a direct relationship among fuel efficiency, fuel consumption, and CO_2 emissions. Fuel efficiency describes how much fuel a vehicle requires to perform a certain amount of work (for example, how many miles it can travel or how many tons it can carry per mile traveled). A vehicle is more fuel-efficient if it can perform more work while consuming less fuel. Higher fuel consumption increases CO_2 emissions directly because the primary source of vehicle-related CO_2 emissions is the combustion of carbon-based fuel in internal combustion engines; combustion of a hydrocarbon essentially produces energy (used to power the vehicle), CO_2, and water. Therefore, fuel consumption is directly related to CO_2 emissions, and CO_2 emissions are directly related to fuel efficiency.

NHTSA estimated increases in CO_2 emissions resulting from fuel consumption increases by assuming that the carbon content of gasoline, diesel, and other fuels is converted entirely to CO_2 during the combustion process.[23] Specifically, NHTSA estimated CO_2 emissions from fuel combustion as the product of the volume of each type of fuel consumed (in gallons), its mass density (in grams per gallon), the fraction of its total mass represented by carbon (measured as a proportion), and CO_2 emissions per gram of fuel carbon (the ratio of the molecular weights of CO_2 and elemental carbon).

Increased fuel consumption also increases CO_2 emissions that result from the use of carbon-based energy sources during fuel production and distribution. Volpe estimated the increase in CO_2 emissions during each phase of fuel and electricity production and distribution (upstream emissions) using CO_2 emissions rates obtained from the GREET model using previous assumptions about how fuel increases are reflected in increases in activity during each phase of fuel production and distribution.[24] The total increase in CO_2 emissions under each alternative is the sum of the increases in motor vehicle emissions from increased fuel combustion compared to the No Action Alternative plus the increase in upstream emissions from a higher volume of fuel production and distribution than is projected under the No Action Alternative.

5.3.2 Social Cost of Greenhouse Gas Emissions

One approach to assessing the potential impact associated with changes in GHG emissions is to monetize those impacts. The social cost of each gas (i.e., the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O) is a metric that estimates the monetary value of impacts associated with marginal changes in emissions in a given year. It includes a wide range of anticipated climate impacts, such as net changes in agricultural productivity and human health, property damage from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

[22] For this rulemaking, NHTSA estimated emissions of vehicular CO_2, CH_4, and N_2O emissions, but did not estimate vehicular emissions of HFCs. HFCs are released to the atmosphere only through air-conditioning system leakage and are not directly related to fuel efficiency. NHTSA's authority under the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act, extends only to the regulation of vehicle fuel efficiency. For reference, CH_4 and N_2O account for 1.5 percent of the tailpipe GHG emissions from passenger vehicles and light trucks, and CO_2 emissions account for the remaining 98.5 percent. Of the total (including non-tailpipe) GHG emissions from passenger cars and light trucks, tailpipe CO_2 represents approximately 94.7 percent, tailpipe CH_4 and N_2O represent approximately 1.5 percent, and HFCs represent approximately 3.9 percent (values are calculated from EPA 2012b).

[23] This assumption results in a slight overestimate of CO_2 emissions, because a small fraction of the carbon content of gasoline is emitted as CO and unburned hydrocarbons. However, the magnitude of this overestimation is likely to be extremely small. This approach is consistent with the recommendation of IPCC for Tier 1 national GHG emissions inventories (IPCC 2006).

[24] Some modifications were made to the estimation of upstream emissions, consistent with NHTSA and EPA assumptions in the NPRM. Section 10.2.3 of the FRIA provides more information regarding these modifications.

As described in NHTSA's scoping notice, the comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 (i.e., monetization of the potential climate change impacts) appears in the FRIA. Section VI.D of the FRIA describes of the methods used for the calculation of SC-CO_2 estimates, and Section VII of the FRIA presents the results of that SC-CO_2 calculation under each alternative. Because one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, the agency believes that is the appropriate place for this analysis. Readers may consult the preamble to the final rule for a description of how the monetized cost-benefit analysis factors into its decision-making process. The final rule preamble and FRIA are both available for public review.

5.3.3 Methods for Estimating Climate Effects

This EIS estimates and reports the projected changes in GHG emissions, particularly CO_2, that would result from the alternatives. The change in GHG emissions is a direct effect of the reduced stringency in passenger car and light truck fuel economy associated with the action alternatives. The changes in CO_2 emissions, in turn, cause indirect effects on five attributes of climate change: CO_2 concentrations, temperature, sea level, precipitation, and ocean pH.

The subsections that follow describe methods and models used to characterize the changes in GHG emissions and the indirect effects on the attributes of climate change.

5.3.3.1 MAGICC Modeling

NHTSA used a reduced-complexity climate model (MAGICC) to estimate the changes in CO_2 concentrations and global mean surface temperature, and used increases in global mean surface temperature combined with an approach and coefficients from the *IPCC WG1 AR5* (IPCC 2013a) to estimate changes in global precipitation. NHTSA used the publicly available modeling software MAGICC6 (Meinshausen et al. 2011) to estimate changes in key direct and indirect effects. NHTSA used MAGICC6 to incorporate the estimated increases in emissions of CO_2, CH_4, N_2O, CO, NO_X, SO_2, and VOCs produced by the MOVES model (tailpipe) and the associated estimated changes in upstream emissions using factors obtained from the GREET model and CAFE model analysis. NHTSA also performed a sensitivity analysis to examine variations in the direct and indirect climate impacts of the action alternatives under different assumptions about the sensitivity of climate to GHG concentrations in Earth's atmosphere. The results of the sensitivity analysis can be used to infer how the variation in GHG emissions associated with the action alternatives affects the anticipated magnitudes of direct and indirect climate impacts.

The selection of MAGICC for this analysis was driven by several factors:

- MAGICC has been used in the peer-reviewed literature to evaluate changes in global mean surface temperature and sea-level rise. Applications include the *IPCC WG1 AR5* (IPCC 2013a), where it was used to estimate global mean surface temperature and sea-level rise for simulations of global emissions scenarios that were not run with the more complex atmospheric-ocean general circulation models (AOGCMs) (Meinshausen et al. 2011).[25]
- MAGICC is publicly available and was designed for the type of analysis performed in this EIS.

[25] As a reduced-complexity model, MAGICC relies on a more limited number of potential climate and carbon cycle responses and a higher level of parameterization to proxy carbon cycle force than more complex models. Results from MAGICC (e.g., projected atmospheric CO_2 concentration in 2100) will, therefore, vary somewhat from those of more complex models (Meinshausen et al. 2011).

- More complex AOGCMs are not designed for the type of sensitivity analysis performed in this EIS and are best used to provide results for groups of scenarios with much greater differences in emissions.
- MAGICC6 uses updated carbon cycle models that can emulate temperature-feedback impacts on the heterotrophic respiration carbon fluxes.
- MAGICC6 incorporates the science from the *IPCC WG1 AR5;* MAGICC 4.1 was used in the *IPCC WG1 AR4* (IPCC 2007).[26]

5.3.3.2 Sea-Level Rise

NHTSA estimated the projected changes in global mean sea level based on data from the *IPCC WG1 AR5* (IPCC 2013a).[27] The sea-level rise analysis uses global mean surface temperature data and projections from 1950 to 2100 and global mean sea-level rise projections from 2010 to 2100. These projections are based on the climate ensemble data of the RCP[28] scenarios for sea level and temperature. Simple equations relating projected changes in sea level to projected changes in temperature are developed for each scenario using a regression model.

The regression models for the RCP4.5 and GCAM6.0 scenarios are developed directly from the RCP4.5 and RCP6.0 data, while the regression model for the GCAM Reference scenario uses a hybrid relation based on the RCP6.0 and RCP8.5 data, as there is no equivalent IPCC scenario. The hybrid relation employs a weighted average of the relationship between RCP6.0 and RCP8.5 sea-level rise and temperature data based on a comparison of the radiative forcings. The temperature outputs of the MAGICC RCP4.5, GCAM6.0, and GCAM Reference simulations are used as inputs to these regression models to project sea-level rise.[29]

5.3.3.3 Ocean pH

NHTSA projected changes in ocean pH using the CO_2 System Calculations (CO2SYS) model, which calculates parameters of the CO_2 system in seawater and freshwater. This model translates levels of atmospheric CO_2 into changes in ocean pH. A lower ocean pH indicates higher ocean acidity, while a higher pH indicates lower acidity.[30] The model was developed by Brookhaven National Laboratory and Oak Ridge National Laboratory and is used by both the U.S. Department of Energy and EPA. Orr et al. (2015) compared multiple ocean carbon system models and found that the CO2SYS model was more efficient at analyzing observed ocean chemistry data than other models.

This model uses two of four measurable parameters of the CO_2 system, total alkalinity, total inorganic CO_2, pH, and either fugacity or partial pressure of CO_2 to calculate the remaining two input parameters. NHTSA used the CO2SYS model to estimate the pH of ocean water in the year 2040, 2060, and 2100 under the No Action Alternative and each of the action alternatives. For each action alternative, total

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[26] Additional capabilities of MAGICC6 as compared to MAGICC 4.1 include a revised ocean circulation model; improved carbon cycle accounting; direct parameterization of black carbon, organic carbon, and ammonia; and updated radiative forcings. Meinshausen et al. 2011 and Wigley et al. 2009 provide further detail on updates from MAGICC 4.1.

[27] Sea-level rise outputs from MAGICC6 were not used, as this component of the model is still under development.

[28] RCP2.6, 4.5, 6.0, and 8.5.

[29] The MAGICC model runs simulations from a preindustrial starting point through the year 2100. Results of this analysis are shown for the years 2040, 2060, and 2100.

[30] Preindustrial average ocean pH was 8.2. The average pH of the world's oceans has decreased by 0.1 unit compared to the preindustrial period, bringing ocean pH to 8.1 (IPCC 2013a).

alkalinity and partial pressure of CO_2 were selected as inputs. The total alkalinity input was held constant at 2,345 micromoles per kilogram of seawater and the projected atmospheric CO_2 concentration (ppm) data was obtained from MAGICC model runs using each action alternative. NHTSA then compared the pH values calculated from each action alternative to the No Action Alternative to determine the impact of the Proposed Action and alternatives on ocean pH.

5.3.3.4 Global Emissions Scenarios

MAGICC uses long-term emissions scenarios that represent different assumptions about key drivers of GHG emissions. The reference scenario used in the direct and indirect analysis for this EIS is the GCAM Reference scenario (formerly MiniCAM), which does not assume comprehensive global actions to mitigate GHG emissions.[31] NHTSA selected the GCAM Reference scenario for its incorporation of a comprehensive suite of GHG and pollutant gas emissions, including carbonaceous aerosols and a global context of emissions with a full suite of GHGs and ozone precursors. The GCAM Reference scenario is the GCAM representation of a scenario that yields a radiative forcing of approximately 7.0 W/m^2 in the year 2100.

In 2003, CCSP released the *Strategic Plan for the U.S. Climate Change Science Program* (CCSP 2003), which called for the preparation of 21 synthesis and assessment products (SAPs) addressing a variety of topics on climate change science, GHG mitigation, and adapting to the impacts of climate change. These scenarios used updated economic and technology data along with improved scenario development tools that incorporated knowledge gained over the years since the *IPCC Special Report on Emissions Scenarios* (IPCC 2000) was released. The strategy recognized that it would be important to have a consistent set of emissions scenarios so that the whole series of SAPs would have the same foundation. Therefore, one of the earliest products in the series—SAP 2.1, Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations and Review of Integrated Scenario Development and Application (Clarke et al. 2007)—developed 15 global emissions scenarios, corresponding to five different emissions trajectories from each of three groups using different models (IGSM, MiniCAM, and MERGE). MiniCAM was later renamed GCAM, which is the updated successor to MiniCAM based on improvements in the modeling, and which is the scenario used in this EIS.

Each climate-modeling group independently produced a unique emissions reference scenario based on the assumption that no climate policy would be implemented beyond the current set of policies in place using a set of assumptions about drivers such as population changes, economic growth, land and labor productivity growth, technological options, and resource endowments. In addition, each group produced four additional stabilization scenarios, which are defined in terms of the total long-term radiative impact of the suite of GHGs that includes CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6. These stabilization scenarios represent various levels of implementation of global GHG emissions reduction policies.

The results of the direct and indirect impacts analysis rely primarily on the GCAM Reference scenario to represent a reference case emissions scenario. The GCAM Reference scenario provides a global context

[31] For the cumulative analysis, NHTSA used the GCAM6.0 scenario as a reference case global emissions scenario; GCAM6.0 assumes a moderate level of global actions to address climate change. For further discussion, see Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact Analysis.*

for emissions of a full suite of GHGs and ozone precursors. NHTSA chose the GCAM Reference scenario to present the results of the direct and indirect effects analysis based on the following factors:

- The GCAM Reference scenario is a slightly updated version of the scenario developed by the MiniCAM model of the Joint Global Change Research Institute, a partnership between Pacific Northwest National Laboratory and the University of Maryland. The GCAM Reference scenario is based on a set of assumptions about drivers such as population, technology, and socioeconomic changes, in the absence of global action to mitigate climate change.
- In terms of global emissions of CO_2 from fossil fuels and industrial sources, the GCAM Reference scenario is an updated version of the MiniCAM model scenario and illustrates a pathway of emissions between the IGSM and MERGE reference scenarios for most of the 21st century. In essence, the GCAM Reference scenario is a middle-ground scenario.
- GCAM Reference was evaluated in CCSP SAP 2.1.

NHTSA and EPA also used the GCAM Reference scenario for the Regulatory Impact Analyses (RIAs) of the Phase 1 and Phase 2 HD National Program Final Rules, as well as the NHTSA and EPA joint final rule that established CAFE and GHG emissions standards for MY 2017–2025 light-duty vehicle fleets.

The impact of each action alternative was simulated by calculating the difference between annual GHG emissions under the No Action Alternative and emissions under that action alternative and subtracting this change from the GCAM Reference scenario to generate modified global-scale emissions scenarios, which show the effects of the various regulatory alternatives on the global emissions path. For example, CO_2 emissions from passenger cars and light trucks in the United States in 2040 under the No Action Alternative are estimated to be 1,148 $MMTCO_2$;[32] the emissions in 2040 under Alternative 3 are estimated to be 1,240 $MMTCO_2$. The difference of 91 $MMTCO_2$ represents the increase in emissions projected to result from adopting Alternative 3. Global emissions for the GCAM Reference scenario in 2040 are estimated to be 51,701 $MMTCO_2$, and are assumed to incorporate emissions from passenger cars and light trucks in the United States under the No Action Alternative. Therefore, global emissions under Alternative 3 are estimated to be 91 $MMTCO_2$ more than this reference level or approximately 51,792 $MMTCO_2$ in 2040. There are some inconsistencies between the overall assumptions that SAP 2.1 and the Joint Global Change Research Institute used to develop the global emissions scenario and the assumptions used in the CAFE model in terms of economic growth, energy prices, energy supply, and energy demand. However, these inconsistencies affect the characterization of each action alternative in equal proportion, so the relative estimates provide a reasonable approximation of the differences in environmental impacts among the action alternatives.

5.3.3.5 Reference Case Modeling Runs

The modeling runs and sensitivity analysis simulate relative changes in atmospheric concentrations, global mean surface temperature, precipitation, and sea-level rise that could result under each alternative. The modeling runs are based on the increases in emissions estimated to result from each of the action alternatives compared to projected emissions under the No Action Alternative. They assume

[32] The emissions estimates in this EIS include GHG emissions resulting from passenger car and light truck fuel combustion (tailpipe emissions), as well as upstream emissions from the production and distribution of fuel.

a climate sensitivity of 3°C (5.4°F) for a doubling of CO_2 concentrations in the atmosphere.[33] The approach uses the following four steps to estimate these changes:

1. NHTSA assumed that global emissions under the No Action Alternative would follow the trajectory provided by the global emissions scenario.
2. NHTSA assumed that global emissions for each action alternative would be equal to the global emissions under the No Action Alternative plus the increase in emissions of CO_2, CH_4, N_2O, SO_2, NO_X, CO, and VOCs estimated to result from each action alternative. For example, the global emissions scenario under Alternative 2 equals the global emissions scenario plus the emissions increases from that alternative. All SO_2 increases were applied to the Aerosol Region 1 of MAGICC, which includes North America.
3. NHTSA used MAGICC6 to estimate the changes in global CO_2 concentrations, global mean surface temperature, and sea-level rise through 2100 using the global emissions scenario under each alternative developed in steps 1 and 2.
4. NHTSA used the increase in global mean surface temperature to estimate the increase in both global average precipitation and sea-level rise for each alternative using the global emissions scenario.

5.3.3.6 Sensitivity Analysis

NHTSA performed a sensitivity analysis to examine the effect of various equilibrium climate sensitivities on the results. Equilibrium climate sensitivity is the projected responsiveness of Earth's global climate system to increased radiative forcing from higher GHG concentrations and is expressed in terms of changes to global surface temperature resulting from a doubling of CO_2 compared to pre-industrial atmospheric concentrations (278 ppm CO_2) (IPCC 2013a). Sensitivity analyses examine the relationship among the alternatives, likely climate sensitivities, and scenarios of global emissions paths and the associated direct and indirect impacts for each combination.

The *IPCC WG1 AR5* expresses stronger confidence in some fundamental processes in models that determine climate sensitivity than the AR4 (IPCC 2013a). According to IPCC, with a doubling of the concentration of atmospheric CO_2, there is a *likely* probability of an increase in surface warming in the range of 1.5°C (2.7°F) to 4.5°C (8.1°F) (*high confidence*), *extremely unlikely* less than 1°C (1.8°F) (*high confidence*), and *very unlikely* greater than 6°C (10.8°F) (*medium confidence*) (IPCC 2013a).

NHTSA assessed climate sensitivities of 1.5, 2.0, 2.5, 3.0, 4.5, and 6.0°C (2.7, 3.6, 4.5, 5.4, 8.1, and 10.8°F) for a doubling of CO_2 concentrations in the atmosphere. NHTSA performed the sensitivity analysis around three of the alternatives—the No Action Alternative, Alternative 1, and Alternative 7—because this was deemed sufficient to assess the effect of various climate sensitivities on the results.

The approach uses the following four steps to estimate the sensitivity of the results to alternative estimates of the climate sensitivity:

1. NHTSA used the GCAM Reference scenario to represent emissions from the No Action Alternative.
2. Starting with the respective GCAM scenario, NHTSA assumed that the increases in global emissions of CO_2, CH_4, N_2O, SO_2, NO_X, CO, and VOCs resulting from the least stringent alternative (Alternative 1) would be equal to the global emissions of each pollutant under the No Action Alternative plus

[33] NHTSA used a climate sensitivity of 3°C, as this is the midpoint of IPCC's estimated range. IPCC states, "the equilibrium climate sensitivity (ECS) is likely in the range 1.5°C to 4.5°C" (IPCC 2013b).

emissions of each pollutant under Alternative 1. Separately, NHTSA used the same approach for Alternative 7 (the highest GHG emissions alternative) as compared to the No Action Alternative.[34] All SO_2 increases were applied to Aerosol Region 1 of MAGICC, which includes North America.

3. NHTSA assumed a range of climate sensitivity values consistent with the 10 to 90 percent probability distribution from the *IPCC WG1 AR5* (IPCC 2013a) of 1.5, 2.0, 2.5, 3.0, 4.5, and 6.0°C (2.7, 3.6, 4.5, 5.4, 8.1, and 10.8°F).
4. For each climate sensitivity value in Step 3, NHTSA used MAGICC6 to estimate the resulting changes in CO_2 concentrations and global mean surface temperature, as well as the regression-based analysis to estimate sea-level rise through 2100 for the global emissions scenarios in Steps 1 and 2.

Section 5.4, *Environmental Consequences*, presents the results of the model runs for the alternatives. For the direct and indirect impacts analysis, the sensitivity analysis was performed against the GCAM Reference scenario (789 ppm in 2100).

5.3.4 Tipping Points and Abrupt Climate Change

The term *tipping point* is most typically used, in the context of climate change, to describe situations in which the climate system (the atmosphere, hydrosphere, land, cryosphere, and biosphere) reaches a point at which a disproportionally large or singular response in a climate-affected system occurs as a result of a moderate additional change in the inputs to that system (such as an increase in the CO_2 concentration). Exceeding one or more tipping points, which "occur when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause" (EPA 2009 citing NRC 2002), could result in abrupt changes in the climate or any part of the climate system. Abrupt climate changes could occur so quickly and unexpectedly that human systems would have difficulty adapting to them (EPA 2009 citing NRC 2002).

NHTSA's assessment of tipping points and abrupt climate change is largely based on an analysis of recent climate change science synthesis reports: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC 2013a), *Climate Change Impacts in the United States: The Third National Climate Assessment* (GCRP 2014), and *Climate Science Special Report: Fourth National Climate Assessment, Volume 1* (GCRP 2017). The analysis identifies vulnerable systems, potential thresholds, and estimates of the causes, likelihood, timing, and impacts of abrupt climate events.

Although there are methodological approaches to estimate changes in temperatures resulting from an increase in GHG emissions and associated radiative forcing, the current state of science does not allow for quantifying how increased emissions from a specific policy or action might affect the probability and timing of abrupt climate change. This area of climate science is one of the most complex and scientifically challenging. Given the difficulty of simulating the large-scale processes involved in these tipping points, or inferring their characteristics from paleoclimatology, considerable uncertainties remain on tipping points and the rate of change. Despite the lack of a precise quantitative methodological approach, NHTSA has provided a qualitative and comparative analysis of tipping points

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[34] Some SO_2 emissions are associated with the charging of EVs. However, total power plant emissions are limited by "caps" under the EPA Acid Rain Program and the Cross-State Air Pollution Rule, and will be reduced through emissions standards such as the Mercury and Air Toxics Standards rule. Because of these rules and advances in technology, emissions from the power-generation sector are expected to decline over time (the grid is expected to become cleaner). Any economic activity or trend that leads to an increase in electrical demand—including increases in electric vehicle sales and use—would be accommodated by the power industry in planning for compliance with applicable emissions limitations.

and abrupt climate change in Chapter 8, *Cumulative Impacts,* Section 8.6.5.2, *Sectoral Impacts of Climate Change*, under *Tipping Points and Abrupt Climate Change*. The analysis applies equally to direct and indirect impacts, as well as to cumulative impacts.

5.4 Environmental Consequences

This section describes projected impacts on climate under the Proposed Action and alternatives relative to the No Action Alternative. NHTSA has identified Alternative 3 as the Preferred Alternative. Using the methods described in Section 5.3, *Analysis Methods*, NHTSA modeled the direct and indirect impacts of the alternatives on atmospheric CO_2 concentrations, temperature, precipitation, sea level, and ocean pH. This analysis is based on a scenario under which no other major global actions would reduce GHGs (i.e., the current climate trajectory, independent of other actions). The analysis of cumulative impacts can be found in Chapter 8, *Cumulative Impacts.*

In summary, each of the action alternatives would result in increased GHG emissions compared with the No Action Alternative. The more an alternative would increase GHG emissions, the more it would be expected to increase the direct and indirect climate change impacts associated with such emissions. However, all of the action alternatives would result, to a greater or lesser extent depending on the alternative, in reductions in GHG emissions on a per-vehicle basis compared with current conditions as newer, more fuel-efficient vehicles replace less fuel-efficient vehicles currently on the road.

5.4.1 Greenhouse Gas Emissions

Using the methods described in Section 5.3, *Analysis Methods*, NHTSA estimated projected emissions increases for 2021 through 2100. These emissions increases represent the differences in total annual emissions in future years of U.S. passenger cars and light trucks in use under the No Action Alternative and each action alternative. The projected change in fuel production and use under each alternative determines the resulting impacts on total energy use and petroleum consumption, which, in turn, determine the increase in CO_2 emissions under each alternative. Because CO_2 accounts for such a large fraction of total GHGs emitted during fuel production and use—more than 94 percent, even after accounting for the higher GWPs of other GHGs—NHTSA's consideration of GHG impacts focuses on increases in CO_2 emissions expected under the Proposed Action and alternatives. However, in assessing the direct and indirect impacts and cumulative impacts on climate change indicators (i.e., global average surface temperature, sea level, precipitation, and ocean pH, as described in Section 5.4.2, *Direct and Indirect Impacts on Climate Change Indicators*, and Section 8.6.4, *Cumulative Impacts on Greenhouse Gas Emissions and Climate Change*), NHTSA incorporates increases of all GHGs by the nature of the models used to project changes in the relevant climate indicators.

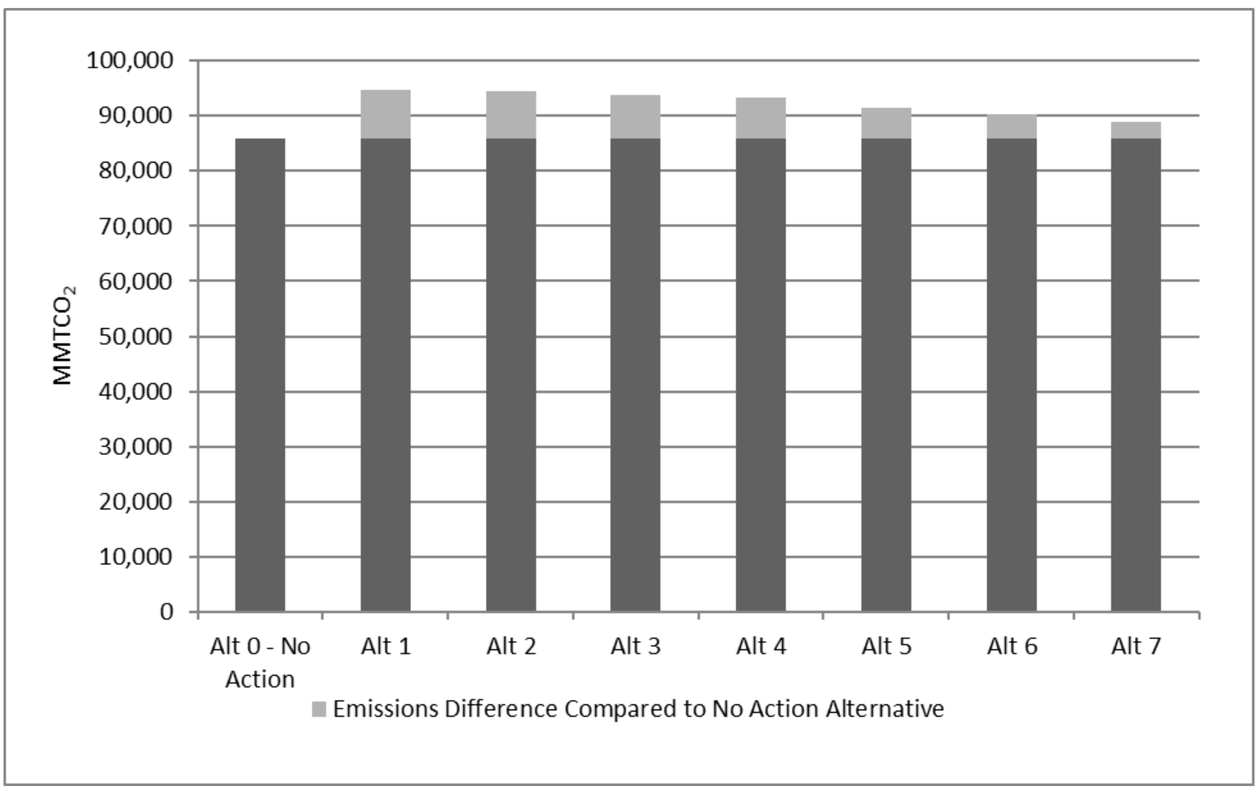
Table 5.4.1-1 and Figure 5.4.1-1 show total U.S. passenger car and light truck CO_2 emissions under the No Action Alternative and emissions increases that would result from the Proposed Action and alternatives from 2021 to 2100. All action alternatives would result in higher CO_2 emissions than the No Action Alternative because all action alternatives involve less stringent CAFE standards than the No Action Alternative. U.S. passenger car and light truck emissions from 2021 to 2100 would range from a low of 85,900 $MMTCO_2$ under the No Action Alternative to a high of 94,700 $MMTCO_2$ under Alternative 1. Compared to the No Action Alternative, projected emissions increase from 2021 to 2100 under the action alternatives would range from 3,100 to 8,800 $MMTCO_2$. Compared to total global emissions of 4,950,865 $MMTCO_2$ over this period (projected by the GCAM Reference scenario), this rulemaking is expected to increase global CO_2 emissions by approximately 0.06 to 0.17 percent from projected levels under the No Action Alternative.

Table 5.4.1-1. Carbon Dioxide Emissions and Emissions Increases ($MMTCO_2$) from All Passenger Cars and Light Trucks, 2021–2100, by Alternative[a]

Alternative	Total Emissions	Emissions Increases Compared to No Action	Percent (%) Emissions Increases Compared to No Action Alternative Emissions
Alternative 0—No Action	85,900	--	--
Alternative 1	94,700	8,800	10%
Alternative 2	94,400	8,500	10%
Alternative 3	93,700	7,800	9%
Alternative 4	93,200	7,300	8%
Alternative 5	91,400	5,500	6%
Alternative 6	90,400	4,500	5%
Alternative 7	89,000	3,100	4%

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the increases do not reflect the exact differences between the values.
$MMTCO_2$ = million metric tons of carbon dioxide

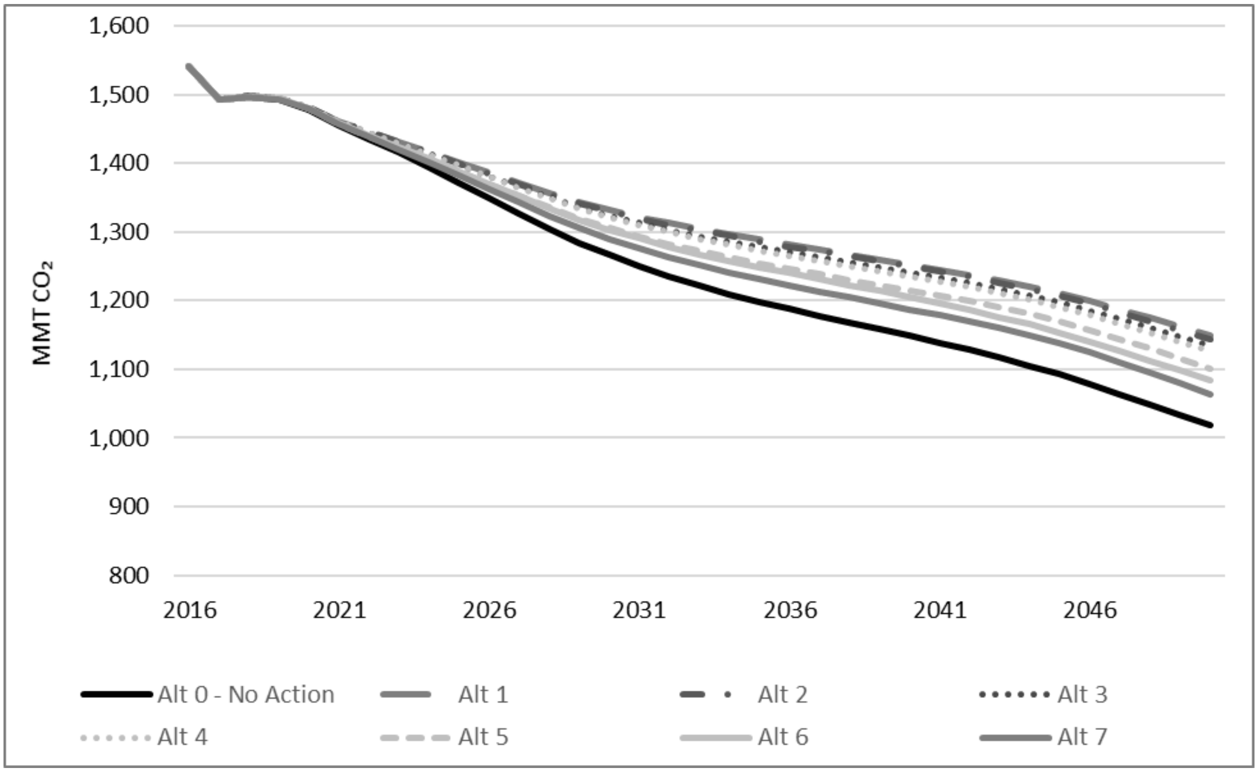
Figure 5.4.1-1. Carbon Dioxide Emissions and Emissions Increases ($MMTCO_2$) from All Passenger Cars and Light Trucks, 2021 to 2100, by Alternative



$MMTCO_2$ = million metric tons of carbon dioxide

To get a sense of the relative magnitude of these increases, it can be helpful to consider emissions from passenger cars and light trucks in the context of emissions projections from the transportation sector. Passenger cars and light trucks currently account for 20 percent of CO_2 emissions in the United States. The action alternatives would increase total CO_2 emissions from U.S. passenger cars and light trucks by a range of 4 to 10 percent from 2021 to 2100 compared to the No Action Alternative. Compared to annual U.S. CO_2 emissions of 7,193 $MMTCO_2e$ from all sources by the end of the century projected by the GCAM Reference scenario (Thomson et al. 2011), the action alternatives would increase annual U.S. CO_2 emissions by a range of 0.4 to 1.2 percent in 2100.[35] Figure 5.4.1-2 shows the projected annual emissions from U.S. passenger cars and light trucks under the alternatives.

Figure 5.4.1-2. Projected Annual Carbon Dioxide Emissions ($MMTCO_2$) from All Passenger Cars and Light Trucks by Alternative



$MMTCO_2$ = million metric tons of carbon dioxide

Table 5.4.1-2 also illustrates that the Proposed Action and alternatives would increase passenger car and light truck emissions of CO_2 from their projected levels under the No Action Alternative. Similarly, under the Proposed Action and alternatives, CH_4 and N_2O emissions in future years are projected to increase from their projected levels under the No Action Alternative. All action alternatives would result in higher emissions increases compared to the No Action Alternative. Of all the action alternatives, Alternative 7 would result in the lowest emissions increases.

[35] 2095 is the last year emissions data are available from GCAM Reference.

Table 5.4.1-2. Emissions of Greenhouse Gases ($MMTCO_2e$ per year) from All Passenger Cars and Light Trucks by Alternative[a]

GHG and Year	Alt. 0 – No Action	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Carbon dioxide (CO_2)								
2020	1,478	1,481	1,481	1,481	1,481	1,479	1,480	1,479
2040	1,148	1,252	1,249	1,240	1,235	1,214	1,205	1,187
2060	1,013	1,143	1,139	1,129	1,122	1,094	1,078	1,057
2080	1,006	1,135	1,130	1,121	1,114	1,086	1,070	1,050
2100	935	1,056	1,051	1,042	1,036	1,010	995	976
Methane (CH_4)								
2020	50	50	50	50	50	50	50	50
2040	39	42	42	42	42	41	41	40
2060	36	39	39	39	39	38	37	37
2080	35	39	39	39	38	38	37	37
2100	33	36	36	36	36	35	35	34
Nitrous oxide (N_2O)								
2020	17	17	17	17	17	17	17	17
2040	14	15	15	15	15	15	14	14
2060	12	14	14	14	13	13	13	13
2080	12	14	14	13	13	13	13	13
2100	11	13	13	12	12	12	12	12
Total (all GHGs)								
2020	1,545	1,548	1,548	1,548	1,548	1,546	1,547	1,545
2040	1,201	1,309	1,306	1,297	1,291	1,270	1,260	1,242
2060	1,061	1,197	1,191	1,181	1,174	1,145	1,128	1,107
2080	1,053	1,188	1,183	1,173	1,165	1,137	1,120	1,099
2100	980	1,105	1,100	1,091	1,084	1,058	1,042	1,022

Notes:
[a] Emissions from 2051 to 2100 were scaled using the rate of change for the U.S. transportation fuel consumption from the GCAM Reference scenario. These assumptions project a slight decline over this period.
$MMTCO_2e$ = million metric tons carbon dioxide equivalent

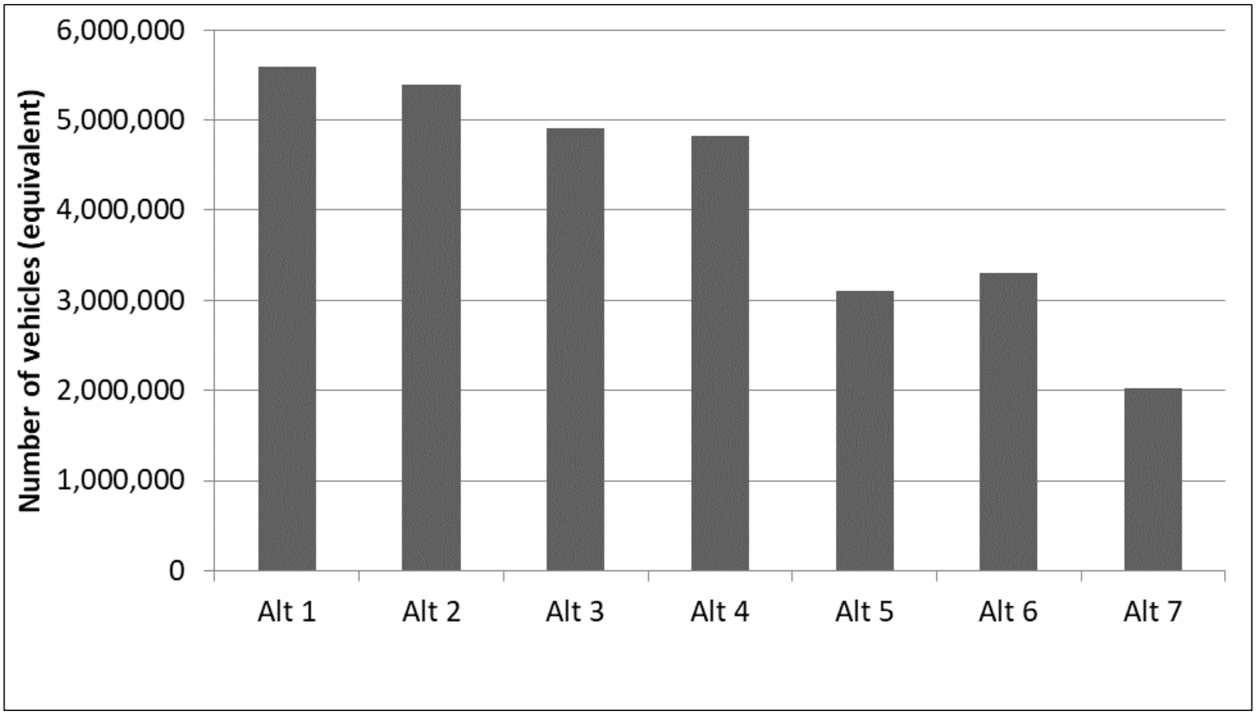
5.4.1.1 Comparison to Annual Emissions from Passenger Cars and Light Trucks

As an illustration of the fuel use projected under the Proposed Action and alternatives, Figure 5.4.1-3 expresses the CO_2 increases under each action alternative in 2025 as the equivalent number of passenger cars and light trucks that would produce those emissions in that year. The emissions increases under the action alternatives would be equivalent to the annual emissions from 2,020,000 passenger cars and light trucks (Alternative 7) to 5,586,000 passenger cars and light trucks (Alternative 1) in 2025, compared to the annual emissions that would occur under the No Action Alternative. A total number of

254,969,000 passenger cars and light trucks are projected to be on the road in 2025 under the No Action Alternative.[36]

From 2022 to 2026, Alternative 5 would have lower emissions than Alternative 6. However, Alternative 6 would result in lower emissions than Alternative 5 from 2027 to 2100, and would be a lower emissions alternative than Alternative 5 cumulatively from 2022 to 2100.[37]

Figure 5.4.1-3. Number of Passenger Cars and Light Trucks Equivalent to Carbon Dioxide Increases in 2025 Compared to the No Action Alternative



5.4.1.2 Global Carbon Budget

In response to public comments received on prior NHTSA EISs, the agency has considered the GHG impacts of its fuel economy actions in terms of a global carbon "budget." This budget is an estimate for the total amount of anthropogenic CO_2 that can be emitted to have a certain chance of limiting the global average temperature increase to below 2°C relative to preindustrial levels. IPCC estimates that if cumulative global CO_2 emissions from 1870 onwards are limited to approximately 1,000 Gigatonnes (Gt) C (3,670 Gt CO_2), then the probability of limiting the temperature increase to below 2°C is greater than 66 percent (IPCC 2013b).[38] It should be noted that since this report was published, various studies

[36] Values for vehicle totals have been rounded.

[37] The passenger car and light truck equivalency is based on an average per-vehicle emissions estimate, which includes both tailpipe CO_2 emissions and associated upstream emissions from fuel production and distribution. The average passenger car and light truck accounts for 3.87 metric tons of CO_2 in 2025 based on MOVES, the GREET model, and EPA analysis.

[38] Factoring in non-CO_2 influences on the climate, the global carbon budget is approximately 790 Gt C (2,900 Gt CO_2). As of 2011, approximately 65 percent, or 515 Gt C (1,890 Gt CO_2) of this budget had already been emitted, leaving a remaining budget of 275 Gt C (1,010 Gt CO_2) (IPCC 2013b). From 2011 to 2015, CO_2 emissions from fossil fuels, cement production, and land-use change totaled approximately 50 Gt C, leaving a remaining budget from 2016 onwards of 225 Gt C, including non-CO_2 influences (CDIAC 2016).

have produced estimates of the remaining global carbon budget; some estimates have been larger (Millar et al. 2017) and others have been smaller (Lowe and Bernie 2018). These estimates vary depending on a range of factors, such as the assumed conditions and the climate model used (Rogelj et al. 2019). Because of underlying uncertainties and assumptions, no one number for the remaining global carbon budget can be considered definite.

Using the IPCC estimated carbon budget, as of 2011, approximately 51 percent, or 515 Gt C (1,890 Gt CO_2), of this budget had already been emitted, leaving a remaining budget of 485 Gt C (1,780 Gt CO_2) (IPCC 2013b). From 2011 to 2017, CO_2 emissions from fossil fuels, cement production, and land-use change totaled approximately 78 Gt C (285 Gt CO_2), leaving a remaining budget from 2018 onwards of 407 Gt C (1,495 Gt CO_2) (CDIAC 2018). Under the No Action Alternative, U.S. passenger cars and trucks are projected to emit 25 Gt C (90 Gt CO_2) from 2018 to 2100, or 5.7 percent of the remaining global carbon budget. Under Alternative 1, this projection increases to 27 Gt C (101 Gt CO_2) or 6.3 percent of the remaining budget.

The emissions reductions necessary to keep global emissions within this carbon budget could not be achieved solely with drastic reductions in emissions from the U.S. passenger car and light truck vehicle fleet but would also require drastic reductions in all U.S. sectors and from the rest of the developed and developing world. Even with the full implementation of global emissions reduction commitments to date, global emissions in 2030 would still be roughly 13 $GtCO_2e$ higher than what is consistent with a scenario that limits warming to 2°C [3.6°F] from preindustrial levels (UNEP 2018).

In addition, achieving GHG reductions from the passenger car and light truck vehicle fleet to the same degree that emissions reductions will be needed globally to avoid using all of the carbon budget would require substantial increases in technology innovation and adoption compared to today's levels and would require the economy and the vehicle fleet to substantially move away from the use of fossil fuels.

5.4.2 Direct and Indirect Impacts on Climate Change Indicators

The direct and indirect impacts of the Proposed Action and alternatives on five relevant climate change indicators are described in Section 5.4.2.1, *Atmospheric Carbon Dioxide Concentrations*, and Section 5.4.2.2, *Climate Change Attributes*. Section 5.4.2.3, *Climate Sensitivity Variations*, presents the sensitivity analysis. The impacts of the Proposed Action and alternatives on global mean surface temperature, atmospheric CO_2 concentrations, precipitation, sea level, and ocean pH would be small compared to the expected changes associated with the emissions trajectories in the GCAM Reference scenario. This is due primarily to the global and multi-sectoral nature of climate change. Although these effects are small, they occur on a global scale and are long-lasting. The combined impact of these emissions increases with emissions increases from other sources could have health, societal, and environmental impacts.

MAGICC6 is a reduced-complexity climate model well calibrated to the mean of the multimodel ensemble results for four of the most commonly used emissions scenarios—RCP2.6 (low), RCP4.5 (medium), RCP6.0 (medium-high), and RCP8.5 (high) from the IPCC RCP series—as shown in Table 5.4.2-1.[39] As the table shows, the results of the model runs developed for this analysis agree relatively well with IPCC estimates for both CO_2 concentrations and surface temperature.

[39] NHTSA used the MAGICC default climate sensitivity of 3.0 °C (5.4 °F).

Table 5.4.2-1. Comparison of MAGICC Modeling Results and Reported IPCC Results[a]

Scenario	CO_2 Concentration (ppm)		Global Mean Increase in Surface Temperature (°C)	
	IPCC WGI (2100)	MAGICC (2100)	IPCC WGI (2081—2100)	MAGICC (2100)
RCP2.6	421	426	1.0	1.1
RCP4.5	538	544	1.8	2.1
RCP6.0	670	674	2.2	2.6
RCP8.5	936	938	3.7	4.2

Notes:
[a] The IPCC values represent the average of the 5 to 95 percent range of global mean surface air temperature.
ppm = parts per million; °C = degrees Celsius; MAGICC = Model for the Assessment of Greenhouse-gas Induced Climate Change; IPCC = Intergovernmental Panel on Climate Change; RCP = Representative Concentration Pathways; WGI = Working Group 1
Source: IPCC 2013b

As discussed in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, NHTSA used the GCAM Reference scenario to represent the No Action Alternative in the MAGICC modeling runs. CO_2 concentrations under the No Action Alternative are 789.11 ppm and range from 789.38 under Alternative 7 to 789.89 ppm under Alternative 1 in 2100 (Table 5.4.2-2). For 2040 and 2060, the corresponding range of ppm differences across alternatives is even smaller. Because CO_2 concentrations are the key determinant of other climate effects (which in turn drive the resource impacts discussed in Section 8.6, *Cumulative Impacts—Greenhouse Gas Emissions and Climate Change*), this leads to very small differences in these effects.

Table 5.4.2-2. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increase, Sea-Level Rise, and Ocean pH (GCAM Reference) by Alternative[a]

	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b, c]			Sea-Level Rise (cm)[b, d]			Ocean pH[e]		
	2040	2060	2100	2040	2060	2100	2040	2060	2100	2040	2060	2100
Totals by Alternative												
Alt. 0—No Action	479.04	565.44	789.11	1.287	2.008	3.484	22.87	36.56	76.28	8.4099	8.3476	8.2176
Alt. 1	479.15	565.77	789.89	1.288	2.010	3.487	22.87	36.58	76.35	8.4098	8.3474	8.2172
Alt. 2	479.15	565.76	789.86	1.288	2.010	3.487	22.87	36.58	76.35	8.4098	8.3474	8.2172
Alt. 3	479.14	565.73	789.80	1.288	2.010	3.487	22.87	36.58	76.34	8.4098	8.3474	8.2172
Alt. 4	479.13	565.72	789.76	1.288	2.010	3.487	22.87	36.57	76.34	8.4098	8.3474	8.2173
Alt. 5	479.10	565.65	789.59	1.287	2.009	3.486	22.87	36.57	76.32	8.4099	8.3474	8.2173
Alt. 6	479.10	565.61	789.50	1.287	2.009	3.486	22.87	36.57	76.32	8.4099	8.3475	8.2174
Alt. 7	479.08	565.56	789.38	1.287	2.009	3.485	22.87	36.57	76.31	8.4099	8.3475	8.2175
Increases Under Proposed Action and Alternatives												
Alt. 1	0.11	0.33	0.78	0.001	0.002	0.003	0.00	0.01	0.07	-0.0001	-0.0002	-0.0004
Alt. 2	0.11	0.32	0.76	0.001	0.002	0.003	0.00	0.01	0.06	-0.0001	-0.0002	-0.0004
Alt. 3	0.10	0.29	0.69	0.000	0.002	0.003	0.00	0.01	0.06	-0.0001	-0.0002	-0.0004
Alt. 4	0.09	0.28	0.65	0.000	0.001	0.003	0.00	0.01	0.06	-0.0001	-0.0002	-0.0003

	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b, c]			Sea-Level Rise (cm)[b, d]			Ocean pH[e]		
	2040	2060	2100	2040	2060	2100	2040	2060	2100	2040	2060	2100
Alt. 5	0.07	0.21	0.49	0.000	0.001	0.002	0.00	0.01	0.04	-0.0001	-0.0001	-0.0002
Alt. 6	0.06	0.17	0.40	0.000	0.001	0.002	0.00	0.01	0.03	0.0000	-0.0001	-0.0002
Alt. 7	0.04	0.12	0.27	0.000	0.001	0.001	0.00	0.01	0.02	0.0000	-0.0001	-0.0001

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the increases might not reflect the exact difference of the values in all cases.
[b] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986 to 2005.
[c] Temperature changes reported as 0.000 are more than zero but less than 0.001.
[d] Sea-level rise changes reported as 0.00 are more than zero but less than 0.01.
[e] Ocean pH changes reported as 0.0000 are less than zero but more than -0.0001.
CO_2 = carbon dioxide; °C = degrees Celsius; ppm = parts per million; cm = centimeters; GCAM = Global Change Assessment Model

5.4.2.1 Atmospheric Carbon Dioxide Concentrations

As Figure 5.4.2-1 and Figure 5.4.2-2 show, the increase in projected CO_2 concentrations under the Proposed Action and alternatives compared to the No Action Alternative amounts to a very small fraction of the projected total increases in CO_2 concentrations. The relative impact of the Proposed Action and alternatives is demonstrated by the increase of CO_2 concentrations under the range of action alternatives. As shown in Figure 5.4.2-2, the increase in CO_2 concentrations by 2100 under Alternative 1 compared to the No Action Alternative is more than three times that of Alternative 7.

Figure 5.4.2-1. Atmospheric Carbon Dioxide Concentrations by Alternative

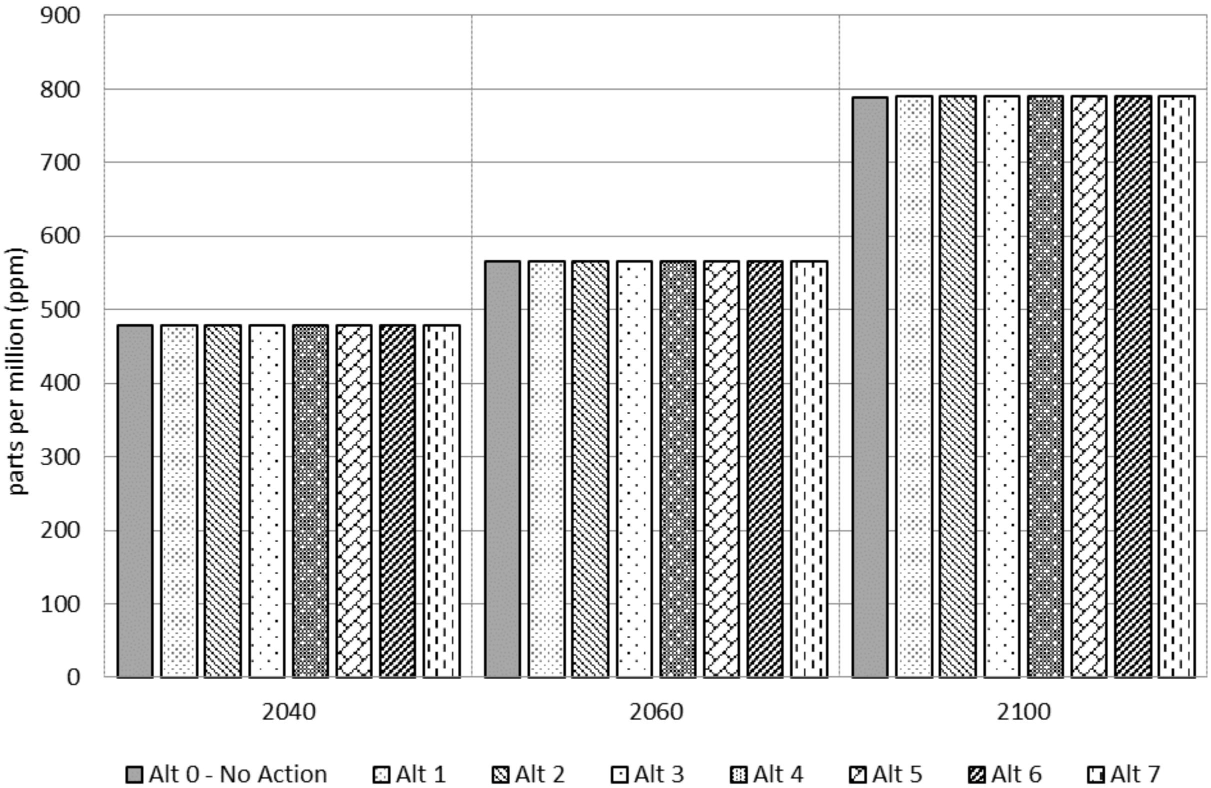
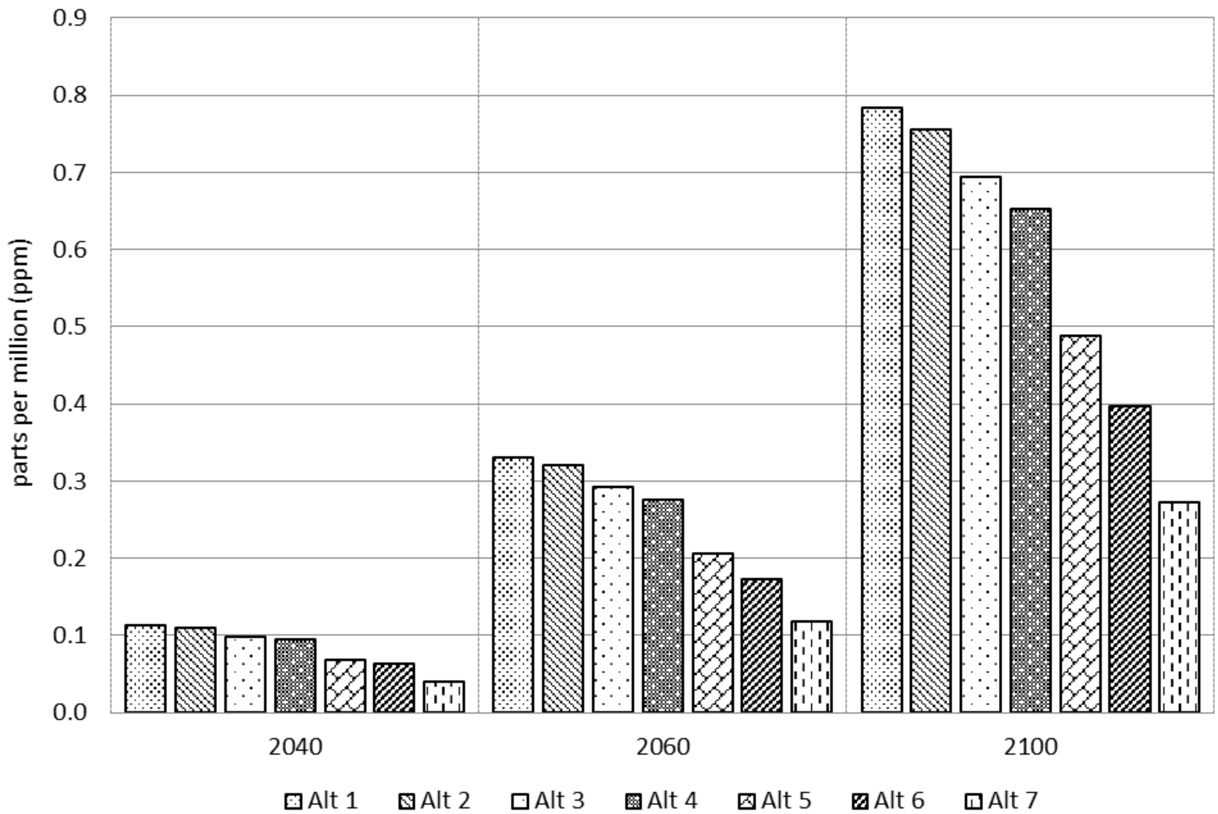


Figure 5.4.2-2. Increase in Atmospheric Carbon Dioxide Concentrations Compared to the No Action Alternative



5.4.2.2 Climate Change Attributes

Temperature

Table 5.4.2-2 lists MAGICC simulations of mean global surface air temperature increases. Under the No Action Alternative in all analyses, global surface air temperature is projected to increase from 1986 to 2005 average levels by 1.29°C (2.32°F) by 2040, 2.01°C (3.61°F) by 2060, and 3.48°C (6.27°F) by 2100.[40] The differences among the increases in baseline temperature increases projected to result from the various action alternatives are very small compared to total projected temperature increases, which are shown in Figure 5.4.2-3. For example, in 2100 the increase in temperature rise compared to the No Action Alternative ranges from 0.001°C (0.002°F) under Alternative 7 to 0.003°C (0.006°F) under Alternative 1.

[40] Because the actual increase in global mean surface temperature lags the "commitment to warming" (i.e., continued warming from GHGs that have already been emitted to date, because of the slow response of the climate system), the impact on global mean surface temperature increase is less than the impact on the long-term commitment to warming. The actual increase in surface temperature lags the commitment due primarily to the time required to heat the ocean to the level committed by the concentrations of the GHGs.

Figure 5.4.2-3. Global Mean Surface Temperature Increase by Alternative

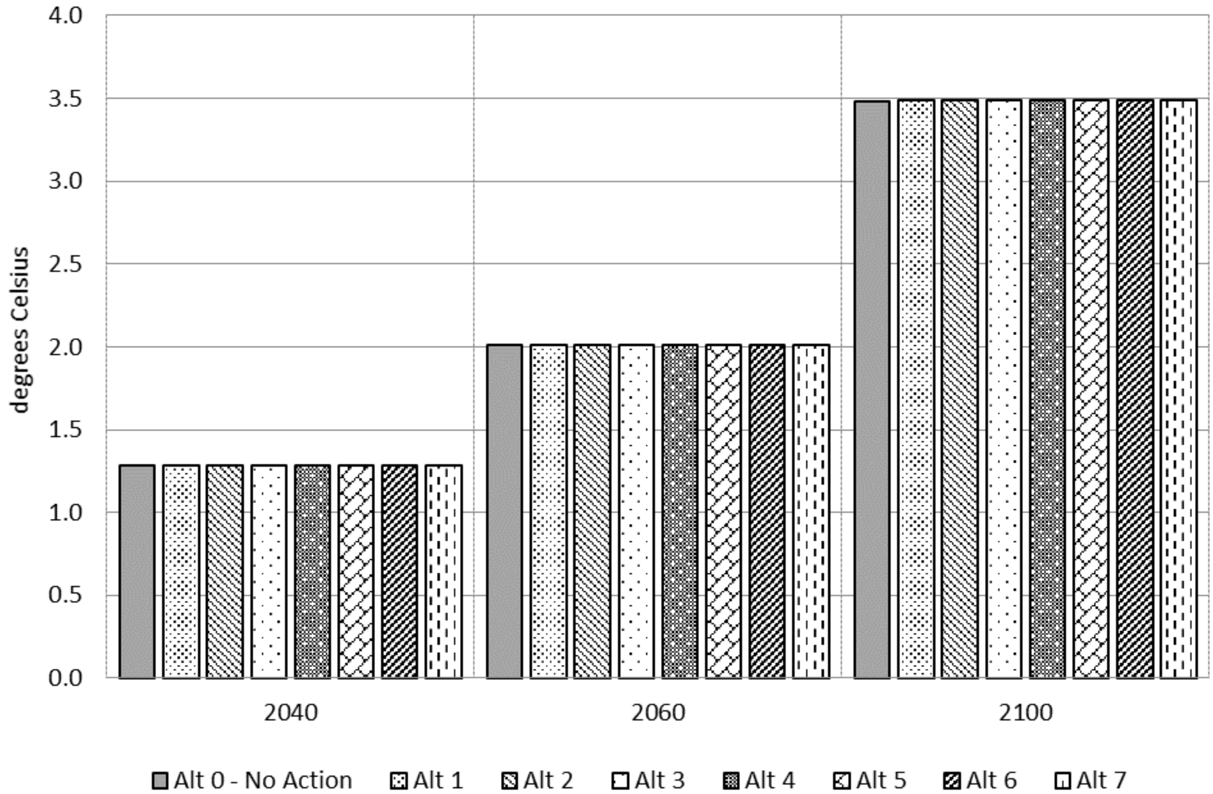


Figure 5.4.2-4 also illustrates that increases in the growth of projected global mean surface temperature under the Proposed Action and alternatives compared to the No Action Alternative are anticipated to be small compared to total projected temperature increases. However, the relative impacts of the Proposed Action and alternatives can be seen by comparing the increases in the rise in global mean surface temperature projected to occur under Alternatives 1 and 7. As shown in Figure 5.4.2-4, the increase in the projected growth in global temperature under Alternative 1 is more than three times as large as that under Alternative 7 in 2100.

At this time, quantifying the changes in regional climate due to the Proposed Action and alternatives is not possible because of the limitations of existing climate models, but the Proposed Action and alternatives would be expected to increase the regional impacts in proportion to increases in global mean surface temperature. To provide context on how the projected changes in temperature from the MAGICC modeling may differentially affect geographic regions, Table 5.4.2-3 summarizes the regional changes in warming and seasonal temperatures presented in the IPCC AR5 from present day through 2100.

Figure 5.4.2-4. Increase in Global Mean Surface Temperature Compared to the No Action Alternative

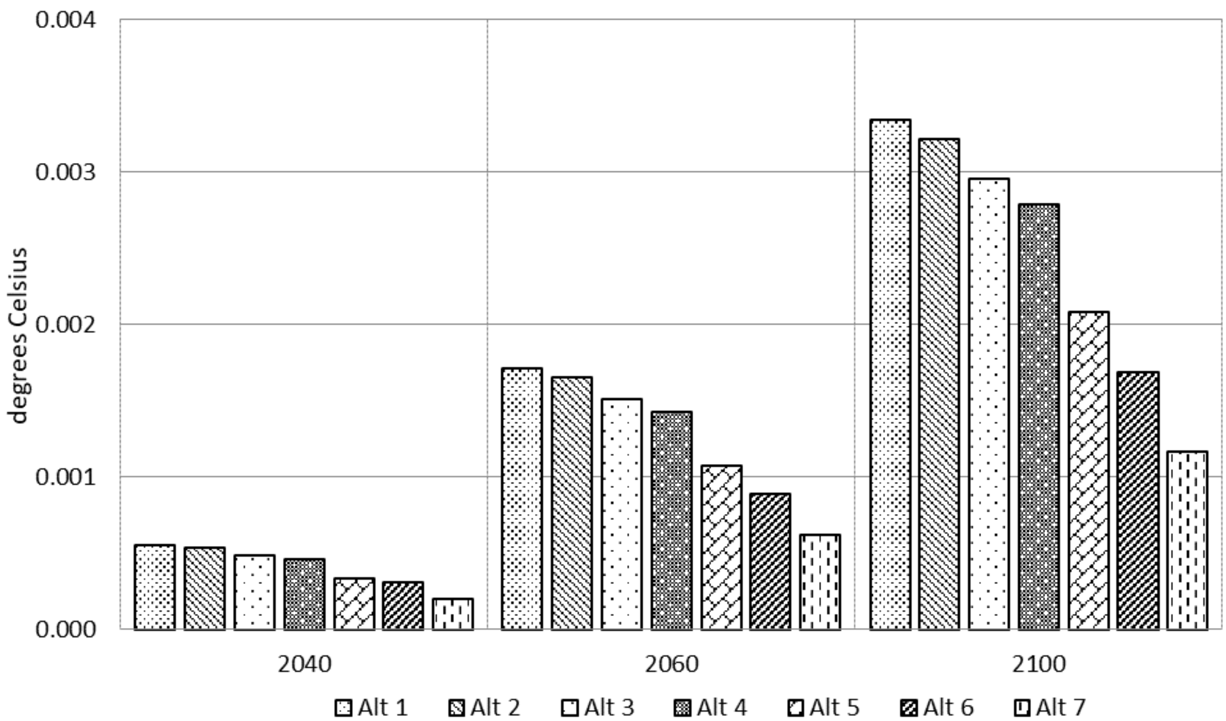


Table 5.4.2-3. Regional Changes to Warming and Seasonal Temperatures in the Year 2100 Compared to Current Conditions, Summarized from the IPCC Fifth Assessment Report

Land Area	Subregion	Mean Warming	Other Impacts on Temperature
Africa	Northern Africa and Northern Sahara	*Very likely* increase in mean annual temperature[a,b] *Likely* increase throughout region to be higher than global mean annual warming[e]	*Likely* greater warming at night compared to day resulting in a reduction in future temperature rise[e]
	East Africa	*Very likely* increase in mean annual temperature[a,b]	--
	Southern Africa	*Very likely* increase in mean annual temperature[a,b] *Likely* higher mean land surface warming than global average	--
	Western Africa	*Very likely* increase in mean annual temperature[a,b]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, and increase in more frequent droughts

Land Area	Subregion	Mean Warming	Other Impacts on Temperature
Mediterranean and Europe	Northern Europe	*Very likely* increase in mean annual temperature, *likely* greater increase in winter temperature than in Central or Southern Europe	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* more frequent heat waves (though little change over Scandinavia)
	Central Europe	*Very likely* increase in mean annual temperature, *likely* greater increase in summer temperature than in Northern Europe	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* more frequent heat waves
	Southern Europe and Mediterranean	*Very likely* increase in mean annual temperature, *likely* greater increase in summer temperature than in Northern Europe	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* more frequent heat waves
Asia	Central Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Northern Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Eastern Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	West Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	South Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Southeast Asia	*Likely* increase in mean annual temperature[a,b,c,d]	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
North America	Northern regions/ Northern North America	*Very likely* increase in mean annual temperature[a,b]	Minimum winter temperatures are *likely* to increase more than the average
	Southwest	*Very likely* increase in mean annual temperature[a,b]	--

Land Area	Subregion	Mean Warming	Other Impacts on Temperature
Central and South America	Central America and the Caribbean	*Very likely* increase in temperatures	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Southeastern South America	*Very likely* increase in temperatures	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Amazon Region	*Very likely* increase in temperatures, greater than in other Central and South American locations	*Likely* increase in hot days and decrease in cool days, *very likely* increase in warm nights and decrease cold nights, *likely* increase in frequency and duration of heat waves
	Andes Region	*Very likely* increase in temperatures	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
	Northeastern Brazil	*Very likely* increase in temperatures	*Likely* increase in hot days and warm nights, decrease in cool days and cold nights, increase in frequency and duration of heat waves
Australia and New Zealand	Southern Australia	*Virtually certain* increase in mean annual temperature	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* increase in frequency and duration of heat waves
	Southwestern Australia	*Virtually certain* increase in mean annual temperature	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* increase in frequency and duration of heat waves
	Rest of Australia	*Virtually certain* increase in mean annual temperature	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* increase in frequency and duration of heat waves
	New Zealand	*Virtually certain* increase in mean annual temperature	*Very likely* increase in hot days and warm nights, decrease in cool days and cold nights, *likely* increase in frequency and duration of heat waves

Land Area	Subregion	Mean Warming	Other Impacts on Temperature
Polar Regions	Arctic	*Likely* that surface temperatures will be strongly influenced by anthropogenic forcing by mid-century	--
	Antarctic	*Very likely* to increase lower than global mean	--
Small Islands		*Very likely* increase in temperature	--

Notes:
Information is omitted from the table where no data was available from AR5.
Regional changes are provided for end-of-century compared to today's baseline, unless otherwise noted. Future modeled change can vary depending on a number of factors such as the concentration pathways used to drive the climate models (e.g., the amount of CO_2 emitted each year around the globe). The following superscripts were used to distinguish the various concentration pathways associated with specific findings:
[a] RCP2.6
[b] RCP8.5
[c] RCP4.5
[d] RCP6.0
[e] SRES A1B
No superscripts were used for those findings where the concentration pathways were not identified.
Source: IPCC 2013a

Sea-Level Rise

IPCC identifies five primary components of sea-level rise: thermal expansion of ocean water, melting of glaciers and ice caps, loss of land-based ice in Antarctica, loss of land-based ice in Greenland, and contributions from anthropogenic impacts on water storage (e.g., extraction of groundwater) (IPCC 2013a). Ocean circulation, changes in atmospheric pressure, and geological processes can also influence sea-level rise at a regional scale (EPA 2009). The Working Group I contribution to the IPCC AR5 (IPCC 2013a) projects the mean sea-level rise for each of the RCP scenarios. As noted in Section 5.3.3.2, *Sea Level Rise,* NHTSA has used the relationship between the sea-level rise and temperature increases for each of the scenarios from IPCC AR5 to project sea-level rise in this EIS.

IPCC AR5 projects ranges of sea-level rise for each of the RCP scenarios. For 2081 to 2100, sea-level rise is likely to increase 26 to 55 centimeters (10.2 to 21.7 inches) for RCP2.6, 32 to 63 centimeters (12.6 to 24.8 inches) for RCP4.5, 33 to 63 centimeters (13.0 to 24.8 inches) for RCP6.0, and 45 to 82 centimeters (17.7 to 32.3 inches) for RCP8.5 compared to 1986–2005 (IPCC 2013a). Sea-level rise projections in the IPCC AR5 are substantially higher than projections in the IPCC AR4 because they include significant contributions of melting from large ice sheets (in particular, Greenland and Antarctica) and mountain glaciers. Further, the contribution from anthropogenic impacts on land water, which were not included in AR4, also adds to the overall increase in projected sea-level rise (IPCC 2013a). However, IPCC results for sea-level projections are still lower than results modeled by some other studies, which were based largely on semi-empirical relationships (USACE 2014). NOAA notes that there is high confidence that the global mean sea level will rise at least 20 centimeters (8 inches) and no more than 200 centimeters (78 inches) by 2100 (GCRP 2014 citing Parris et al. 2012). See Section 5.3.3.2, *Sea-Level Rise*, for more information.

Table 5.4.2-2 lists the impacts of the Proposed Action and alternatives on sea-level rise under the GCAM Reference scenario. This analysis shows sea-level rise in 2100 ranging from 76.28 centimeters (30.03 inches) under the No Action Alternative to between 76.35 centimeters (30.06 inches) under Alternative 1 and 76.31 centimeters (30.04 inches) under Alternative 7. This represents a maximum increase of 0.07 centimeter (0.03 inch) by 2100 under Alternative 1 compared to the No Action Alternative.

Precipitation

In some areas, the increase in energy available to the hydrologic cycle is expected to increase precipitation. Increases in precipitation result from higher temperatures causing more water evaporation, which causes more water vapor to be available for precipitation (EPA 2009). Increased evaporation leads to increased precipitation in areas where surface water is sufficient, such as over oceans and lakes. In drier areas, increased evaporation can actually accelerate surface drying (EPA 2009). Overall, according to the IPCC (IPCC 2013a), global mean precipitation is expected to increase under all climate scenarios. However, spatial and seasonal variations will be considerable. Generally, precipitation increases are very likely to occur in high latitudes, and decreases are likely to occur in the subtropics (EPA 2009).

MAGICC does not directly simulate changes in precipitation, and NHTSA has not undertaken precipitation modeling with a full AOGCM (further explained in Chapter 8, *Cumulative Impacts*). However, the IPCC (IPCC 2013a) summary of precipitation represents the most thoroughly reviewed, credible means of producing an assessment of this highly uncertain factor. NHTSA expects that the Proposed Action and alternatives would increase anticipated changes in precipitation (i.e., in a reference case with no GHG emissions reduction policies) in proportion to the impacts of the alternatives on temperature.

The global mean change in precipitation provided by IPCC for the RCP8.5 (high), RCP6.0 (medium-high), RCP4.5 (medium) and RCP2.6 (low) scenarios (IPCC 2013a) is given as the scaled change in precipitation (expressed as a percentage change from 1980 to 1999 averages) divided by the increase in global mean surface warming for the same period (per °C), as shown in Table 5.4.2-4. IPCC provides average scaling factors in the year range of 2006 to 2100. NHTSA used the scaling factors for the RCP6.0 scenario (which has a radiative forcing in 2100 of 6 W/m^2, similar to the GCAM Reference scenario's radiative forcing of 7 W/m^2) in this analysis because MAGICC does not directly estimate changes in global mean precipitation.

Table 5.4.2-4. Rates of Global Mean Precipitation Increase over the 21st Century, per Emissions Scenario

Scenario	Percent per °C
RCP8.5	1.58
RCP6.0	1.68
RCP4.5	1.96
RCP2.6	2.39

Notes:
Source: Figure 12-7 in IPCC 2013a

Applying these scaling factors to the increases in global mean surface warming provides estimates of changes in global mean precipitation. The Proposed Action and alternatives are projected to increase temperature rise and predicted increases in precipitation slightly compared to the No Action Alternative, as shown in Table 5.4.2-5 (based on the scaling factor from the RCP6.0 scenario); however, the increase in precipitation is less than 0.005 percent and thus is rounded to 0.00 percent in the table.

Table 5.4.2-5. Global Mean Precipitation (Percent Increase) Based on GCAM Reference Scenario Using Increases in Global Mean Surface Temperature Simulated by MAGICC, by Alternative[a]

Scenario	2040	2060	2100
Global Mean Precipitation Change (scaling factor, % change in precipitation per °C change in temperature)	1.68%		
Global Temperature Above Average 1986–2005 Levels (°C) for the GCAM Reference Scenario by Alternative			
Alternative 0—No Action	1.287	2.008	3.484
Alternative 1	1.288	2.010	3.487
Alternative 2	1.288	2.010	3.487
Alternative 3	1.288	2.010	3.487
Alternative 4	1.288	2.010	3.487
Alternative 5	1.287	2.009	3.486
Alternative 6	1.287	2.009	3.486
Alternative 7	1.287	2.009	3.485
Increases in Global Temperature (°C) by Alternative, (Compared to the No Action Alternative)[b]			
Alternative 1	0.001	0.002	0.003
Alternative 2	0.001	0.002	0.003
Alternative 3	0.000	0.002	0.003
Alternative 4	0.000	0.001	0.003
Alternative 5	0.000	0.001	0.002
Alternative 6	0.000	0.001	0.002
Alternative 7	0.000	0.001	0.001
Global Mean Precipitation Increase by Alternative (%)			
Alternative 0—No Action	2.16%	3.37%	5.85%
Alternative 1	2.16%	3.38%	5.86%
Alternative 2	2.16%	3.38%	5.86%
Alternative 3	2.16%	3.38%	5.86%
Alternative 4	2.16%	3.38%	5.86%
Alternative 5	2.16%	3.38%	5.86%
Alternative 6	2.16%	3.38%	5.86%
Alternative 7	2.16%	3.37%	5.86%

Scenario	2040	2060	2100
Increase in Global Mean Precipitation Increase by Alternative (% Compared to the No Action Alternative)			
Alternative 1	0.00%	0.00%	0.01%
Alternative 2	0.00%	0.00%	0.01%
Alternative 3	0.00%	0.00%	0.00%
Alternative 4	0.00%	0.00%	0.00%
Alternative 5	0.00%	0.00%	0.00%
Alternative 6	0.00%	0.00%	0.00%
Alternative 7	0.00%	0.00%	0.00%

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the increases might not reflect the exact difference of the values in all cases.
[b] Precipitation changes reported as 0.000 are more than zero but less than 0.001.
[c] The increase in precipitation is less than 0.005%, and thus is rounded to 0.00%.
GCAM = Global Change Assessment Model; MAGICC = Model for the Assessment of Greenhouse-gas Induced Climate Change; °C = degrees Celsius

In addition to changes in mean annual precipitation, climate change is anticipated to affect the intensity of precipitation.[41] Regional variations and changes in the intensity of precipitation cannot be further quantified, primarily due to the lack of available AOGCMs required to estimate these changes. These models typically are used to provide results among scenarios with very large changes in emissions, such as the RCP2.6 (low), RCP4.5 (medium), RCP6.0 (medium-high) and RCP8.5 (high) scenarios; very small changes in emissions profiles (such as those resulting from the Proposed Action and alternatives) would produce results that would be difficult to resolve among scenarios. In addition, the multiple AOGCMs produce results regionally consistent in some cases but inconsistent in others.

Quantifying the changes in regional climate under the Proposed Action and alternatives is not possible at this time, but the action alternatives would be expected to increase the relative precipitation changes in proportion to the increase in global mean surface temperature. To provide context on how the projected changes in precipitation from the MAGICC modeling may differentially affect geographic regions, Table 5.4.2-6 summarizes, in qualitative terms, the regional changes in precipitation from the IPCC AR5 from the present day through 2100.

[41] As described in Meehl et al. 2007, the "intensity of precipitation events is projected to increase, particularly in tropical and high latitude areas that experience increases in mean precipitation. Even in areas where mean precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is projected to increase but periods between rainfall events would be longer. The mid-continental areas tend to dry during summer, indicating a greater risk of droughts in those regions. Precipitation extremes increase more than the mean in most tropical and mid- and high-latitude areas."

Table 5.4.2-6. Regional Changes to Precipitation in the Year 2100 Compared to Current Conditions, Summarized from the IPCC Fifth Assessment Report

<table>
<tr><th>Land Area</th><th>Subregion</th><th>Precipitation</th><th>Snow Season and Snow Depth</th></tr>
<tr><td rowspan="6">Africa</td><td>Northern Africa and Northern Sahara</td><td>Very Likely decreases in mean annual precipitation[b]</td><td rowspan="6">--</td></tr>
<tr><td>Eastern Africa</td><td>Likely increases in mean annual precipitation beginning mid-century[b]
Likely to increase during short rainy season
Likely increase in heavy precipitation</td></tr>
<tr><td>Central Africa</td><td>Likely increases in mean annual precipitation beginning mid-century[b]</td></tr>
<tr><td>Southern Africa</td><td>Very likely decreases in mean annual precipitation[b]</td></tr>
<tr><td>Western Africa</td><td>--</td></tr>
<tr><td rowspan="3">Mediterranean and Europe</td><td>Northern Europe</td><td>--</td><td>Likely to decrease</td></tr>
<tr><td>Central Europe</td><td>--</td><td>--</td></tr>
<tr><td>Southern Europe and Mediterranean</td><td>Likely decrease in summer precipitation</td><td>--</td></tr>
<tr><td rowspan="6">Asia</td><td>Central Asia</td><td>Very likely increase in annual precipitation by mid-century[a]</td><td rowspan="3">--</td></tr>
<tr><td>Northern Asia</td><td>Very likely increase in annual precipitation by mid-century[a]</td></tr>
<tr><td>Eastern Asia</td><td>Precipitation in boreal summer and winter is likely to increase.
Very likely to be an increase in the frequency of intense precipitation. Extreme rainfall and winds associated with tropical cyclones are likely to increase</td></tr>
<tr><td>West Asia</td><td>--</td><td>--</td></tr>
<tr><td>South Asia</td><td>Very likely increase in annual precipitation by end of century[a]</td><td>--</td></tr>
<tr><td>Southeast Asia</td><td>Very likely increase in annual precipitation by end of century[a]</td><td>--</td></tr>
</table>

Land Area	Subregion	Precipitation	Snow Season and Snow Depth
North America	Northern regions/Northern North America	*Very likely* increase in precipitation by mid-century[a]	Snow season length and snow depth are *very likely* to decrease
	Southwest	--	Snow season length and snow depth are *very likely* to decrease
	Northeast USA	--	Snow season length and snow depth are *very likely* to decrease
	Southern Canada	--	--
	Canada	*Very likely* increase in precipitation by mid-century[a]	Snow season length and snow depth are *very likely* to decrease
	Northernmost part of Canada	*Very likely* increase in precipitation by mid-century[a]	Snow season length and snow depth are *likely* to increase
Central and South America	Central America and the Caribbean	--	--
	Southeastern South America	*Very likely* that precipitation will increase	
	Amazon Region	*Very likely* that precipitation will decrease in the eastern Amazon during the dry season	
	Andes and Western South America	*Very likely* that precipitation will decrease in the Central Chile and the Northern part of this region	
	Northeastern Brazil	*Very likely* that precipitation will decrease during the dry season	
Australia and New Zealand	Southern Australia	--	--
	Southwestern Australia	--	
	New Zealand	*Likely* to increase in the western regions during winter and spring	
Polar Regions	Arctic	*Likely* increase in precipitation	--
	Antarctic	*Likely* increase in precipitation	
Small Islands	--	Rainfall *likely* to increase over certain regions	

Notes:
Information is omitted from the table where no data was available from IPCC AR5.
Regional changes are provided for end-of-century compared to today's baseline, unless otherwise noted. Future modeled change can vary depending on a number of factors such as the concentration pathways used to drive the climate models (e.g., the amount of CO_2 emitted each year around the globe). The following superscripts were used to distinguish the various concentration pathways associated with specific findings:
[a] RCP2.6
[b] RCP8.5
Source: IPCC 2013a

Ocean pH

As Table 5.4.2-2 shows, the decrease of projected ocean pH under the Proposed Action and alternatives compared to the No Action Alternative amounts to a small portion of the projected total decrease in ocean pH due to global CO_2 emissions. The relative impact of the action alternatives is demonstrated by the decrease of ocean pH under the range of action alternatives. As shown in Table 5.4.2-2, the decrease of ocean pH by 2100 under Alternative 1 is more than four times that of Alternative 7.

5.4.2.3 Climate Sensitivity Variations

Using the methods described in Section 5.3.3.6, *Sensitivity Analysis*, NHTSA examined the sensitivity of projected climate impacts on key technical or scientific assumptions used in the analysis. This examination included modeling the impact of various climate sensitivities on the climate effects under the No Action Alternative using the GCAM Reference scenario.

Table 5.4.2-7 lists the results from the sensitivity analysis, which included climate sensitivities of 1.5°C, 2.0°C, 2.5°C, 3.0°C, 4.5°C, and 6.0°C (2.7°F, 3.6°F, 4.5°F, 5.4°F, 8.1°F, and 10.8°F) for a doubling of CO_2 compared to preindustrial atmospheric concentrations (278 ppm CO_2) (Section 5.3.3.6, *Sensitivity Analysis*).

Table 5.4.2-7. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increases, Sea-Level Rise, and Ocean pH for Varying Climate Sensitivities for Selected Alternatives[a]

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b]			Sea Level Rise (cm)[b]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Alternative 0—No Action	1.5	469.61	546.10	737.48	0.741	1.128	1.890	41.05	8.2445
	2.0	473.09	553.09	755.49	0.941	1.446	2.451	52.74	8.2350
	2.5	476.22	559.52	772.69	1.123	1.738	2.981	64.52	8.2260
	3.0	479.04	565.44	789.11	1.287	2.008	3.484	76.28	8.2176
	4.5	486.00	580.62	834.28	1.699	2.707	4.868	110.93	8.1952
	6.0	491.34	592.87	874.88	2.020	3.279	6.171	144.70	8.1759
Alternative 1	1.5	469.72	546.42	738.20	0.741	1.129	1.892	41.07	8.2441
	2.0	473.20	553.42	756.23	0.942	1.447	2.453	52.78	8.2346
	2.5	476.33	559.85	773.45	1.123	1.740	2.984	64.57	8.2256
	3.0	479.15	565.77	789.88	1.288	2.010	3.487	76.34	8.2172
	4.5	486.11	580.96	835.13	1.699	2.709	4.872	111.03	8.1948
	6.0	491.46	593.22	875.76	2.021	3.282	6.177	144.84	8.1755
Alternative 7	1.5	469.65	546.21	737.73	0.741	1.128	1.891	41.06	8.2444
	2.0	473.13	553.21	755.74	0.941	1.446	2.452	52.76	8.2348
	2.5	476.26	559.64	772.95	1.123	1.739	2.982	64.54	8.2259
	3.0	479.08	565.56	789.37	1.287	2.009	3.485	76.30	8.2175
	4.5	486.04	580.74	834.57	1.699	2.708	4.870	110.97	8.1951
	6.0	491.38	593.00	875.16	2.020	3.280	6.173	144.75	8.1758

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b]			Sea Level Rise (cm)[b]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Increase Under Alternative 1 Compared to No Action Alternative									
Alternative 1	1.5	0.11	0.32	0.72	0.000	0.001	0.002	0.03	-0.0004
	2.0	0.11	0.32	0.74	0.000	0.001	0.002	0.04	-0.0004
	2.5	0.11	0.33	0.76	0.001	0.001	0.003	0.05	-0.0004
	3.0	0.11	0.33	0.78	0.001	0.002	0.003	0.06	-0.0004
	4.5	0.11	0.34	0.85	0.001	0.002	0.004	0.10	-0.0004
	6.0	0.11	0.34	0.88	0.001	0.002	0.006	0.14	-0.0004
Increase Under Alternative 7 Compared to No Action Alternative									
Alternative 7	1.5	0.04	0.11	0.25	0.000	0.000	0.001	0.01	-0.0001
	2.0	0.04	0.12	0.26	0.000	0.000	0.001	0.01	-0.0001
	2.5	0.04	0.12	0.26	0.000	0.001	0.001	0.02	-0.0001
	3.0	0.04	0.12	0.27	0.000	0.001	0.001	0.02	-0.0001
	4.5	0.04	0.12	0.29	0.000	0.001	0.001	0.03	-0.0001
	6.0	0.04	0.12	0.28	0.000	0.001	0.002	0.05	-0.0001

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the increases do not reflect the exact difference of the values.
[b] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986–2005.
ppm = parts per million; °C = degrees Celsius; CO_2 = carbon dioxide; cm = centimeters

As the tables show, varying climate sensitivities (the equilibrium warming that occurs at a doubling of CO_2 from preindustrial levels) can affect not only estimated warming, but also estimated sea-level rise, ocean pH, and atmospheric CO_2 concentration. This complex set of interactions occurs because both atmospheric CO_2 and temperature affect ocean absorption of atmospheric CO_2, which reduces ocean pH. Specifically, higher temperatures result in lower aqueous solubility of CO_2, while higher concentrations of atmospheric CO_2 lead to more ocean absorption of CO_2. Atmospheric CO_2 concentrations are affected by the amount of ocean carbon storage. Therefore, as Table 5.4.2-7 shows, projected future atmospheric CO_2 concentrations differ with varying climate sensitivities even under the same alternative, despite the fact that CO_2 emissions are fixed under each alternative. Regardless of the climate sensitivity used in the model, increases in global CO_2 concentrations under the Proposed Action and alternatives would be very small compared to total projected increases in global CO_2 concentrations.

Simulated atmospheric CO_2 concentrations in 2040, 2060, and 2100 are a function of changes in climate sensitivity. The small changes in concentration are due primarily to small changes in the aqueous solubility of CO_2 in ocean water: slightly warmer air and sea surface temperatures lead to less CO_2 being dissolved in the ocean and slightly higher atmospheric concentrations.

The response of simulated global mean surface temperatures to variation in the climate sensitivity parameter varies among the years 2040, 2060, and 2100, as shown in Table 5.4.2-7. In 2040, the impact of assumed variation in climate sensitivity is low, due primarily to the limited rate at which the global mean surface temperature increases in response to increases in radiative forcing. In 2100, the impact of variation in climate sensitivity is magnified by the larger change in emissions. The increase in 2100 global mean surface temperature from the No Action Alternative to Alternative 1 ranges from 0.002°C (0.004°F) for the 1.5°C (2.7°F) climate sensitivity to 0.006°C (0.011°F) for the 6.0°C (10.8°F) climate sensitivity.

The sensitivity of the simulated sea-level rise to change in climate sensitivity and global GHG emissions mirrors that of global temperature, as shown in Table 5.4.2-7. Scenarios with lower climate sensitivities show generally smaller increases in sea-level rise; at the same time, sea-level rise is higher under the Proposed Action and alternatives compared to the No Action Alternative. Conversely, scenarios with higher climate sensitivities have higher projected sea-level rise; again, however, sea-level rise is higher under the Proposed Action and alternatives compared to the No Action Alternative. The range in increase of sea-level rise under Alternative 1 compared to the No Action Alternative is 0.03 to 0.14 centimeter (0.012 to 0.055 inch), depending on the assumed climate sensitivity.

CHAPTER 6 LIFE-CYCLE ASSESSMENT OF VEHICLE ENERGY, MATERIAL, AND TECHNOLOGY IMPACTS

6.1 Introduction

The International Organization for Standardization (ISO) defines a life-cycle assessment (LCA) as the "compilation and evaluation of the input, output, and potential environmental impact of a product system throughout its life cycle" (ISO 2006). Like any product, a vehicle's life-cycle impacts do not accrue exclusively during the time it spends in use (i.e., they are not limited to engine exhaust emissions and evaporative emissions during vehicle operation). Each phase of a vehicle's life cycle, including production of fuel for vehicle use, contributes to greenhouse gas (GHG) emissions, energy use, and other environmental impacts.

Life-cycle considerations are already included in other analyses in this EIS. For example, air quality and climate impacts reported in Chapter 4, *Air Quality,* and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, include upstream emissions from the following sources:

- Feedstock extraction.
- The use, leakage, spillage, flaring, and evaporation of fuels during feedstock production (e.g., crude oil or natural gas).
- Feedstock transportation (to refineries or processing plants).
- Fuel refining and processing (into gasoline, diesel, dry natural gas, and natural gas liquids).
- Refined product transportation (from bulk terminals to retail outlets).
- Electricity generation.

These upstream emissions account for around 20 percent of total GHG emissions from passenger car and light truck use and 1 to 96 percent of non-GHG emissions from passenger car and light truck fuel use, depending on the specific pollutant. Air quality and climate impacts reported in Chapter 4, *Air Quality,* and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, however, include only emissions associated with the vehicle fuel life cycle. Therefore, Chapters 4 and 5 do not include any estimated life-cycle impacts associated with passenger car and light truck materials or technologies that might be applied to improve fuel efficiency, including emissions related to vehicle manufacturing.

A complete LCA of the impacts of this rulemaking, which is beyond the scope of this EIS, would require extensive data collection on many variables that are highly uncertain, such as the following variables:

- The future response of passenger car and light truck manufacturers to the MY 2021–2026 fuel economy standards.
- The specific design of multiple fuel efficiency technologies and their manufacturing processes, application to vehicles, and disposal after use.
- Interactions between applications of multiple fuel savings technologies.
- Regional fuel sourcing projections.
- Primary data on the variety of vehicle types, manufacturers, and uses expected in the future.

The Proposed Action and alternatives are based on performance and do not mandate the adoption of specific technologies. As a result, NHTSA does not know precisely how manufacturers will choose from a suite of available technologies to meet the standards. In addition, manufacturing and disposal processes may change over time and are beyond the scope of NHTSA's capabilities to predict and effectively analyze. Because the information necessary to quantitatively differentiate between the alternatives in this chapter is too extensive and unknowable, the intent of this chapter instead is to understand the life-cycle implications of energy production, material substitution, and fuel efficiency technologies for passenger cars and light trucks. This information is helpful to the decision-maker in understanding the potential life-cycle impacts of manufacturer responses to different levels of stringency based on forecasts of materials and technologies manufacturers could employ to meet the proposed standards. Therefore, this chapter focuses on existing credible scientific information to evaluate the most significant environmental impacts from some of the fuels, materials, and technologies that may be used to comply with the Proposed Action and alternatives.

The literature synthesis in this chapter is divided into the following sections:

- Section 6.1, *Introduction*, provides background on applying LCA methods to passenger cars and light trucks.
- Section 6.2, *Energy Sources*, examines LCA impacts associated with different passenger car and light truck fuels.
- Section 6.3, *Materials and Technologies,* examines LCA impacts associated with passenger car and light truck materials and technologies.
- Section 6.4, *Conclusions*, presents conclusions from this research synthesis.

This chapter does not attempt to provide a comprehensive review of all LCA studies related to passenger cars and light trucks. Rather, it focuses on recent studies that provide more background on fuel use and upstream emissions already incorporated in the analyses in Chapters 3, 4, and 5, as well as the material and technology life-cycle impacts not reflected in the analyses in those chapters. This literature synthesis supplements the quantitative analysis of the Proposed Action and alternatives reported in Chapters 3, 4, and 5.

6.1.1 Life-Cycle Assessment for Vehicles

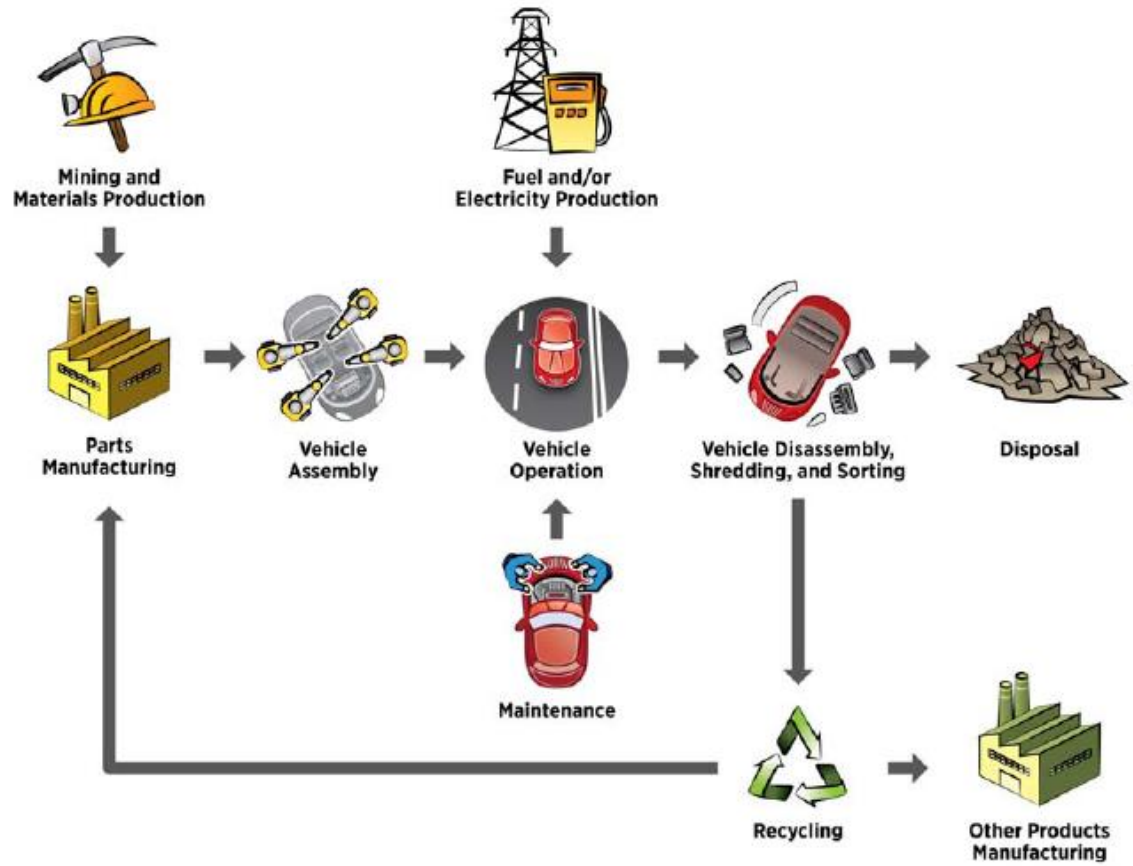
Activities at each phase of a vehicle's life cycle contribute to GHG emissions, energy use, and other environmental impacts. For example, mining and transporting ore requires energy (usually in the form of fossil fuels), as does transforming ore into metal, shaping the metal into parts, assembling the vehicle, driving and maintaining the vehicle, and disposing of and/or recycling the vehicle at the end of its life. Recycling vehicle components can save energy and resources and can reduce emissions by displacing the production of virgin materials (e.g., ore, bauxite); however, recycling processes also require energy and produce emissions. Vehicle LCAs typically evaluate environmental impacts associated with five primary phases:

- **Raw-material extraction.** Extraction includes the mining and sourcing of material and fuel inputs.
- **Manufacturing.** Manufacturing can be identified by phases, such as material and part production and vehicle assembly.
- **Vehicle use.** Use typically consists of two phases: the vehicle operations (e.g., fuel supply and consumption) and maintenance (e.g., part repair or replacement).

- **End-of-life management.** Steps in this phase can include parts recovery, disassembly, shredding, recycling, and landfilling.
- **Transportation.** Materials and product are moved between these various phases.

Figure 6.1.1-1 shows a general example of a light-duty vehicle's life cycle.

Figure 6.1.1-1. Light-Duty Vehicle Life Cycle



Source: NHTSA 2012

An LCA study can help identify major sources of environmental impacts throughout a vehicle's life cycle, and it can identify opportunities for impact mitigation. LCA is useful for examining and comparing vehicle technologies and material alternatives. For example, analysts often assess whether certain materials and technologies save energy over the entire life cycle of vehicles, holding other factors (e.g., miles traveled, tons of freight carried, vehicle life) constant. Changes in the material composition of vehicles could decrease potential emissions during vehicle use but increase them during raw material extraction and manufacturing (Geyer 2008). Because a high proportion of total emissions occur during the vehicle's use, the fuel-saving benefits from improved fuel economy often outweigh the additional energy investment associated with material changes (Cheah et al. 2009).

While LCA allows users to evaluate the environmental impacts of different vehicle technologies on an equal basis *within* a given study, LCAs nonetheless often vary greatly in their scope, design, data sources, data availability, and assumptions, making it challenging to compare results *between* studies. In setting the scope of each study, LCA practitioners decide on the unit of measure, life-cycle boundaries, environmental impact categories to consider, and other factors that address the defined purpose of the study. Most studies in this analysis evaluate different types of passenger cars and light trucks with different assumptions for vehicle weight, vehicle life, and miles traveled, which influence the final study results.

In terms of impacts, some studies include those across the entire cradle-to-grave life cycle (i.e., from resource extraction through end of life), including impacts from extraction of all energy and material inputs. Others include impacts only from cradle to [factory] gate (i.e., from resource extraction through manufacturing and assembly, but excluding vehicle use and end of life). Most of the studies evaluate energy use and climate change impact measured by GHG emissions, but several also include other environmental impact categories (e.g., acidification, eutrophication, odor and aesthetics, water quality, landfill space, ozone depletion, particulates, solid and hazardous waste generation, and smog formation). Data and time often influence the boundaries and impacts included. LCA practitioners decide how to assign or allocate environmental impacts between the product under study and other products produced by the system.[1] For example, scrap material can perform functions after its use in a vehicle. Studies that consider scrap flows outside the vehicle life-cycle boundary might account for it in the following ways:

- Allocating a portion of the impacts associated with vehicle manufacture or recycling to the scrap flow.
- Treating scrap as a waste flow and not allocating any impacts to it.
- Expanding the system to include the scrap output flow within the system boundary.

The varying treatment of scrap material and other LCA aspects and assumptions in each study limits the comparability of the results.

For some of the studies considered in this chapter, the authors used existing models to assess life-cycle emissions. Other studies addressed life-cycle implications using study-specific models developed from life-cycle inventory data sources, such as the ecoinvent database.[2] The most commonly used model in the surveyed literature is the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model, a public-domain model developed at Argonne National Laboratory that allows users to estimate life-cycle energy and emissions impacts on a full fuel-cycle and vehicle life-cycle basis (ANL 2018). Argonne National Laboratory developed GREET in 1996 and has updated the model to reflect recent data, new fuel pathways, and vehicle technologies. GREET uses a process-based approach wherein the model calculates life-cycle results by modeling the various processes and technologies used to extract, refine, and distribute fuels, and to manufacture, use, and dispose of vehicles. The upstream emissions included in the air quality and climate impacts reported in Chapters 4 and 5 are estimates based on information from GREET.

Because LCAs are highly sensitive to design and input assumptions, their impact results vary. When comparing and synthesizing studies, this chapter identifies which assumptions influence variability in

[1] ISO advises that LCAs avoid allocation by dividing the process into separate production systems or through system expansion, including the additional coproduct functions (ISO 2006).

[2] Life-cycle inventory data is information on the inputs, outputs, and potential environmental impacts of a product or process. The ecoinvent database, managed by the Swiss Centre for Life Cycle Inventories, is a large source of life-cycle inventory data on products and processes from different countries around the world, including the United States.

studies. The intent is to synthesize the key existing and emerging topics in LCAs of passenger cars and light trucks, including research challenges and opportunities.

6.1.2 Life-Cycle Assessment Literature

NHTSA identified LCA studies across a range of sources, including academic journals and publications of industry associations and nongovernmental organizations. Appendix C, *Life-Cycle Assessment Studies*, lists all the studies reviewed. Most studies identified were published within the last 10 years. NHTSA prioritized literature published in the last 3 years and LCAs specifically focused on passenger car and light truck technologies, including studies that take into account full fuel life cycles. NHTSA incorporates by reference the related LCA literature synthesis for passenger cars and light trucks reported in Chapter 6 of the *Final Environmental Impact Statement for Corporate Average Fuel Economy Standards, Model Years 2017–2025* (the MY 2017–2025 CAFE standards Final EIS) (NHTSA 2012), and for medium- and heavy-duty engines and vehicles reported in Chapter 6 of the *Final Environmental Impact Statement for Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles* (NHTSA 2016c).

Passenger cars and light trucks have many variations and combinations of drivetrain, fuel sources, and other materials/technologies. Passenger car and light truck LCAs commonly include gasoline and diesel powered conventional vehicles, hybrid-electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and flex-fuel vehicles. Each vehicle type is potentially capable of accepting multiple energy or fuel sources in operations. This chapter compares these variations through common functional units. For any LCAs, the functional unit represents the basis for which all environmental impacts are quantified to generate results throughout a product's or process's lifetime (ISO 2006). For example, LCA results between vehicle types or life-cycle phases are often communicated in GHG emissions per unit of distance traveled. In this example, the unit of distance is the functional unit. In this chapter, functional units vary based on the specific technology examined but are consistent within specific sections for comparison purposes.

6.2 Energy Sources

In the *Annual Energy Outlook 2019* (EIA 2019a), the transportation sector accounted for 77.6 percent of total U.S. petroleum consumption in 2018, and transportation is expected to account for 72.4 percent of U.S. petroleum use in 2040. Passenger cars and light trucks accounted for 55 percent of transportation energy consumption in 2018, and they are expected to account for 46 percent of transportation energy consumption in 2040. Despite a 13.4 percent forecast increase in vehicle miles travelled by passenger cars and light trucks from 2018 to 2040, transportation sector gasoline consumption is projected to decrease by 28.0 percent due to increased fuel economy.

According to the Annual Energy Outlook (AEO) 2019, gasoline accounted for 99.1 percent of passenger car and light truck fuel consumption in 2018, and is projected to account for 92.4 percent of consumption in 2040. As illustrated in Table 6.2-1, gasoline is projected to be displaced in part by a projected growth in diesel, E85 ethanol, electricity, and other fuels (e.g., natural gas and hydrogen).[3]

[3] The AEO 2019 forecast reflects projected impacts of NHTSA's augural standards set forth for MYs 2022–2025 in the 2012 joint NHTSA-EPA final rule, and NHTSA does not anticipate the same level of alternative fuel use under the action alternatives considered in this EIS. In the CAFE model used to estimate the impacts of the standards considered in this EIS, NHTSA relies on different assumptions than the AEO regarding alternative fuel use. These CAFE model inputs are described in detail in Section VI of the Final Regulatory Impact Analysis (FRIA) and the final rule preamble.

Table 6.2-1. Fuel Consumption for Passenger Cars and Light Trucks for 2017 and 2040

Fuel	2018 (%)	2040 (%)
Gasoline	99.1	92.4
Electricity	0.1	3.4
Diesel	0.4	1.7
E85	0.3	2.2
Other fuels	0.1	0.3

Source: EIA 2019a

The AEO 2019 projections represent hypothetical scenarios based on current policies, market prices, resource constraints, and technologies. Broad national and international projections are inherently uncertain and will fail to incorporate major events that generate sudden, unforeseen shifts. Additionally, energy market forecasts are highly uncertain because it is difficult to predict changes in forces that shape these markets, such as changes in technology, demographics, and resources. However, these projections offer opportunities to analyze how different assumptions for variables influence future scenarios (Piotrowski 2016). This section uses the AEO 2019 reference case as a guide in analyzing the most relevant trends for passenger cars and light trucks.

This section synthesizes life-cycle findings on fuel sources for passenger cars and light trucks in Sections 6.2.1, *Diesel and Gasoline*, 6.2.2*, Natural Gas*, 6.2.3, *Electric Vehicles*, 6.2.4, *Biofuels*, and 6.2.5, *Fuel Cells*. The synthesis of LCA studies related to fuel cells is relatively brief because the AEO 2019 does not forecast substantial changes in fuel cell use, and this rulemaking is not expected to have a large impact on the extent of fuel cell use.

6.2.1 Diesel and Gasoline

Gasoline and diesel represent the largest share of light-duty vehicle fuel consumption, both now (99.5 percent of total fuel consumption in 2018 for diesel and gasoline) and in the future (94.1 percent in 2040) based on the AEO 2019 projections (EIA 2019a). Life-cycle GHG emissions from the extraction, refining, supply, and combustion of gasoline and diesel generally account for 80 percent of total vehicle life-cycle emissions, but this can vary based on vehicle type and supply chain characteristics (Samaras and Meisterling 2008, Hawkins et al. 2012). Although upstream emissions are associated with conventional oil production and refining, there is less consensus on the LCA impacts of unconventional sources of petroleum, including shale oil produced by advanced well completion processes involving fracturing (fracking) and petroleum from oil sands. The methane emissions from upstream petroleum production and natural gas systems are discussed in Section 6.2.2.1, *Methane Emissions from Oil and Natural Gas*.

Oil sands, also known as tar sands or bituminous sands, are a mixture of sand and clay saturated with a viscous form of petroleum (bitumen). The United States imports oil sands products—primarily diluted bitumen and synthetic crude from Canada (Canadian National Energy Board 2014). Gasoline and diesel refined from oil sands can be substituted for gasoline and diesel produced from conventional sources without any modifications to vehicle equipment or changes in performance. From a life-cycle perspective, the sole difference occurs upstream in the life cycle during extraction and processing, resulting in additional GHG emissions and environmental impacts. The recent, rapid rise of U.S. shale oil production and declines in crude oil prices have created uncertainty in the growth of oil sands production (Findlay 2016).

A variety of studies have evaluated the well-to-wheels emissions associated with petroleum from oil sands, and have reached a consensus that oil sands petroleum is more GHG-intensive to produce than conventional counterparts, because oil sands petroleum requires more energy to extract and process. Oil sands also contain higher amounts of impurities that require more energy-intensive processing prior to end use (Lattanzio 2014).

In addition to upstream GHG emissions from extraction and processing, the mining of oil sands affects land to a higher degree than conventional oil extraction. Surface mining involves land clearance and extraction of shallow deposits, and *in situ* recovery involves drilling wells and injecting steam underground to reduce bitumen viscosity. One study showed that land disturbance in Alberta ranges from 1.6 to 7.1 hectares per well pad, averaging 3.3 hectares. These impacts are significantly higher than land disturbance for conventional oil drilling in California, which averages 1.1 hectares per well (Yeh et al. 2010). Furthermore, land disturbance for oil sands extraction in Alberta has been shown to affect peat deposits, which results in additional life-cycle GHG emissions regardless of reclamation efforts. Changes in soil carbon stocks and biomass removal from surface mining emit 3.9 and 0.04 grams of carbon dioxide equivalent[4] per megajoule of energy (g CO_2e/MJ), respectively, from *in situ* extraction of oil sands in Alberta.

Shale oil, commonly called tight oil, represents the other major unconventional oil source. Shale oil comes from hydraulic fracturing of porous geologic formations containing oil. The specific processes, equipment, and resources required in hydraulic fracturing operations are discussed in Section 6.2.2.2, *Shale Gas and Hydraulic Fracturing*. In 2018, shale oil represented the largest portion of U.S. oil production (60.8 percent), totaling 6.53 million barrels per day (EIA 2019a).

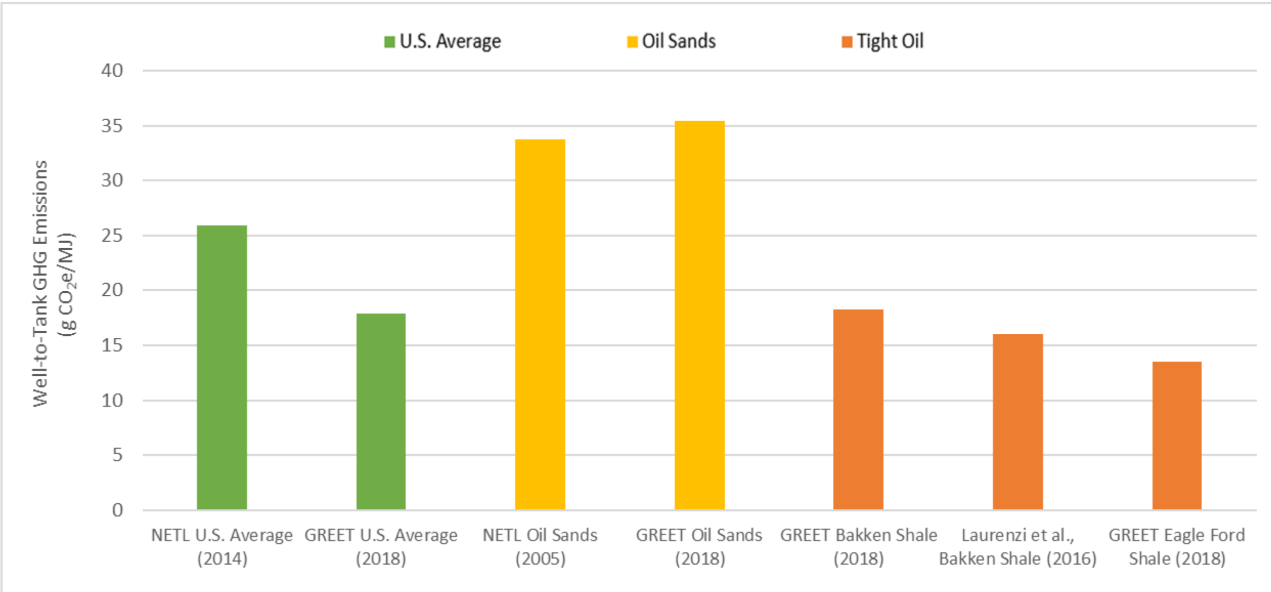
In 2015, the National Energy Technology Laboratory (NETL) published updated estimates of the well-to-tank and well-to-wheels GHG emissions from conventional petroleum fuels produced in the United States, providing comparisons between the original 2005 baseline model and an updated baseline for 2014 (NETL 2015). When comparing the average conventional motor gasoline consumed in the United States in 2014 to the original 2005 estimates, the values show a 70 percent increase in crude extraction emissions, a 31 percent increase in well-to-tank emissions, and a 7 percent increase in well-to-wheels emissions. These changes are the result of several factors, including changes in the crude oil mix and increasing refinery hydrogen demand from the transition to ultra-low sulfur diesel.

Argonne National Laboratory's GREET model provides a snapshot of life-cycle GHG impacts associated with international and domestic conventional petroleum-based fuel pathways. In the model's updates in 2014 and 2015, researchers updated the refinery efficiencies and included values for Canadian oil sands and domestic tight oil from shale based on research at Stanford University and the University of California, Davis (Englander and Brandt 2014, Ghandi et al. 2015, Brandt et al. 2015). GREET's 2018 version uses U.S. Energy Information Administration (EIA) projections for crude oil supplies to generate a default average (72 percent conventional, 18 percent shale oil, 10 percent oil sands) for well-to-tank or well-to-wheels gasoline, as well as enabling the model user to define custom supply profiles.
Figure 6.2.1-1 summarizes the LCA findings for gasoline production from NETL and GREET, including a

[4] Carbon dioxide equivalent (CO_2e) is a measure that expresses the relative global warming potential of greenhouse gas emissions, usually measured over 100 years.

shale oil LCA that focuses on the same Bakken region assessed in the GREET model (Laurenzi et al. 2016).[5]

Figure 6.2.1-1. Well-to-Tank Greenhouse Gas Emissions for Gasoline

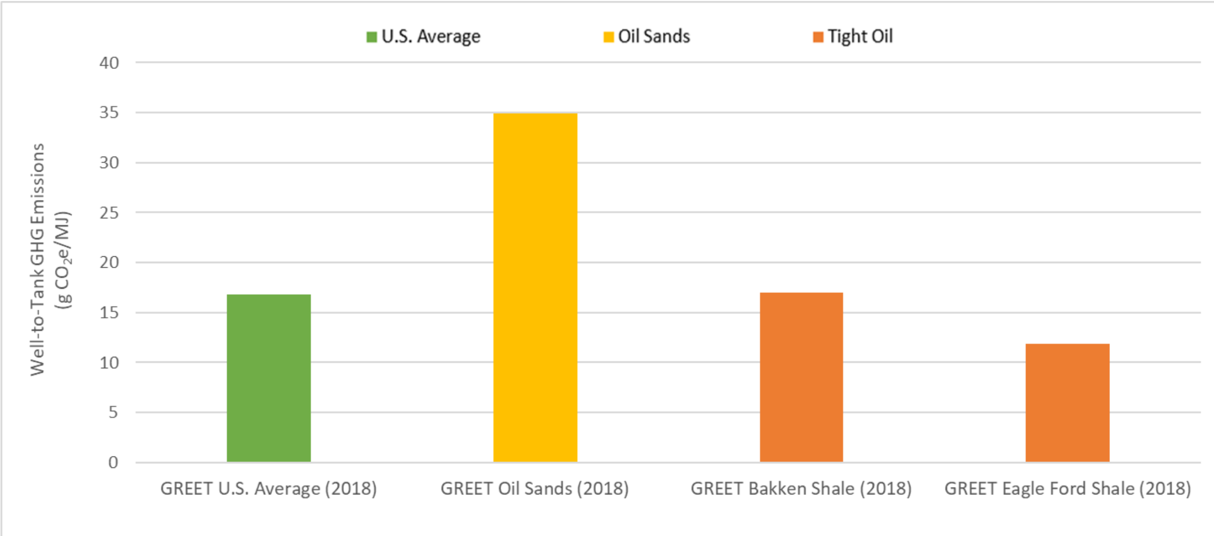


Source: NETL 2015, ANL 2018, Laurenzi et al. 2016
GHG = greenhouse gas; g CO_2e/MJ = grams of carbon dioxide equivalent per megajoule; NETL = National Energy Technology Laboratory; GREET = Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation

Diesel production has similar but slightly lower well-to-tank LCA results than gasoline. Figure 6.2.1-2 shows the variations in diesel emissions from GREET modeling results. The lower well-to-tank results are primarily driven by slightly less overall energy use in diesel refining operations, based on GREET's 2018 simulation of refining processes.

[5] Laurenzi et al. 2016 uses IPCC 5th *National Climate Assessment* (NCA) (AR5) global warming potential factors, while GREET uses 4th NCA (AR4) values. However, those factors have little impact on results, as the CO_2 global warming potential factor is constant in the AR4 and AR5 factors and accounts for the vast majority of well-to-tank GHG emissions.

Figure 6.2.1-2. Well-to-Tank Greenhouse Gas Emissions for Diesel



Source: ANL 2018

GHG = greenhouse gas; g CO_2e/MJ = grams of carbon dioxide equivalent per megajoule; GREET = Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation

The boundaries for the previous two figures are limited to well-to-tank emissions, which is common in LCA literature on transportation fuels. Table 6.2.1-1 presents the carbon dioxide (CO_2), methane, and nitrous oxide emissions from tank-to-wheels (i.e., vehicle operations) for gasoline and diesel fuels.

Table 6.2.1-1. Estimated Diesel and Gasoline Tank-to-Wheel Emissions (g CO_2e/MJ)

Fuel	Carbon Dioxide	Methane[a]	Nitrous Oxide[a]	CO_2e Totals
Diesel	74.9	0.082	0.05	75.7
Gasoline	72.7	0.057	0.445	73.2

Source: ANL 2018

[a] The values are calculated using AR5 global warming potential factors.

g CO_2e/MJ = grams of carbon dioxide equivalent per megajoule; CO_2e = carbon dioxide equivalent

6.2.2 Natural Gas

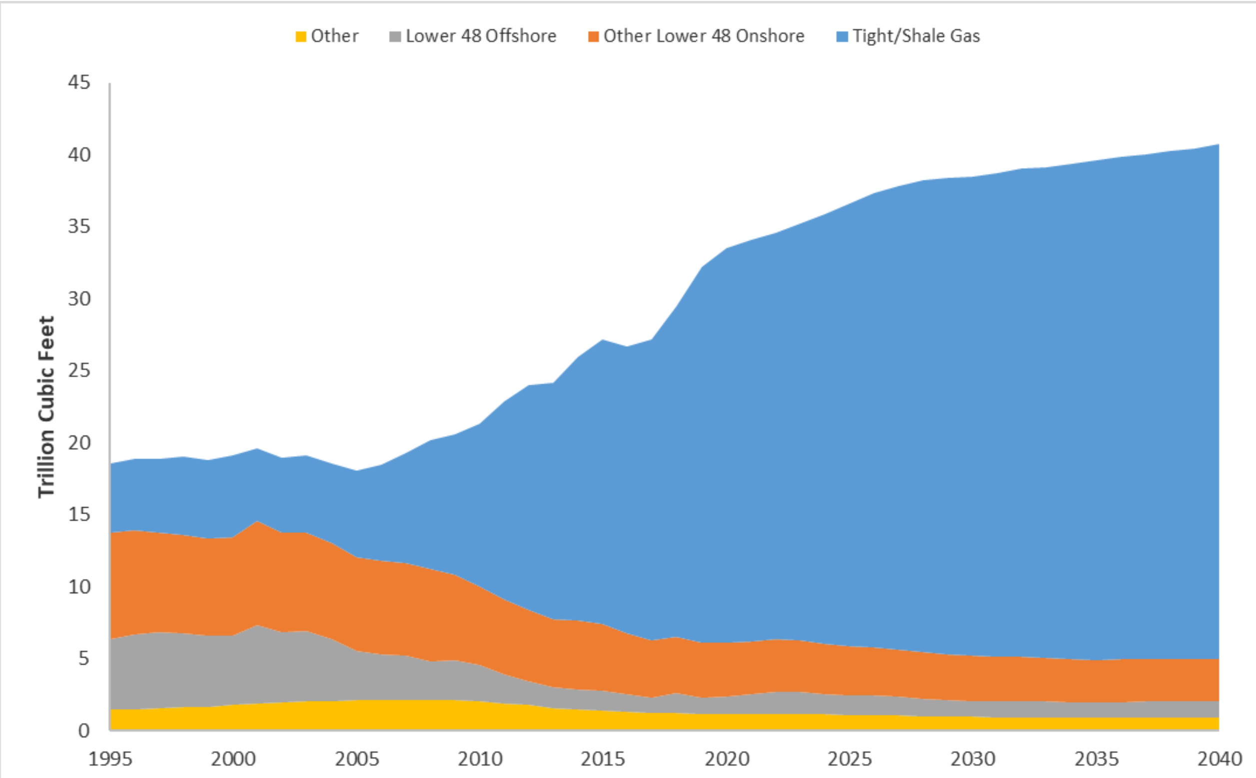
Natural gas can be used in vehicles in compressed or liquid forms. In 2017, natural gas represented 0.1 percent of the total fuel supplied for passenger cars and light trucks. This share is projected to decline in coming decades to less than 0.1 percent by 2040 (EIA 2019a).[6] However, natural gas has recently become a significantly larger portion of U.S. electricity generation and is projected to increase in generation capacity over the coming decades. Electric vehicle sales could increase in the future compared to current levels (Chapter 8, *Cumulative Impacts*), and electricity is projected to be the largest

[6] Some compressed and liquefied natural gas used in vehicles is considered renewable natural gas (RNG), which is derived from biogas collected at landfills, municipal wastewater treatment facility digesters, agricultural digesters, and separated municipal solid waste digesters. Biogas from these sources is processed to be the same quality as pipeline-quality natural gas. EIA projects that 221 million gallons (approximately 0.0183 trillion cubic feet) of compressed natural gas or liquefied natural gas derived from renewable natural gas will be produced in 2018 (EIA 2017m). Because this accounts for a very small share of total U.S. natural gas production, renewable natural gas is not explored in detail as part of this chapter.

source of non-gasoline light-duty vehicle fuel consumption by 2050 (EIA 2019a). Based on this, the life-cycle impacts of natural gas production and consumption are considered here.

Increased market penetration of natural gas in the industrial and power sectors is a result of increased U.S. production of natural gas, in large part due to development of shale gas resources, as shown in Figure 6.2.2-1. Production growth and improvements in shale gas extraction technologies have lowered natural gas prices, generating increased consumption in the previously mentioned sectors (EIA 2019a).

Figure 6.2.2-1. U.S. Natural Gas Production by Source, Annual Energy Outlook 2019 Reference Case



Source: EIA 2019a

During the vehicle use phase, natural gas results in lower GHG emissions per unit of energy than other fossil fuels (EIA 2014a, 2014b). When substituted for coal to produce heat or electricity, natural gas has lower emissions of sulfur dioxide, nitrogen oxides, and mercury (Moore et al. 2014).

6.2.2.1 Methane Emissions from Oil and Natural Gas

Methane accounted for an estimated 10 percent of total U.S. GHG emissions in 2017 (EPA 2019d). From 1990 through 2017, annual U.S. methane emissions decreased by 16 percent, largely because of emissions reductions from landfills and natural gas systems (EPA 2019d). Natural gas systems are currently the largest source of anthropogenic methane emissions in the United States (EPA 2019d). In 2017, approximately 25 percent of the methane emitted in the United States is attributed to natural gas systems, and 6 percent comes from petroleum systems. Because methane emissions from oil and natural gas are often presented together in the literature, this section includes a discussion of both natural gas and petroleum systems. Additional information on the life-cycle impacts of oil-based fuels is presented in Section 6.2.1, *Diesel and Gasoline*.

Methane emissions occur at multiple points upstream of the end use of oil and natural gas for industrial, power generation, and transportation purposes. Natural gas systems consist of four major stages: production (extracting the natural gas), processing, transmission and storage, and distribution. Oil supply chain methane emissions primarily emanate from production, with smaller amounts emanating from transportation and refining. Methane emissions, which represent a combination of venting and leakage, occur at a variety of points in these different supply chain stages. EPA estimates that in 2017, the United States emitted 165.6 $MMTCO_2e$ of methane from upstream natural gas systems and 37.7 $MMTCO_2e$ from upstream oil processes. For natural gas, 66.0 percent of methane emissions were from field production, 7.1 percent were from processing, 19.7 percent were from transmission and storage, and 7.2 percent were from distribution. For oil, field production is the primary source of emissions with 97.6 percent of total emissions and 2.4 percent from transportation and refining (EPA 2019d). These emissions do not include emissions related to use of natural gas (i.e., combustion of natural gas in vehicles). The primary sources of methane emissions are as follows:

- **Production (natural gas and oil)**. In 2017, the most significant identified natural gas production sources of methane emissions identified in the EPA Inventory[7] are gathering stations, pneumatic controllers, kimray pumps, liquids unloading, condensate tanks, gathering pipeline leaks, and offshore platforms. Sources of emissions in oil production include pneumatic controllers, offshore oil platforms, gas venting and flaring, engines, chemical injection pumps, oil tanks, hydraulically fractured well completions, and oil wellheads (EPA 2019d).
- **Processing (natural gas).** Raw natural gas is composed of methane as well as other impurities. To prevent pipeline corrosion, these impurities must be removed before the natural gas can be transported and serve its end-use purpose. At processing facilities, the natural gas is separated from the other constituents of the raw gas. This requires maintaining certain levels of pressure during processing, and during the processing stage methane emissions arise mainly from compressors (EPA 2019a).
- **Transmission and storage (natural gas).** This processed natural gas is then sent to transmission systems to be transported to distribution systems and hence to end-use consumption. In some instances, the processed product is stored in underground formations or liquefied and stored above ground in tanks. During transmission, methane emissions mainly arise from the compressor stations and pneumatic controllers. Natural gas is stored during periods of low demand and distributed during periods of high demand. When natural gas is stored, it can leak from compressors and dehydrators (EPA 2019d).
- **Distribution (natural gas).** During distribution, natural gas is emitted mainly from the gate stations and pipelines (EPA 2019d).

A reduction in leaks and venting throughout upstream natural gas life-cycle stages has resulted in a 14 percent decrease in overall natural gas methane emissions from 1990 to 2017. Methane emissions from petroleum supply declined by 10 percent between 1990 and 2017 due to decreases in vented methane (EPA 2019d).

There has been a wealth of research and literature around quantifying methane emissions and understanding how to reduce emissions. Previous studies find that methane emissions can occur in multiple locations upstream and near the point of use, although these emissions are highly variable and

[7] Annually, EPA compiles the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* report, referred to here as the EPA Inventory. The EPA Ininventory estimates national GHG emissions and removals by source, economic sector, and GHG type. The latest report includes data for each year from 1990 to 2017 (EPA 2019d).

difficult to quantify (Jackson et al. 2014, Payne and Ackley 2012, Peischl et al. 2013, Phillips et al. 2012). More recent studies that use on-site measurements for specific regions have analyzed upstream methane emissions from natural gas and oil production and processing (Marchese et al. 2015, Zavala-Araiza et al. 2015a, Lyon et al. 2015) to storage and distribution (Zimmerle et al. 2015, Lamb et al. 2015). These studies reveal that emissions can vary significantly throughout natural gas and oil systems, but additional on-site measurements—particularly of super-emitters that constitute a major share of total industry emissions—are needed to better quantify overall emissions and identify emissions-reduction opportunities. The EPA Inventory has been significantly updated in light of these studies. Using Intergovernmental Panel on Climate Change (IPCC) and EPA resources on oil and gas densities, and EIA data for U.S. production, the EPA Inventory leak rate in 2017 for oil and gas systems was about 1 percent of total production (EPA 2019a, IPCC 2006, EIA 2019b, EIA 2019c, EPA 1995b).

Methane leak rates upstream of oil and gas consumption play a critical role in LCAs of fuel pathways. Multiple studies modeled the effects of various leak rates on life-cycle GHG emissions of natural gas for electricity generation. An LCA assessing natural gas pathways for use in alternative light-duty fuel vehicles found that, on a life-cycle basis, natural gas vehicles became less fuel efficient than conventional gasoline vehicles at given upstream methane leak rates (1 to 11 percent) depending on the vehicle and fuel type (Tong et al. 2015). A similar study modeled the effects of various methane leak rates of less than 5 percent in natural gas systems, finding that increasing a leak rate from 1 to 5 percent increases overall life-cycle emissions of natural gas from 0.16 to 0.81 g CO_2e/MJ (Farquharson et al. 2016). While the latest EPA Inventory estimate for overall leak rates is on the lower end of these variations, a few specific sites in natural gas systems can exceed 4.6 percent, with these super-emitter sites responsible for a majority of methane emissions (Zavala-Araiza et al. 2015b). However, a recent study estimated that in 2015 the EPA Inventory was underreporting supply chain methane emissions from oil and natural gas industries by about 60 percent. The authors found that this underreporting is due to EPA Inventory estimation methods at the time not capturing methane emissions from abnormal operating conditions in production (Alvarez et al. 2018).

In August 2019, EPA proposed removing methane emissions-control requirements for the oil and gas industry.[8] EPA estimated that this would increase annual emissions by 30,000 MT CH_4 in 2019, and 65,000 MT CH_4 in 2025 (EPA 2019f).

6.2.2.2 Shale Gas and Hydraulic Fracturing

Hydraulic fracturing of shale gas deposits has traditionally been referred to as an unconventional source of natural gas but has become the largest source of natural gas in the United States in the last decade. In 2018, hydraulically fractured wells accounted for 78 percent of marketed U.S. natural gas production. This share is projected to increase to 88 percent of natural gas production by 2040 (EIA 2019a).

Shale gas is sourced from gas-rich, low-permeability shale formations that consist of hydrocarbons trapped in fractures and pores of rock deep underground. To access and extract this gas, a well is drilled down to the shale formation and then turned horizontally to follow the shale formation. Gas is then freed by forcing a mixture of water, sand, and chemicals at high pressure to fracture the shale formation and force the gas to the wellhead (NETL 2011). These techniques result in upstream environmental impacts that differ from those of conventional natural gas extraction. This section focuses on two

[8] Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review; Proposed Rule, 84 FR 50244 (Sept. 24, 2019).

significant environmental concerns surrounding shale gas development: GHG and other air pollutant emissions, and water-related impacts (i.e., water pollution and consumption).

Following the rapid rise of shale gas development and consumption, shale gas became a trending topic in LCA research, primarily focused on life-cycle GHG emissions. Two LCA shale gas literature reviews compare and assess the results of almost 20 different LCAs. Weber and Clavin (2012) analyzed the sensitivity of emissions from hydraulic fracturing natural gas production to different study assumptions. Heath et al. (2014) used a harmonization approach as part of the broader National Renewable Energy Laboratory's electricity LCA harmonization research. This harmonization approach adjusts the models of existing LCAs to create comparable boundaries and assumptions (e.g., including emissions from liquids unloading, consistent global warming potential factors) for a more consistent comparison of results (Heath et al. 2014).

Upstream of electricity generation or other fuel combustion, production and supply of shale gas has several variables that drive LCA emissions estimates. Regional variations in the characteristics of shale formations and wells affect the estimated ultimate recovery of methane (Weber and Clavin 2012). Methane leaked, vented, or flared varies between studies. Methane emissions from shale gas development, production, and supply are detailed in Section 6.2.2.1, *Methane Emissions from Oil and Natural Gas.* Table 6.2.2-1 summarizes the results from upstream GHG emission for both shale and conventional gas from these LCA reviews. For the median case in each study, upstream natural gas GHG emissions represent 13 to 20 percent of shale gas life-cycle emissions, and 14 to 16 percent of conventional natural gas life-cycle emissions.[9] Note that the low and high results for Heath et al. (2014) reflect the 25th and 75th percentiles and maximum and minimum values for Weber and Clavin (2012). A more recent LCA of shale gas produced from the Marcellus shale formation found upstream GHG emissions to be 28 g CO_2e/MJ, or about 20 percent of total life-cycle emissions, similar to the results of Heath et al. (2014) (Laurenzi 2015).

Table 6.2.2-1. Results Summary for Upstream Shale Gas LCA Literature Reviews

LCA Literature Review	Shale Gas (g CO_2e/MJ Generated)			Conventional Gas (g CO_2e/MJ Generated)		
	Low	Median	High	Low	Median	High
Heath et al. (2014)	18	25	39	11	19	22
Weber and Clavin (2012)	8	15	27	5	16	18

LCA = life-cycle assessment; g CO2e/MJ = grams of carbon dioxide equivalent per megajoule

Upstream shale gas production activities have also created concerns for increased air pollution emissions from drilling and fracturing operations and trucking (Zoback and Arent 2014). One study estimated Pennsylvania air pollution emissions (volatile organic compounds, nitrogen oxides, sulfur oxides, and particulate matter less than 2.5 or 10 microns in diameter (PM2.5 and PM10, respectively)) using 2011 data from transportation activities (water, equipment, and wastewater), well drilling and hydraulic fracturing (fuel use), natural gas production (fuel use and methane leaks), and compressor stations (fuel use). Drilling, fracturing, and production activities accounted for the majority of emissions, with transportation contributing less than 10 percent across all pollutants (Litovitz et al. 2013).

Hydraulic fracturing water pollution concerns center on wastewater handling and local groundwater vulnerabilities. Wastewater primarily comes from flowback, the fluid used in hydraulic fracturing that

[9] Life-cycle emission calculations assume natural gas will be combusted for electricity generation.

returns to the surface during and after operations, which can contain contaminants (e.g., salt, selenium, arsenic, iron). Efforts to reduce wastewater treatment needs include flowback reuse, where some operations reuse nearly all flowback for future wells, returning contaminants to the original formations (Zoback and Arent 2014). Flowback reuse also alleviates freshwater use in fracturing operations. While freshwater consumption estimates in the literature have significant uncertainties, one literature review estimates freshwater consumption in shale gas extraction to be more than twice as high as in conventional gas extraction (Cooper et al. 2016). Other industry practices in minimizing freshwater consumption include using brackish or saline water for fracturing (Zoback and Arent 2014). Local groundwater contamination impacts can come from well construction or drilling practices. Close attention in casing and cement design and construction and pressure management can prevent contamination risks (Zoback and Arent 2014).

There is also evidence that hydraulic fracturing can induce seismic events, where an increase in earthquakes is clustered around hydraulic fracturing sites. This evidence has been limited to a study in Western Canada, where injection occurs in shale formations with highly impermeable layers (Bao and Eaton 2016). Induced seismic events in the United States, namely in the Midwest, have been linked to wastewater and saltwater disposal wells into permeable layers (Bao and Eaton 2016, USGS 2017). A USGS analysis revealed that earthquakes east of the Rocky Mountains, primarily in Oklahoma, have increased substantially since 2009. This timeline coincides with the rise of shale oil and gas production in the region, which generates increased volumes of wastewater injection into geologic formations. Before 2009, Oklahoma experienced low-magnitude (a rating of three to four on the momentum magnitude scale) earthquakes once or twice annually. Since 2014, these low-magnitude events have been occurring daily, with limited instances of higher-magnitude events (ratings of five to six) (EIA 2017i).

6.2.3 Electricity

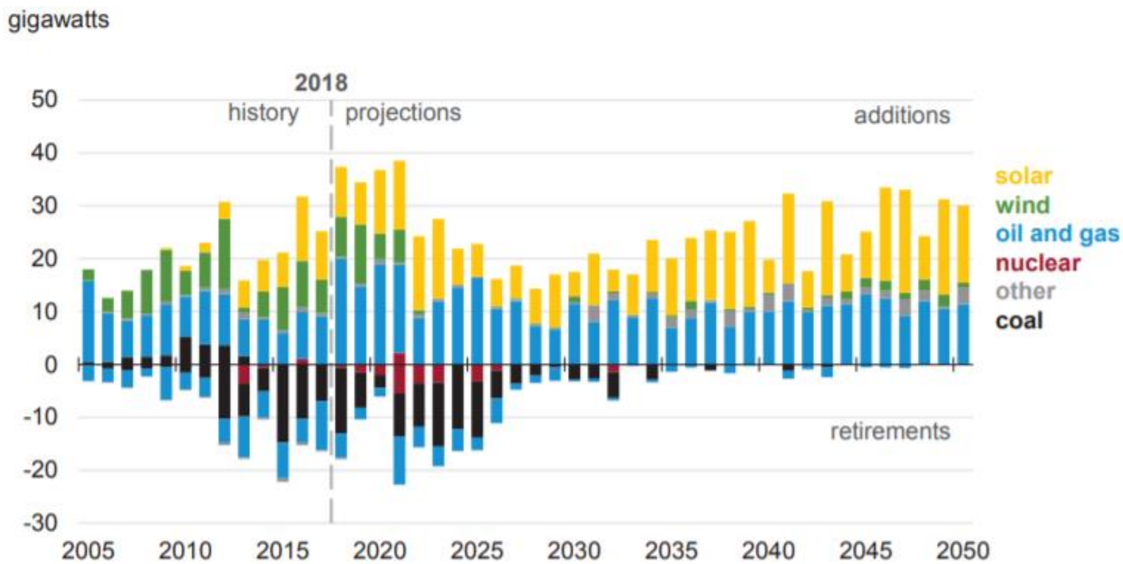
Electricity currently makes up 0.1 percent of light-duty vehicle fuel use, but the AEO 2019 projects this proportion to increase to 4.9 percent by 2050, representing the largest share of fuel consumption outside of gasoline (EIA 2019a). Electric vehicles (EVs) use battery technologies to provide power, thereby reducing or even eliminating liquid fuel consumption during vehicle operation. EVs cover a range of different engine types, including BEVs, HEVs, and PHEVs (Notter et al. 2010, Patterson et al. 2011, DOE 2013a). HEVs incorporate a battery and electric motor combined with an internal combustion engine (or fuel cell), and have onboard charging capabilities (e.g., regenerative braking) but are not charged by the electric grid. PHEVs are fitted with a large-capacity rechargeable battery that can be charged from the electric grid; like HEVs, they also use an internal combustion engine or fuel cell as backup when battery power is depleted. BEVs are purely electrically powered and do not incorporate an internal combustion engine. For more information on EVs and market trends, see Chapter 8, *Cumulative Impacts*.

EV LCAs have centered on three primary life-cycle phases in quantifying environmental impacts: vehicle manufacturing, battery manufacturing, and vehicle operations. Air quality and climate impacts reported in Chapter 4, *Air Quality,* and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, do not include vehicle or battery manufacturing LCA impacts but do reflect downstream (tailpipe) and upstream (refinery and electricity generation) emissions associated with fuel used in vehicle operations. Upstream emissions reflected in Chapters 4 and 5 are based on recent forecasts for the mix of fuels used for U.S. electricity generation, consistent with the AEO 2019 forecast. This U.S. grid mix has changed significantly over the past decade, and this means that older LCAs based on different grid mix assumptions might not be comparable with findings in Chapters 4 and 5, which are based on more recent grid mix forecasts.

Some LCAs of EVs and internal combustion vehicles have also examined the impacts from end-of-life management of vehicle batteries, as summarized in Section 6.3.3, *Vehicle Batteries*.

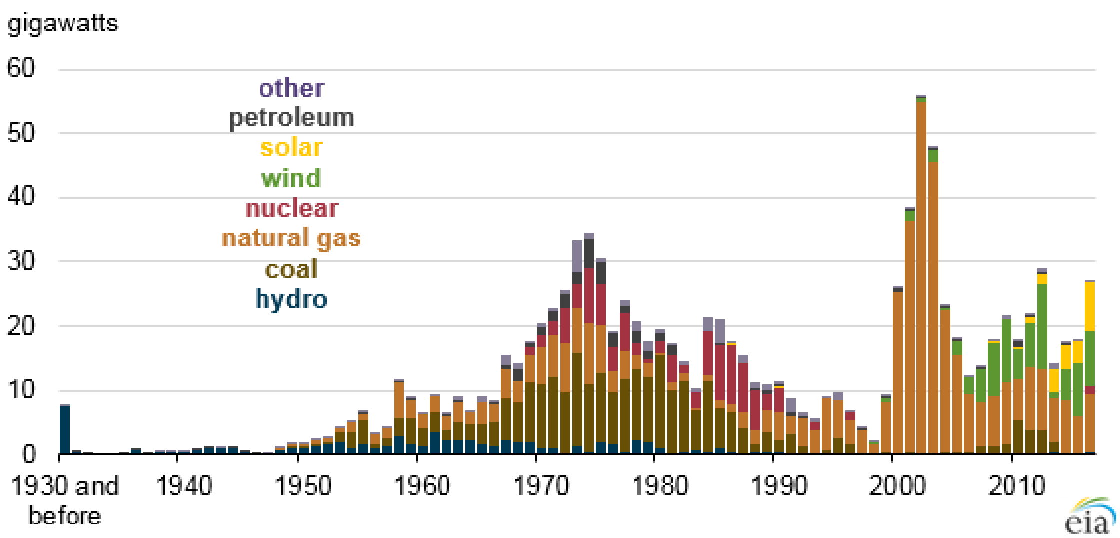
Figure 6.2.3-1 shows that oil, natural gas, wind, and solar power accounted for most electricity capacity additions from 2005 through 2018, and coal power plants accounted for most power plant retirements. Figure 6.2.3-2 shows that natural gas power plants also accounted for most of the capacity additions in the 1990s. This projected increase in natural gas and renewable energy sources in the electricity grid mix will lower the GHG emissions associated with electricity consumption, and subsequently BEV use, over time.

Figure 6.2.3-1. Historical and Projected U.S. Utility-Scale Electric Capacity Additions and Retirements (2005 to 2050)



Source: EIA 2019a

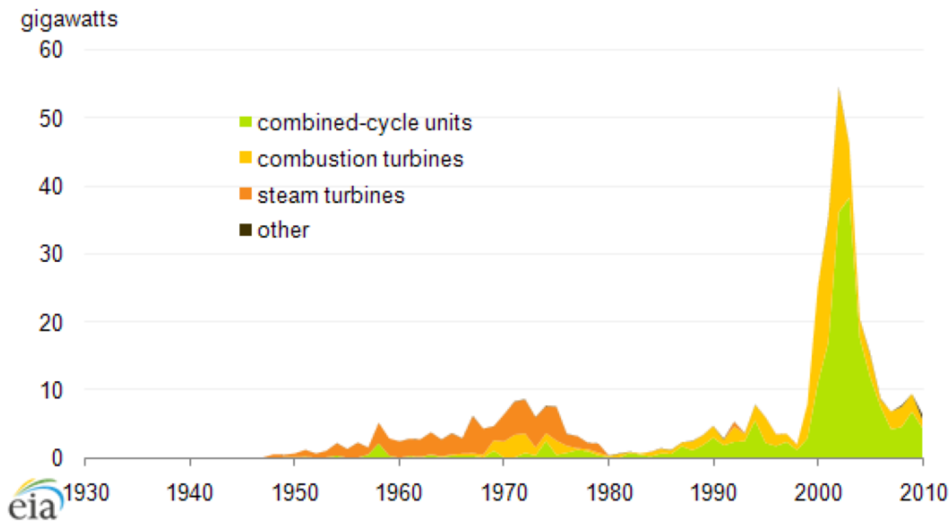
Figure 6.2.3-2. U.S. Utility-Scale Electric Generating Capacity by Initial Operating Year (as of December 2016)



Source: EIA 2017j

The increase in natural gas power plant capacity since the 1980s is primarily from the addition of combined-cycle units, as shown in Figure 6.2.3-3. Combined-cycle plants are much more efficient than other types of power plants, where efficiency is measured by power plant heat rate, which is the number of British thermal units (Btu) from source fuel needed to generate 1 kilowatt-hour (a lower heat rate indicates more efficient source fuel conversion). The average heat rate for combined-cycle natural gas plants is approximately 7,500 Btu per kilowatt-hour, compared to average heat rates above 10,000 Btu per kilowatt-hour for coal power plants and older natural gas combustion turbine and steam turbine plants (EIA 2017l).

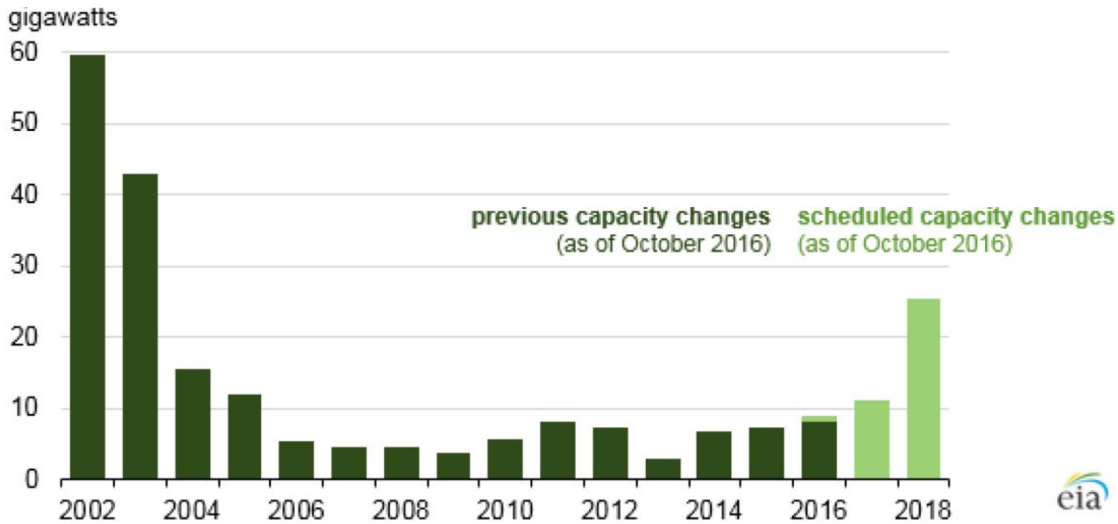
Figure 6.2.3-3. 2010 Capacity of Natural Gas Generators, by Initial Year of Operation and Type



Source: EIA 2011c

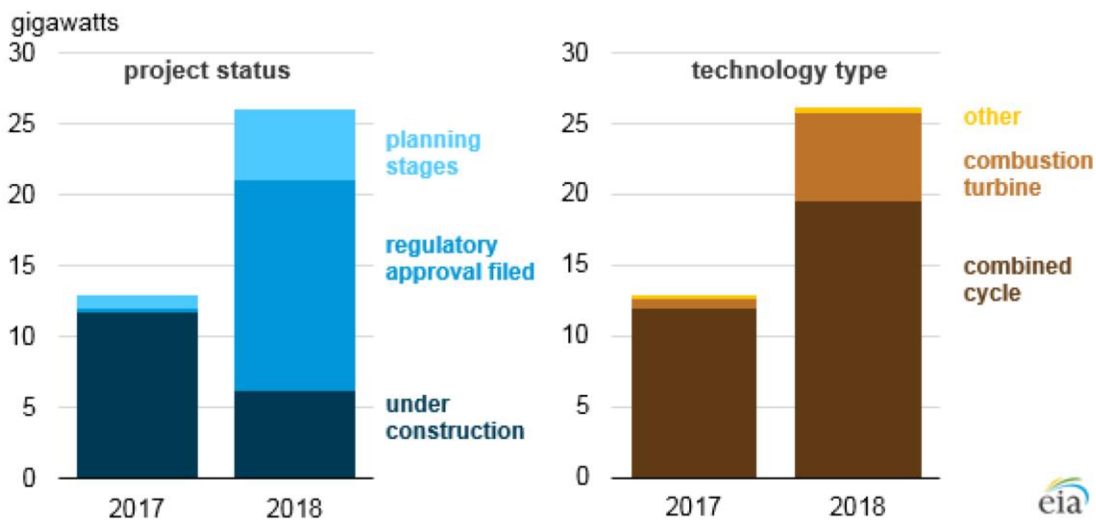
As new combined-cycle plants have been added, and less-efficient natural gas combustion and steam turbine plants are retired, the overall average heat rate for natural gas power plants has declined from approximately 8,100 BTU per kWh in 2006 to 7,800 in 2015 (EIA 2017l). EIA also reports substantial scheduled natural gas capacity additions in 2017 and 2018, with combined-cycle power plants accounting for most of this increase in generating capacity, as shown in Figures 6.2.3-4 and 6.2.3-5. In the AEO 2019, EIA reported an increase of 18 gigawatts of natural gas combined cycled capacity between 2017 and 2018. Steam power capacity from oil and natural gas declined by 4 gigawatts, and natural gas and diesel combustion turbine capacity added 1 gigawatt of capacity over this same time period (EIA 2019a).

Figure 6.2.3-4. Net Annual Change in U.S. Natural Gas Electric Generating Capacity (2002 to 2018)



Source: EIA 2017k

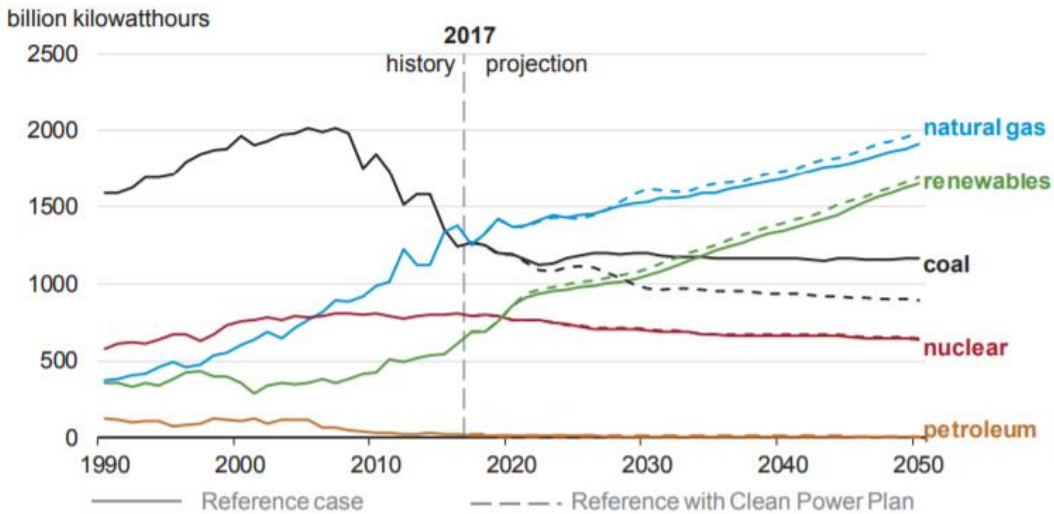
Figure 6.2.3-5. Capacity of Natural Gas Generators, by Initial Year of Operation and Type



Source: EIA 2017k

Figure 6.2.3-6 shows that coal U.S. electricity generation fell from approximately 2,000 billion kilowatt-hours (kWh) in 2010 to 1,250 billion kWh in 2017, reflecting the combined impact of additional natural gas and renewable energy generating capacity and historically low natural gas prices. The 2019 AEO projects that generation will remain near this level out to 2050 (EIA 2019a).

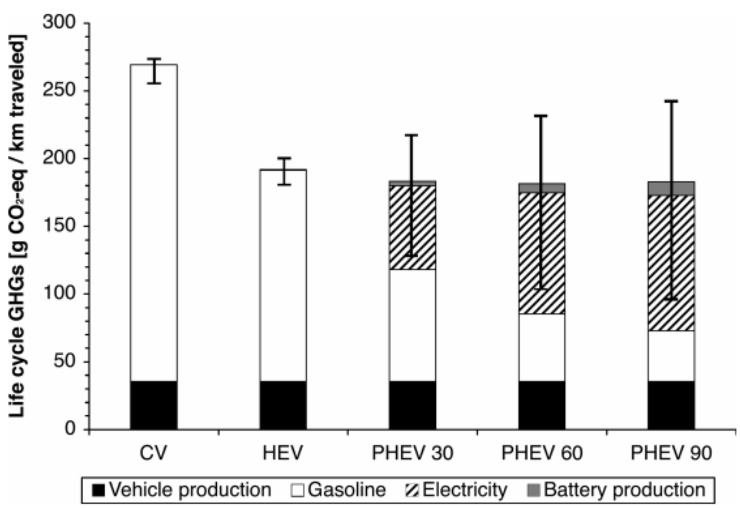
Figure 6.2.3-6. Net Electricity Generation by Source (1990 to 2050)



Source: EIA 2019a

Figure 6.2.3-7 shows the relative contributions of these phases to life-cycle EV GHG emissions, including variations for electricity grid mixes, from an LCA published by Samaras and Meisterling (2008).[10] The operation phase (more specifically, electricity consumption during operation) accounts for a significant portion of a vehicle's life-cycle environmental impacts (Samaras and Meisterling 2008, Gaines et al. 2011, Notter et al. 2010).

Figure 6.2.3-7. Life-Cycle Greenhouse Gas Emissions of U.S. Electric Vehicles



Source: Samaras and Meisterling 2008

CO_2-eq = carbon dioxide equivalent; CV = conventional vehicle; HEV = hybrid electric vehicle; PHEV 30/60/90 = plug-in hybrid electric vehicle with all-electric ranges of 30, 60, or 90 km, respectively. Life cycle GHG intensity of electricity represents a U.S. average value of 670 g CO_2e/kWh; uncertainty bars represent changes in total emissions under the carbon-intensive electricity scenario (950 g CO_2e/kWh) or low-carbon electricity scenario (200 g CO_2e/kWh).

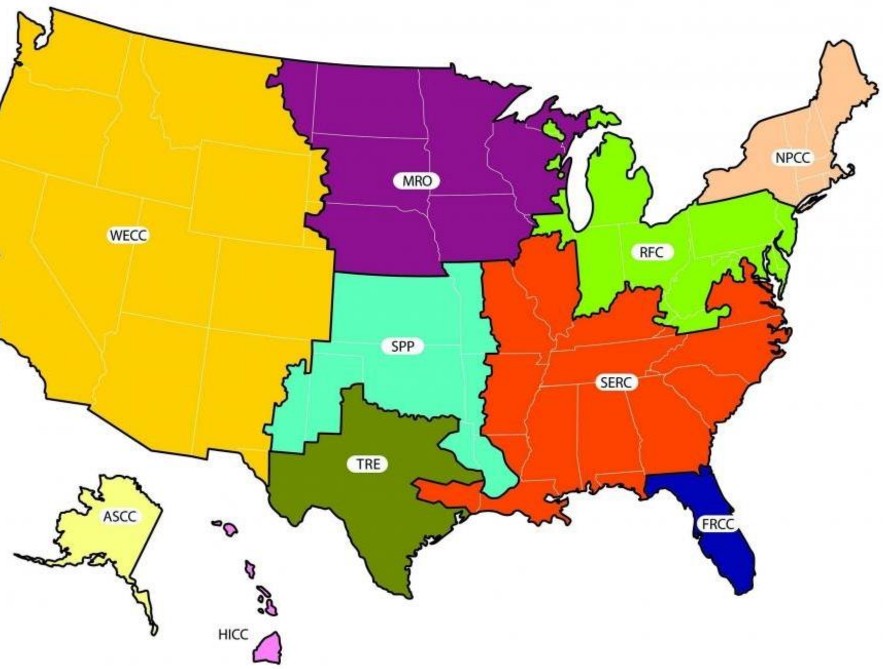
[10] Although Figure 6.2.3-7 is focused on HEVs and PHEVs, the operation phase findings extend to BEVs based on conclusions from more recent studies including Hawkins et al. (2012) and Nealer and Hendrickson (2015).

This section focuses on EV operations (i.e., use phase) and the associated life-cycle environmental impacts. This primarily consists of examining the dynamics of EV electricity consumption, including location and time of consumption. Electricity generation sources are the drivers of EV operation impacts. However, material production impacts are important considerations in EV LCAs, as EVs use more rare earth elements in drivetrain and battery design than internal combustion vehicles, which increase overall environmental impacts outside of vehicle operations (Gradin et al. 2017). Similarly, rare earth metals (platinum, palladium) are required for emissions controls in catalytic converters for internal combustion engine vehicles (ICEVs), and material demands will increase with stricter controls (Seo and Morimoto 2017). Associated impacts of EV and vehicle material production and end-of-life management are examined in Section 6.3.3, *Vehicle Batteries*.

6.2.3.1 Charging Location

The LCA literature concludes that use-phase GHG emissions from EVs depend on several factors, including *where* they are charged (Elgowainy et al. 2010, Holland et al. 2015, Nealer and Hendrickson 2015, Onat et al. 2015, Tamayao et al. 2015, Kawamoto et al. 2019). This is primarily because the grid mix used to supply electricity to EVs varies by location. In the United States, the grid mix consists of coal, natural gas, nuclear, hydroelectric, oil, and renewable energy sources. The relative proportions of these components can be analyzed by regions, including National Electricity Reliability Commission (NERC) regions (Figure 6.2.3-8) and EPA Emissions & Generation Resource Integrated Database (eGRID) subregions, which are based on energy transmission, distribution, and utility territories to analyze the environmental aspects of power generation (Figure 6.2.3-9) (Tamayao et al. 2015). For example, in the eGRID subregion that includes Missouri and much of Illinois, 74 percent of electricity is generated by coal, while in most of Alaska, 78 percent of energy comes from hydropower, indicating that the magnitude of emissions associated with EVs charged in the two subregions would likely differ significantly. A breakdown of grid mix by eGRID subregion is shown in Figure 6.2.3-10.

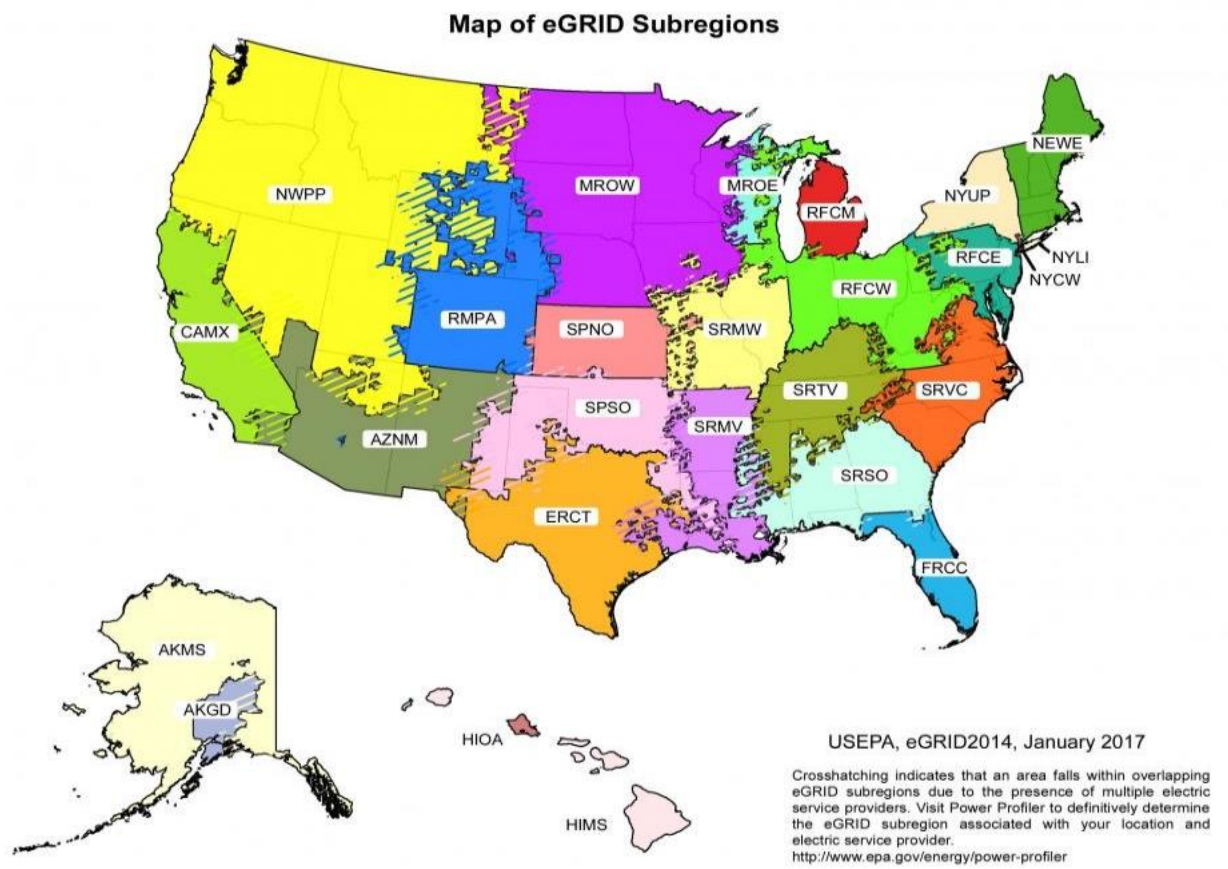
Figure 6.2.3-8. National Electricity Reliability Commission Regional Map



Source: EPA 2015e

FRCC = Florida Reliability Coordinating Council; MRO = Midwest Reliability Organization; NPCC = Northeast power Coordinating Council; RFC = Reliability First Corporation; SERC = SERC Reliability Corporation; SPP= Southwest Power Pool; TRE = Texas Reliability Entity; WECC = Western Electricity Coordinating Council; ASCC = Alaska Grid; HICC = Hawaii

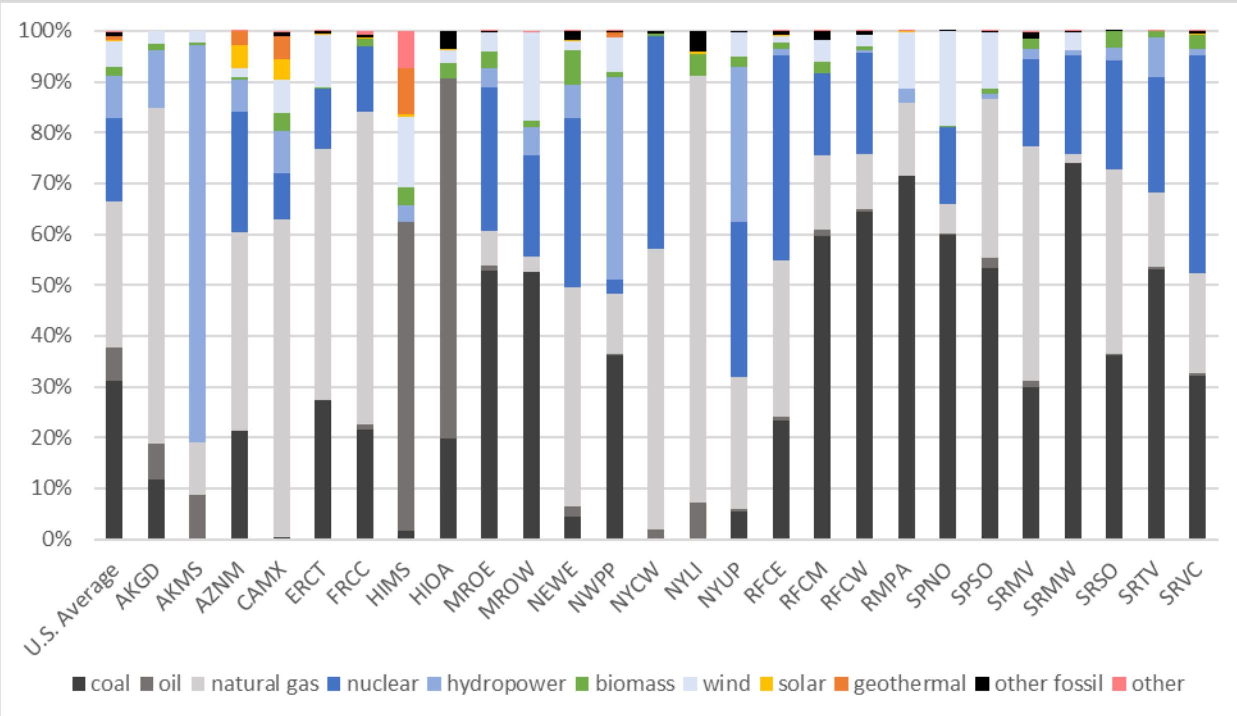
Figure 6.2.3-9. Environmental Protection Agency eGRID Subregions



Source: EPA 2017a

eGRID = Emissions & Generation Resource Integrated Database. eGRID subregions are derived from NERC names: FRCC = FRCC All; MORE = MRO East; MROW = MRO West; NEWE = NPCC New England; NYCW = NPCC NYC/Westchester; NYLI = NPSS long island; NYUP = NPCC Upstate NY; RFCE = RFC East; RFCM = RFC Michigan; RFCW = RFC West; SRMW = SERC Midwest; SRMV = SERC Mississippi Valley; SRSO = ERV South, SRTV = SERC Tennessee Valley; SRVC = SERC Virginia/Carolina; SPNO = SPP North; SPSO = SPP South; CAMX = WECC California; NWPP = WECC Northwest; RMPA = WECC Rockies; AZNM = WECC Southwest; ERCT = Electric Reliability Council of Texas; AKGD = ASCC Alaska Grid; AKMS = ASCC Miscellaneous; HIOA = HICC Oahu; HIMS = HICC Miscellaneous

Figure 6.2.3-10. 2014 U.S. Average and eGRID Subregion Grid Mix

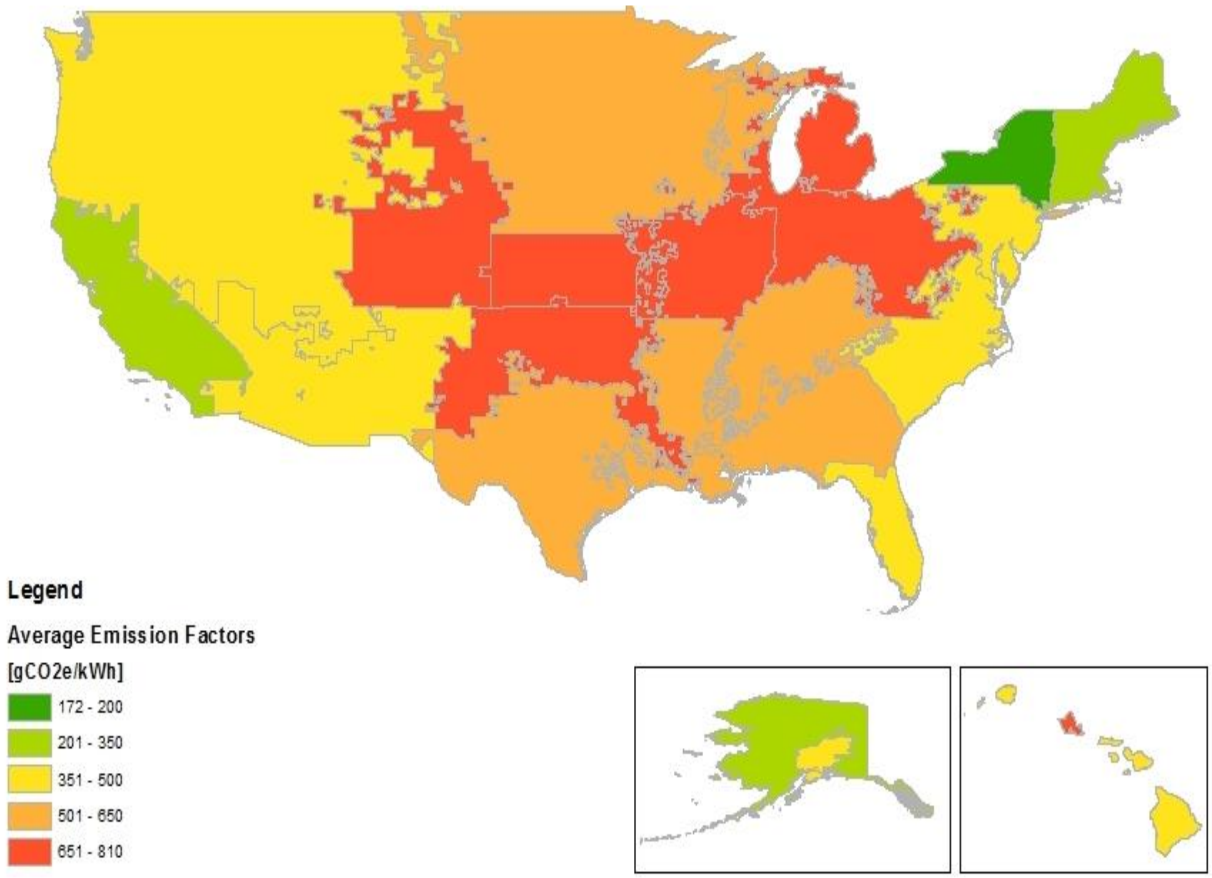


Source: EPA 2017c

eGRID = Emissions & Generation Resource Integrated Database. Regional names are derived from NERC regional names: FRCC = FRCC All; MORE = MRO East; MROW = MRO West; NEWE = NPCC New England; NYCW = NPCC NYC/Westchester; NYLI = NPSS long island; NYUP = NPCC Upstate NY; RFCE = RFC East; RFCM = RFC Michigan; RFCW = RFC West; SRMW = SERC Midwest; SRMV = SERC Mississippi Valley; SRSO = ERV South, SRTV = SERC Tennessee Valley; SRVC = SERC Virginia/Carolina; SPNO = SPP North; SPSO = SPP South; CAMX = WECC California; NWPP = WECC Northwest; RMPA = WECC Rockies; AZNM = WECC Southwest; ERCT = Electric Reliability Council of Texas; AKGD = ASCC Alaska Grid; AKMS = ASCC Miscellaneous; HIOA = HICC Oahu; HIMS = HICC Miscellaneous

Because of the variation in grid mixes, electricity average emission factors (AEFs) vary significantly by subregion, with the most carbon-intensive subregion of the United States emitting more than 4.7 times as much CO_2 per kilowatt-hour relative to the least carbon-intensive subregion, as shown in Figure 6.2.3-11. Generally, AEFs (and emissions associated with EV use-phase electricity consumption) are lowest in the West, Northeast, and Alaska, and highest in the middle of the country.

Figure 6.2.3-11. eGRID Subregion Average Emission Factors for Electricity (g CO_2e/kWh)

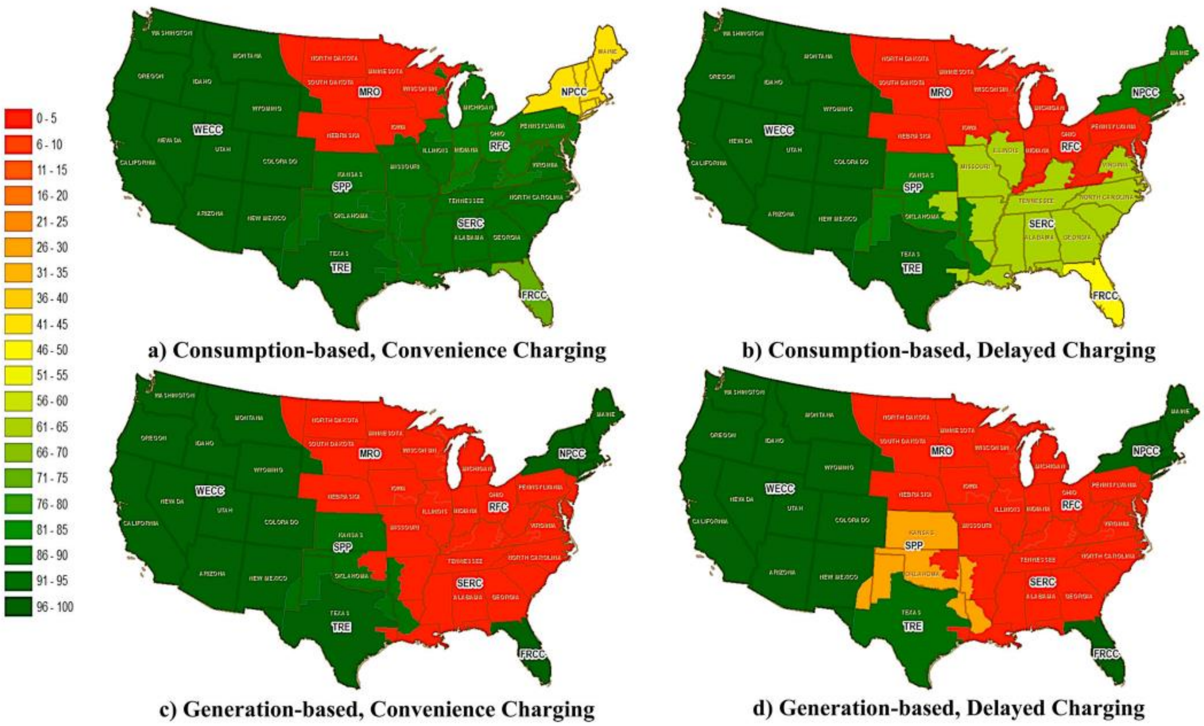


Source: EPA 2017c
eGRID = Emissions & Generation Resource Integrated Database; g CO_2e/kWh = grams of carbon dioxide equivalent per kilowatt –hour; g CO_2e/kWh = grams of carbon dioxide equivalent per kilowatt-hour

A National Renewable Energy Laboratory (NREL) BEV use-phase study (McLaren et al. 2016) estimated GHG emissions per day for potential BEV and PHEVs, and found that total daily emissions for a BEV increased by more than a factor of three between a low carbon electricity mix (97 percent renewables and hydropower, 8.8 kg CO_2/day) and high carbon mix (93 percent coal, 26.4 kg CO_2/day).

Marginal electricity refers to electricity generated in response to a new load at a given time and location (Tamayao et al. 2015). The use of marginal emission factors (MEFs) rather than AEFs can significantly affect EV life-cycle impacts, as electricity consumption emission factors are highly variable and dictate use-phase emissions. Tamayao et al. (2015) characterized regionally specific life-cycle CO_2 emissions per mile traveled for BEVs, HEVs, and internal combustion engine vehicles by NERC region under alternative assumptions for regional electricity emission factors and charging schemes. The authors presented their findings by listing the median CO_2 emissions difference between a BEV and a HEV and between a BEV and an internal combustion engine vehicle in a given NERC subregion. The authors accounted for two different electricity emission factor methods (consumption-based MEFs and generation-based MEFs) and two different charging schemes (convenience charging and delayed charging at off-peak hours). Consumption-based MEFs refer to electricity CO_2 emissions based on total electricity consumed, and generation-based uses total electricity generated (Zivin et al. 2014). Tamayao et al. (2015) found that BEVs produced the lowest emissions relative to HEVs and internal combustion engine vehicles in western regions and in Texas. Results indicate that the MEF method chosen and the charging scheme can have a significant impact on BEV emissions (Figure 6.2.3-12).

Figure 6.2.3-12. Probability that a BEV Emits CO_2 at a Lower Rate than a HEV or Internal Combustion Engine Vehicle



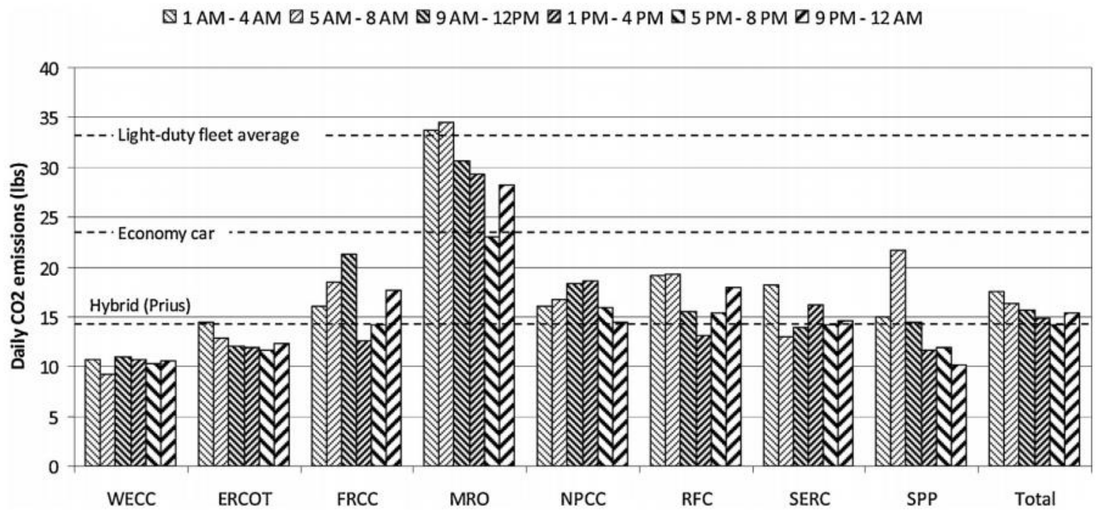
Source: Tamayao et al. 2015

Green indicates that the BEV is lower emitting than the gasoline vehicle (HEV or sales-weighted internal combustion engine vehicle), while red means the opposite.

FRCC = Florida Reliability Coordinating Council; MRO = Midwest Reliability Organization; NPCC = Northeast power Coordinating Council; RFC = Reliability First Corporation; SERC = SERC Reliability Corporation; SPP= Southwest Power Pool; TRE = Texas Reliability Entity; WECC = Western Electricity Coordinating Council

Zivin et al. (2014) analyzed spatial variation in average and marginal emissions and found that average emission rates are nearly twice as much in the upper Midwest relative to the western United States (1.63 versus 0.83 pounds CO_2 per kilowatt-hour). Marginal emission rates are nearly three times greater in the upper Midwest relative to the western United States (2.30 versus 0.80 pounds CO_2 per kilowatt-hour). Marginal emission rates are further discussed in Section 6.2.3.2, *Marginal Grid Greenhouse Gas Intensity.* Using marginal emissions to estimate CO_2 emissions per mile, Zivin et al. (2014) found that emissions are lower for EVs than from HEVs in the western United States (WECC) and Texas (ERCOT), while the opposite is true in the upper Midwest (MRO), as shown in Figure 6.2.3-13 (Zivin et al. 2014). Under this study, the upper Midwest MRO region is also the only region where the average internal combustion engine economy car is less GHG-intensive than an EV.

Figure 6.2.3-13. Daily Battery Electric Vehicle Carbon Dioxide Emissions by National Electricity Reliability Commission Region and Time of Day, Assuming 35 Miles Driven per Day[a]



Source: Zivin et al. 2014

[a] The dashed horizontal lines illustrate emissions from internal combustion engines, including the average light-duty vehicle and economy car, and from the Prius hybrid electric vehicle.

CO_2 = carbon dioxide; lbs = pounds; WECC = Western Electricity Coordinating; ERCOT = Electric Reliability Council of Texas; FRCC = Florida Reliability Coordinating Council; MRO = Midwest Reliability Organization; NPCC = Northeast power Coordinating Council; RFC = Reliability First Corporation; SERC = SERC Reliability Corporation; SPP= Southwest Power Pool

Electricity grid mix also plays a substantial role in EV life-cycle air pollution outside of GHG emissions. EV electricity consumption is a main driver of life-cycle particulate matter, sulfur oxides, and nitrogen oxide emissions, as well as ozone formation (Weis et al. 2016, Tessum et al. 2014, Hawkins et al. 2013). Carbon-intensive grid mixes, primarily those that are reliant on coal, create significantly higher particulate emissions and ozone formation potential than conventional internal combustion engine vehicles (Hawkins et al. 2013, Tessum et al. 2014). Substituting coal electricity generation with renewable or less carbon-intensive sources can reduce EV life-cycle particulate matter, nitrogen oxide, and sulfur oxide emissions substantially (Weis et al. 2016).

Kawamoto et al. (2019) assessed the relationship between driving distance and electricity mix in life-cycle emissions of EVs in comparison to ICEVs. The authors found that regional differences in the energy mix of electricity generation showed great significance in the overall LCA of an EV depending on the distance traveled throughout the vehicles' lifetime. In particular, regions with higher penetrations of renewables and/or lower carbon alternatives improved the LCA of EVs, such that a breakeven point with ICEVs—in terms of life-cycle emissions—would occur in the United States at approximately 60,000 kilometers (around 37,000 miles) (Kawamoto et al. 2019).

In summary, the studies cited in Section 6.2.3.1 find that EVs use-phase emissions are lowest for EVs charged in the West, Northeast, and Texas, a pattern that is consistent with grid mix and associated emission factors. The literature indicates that in current grid mixes, EVs emit less than internal combustion engine vehicles throughout most, if not all, of the United States; the upper Midwest (the MRO NERC region) is the only region where this is consistently shown to not hold true based on the studies reviewed.[11] In comparing EV and HEV emissions, EVs emit less than HEVs in the West and Texas (the WECC and TRE/ERCOT NERC regions) and emit more in the upper Midwest (the MRO region). The results are mixed, varying based on emission factor estimation method and charging time, in the Northeast, the Southeast, and Central United States (the NPCC, FRCC, SPP, SERC, and RFC regions). Reducing grid mix carbon intensity reduces both GHG and criteria pollutant emissions for the EV use phase.

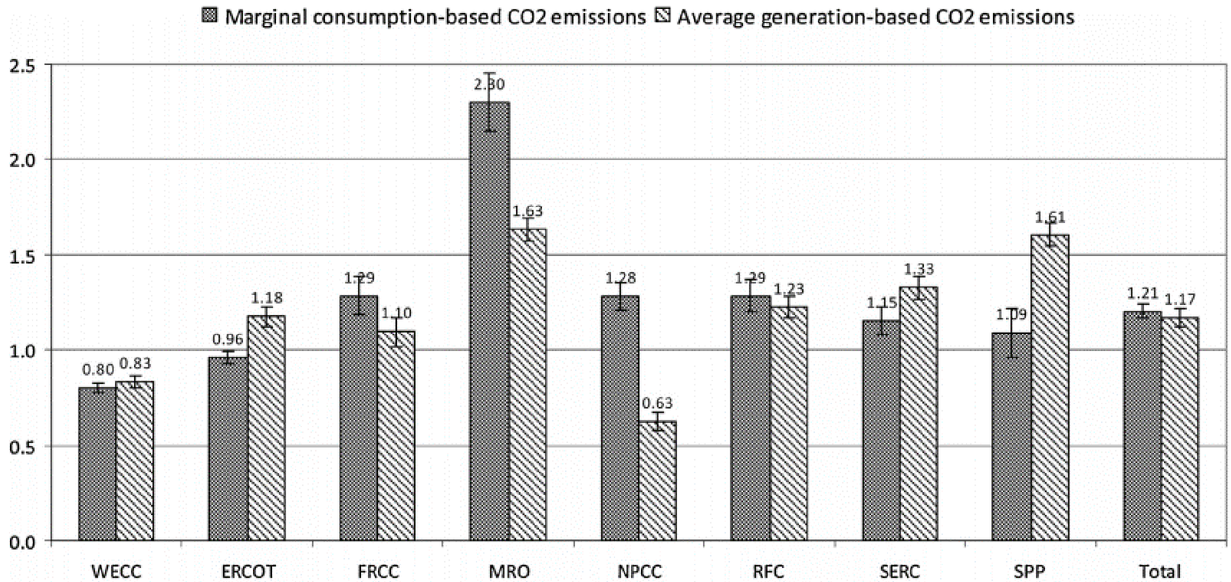
6.2.3.2 Marginal Grid Greenhouse Gas Intensity

MEFs discussed in Section 6.2.3.1 focus on specific locations relative to the national average, but several studies have focused on emission variations from the timing of electricity consumption and EV charging. Both time of day (peak vs. off-peak loads) and seasonal fluctuations can affect the GHG intensity of electricity generation (Archsmith et al. 2015). Some studies argue that MEFs more accurately reflect the emissions associated with the electricity used to fuel EVs (Nealer and Hendrickson 2015, Ryan et al. 2016). However, the high variation in MEFs creates difficulty in determining which power plant responds to meet marginal electricity demand (Tamayao et al. 2015). Therefore, many studies use AEFs to calculate EV emissions (Nealer and Hendrickson 2015, Tamayao et al. 2015). The difference between the two types of emission factors can translate to a discrepancy of up to 50 percent for a given NERC region and 120 percent for a given state for estimates of GHG emissions per vehicle mile traveled (Tamayao et al. 2015). Some studies take an alternate approach, generating hypothetical scenarios for electricity emissions outside of MEFs or AEFs, but these studies are subjective and may not reflect real-world behavior (Weis et al. 2016).

The regional discrepancy between MEFs and AEFs is illustrated in Figure 6.2.3-14 (Zivin et al. 2014). While MEFs differ significantly from AEFs in the Northeast (NPCC: 103 percent difference), upper Midwest (MRO: 40 percent difference), and central United States (SPP: -32 percent difference), differences are minimal in the West (WECC: 4 percent difference) and the Mid-Atlantic/Midwest (RFC: 5 percent difference). Gas is generally the largest marginal fuel source in regions where MEFs approximate or are lower than AEFs (e.g., marginal fuel is 81 percent gas in NPCC, 86 percent in WECC, 84 percent in TRE [ERCOT]). Coal or oil are significant marginal fuel sources where MEFs exceed AEFs (e.g., marginal fuel is 79 percent coal in MRO and 70 percent in RFC, and marginal fuel is 12 percent oil in FRCC and 11 percent in NPCC) (Siler-Evans et al. 2012).

[11] Future electricity grid mixes could change and potentially raise the GHG intensity of regional grid mixes, which could affect this conclusion.

Figure 6.2.3-14. Marginal Emission Factors and 95 Percent Confidence Intervals versus Average Emission Factors by National Electricity Reliability Commission Region

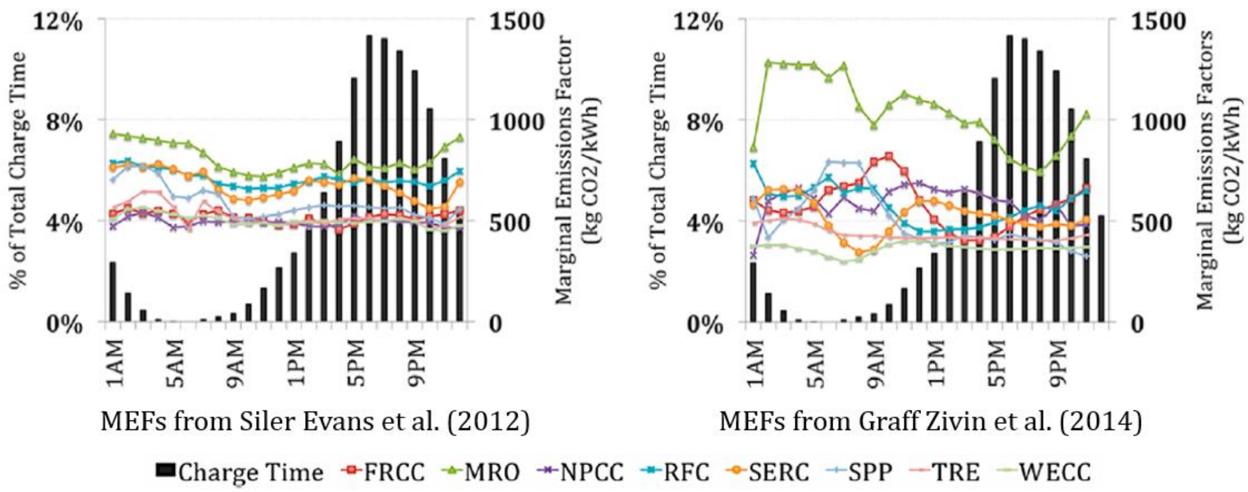


Source: Zivin et al. 2014

CO_2 = carbon dioxide; FRCC = Florida Reliability Coordinating Council; MRO = Midwest Reliability Organization; NPCC = Northeast Power Coordinating Council; RFC = Reliability First Corporation; SERC = SERC Reliability Corporation; SPP= Southwest Power Pool; WECC = Western Electricity Coordinating Council

MEFs vary throughout the day (Figure 6.2.3-15). For many NERC regions, MEFs are lower than AEFs during the 7 to 8 a.m. electricity load peak, at which point natural gas is often used to fuel marginal electricity (Tamayao et al. 2015). However, EVs are not typically charged during this time; they are charged after the last trip of the day, a pattern known as convenience charging. Tamayao et al. (2015) presents the profile of EV convenience charging (black bars in Figure 6.2.3-15) with diurnal MEF estimates for NERC regions (colored plots in Figure 6.2.3-15) for two MEF estimation methods. While in some regions the convenience charge peak coincides with a dip in MEFs (e.g., MRO), in others it does not.

Figure 6.2.3-15. Convenience Charging Profile[a] and Hourly Marginal Emission Factors[b] by National Electricity Reliability Commission Region[c]



Source: Tamayao et al. 2015

[a] Black vertical bars, left axis

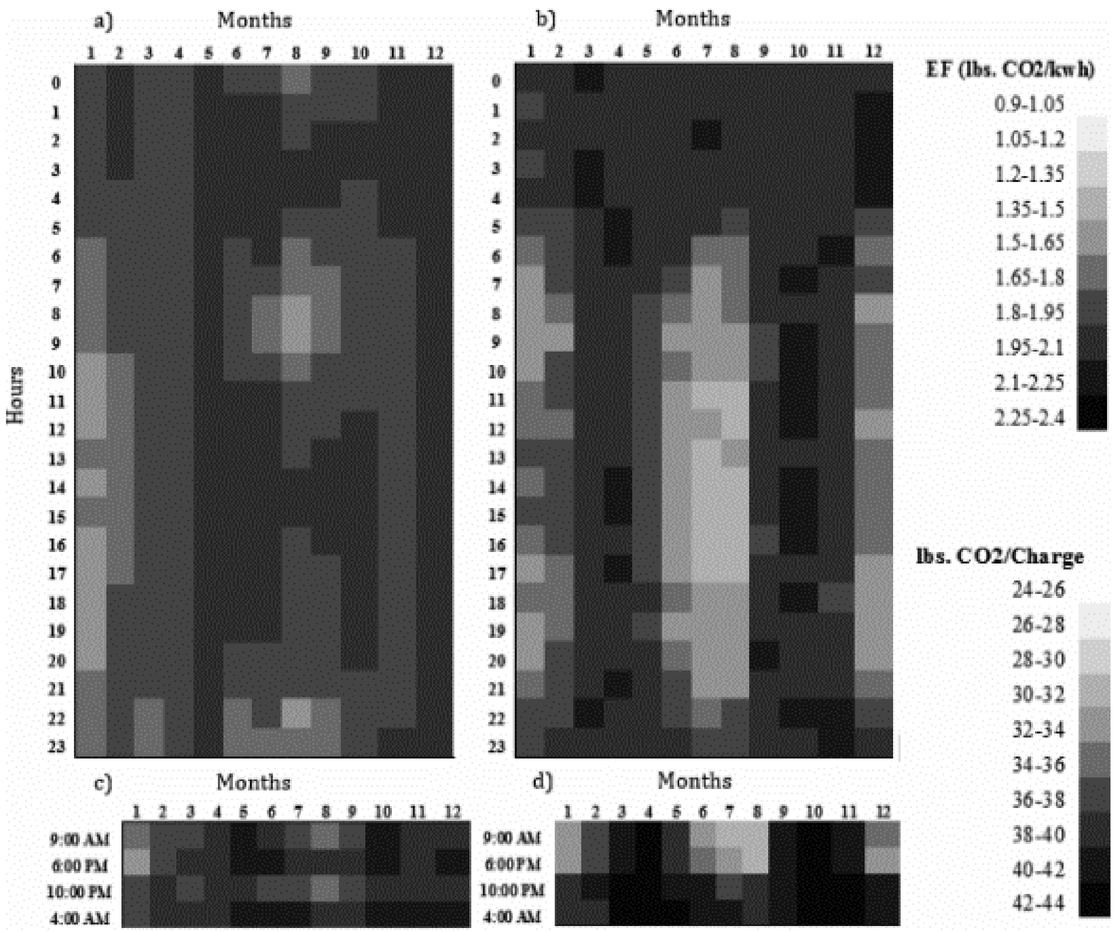
[b] Colored horizontal plots, right axis

[c] On the left MEFs are calculated using the methodology presented in Siler-Evans et al. (2012) while on the right MEF calculations use the methodology from Zivin et al. (2014)

MEF = marginal emission factor; kg/CO_2/kWh = kilograms of carbon dioxide per kilowatt-hour; FRCC = Florida Reliability Coordinating Council; MRO = Midwest Reliability Organization; NPCC = Northeast Power Coordinating Council; RFC = Reliability First Corporation; SERC = SERC Reliability Corporation; SPP= Southwest Power Pool; TRE = Texas Reliability Entity; WECC = Western Electricity Coordinating Council

MEFs also vary over the course of the year. However, as with diurnal MEF estimates, different models produce different seasonal patterns (Ryan et al. 2016). Figure 6.2.3-16 shows results from two models, PLEXOS and AVERT, which estimate MEFs over time for the upper Midwest. While AVERT produces a clear pattern of lower MEFs during the day in winter and summer relative to spring and fall, PLEXOS does not produce the same trend and produces less variation overall (Ryan et al. 2016). Ryan et al. (2016) suggest that the minimal hourly variability in the PLEXOS model may be because PLEXOS incorporates interregional trading while AVERT does not. Because of the variability in MEF estimates, model selection and results interpretation must consider the assumptions of estimation methods (Ryan et al. 2016).

Figure 6.2.3-16. Hourly and Monthly Carbon Dioxide Emission Factors and Emissions from Electric Vehicle Charging[a, b, c, d]



Source: Ryan et al. 2016

[a] MISO MOIL region emission factors estimated through PLEXOS

[b] Upper Midwest (WMW) region emission factors estimated through AVERT

[c] MISO MOIL emissions per charge (PLEXOS)

[d] Upper Midwest (WMW) emissions per charge (AVERT)

EF = emission factor; lbs/CO_2/kWh = pounds of carbon dioxide per kilowatt-hour

6.2.4 Biofuels

Over the past decade, the United States has seen significant increases in biofuel production due to federal legislation mandating that transportation fuel contain a minimum volume of renewable fuels, or biofuels. In 2005, the Energy Policy Act[12] established the Renewable Fuel Standard, which was expanded by the Energy Independence and Security Act of 2007.[13] The Renewable Fuel Standard requires that transportation fuel contain a certain volume of four categories of biofuel: biomass-based diesel,

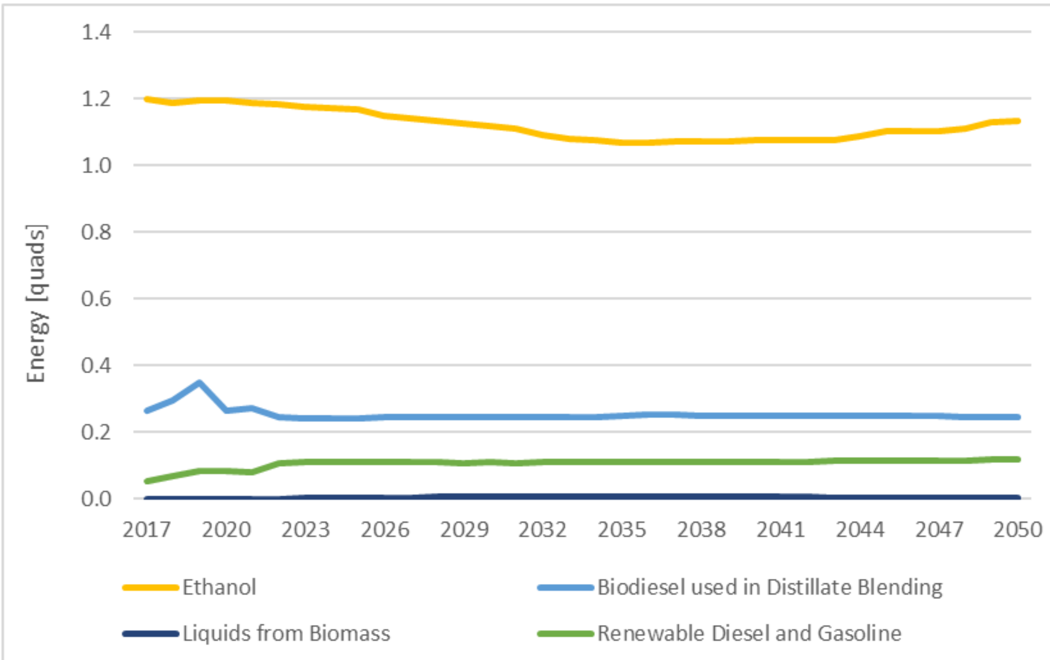
[12] Pub. L. No 109–58, 119 Stat. 594 (Aug. 8, 2005).

[13] Pub. L. No. 110–140, 121 Stat. 1492 (Dec. 19, 2007).

cellulosic biofuel, advanced biofuel, and total renewable fuel. By 2022, the program mandates the production of 36 billion gallons of total renewable fuel.

As illustrated in Figure 6.2.4-1, ethanol is projected to make up the majority of transportation sector renewable fuel, followed by biodiesel and renewable diesel and gasoline.

Figure 6.2.4-1. Transportation Renewable Energy Projections by Source



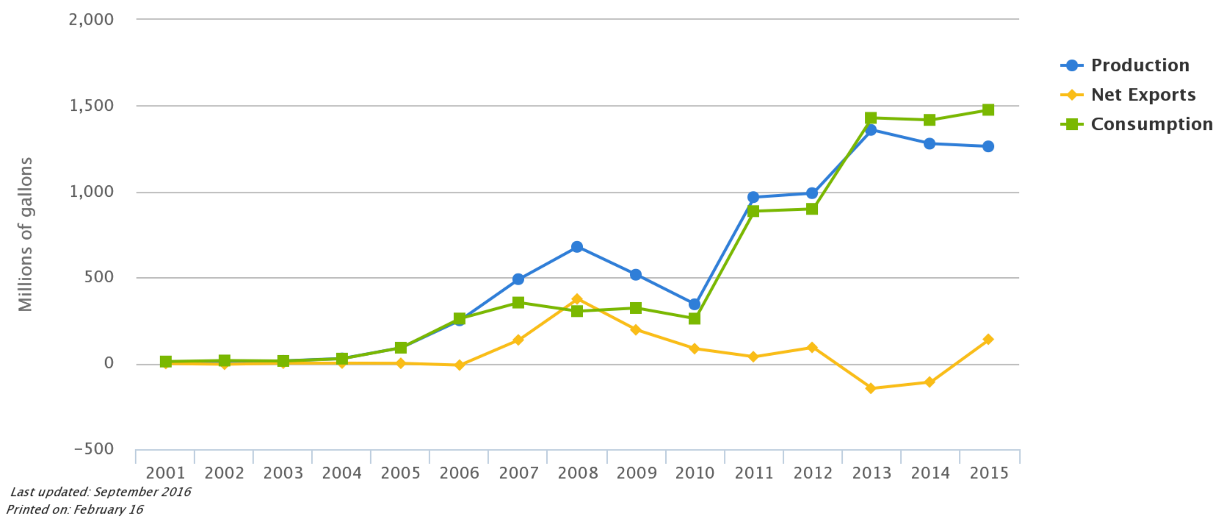
Source: EIA 2019a

Given AEO 2019 (EIA 2019a) projections, the biofuel component of this literature synthesis focuses on ethanol and biodiesel. All diesel-powered passenger cars and light trucks are potential candidates for biodiesel blends.

6.2.4.1 Biodiesel

When used as a fuel in on-road vehicles, biodiesel offers significant GHG emissions advantages over conventional petroleum diesel. Biodiesel is a renewable fuel that can be manufactured domestically from used cooking and plant oils, as well as from animal fats, including beef tallow and pork lard. To produce biodiesel, oils and fats are put through a process called transesterification, which converts oils and fats by causing them to react with a short-chain alcohol and catalyst to form fatty-acid methyl esters (NREL 2009). The majority of U.S. biodiesel can be combined with petroleum diesel to create different blends, the most common being B2 (2 percent biodiesel), B5 (5 percent biodiesel), and B20 (6 to 20 percent biodiesel) (AFDC 2017a). Biodiesel for sale in the United States must meet standards specified by American Society for Testing and Materials (ASTM) International. Biodiesel blends of 6 to 20 percent must meet ASTM D7467 specifications while pure biodiesel (B100) must meet ASTM D6751 specifications. As illustrated in Figure 6.2.4-2, U.S. biodiesel consumption and production has increased significantly over the past 10 years.

Figure 6.2.4-2. U.S. Biodiesel Production, Exports, and Consumption



Source: EIA 2016a

B20 and other lower-concentration biodiesel blends can be used in nearly all diesel equipment with few or no engine modifications (AFDC 2017a). B100 and other high-level blends used in motors not recommended or approved by the manufacturer to use B100 can degrade and soften incompatible vehicle parts and equipment such as hoses and plastics. Starting in 1994, many engine manufacturers began replacing the vulnerable parts of the engine, including rubber components, with materials compatible with biodiesel blends (AFDC 2017a). Because not all engines are compatible with higher-level blends, the National Renewable Energy Laboratory recommends contacting the engine manufacturer before using them (NREL 2009). Reducing the blend of biodiesel used in the winter months can avoid having biodiesel crystallize in cold temperatures. While biodiesel performance tends to improve in cold temperatures as the blend is reduced, additional measures such as incorporation of cold-flow additives can allow use of biodiesel blends up to B20 in cold weather conditions (AFDC 2015).

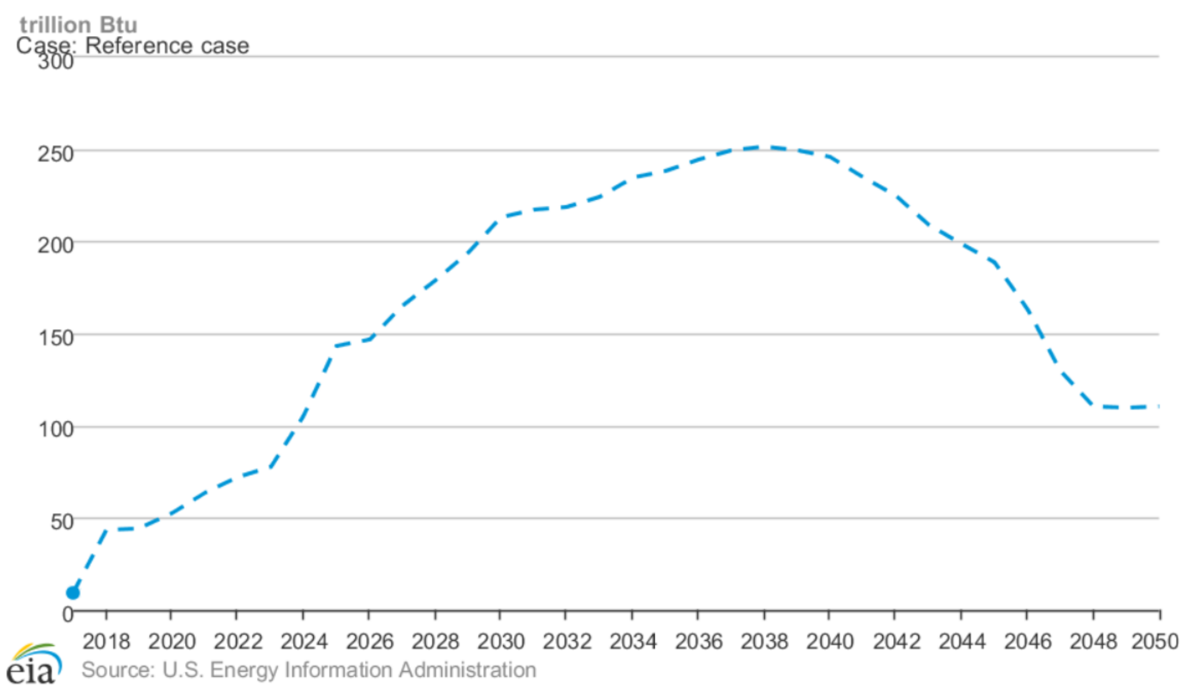
Argonne National Laboratory's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool shows that replacing one passenger car with a comparable model running on B20 reduces GHG emissions from 4.4 to 3.7 metric tons CO_2e annually, and replacement with a B100 vehicle reduces GHG emissions to 1.1 metric tons CO_2e annually. Similarly, the GREET model estimates well-to-wheels emissions for petroleum diesel and B20 biodiesel at 350 and 309 grams of CO_2e per mile, respectively (ANL 2018). These well-to-wheels emissions assume a soybean feedstock, which has lower life-cycle CO_2 emissions than algae feedstock. These estimates are consistent with an Argonne National Laboratory LCA that shows that GHG emissions can be decreased by up to 74 percent when using 100 percent biodiesel as a replacement for petroleum diesel (AFDC 2017a).

6.2.4.2 Ethanol

Ethanol used as an on-road vehicle fuel has the potential to reduce GHG emissions substantially, compared with conventional gasoline, depending on feedstock and blend level. The vast majority (98 percent) of ethanol produced in the United States is manufactured from corn (DOE 2015a). However, ethanol also can be produced from cellulosic feedstock like woody biomass and crop residue. Similar to biodiesel, when ethanol crops are grown, they capture CO_2 and offset the GHG emissions later released through fuel combustion. The higher the blend of ethanol in the fuel, the lower the net GHG emissions.

Corn ethanol production has increased significantly in recent years, growing by 40 percent from 2009 to 2014, to more than 14 billion gallons per year (Rosenfeld et al. 2018). Most of the gasoline sold in the United States contains up to 10 percent ethanol (E10). All gasoline-powered vehicles are approved by EPA to use E10 in their engines because the fuel is considered substantially similar to gasoline. Regarding other low-level blends of ethanol, 15 percent ethanol (E15) and 85 percent gasoline was approved by EPA for use in conventional gasoline passenger vehicles of model year 2001 and newer. Mid-level blends containing 25 to 40 percent ethanol can be used in a high-octane fuel. High-octane fuel is designed to enable efficiency improvements that are sufficient to offset its lower energy density in a suitably calibrated and designed engine system, such as a flex fuel vehicle (Theiss et al. 2016). Besides E10, the most commonly used blend of ethanol in the United States is a blend of gasoline and ethanol containing 51 to 83 percent ethanol (E85). Ethanol blends over E15, including E85, are designed to be used primarily in flexible fuel vehicles, because ethanol has a high alcohol content and can soften and degrade gaskets, seals, and other equipment in nonflexible fuel vehicles. To meet flexible fuel demands, fueling system equipment manufacturers have produced materials and products that are compatible with ethanol blends over E15 for fuel station infrastructure (DOE 2013b). Additionally, EPA approved a pilot program in Nebraska to study the use of E30 in conventional vehicles owned by the state, assessing impacts on vehicle performance, fuel economy, and emissions control systems (State of Nebraska 2018). As illustrated in Figure 6.2.4-3, E85 consumption is projected to increase through 2038.

Figure 6.2.4-3. Projected Light-Duty Vehicle E85 Consumption



Source: EIA 2019a
Btu = British thermal units

Recent studies and LCA models have found that corn ethanol has declined in carbon intensity over time, revealing increased GHG emission savings relative to gasoline and other fossil fuels. This section summarizes these updates in ethanol LCA research that address improved modeling, technologies, and management practices through well-to-wheel life-cycle stages, including land-use change, farming, fuel production, supply-chain transportation, and end-use fuel efficiencies.

Wang et al. (2007) found that, depending on the energy source used during production, corn ethanol can reduce well-to-wheels GHG emissions by up to 52 percent compared to gasoline. Similarly, Canter et al. (2016) estimate that corn grain ethanol can lead to a 40 percent reduction in GHG emissions. Cellulosic ethanol can create an even larger reduction in GHG emissions, ranging from 74 to 91 percent in reductions compared to gasoline (AFDC 2014, Morales et al. 2015, Canter et al. 2016). The GREET model estimates well-to-wheels emissions for gasoline, E85 in a dedicated ethanol vehicle, and pure corn ethanol fuel cell vehicle to be 414, 273, and 165 grams of CO_2e per mile, respectively (ANL 2018). A study by the Oak Ridge National Laboratory, the National Renewable Energy Laboratory, and Argonne National Laboratory (Theiss et al. 2016) examined the impact on well-to-wheels GHG emissions from high-octane fuel vehicles resulting from miles per gallon of gasoline-equivalent (MPGGE) gains of 5 and 10 percent, various ethanol blend levels (E10, E25 and E40), and changes in refinery operation with high-octane fuel production relative to baseline E10 gasoline vehicles. Table 6.2.4-1 presents the percent change in well-to-wheels GHG emissions resulting from the high-octane fuel vehicle scenarios modeled in Theiss et al. (2016).

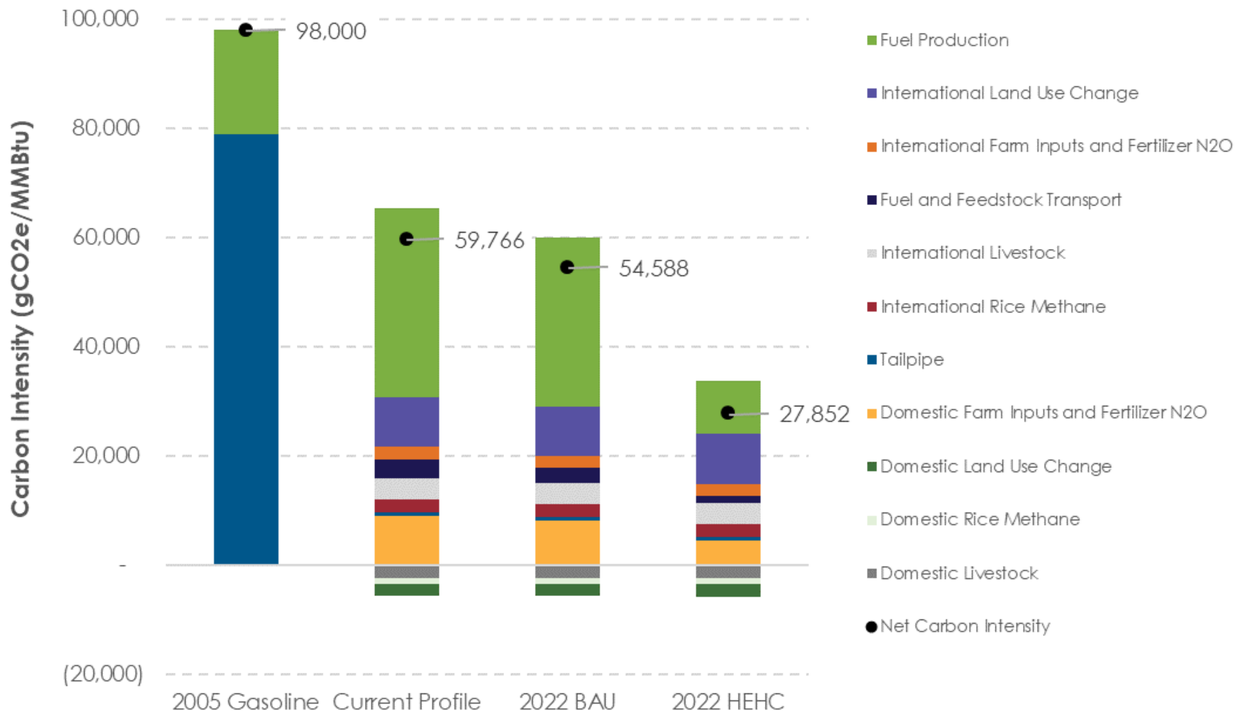
Table 6.2.4-1. Well-to-Wheels GHG Emissions Reductions in Vehicles Fueled by High-Octane Fuels with Different Ethanol Blending Levels Relative to Regular Gasoline (E10) Baseline Vehicles

	Corn Ethanol			Corn Stover Ethanol		
Efficiency Scenario	**E10**	**E25**	**E40**	**E10**	**E25**	**E40**
5% MPGGE Gains	4%	8%	13%	6%	16%	27%
10% MPGGE Gains	8%	12%	17%	10%	20%	31%

Source: Theiss et al. 2016
MPGGE = miles per gallon of gasoline-equivalent

Rosenfeld et al. (2018) estimated that, based on 2014 conditions, U.S. corn grain ethanol life-cycle GHG emissions are 59,766 grams of carbon dioxide equivalent per million British thermal units (g CO_2e/MMBtu), approximately 43 percent lower than those from gasoline on an energy equivalent basis (Figure 6.2.4-4). Other studies have produced similar results, including 60,000 g CO_2e/MMBtu (Canter et al. 2016) and 62,700 to 72,700 g CO_2e/MMBtu (Zhang and Kendall 2016). GHG emission estimates from corn stover (the stalks and cobs remaining after harvest) cellulosic ethanol are as low as 26,000 g CO_2e/MMBtu (Canter et al. 2016), 15,400 to 33,900 g CO_2e/MMBtu (Zhang and Kendall 2016), and 21,000 to 32,000 g CO_2e/MMBtu (Murphy and Kendall 2015). By 2022, the carbon intensity of corn grain ethanol is projected to decline from 2014 levels by nearly 10 percent under a business as usual scenario and by nearly 55 percent under a scenario with increased agricultural conservation and efficiency gains throughout the life cycle, making ethanol between 44 and 72 percent less GHG-intensive than gasoline (Rosenfeld et al. 2018).

Figure 6.2.4-4. Greenhouse Gas Profiles of Gasoline and Corn Ethanol



Source: Rosenfeld et al. 2018
g CO_2e/MMBtu = grams of carbon dioxide equivalent per million British thermal units; N_2O = nitrous oxides
BAU = business as usual, HEHC = high efficiency-high conservation

As illustrated in Figure 6.2.4-4, the largest components of the Rosenfeld et al. (2018) corn ethanol life-cycle GHG profile for 2014 conditions ("current profile") include fuel production (58 percent, 34,518 g CO_2e/MMBtu), domestic farm inputs and fertilizer (15 percent, 9,065 g CO_2e/MMBtu), and international land use change (15 percent, 9,082 g CO_2e/MMBtu). Previous studies have estimated similar GHG profiles for corn ethanol production, including 28 g CO_2e/MJ (EPA 2010d), 30 g CO_2e/MJ (Wang et al. 2012), 15 to 20 g CO_2e/MJ (Wang et al. 2015), and 20 to 35 g CO_2e/MJ (Boland and Unnasch 2014). Boland and Unnasch (2014) estimated that production using biomass produces a 10 g CO_2e/MJ emission intensity. Ethanol production GHG intensity declined by 4 percent from 2010 to 2014, and is projected to decline by between 9 and 53 percent from 2012 to 2022 (Boland and Unnasch 2014, Rosenfeld et al. 2018) because of improved technology and the development of new coproducts.

6.2.5 Fuel Cells

Fuel-cell vehicles are fueled by hydrogen that is converted to electricity via a fuel cell. While current light-duty fuel cell vehicle hydrogen consumption is less than 0.1 percent of total light-duty fuel consumption (EIA 2019a), fuel cells represent another potential alternative to carbon-intensive fuels, depending on the hydrogen production pathway. The fuel cell is similar in structure to an EV battery, but active components (i.e., cathode, anode, and electrolyte) use different materials. Fuel-cell vehicles emit no GHG or air pollutants when operating because the chemical conversion of hydrogen to electricity generates only water and heat. However, upstream fuel production (well-to-tank) of hydrogen from natural gas or grid electricity, plus compression and cooling, can yield significant GHG and air pollution emissions (Elgowainy et al. 2016). Life-cycle emissions vary widely based on this hydrogen production technology (Nitta and Moriguchi 2011).

Hydrogen is most commonly produced using steam methane reforming, but can also be produced with water electrolysis (using grid electricity) or biomass gasification. In transportation and distribution, electricity is required for compression and conditioning of hydrogen for eventual refueling and vehicle storage (Elgowainy et al. 2016). Using steam methane reforming, the GREET model estimates the well-to-wheel GHG emissions for a fuel-cell vehicle to be 114 g CO_2e/MJ using default inputs. Fuel production, which encompasses all well-to-tank activities after natural gas is delivered to the production plant, accounts for 88 percent of life-cycle emissions (ANL 2018).

Numerous factors limit fuel-cell vehicle manufacture and consumer adoption, namely the cost and the lack of a hydrogen distribution infrastructure (NRC 2013c). The CAFE model for this EIS projects that light-duty hydrogen fuel consumption in 2050 will be just 0.01 percent of total fuel consumption under the Proposed Action and all alternatives, including the No Action Alternative.

Ongoing research and development are currently targeting breakthroughs to reduce the cost of hydrogen distribution infrastructure by a factor of two by 2025. It is possible that additional demand for hydrogen in transportation can be established by emerging applications such as synthetic fuels, which are being explored by DOE’s H2@Scale initiative (DOE 2018).

6.3 Materials and Technologies

Vehicle manufacturers have improved and will continue to improve fuel efficiency by reducing overall vehicle weight, reducing drag and friction, and by introducing new technologies that support alternative fuels. LCA studies have examined the GHG emissions impacts associated with the production, supply, and disposal of new materials to support these fuel efficiency improvements. LCAs have also compared these fuel efficiency benefits against potential increased emissions in upstream and downstream life-cycle stages from new materials. This section reviews LCA literature related to six broad categories of materials and technologies that can improve passenger car and light truck fuel efficiency.

6.3.1 Vehicle Mass Reduction by Manufacturing Technologies

Technologies for manufacturing vehicles and vehicle components discussed in this section improve fuel efficiency by reducing vehicle weight. Certain manufacturing technologies can also reduce waste generated and provide energy savings from streamlined manufacturing that can further reduce the environmental impacts from across the vehicle life cycle.

6.3.1.1 Laser Welding

Standard arc welding techniques use an electrical arc to melt the work materials as well as filler material for welding joints, whereas laser welding joins pieces of metal with a laser beam that provides a concentrated heat source. Hot-wire laser welding requires 16 percent less energy than cold-wire laser welding (Wei et al. 2015). Sproesser et al. (2015) conducted an LCA of four different welding processes. Manual metal arc welding had the highest environmental impact as it consumes more material and electricity per a given weld seam length than the other three processes. This is because it has a low deposition rate and welding speed compared to the other processes. Automatic laser-arc hybrid welding had the lowest global warming potential, as it consumed the least electricity and material during operation (Sproesser et al. 2015). The study notes that laser-arc welding requires a critical overall weld seam length to become environmentally beneficial compared to alternative methods, due to differences in the filler material for each method (Sproesser et al. 2015). Another study of laser welding in production processes found improved and more efficient vehicle manufacturing and reduced material use for the same level of energy consumption (Kaierle et al. 2011). Reducing overall material use avoids the environmental burden associated with a material's life cycle, including any inputs and outputs from raw material extraction, refining, shipping, processing, and production (Figure 6.1.1-1).

6.3.1.2 Hydroforming

Hydroforming is the process of creating hollow metal structural parts from a tubular element that is shaped inside a mold by fluid under pressure. Hydroforming requires fewer moldings and lighter parts than typical die forming processes. The process allows manufacturers to produce entire components in a single process that would otherwise be made using multiple parts joined together. Hydroforming has been applied to steel and aluminum automobile parts to reduce vehicle weight. Hydroforming has led to mass savings by eliminating the flanges required for welding and allowing for the use of thinner steel (Kocańda and Sadłowska 2008).[14] The use of hydroforming to manufacture a hollow crankshaft reduced material usage by 87 percent and weight by 57 percent, compared to a solid shaft with the same torque formed with conventional welding techniques (Shan et al. 2012). Hydroforming has reduced the weight of several other parts, such as shift beams, doors, and various frame components (Shinde et al. 2016).

6.3.1.3 Tailor-Welded Blanks

Tailor-welded blanks are a weight-saving technology in which two or more sheet pieces with different shapes, gages, and material specifications are welded together so that the ensuing subassembly is lighter and has few components (Merklein et al. 2014). The use of tailored blanks eliminates the need for additional reinforcements and overlapping joints in a vehicle body, and it saves materials, further reducing the weight.

6.3.1.4 Aluminum Casting and Extrusion

Both die-casting and extrusion offer an alternative way to produce aluminum parts instead of the more traditional method of stamping. To die cast a part, molten metal is injected into a mold, called the die. To extrude a part, aluminum is forced through a mold. Casting allows manufacturers to create equally strong parts with less material relative to stamping. Aluminum casting can also reduce the total number of components used in assembly (Shinde et al. 2016). One study examining the production of a cast aluminum crossbeam found its weight to be 50 percent less than its steel counterpart (Cecchel et al. 2016).

6.3.2 Vehicle Mass Reduction by Material Substitution

Reducing vehicle mass through material substitution has implications across the life cycle of a vehicle, including reducing the amount of conventional material required to manufacture vehicles; increasing the amount of alternative, lighter-weight materials used to manufacture vehicles; saving fuel over the life of the vehicle; and influencing disassembly and recycling at end of life. Replacing materials such as conventional steel with other lightweight materials reduces vehicle fuel consumption but also could increase the upstream environmental burden associated with producing these materials. A literature review of vehicle mass reduction LCAs found that overall life-cycle energy use will decline for passenger cars and light trucks through use-phase fuel economy benefits of material substitution, but will increase upstream energy use in material production (Hottle et al. 2017). This tradeoff is often measured by the

[14] Kocańda and Sadłowska (2008) did not perform an LCA of hydroforming but instead discussed the mass savings achieved from the production technology.

material's breakeven distance. Breakeven distance is the mileage at which the use-phase energy reductions outweigh any increases in the extraction and manufacturing life-cycle phases (Das 2014, Kelly et al. 2015).

A study by Kelly et al. (2015) compared the life-cycle impacts of material substitution; specifically, of replacing steel with one of four lightweight materials: advanced high-strength steel, magnesium, polymer composites (both carbon fiber-reinforced polymer, and glass fiber-reinforced polymer), and two types of aluminum (cast and wrought). Life-cycle impacts and driving breakeven distance for each material were calculated for two different fuel reduction values representing cases with or without powertrain adjustments (0.15 to 0.25 and 0.25 to 0.5 liter per 100 kilometers by 100 kilograms), respectively). The authors used the GREET2 model for energy and emissions data and for modifying vehicle models to explore the substitution impacts. GREET2 is a module of Argonne National Laboratory's GREET model. GREET2 assesses life-cycle impacts from vehicle materials production and management, whereas GREET evaluates impacts from energy production and vehicle use.

Material substitution ratios were obtained separately from a U.S. Department of Energy report (DOE 2013d). Magnesium, cast aluminum, and wrought aluminum had breakeven distances under 100,000 kilometers (62,000 miles) regardless of fuel reduction values, except for the highest substitution ratio scenarios for wrought aluminum and magnesium. In general, cast aluminum demonstrated the lowest breakeven distance among those three. Carbon fiber-reinforced polymer had a breakeven distance of more than 100,000 kilometers (62,000 miles) for several scenarios but could be less than 50,000 kilometers (31,000 miles) in multiple scenarios using the low substitution ratio. Glass fiber-reinforced polymer fared the best of all materials, having breakeven distances of less than 10,000 kilometers (6,200 miles) for all scenarios (Figure 6.3.2-1).

Figure 6.3.2-1. Breakeven Driving Distance for Different Material Substitution Pairs and Substitution Ratios

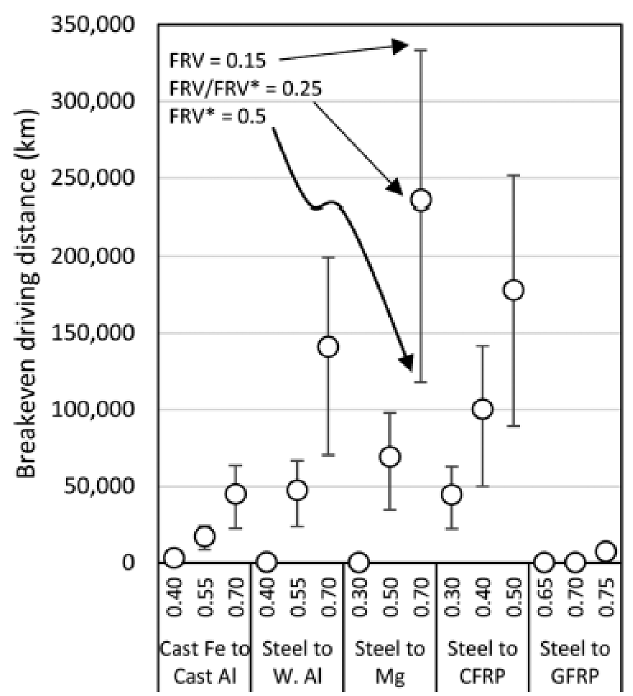


Figure 5. Breakeven driving distance for different material substitution pairs and substitution ratios, assuming different FRV/FRV* values.

Source: Kelly et al. 2015
FRV = fuel reduction values; km = kilometers; Fe = iron; Al = aluminum; W. Al = wrought aluminum; Mg = magnesium; CFRP = carbon fiber-reinforced polymer; GFRP = glass fiber-reinforced polymer

A comprehensive review of vehicle lightweighting LCAs examined the range of estimated fuel savings from almost 50 studies and models for 3 different vehicle types (i.e., internal combustion vehicles, HEVs, and BEVs). The study found that fuel reduction estimates varied significantly when reducing overall vehicle weight by 100 kilograms. The authors studied the effect of different variables on life-cycle fuel reduction including powertrain size, vehicle class (e.g., car, sport-utility vehicle), and driving settings (i.e., city or highway). The results show that driving settings had the greatest influence on overall fuel savings, with mass reduction leading to larger fuel savings during city driving and significantly lower fuel savings (60 to 90 percent less savings) during highway driving. Powertrain sizing also had a significant impact, but vehicle class showed little variation in results (Luk et al. 2017).

6.3.2.1 Aluminum and High-Strength Steel

Aluminum, which is used intensively in the transportation sector, has a high strength-to-weight ratio, corrosion resistance, and processability. (Cheah et al. 2009). High-strength steel has the same density as conventional steel but provides greater strength; thus, less high-strength steel is required to fulfill the same function as conventional steel. Aluminum and high-strength steel can reduce weight while providing strength and rigidity similar to conventional steel. Aluminum is lighter than the conventional steel it replaces, and high-strength steel saves weight by using less material to provide the same level of strength. Aluminum is a suitable substitute for cast-iron components, molded steel parts such as wheels, and stamped-steel body panels. High-strength steel provides the greatest weight-reduction benefits in structural or load-bearing applications, where strength is a key factor in material selection (Cheah and Heywood 2011, Kim et al. 2010b, Koffler and Provo 2012, Mohapatra and Das 2014).

NHTSA identified 22 studies[15] that examined the life-cycle impacts of substituting aluminum and/or high-strength steel for mild steel components in vehicles (Kim et al. 2010a, Hakamada et al. 2007, Bertram et al. 2009, Dubreuil et al. 2010, Cáceres 2009, Stodolsky et al. 1995, Lloyd and Lave 2003, Geyer 2008, Birat et al. 2003, Weiss et al. 2000, Bandivadekar et al. 2008, Ungureanu et al. 2007, Mayyas et al. 2012, Liu and Muller 2012, Shinde et al. 2016, Kelly et al. 2015, Das 2014, Modaresi et al. 2014, Raugei et al. 2015, Sebastian and Thimons 2017, Milovanoff et al. 2019, Palazzo and Geyer 2019). Some of these (Bertram et al. 2009, Geyer 2008, Lloyd and Lave 2003, Hakamada et al. 2007, Mayyas et al. 2012, Kelly et al. 2015) focus on material substitution in specific vehicle components. Other studies estimate overall mass reduction from material substitution and vehicle redesign (Weiss et al. 2000, Bandivadekar et al. 2008, Ungureanu et al. 2007, Kim et al. 2010a, Das 2014). The studies show the following trends:

- **Net energy reduction.** In general, the reduced energy use and GHG emissions during the use phase of aluminum and high-strength steel material substitution is greater than the increased energy use (and associated GHG emissions) needed to manufacture these lightweight materials at the vehicle production phase; thus, a net energy reduction ensues.
- **Variables affecting reduced energy consumption and emissions.** The magnitudes of life-cycle GHG emissions reductions and energy-use savings are influenced by the amount of recycled material used in vehicle components, end-of-life recycling rate, lifetime of vehicles in use,[16] and location of aluminum production.

On a fleet-wide scale, substituting aluminum for steel in body panels in one year's sales volume of vehicles in the United States in 2000 (16.9 million vehicles) would, according to one study, have led to a decrease in 3.8 million tons of GHGs over the life cycle of the vehicles (Lloyd and Lave 2003). The impacts of a future fleet with a more aluminum-intensive design than currently implemented could result in global annual savings as high as 1 gigaton CO_2e annually by 2050 (Modaresi et al. 2014). Another study used a fleet-based life-cycle model to estimate the GHG emissions savings from lightweighting the U.S. light-duty fleet using aluminum or high-strength steel from 2016 to 2050. An aggressive aluminum lightweighting scenario led to cumulative life-cycle GHG emissions savings of 2.9 gigatons of CO_2e and annual emissions savings of 11 percent by 2050 (Milovanoff et al. 2019). One study comparing aluminum substitution for mild-steel and cast iron components in individual cars and fleets showed that the additional CO_2 emissions from the production of aluminum for aluminum castings were

[15] The following studies in this literature review indicated that they relied—at least partially—on industry funding or industry-funded data to evaluate the life-cycle impacts of aluminum and high-strength steel material substitution: Kim et al. (2010a), Geyer (2007, 2008), Dubreuil et al. (2010), Das (2014), Birat et al. (2003), Sebastian and Thimons 2017, and Milovanoff et al. (2019). Most of the studies reviewed have undergone peer review for publication in academic journals, although Sebastian and Thimons (2017) was not published in an academic journal. Certain studies noted where critical reviews were conducted in accordance with ISO 14044 standards on either the method (Geyer 2008), life-cycle inventory inputs (Dubreuil et al. 2010), or both (Sebastian and Thimons 2017), or where critical review was not performed (Bertram et al. 2009).

[16] LCA studies often use different assumptions for vehicle lifetime that can influence final results. For example, a study that expresses results per vehicle as a functional unit (e.g., kg CO_2e/vehicle) would have greater life-cycle emissions with a 10-year lifetime assumption than an 8-year assumption. VMT assumptions over a vehicle's lifetime can also significantly impact results, which is why many vehicle LCA's express results per kilometer or mile as a functional unit.

offset by fuel savings in 2 to 3 years of vehicle use. CO_2 emissions from aluminum beams and panels were offset in 4 to 7 years of vehicle use (Cáceres 2009).

The U.S. Department of Energy funded a project, completed in 2015, to design and build an aluminum-intensive lightweight vehicle called the Mach I. This vehicle achieved a 364-kilogram mass savings over a 2013 Ford Fusion by primarily using aluminum in place of iron and steel. Bushi et al. (2015) performed an LCA as part of the project, finding a 16 percent reduction in life-cycle GHG emissions from the 2013 Fusion (68,500 kilograms CO_2e) to the Mach I (57,600 kilograms CO_2e), and a 16 percent reduction in life-cycle primary energy use (156,000 megajoule in savings). These savings stemmed from a 21 percent increase in the Mach I's fuel economy over the Fusion (increase of 6 miles per gallon) (Bushi et al. 2015).

Other research has focused on the breakeven driving distance. Depending on which parts are substituted and the amount of material displaced, studies estimated that aluminum parts substituting for steel parts have a breakeven distance between 19,000 and 160,000 miles (Das 2014, Kelly et al 2015, Mayyas et al 2012). The lower end of that range equates to approximately 1 year of vehicle lifetime (Das 2014). In a study comparing the total life cycle emissions impacts of several different lightweight materials compared to a steel baseline, aluminum showed the greatest potential reduction (Raugei et al. 2015).

In addition to vehicle mileage, many studies emphasize the sensitivity of LCA results to the amount of recycled material used in automobile components and the materials recycling rate at end of life (Mayyas et al. 2012, Raugei et al. 2015). Substituting rolled aluminum or high-strength steel for mild-steel sheet parts reduces the total life-cycle GHG emissions. The savings in aluminum results can depend on scrap recycling rather than just vehicle fuel economy improvement (Geyer 2008). Life-cycle GHG savings from aluminum component substitution also depends heavily on the location of aluminum production and the share of secondary aluminum used (Kim et al. 2010a).

LCA results are also sensitive to how energy and emissions savings from recycling end-of-life aluminum and high-strength steel vehicle components are allocated in a given study. Sebastian and Thimons (2017) found that substituting aluminum or high-strength steel for mild-steel sheet parts reduces the total life-cycle GHG emissions when using the avoided burden method to account for a credit from metals recycling "based on the premise that use of scrap offsets or substitutes the use of virgin materials." However, when only accounting for the effects of recycled materials in the manufacturing of vehicle components and not including a credit for avoided use of virgin materials, the study found that life-cycle GHG emissions from aluminum components exceeded those of both mild-steel and high-strength steel vehicles, while high-strength steel vehicles continued to show lower life-cycle GHG emissions compared to mild-steel (Sebastian and Thimons 2017). Similar results were shown in a study by Palazzo and Geyer (2019) examining the life-cycle GHG emissions from replacing steel with aluminum in production of North American vehicles. The authors noted that "technological limitations currently prevent recycling all of the incremental aluminum scrap back into the wrought components." The authors examined the impact on life-cycle GHG emissions for aluminum substitution scenarios when the aluminum displacement rate falls below the one-to-one displacement assumed under the avoided burden method. The results show that lower aluminum displacement rates can significantly impact the breakeven time required for GHG emissions savings from vehicle use to exceed increased GHG emissions from aluminum production and end-of-life management. For scenarios where the aluminum displacement ratio was lower than 35 percent, the authors found that aluminum vehicles do not achieve GHG emissions savings across the vehicle life-cycle (Palazzo and Geyer 2019).

In practice, recycling aluminum results in the accumulation of impurities, typically other metals that are challenging and energy-intensive to remove. Consequently, recycled aluminum is usually blended with primary aluminum to mitigate the buildup of contaminants. This practice results in an effective cap on the share of post-consumer aluminum that can be in recycled aluminum (Gaustad et al. 2012). A report using material flow analysis and industry data estimated that more than 90 percent of automotive aluminum is recycled in an open-loop system (Kelly and Apelian 2016).

GHG emissions savings from vehicles using lightweight materials might or might not depend on the materials recycling rates achieved. Estimates range from lower life-cycle GHG emissions only under scenarios with very high recycling levels for aluminum components, to significantly lower life-cycle GHG emissions compared to comparable mild-steel components, even with an unrealistic recycling rate of 0 percent (Bertram et al. 2009, Birat et al. 2003). One study found that an aluminum chassis substituted for a steel chassis resulted in net GHG savings under all recycling scenarios. The recycling scenarios ranged from *pessimistic*, where 75 percent of aluminum parts are open-loop recycled and 25 percent landfilled, to *optimistic*, where 90 percent of aluminum parts are closed-loop recycled (Raugei et al. 2015). Another study noted that replacing conventional steel with recycled aluminum for various frame components reduced life-cycle emissions of CO_2 by 7 percent within 1 year and 11 percent after 10 years of use (Ungureanu et al. 2007).

One study suggested that secondary sources of aluminum (recycled aluminum from landfill or urban mining) will likely be easier to access in the future than primary aluminum (from bauxite mining) (Chen and Graedel 2012a). This trend suggests that the quality of secondary aluminum will affect the cost and supply of primary aluminum used in vehicles in the future. Aluminum alloy scrap includes alloy elements, which degrade the quality of the material when recycled. Avoiding quality degradation will require processors to identify and segregate alloys at the point of discard so the alloy can be reused as originally designed (Chen and Graedel 2012b). An aluminum smelter's location also affects GHG emissions because aluminum's carbon intensity is strongly tied to the electricity grid's carbon intensity in the smelter's region, with a 479 percent difference in emission factors depending on how and where the electricity is generated (Colett 2013).

6.3.2.2 Plastics

Plastics, also known as polymers, include thermosets, thermoplastics, and rubber materials (Park et al. 2012). Because plastics are typically not as strong as metal or carbon fiber-reinforced plastics, they are typically used for interior or exterior parts that do not have structural strength requirements, such as bumpers, lighting, trim parts, or instrument panels (Park et al. 2012). Plastics tend to be lightweight, resistant to corrosion and electricity, have a low thermal conductivity, and are formable. They are typically cheaper than aluminum and high-strength steel and lighter than conventional steel (Munjurulimana et al. 2016 citing McKinsey 2012). An EPA study on weight reduction strategies proposes several instances in which plastic could be substituted for steel parts. Substitution of plastic for steel in parts such as the oil pan, water pump, and fasteners can reduce weight by 25 percent to 80 percent for the individual parts (EPA 2014e). Few LCA studies quantify the life-cycle benefits of plastic substitution. One study conducted a cradle-to-cradle LCA (the full life cycle and recycling at the end of life) of replacing a steel fender with a thermoplastic resin fender (Baroth et al. 2012). They found that the plastic fender resulted in up to 47 percent lower carbon footprint than its steel counterpart. These emission reductions predominantly occurred during the use phase, where the emissions from the vehicle with the plastic fender (91.7 kilograms [202 pounds] of CO_2) were much lower than the vehicle with the steel fender (200 kilograms [440 pounds] of CO_2).

6.3.2.3 Polymer Composites

Various types of reinforced polymer composites are in use or in development as substitutes for mild steel or aluminum, predominantly in vehicle body panels. These materials offer added tensile strength and weight-reduction potential compared to mild steel.[17] They include glass- and carbon-fiber-reinforced polymer composites and nanocomposites, such as those reinforced with nanoclays or carbon nanotubes (Lloyd and Lave 2003, Cheah 2010, Park et al. 2012). At the nano scale, carbon fibers offer additional tensile strength and provide other functionalities such as electrical conductivity and antistatic properties, which are useful properties for automobile components such as body panels and casings for electronic equipment (Khanna and Bakshi 2009).

Eighteen studies examine the life-cycle environmental impacts of substituting reinforced polymers or composites for aluminum or mild-steel components in vehicles (Lloyd and Lave 2003, Khanna and Bakshi 2009, Cheah 2010, Overly et al. 2002, Gibson 2000, Weiss et al. 2000, Sullivan et al. 2010, Das 2011, Keoleian and Kar 1999, Tempelman 2011, Spitzley and Keoleian 2001, Boland et al. 2014, Raugei et al. 2015, Koffler and Provo 2012, Delogu et al. 2015, Witik et al. 2011, Mayyas et al. 2012, Kelly et al. 2015). Two of these studies (Lloyd and Lave 2003, Khanna and Bakshi 2009) focus on applications based on nanotechnology. The studies show the following trends:

- Polymer composites (including those reinforced with glass, carbon fiber, or nanoclays) used in vehicle body panels are generally more energy- and GHG-intensive to produce compared to conventional steel, but greater or less energy- and GHG-intensive than aluminum depending on the study. However, energy-efficient manufacturing processes, such as the pultrusion, injection molding, and thermoforming processes, can make fiber-reinforced composites less energy intensive to produce relative to both steel and aluminum.
- Carbon-fiber-reinforced polymer composites used for specific automotive parts (e.g., a floor pan) are typically less GHG-intensive across the life cycle (including end of life) than similar components made from conventional materials, but the magnitude of the difference depends on the vehicle weight reduction due to the composite materials.
- The use of polymer composites in vehicle parts leads to reduced energy use and GHGs emitted over the vehicle life cycle compared to vehicles with similar aluminum or steel parts. This reduction is due to significant reductions in vehicle weight and associated improvements in fuel economy.
- For other environmental impact categories (e.g., acidification, water use, water quality, landfill space), polymer composite materials also tend to result in overall lower life-cycle impacts compared to conventional steel and to aluminum.
- Composites are more difficult to recycle than their metal counterparts are. Some studies assign a credit for incineration of composites in a waste-to-energy plant, but this could overstate composites' life-cycle benefits compared to metals if this energy-recovery option is unavailable. In general, end-of-life assumptions and the post-consumer material content of composite materials have not been studied as thoroughly as other life-cycle phases.

Several studies show that the upstream extraction, materials processing, and manufacturing stages for carbon-fiber- and glass-fiber-reinforced composites used in vehicles are more energy- and GHG-

[17] Estimates of the weight reduction in automobile body parts range from 38 to 67 percent (Overly et al. 2002, Cheah 2010, Lloyd and Lave 2003, Khanna and Bakshi 2009).

intensive than those for conventional (mild) steel, but less than those for aluminum (Overly et al. 2002,[18] Cheah 2010, Weiss et al. 2000, Gibson 2000, Tempelman 2011, Khanna and Bakshi 2009, Raugei et al. 2015, Koffler and Provo 2012). For example, estimates of the cradle-to-gate[19] energy required for carbon nanofiber polymer composites range from nearly 2 to 12 times greater than the energy requirements for steel[20] (Khanna and Bakshi 2009). Other estimates of cradle-to-gate energy indicate that carbon-fiber production is almost 20 times more energy intensive than conventional galvanized steel, and 15 times more CO_2 intensive on a weight basis (Das 2011). According to one study, in relation to aluminum used in automobile bodies, polymer composites require less primary energy and are associated with lower GHG emissions;[21] however, if recycled aluminum is used, the energy requirements and upstream GHGs are comparable to that of polymer composites (Weiss et al. 2000). One study analyzed the cradle-to-gate emissions associated with a traditional steel vehicle and a lightweight vehicle composed of magnesium structural components and plastic composite nonstructural components. The material production emissions for the magnesium-plastic composite car were almost double those of the steel vehicle (Raugei et al. 2015).

While polymer composites used in vehicle body panels are more energy- and GHG-intensive to produce compared to mild steel and, in some cases aluminum, inclusion of the product use phase results in net life-cycle energy savings and reduced GHGs. This crossover occurs sometime during the lifetime of the vehicle (Gibson 2000, Delogu et al. 2015). One study estimates that substituting a high-performance clay-polypropylene nanocomposite for steel in a passenger car or light truck could reduce life-cycle GHG emissions by as much as 8.5 percent and that GHG emissions associated with material production of that high-performance material are 380 times smaller than GHG emissions associated with vehicle use[22] (Lloyd and Lave 2003). This energy and GHG reduction is a result of the significant reductions in vehicle weight and the subsequent improvements in fuel economy. A study by PE International for American Chemistry Council notes that a 66 percent reduction in part weight by switching from steel to glass-reinforced plastic results in a decrease in use-phase emissions (74.01 kg CO_2e/part) (Koffler and Provo 2012).

In general, the studies that examine multiple environmental impact categories conclude that these lightweight composite materials offer overall environmental benefits compared to mild steel—and in most cases, compared to aluminum—across the vehicle life cycle. Carbon-fiber-reinforced polymer composite used in vehicle closure panels[23] show fewer environmental impacts compared to steel, aluminum, and glass-fiber-reinforced polymer composite in most impact categories—including nonrenewable and renewable resource use, energy use, global warming potential, acidification, odor/aesthetics, water quality (biochemical oxygen demand), and landfill space (Overly et al. 2002). When substituting small parts, glass-fiber-reinforced polypropylene has a lower breakeven distance over magnesium, carbon-fiber-reinforced polypropylene, and welded aluminum when replacing steel. These

[18] Note that Overly et al. (2002) include extraction and material processing, but not manufacturing, in the study scope due to data limitations, but note that the impacts are typically the smallest during this stage.

[19] Including carbon nanofiber production, polymer resin production, carbon nanofiber dispersion, and composite manufacture; excluding vehicle use and associated gasoline production and the end-of-life stages.

[20] Standard steel plate used in this study.

[21] This upstream energy and GHG impact for a plastic automobile body is approximately about one-third of that of one with virgin aluminum components (Weiss et al. 2000).

[22] Including petroleum production, which refers to the upstream emissions associated with producing the petroleum that the vehicles consume.

[23] Includes four door panels, the hood, and the deck lid.

results vary based on the substitution ratios used and whether powertrain resizing is considered (Kelly et al. 2015). When analyzing fiber-reinforced polypropylene and polyamide, one study found that a majority of the eutrophication and acidification came from the material production stage of a vehicle's lifecycle instead of the use phase, unlike GHG emissions, where the use phase was the greatest source of emissions (Delogu et al. 2015). However, glass-reinforced polymer composite manufacturing can have greater acidification than steel manufacturing (Koffler and Provo 2012).

Other studies note additional carbon composite benefits in air emissions, water emissions, and hydrogen fluoride emissions over the entire vehicle life cycle compared to mild steel and aluminum (Gibson 2000). A clay-polypropylene nanocomposite substituted for steel shows reduced life-cycle environmental impacts across all impact categories (including electricity use, energy use, fuel use, ore use, water use, conventional pollutants released, global warming potential, and toxic releases and transfers), except for a slight increase for hazardous waste generation (Lloyd and Lave 2003). The lower impacts are largely because the vehicle production requires less material with the lighter material. When carbon-fiber-reinforced polymer replaces a much larger share of the steel in the vehicle body panel (i.e., beyond the closure panels), the environmental benefits of carbon fiber lessen (Overly et al. 2002). When a nylon composite manifold was compared to two similar aluminum parts (sand-cast and multi-tubed brazed), the composite manifold showed lower life-cycle impacts across certain metrics (energy use and GHG, carbon monoxide, nonmethane hydrocarbons, and nitrogen oxide emissions), but increases among others (methane, PM10, and sulfur dioxide) relative to one or both of the aluminum manifolds (Keoleian and Kar 1999). Two other studies featuring manifolds show similar results (Raugei et al. 2015, Delogu et al. 2015).

Studies acknowledge that large uncertainties underlie the results and that certain assumptions have a significant influence on the results. For example, consideration of fleet effects, such as upstream production energy mix (e.g., the high share of hydropower used in the production of aluminum), could change the results (Lloyd and Lave 2003, Spitzley and Keoleian 2001). The substitution ratio used for magnesium substituting steel can vary the breakeven distance by approximately 225,000 kilometers (140,000 miles) (Kelly et al. 2015). If a component is large enough, the powertrain may need to be resized, leading to additional weight reduction benefits (Kelly et al. 2015, Kim et al. 2015). Studies handled the impacts from end of life in different ways (e.g., assuming composites were landfilled at end of life [Overly et al. 2002] or excluding the impacts altogether [Khanna and Bakshi 2009]). Studies noted that a more complete analysis would look at impacts associated with recycling composites and the effect of using recycled versus virgin material inputs in their production (Lloyd and Lave 2003, Weiss et al. 2000, Witik et al. 2011) and would consider reparability and replacement impacts (Lloyd and Lave 2003, Overly et al. 2002, Koffler and Provo 2012). Composites demonstrate lower recyclability than metals, but this is partially offset by their high energy content for the purposes of incineration. If waste-to-energy disposal is not an option for composite auto body components, the low recyclability of these materials results in significantly more life-cycle waste generation than their metal alternatives (Tempelman 2011). Incineration has lower life-cycle impacts for composite materials than landfilling as the material avoids the longer-term release of methane during the anaerobic degradation of material (Witik et al. 2011), but these benefits could be diminished if composite-based panels need to be discarded and replaced especially frequently.

6.3.2.4 Magnesium

Magnesium is an abundant metal with a density that is approximately 20 percent that of steel and approximately 60 percent that of aluminum. At present, on average, magnesium content per vehicle is approximately 5 kilograms (11 pounds), but it is estimated that this average content will double to approximately 10 kilograms (22 pounds) by 2020 (Cheah 2010). Magnesium-substituted vehicles have higher fuel efficiencies than conventional and aluminum-substituted vehicles due to lighter vehicle weights from magnesium's low density (Hakamada et al. 2007, Cáceres 2009, Shinde et al. 2016). On average, magnesium provides a 60 percent weight reduction over steel and 20 percent over aluminum, with equal stiffness (Cheah 2010, Easton et al. 2012).

Magnesium is abundant throughout Earth's upper crust, although it does not occur naturally in its isolated form. Instead, magnesium is typically refined from salt magnesium chloride using electrolysis or from ore (mainly dolomite) using the Pidgeon process, which involves reducing magnesium oxide at high temperatures with silicon. The majority (85 percent) of the world's magnesium is produced via the Pidgeon process in China (Johnson and Sullivan 2014). In general, magnesium is more expensive and energy-intensive to produce than steel.

Twelve studies examined the life-cycle environmental impacts of substituting magnesium for steel and aluminum components in vehicles (Hakamada et al. 2007, Dubreuil et al. 2010, Cheah 2010, Tharumarajah and Koltun 2007, Sivertsen et al. 2003, Cáceres 2009, Witik et al. 2011, Ehrenberger 2013, Easton et al. 2012, Raugei et al. 2015, Li et al. 2015, and Kelly et al. 2015). Overall, the studies show the following trends:[24]

- Magnesium is more energy- and GHG-intensive to produce than steel or aluminum.
- Significant reductions in vehicle weight and GHG emissions can be achieved in the future by substituting magnesium for heavier components currently in use. However, breakeven distances can be relatively high in relation to other materials (Kelly et al. 2015). For example, examining only mass reduction of the engine block, use of coal-based Pidgeon process magnesium could result in a breakeven distance of from approximately 20,000 kilometers (12,500 miles) to 236,000 kilometers (147,000 miles) compared to other materials ranging from iron to aluminum produced from different production processes and locations (Tharumarajah and Koltun 2007). The use of coal-based Pidgeon process magnesium decreases the life-cycle energy and GHG benefits of magnesium. The greater the amount of GHG-intensive Pidgeon process magnesium incorporated into the vehicle, the longer the break-even distance becomes (Cáceres 2009).
- If a large proportion of recycled magnesium is used, the production energy and GHG disadvantages of using magnesium can be significantly offset (Hakamada et al. 2007). Generally, the higher the proportion of recycled magnesium, the shorter the breakeven distance.
- Several of the studies looked at the effects of replacing particular automotive parts. Given the heterogeneity of the studies, it is difficult to make conclusive statements, but which part of the automobile is substituted could make a difference to LCA results. In general, however, weight reduction is probably the primary consideration in use-phase GHG emissions, and which parts are replaced will be subject mostly to engineering considerations (Hakamada et al. 2007).

The LCA literature generally agrees that magnesium substituted in vehicles requires more energy to produce than conventional and aluminum-substituted vehicles, and therefore produces more GHGs

[24] Differences in scope and functional units (i.e., the reference unit against which environmental impacts are compared) across the studies limit their comparability with each other. For example, modeling different magnesium production processes and recycled contents has a great effect on the life-cycle emissions. Assumptions about which parts are replaced or supplemented with magnesium vary widely across studies, as do methods such as the weight-for-weight ratio at which magnesium is substituted for steel.

during that phase (e.g., Dubreuil et al. 2010, Tharumarajah and Koltun 2007). Both electrolysis and the Pidgeon process are energy intensive, although electrolysis is three to five times more energy efficient than the Pidgeon process, in part because electrolysis is often powered by hydroelectricity or other lower-carbon energy sources (Cheah 2010). In addition, three potent GHGs are used during primary metal production: sulfur hexafluoride and two perfluorocarbons (Dhingra et al. 2000). Sulfur dioxide is also used as a protective gas to cover molten magnesium during production (i.e., cover gas) (Dubreuil et al. 2010).

Magnesium components have been determined to have 2.25 times the impact on human toxicity as steel (including respiratory effects, ionizing radiation, and ozone layer depletion). These toxicity impacts can result from fuel consumption, materials manufacturing, or other supply chain activities associated with the different materials. Human toxicity impacts of the magnesium material and manufacturing phase are greater than the toxicity benefits achieved from reduced fuel consumption due to lightweighting during the use phase relative to steel (Witik et al. 2011).

Even considering the energy required to produce magnesium, several LCAs have found that, over vehicle life, the high fuel efficiency of magnesium-substituted vehicles lowers total energy use below that of conventional and aluminum-substituted vehicles. The degree of energy savings is determined by which vehicle parts are substituted and the methods used in manufacturing the magnesium. The results of each LCA vary depending on which component in the vehicle was substituted and which manufacturing methods were used. The following key assumptions affect life-cycle environmental impacts associated with magnesium substitution.

- **Method of magnesium production**. Assumptions about what proportion of magnesium comes from the Pidgeon process and what portion from electrolysis, as well as the assumed fuel sources, will have an effect on GHG emissions and energy use, because the Pidgeon process is more energy and GHG intensive. The Pigeon process is improving; a 2015 study calculated that the process emitted 38 to 48 percent less CO_2 per ton of magnesium than previously estimated, and emissions are predicted to fall further (Li et al. 2015). This implies that older LCA studies are likely to underestimate the LCA benefits of magnesium substitution.
- **Sulfur hexafluoride (SF_6).** SF_6 is a potent GHG[25] and might be phased out of manufacturing in the near future in most countries. At present, SF_6 is used as a cover gas (i.e., a protective gas to cover molten magnesium during production). To lower GHG emissions, sulfur dioxide can also be used to treat magnesium, but it is toxic (Johnson and Sullivan 2014). The inclusion of SF_6 as part of the emission impacts from manufacturing can increase the vehicle breakeven point to approximately 200,000 kilometers (124,000 miles) (Sivertsen et al. 2003). The inclusion of sulfur dioxide as part of the emission impacts from manufacturing leads to a vehicle breakeven point of approximately 67,000 kilometers (41,600 miles) (Sivertsen et al. 2003). One study comparing the life-cycle impacts of a magnesium body and chassis to a steel baseline estimated that variations in SF_6 use in manufacturing for magnesium parts (from high use to no use) can yield approximately a 30 percent change in life cycle emissions. Furthermore, magnesium substitution results in a net global warming potential reduction only when using the most favorable assumptions on SF_6 use (Raugei et al. 2015).
- **Substitution characteristics.** The weight-to-weight ratio at which one metal is substituted for another would affect LCA results, as would any assumptions about metal stiffness and strength. One study estimated that the magnesium breakeven distance with steel can more than triple from

[25] SF_6 has a global warming potential of 23,500 according to the IPCC Fifth Assessment Report (AR5).

approximately 70,000 kilometers (43,500 miles) to 240,000 kilometers (149,000 miles) depending on substitution ratios (Kelly et al. 2015).

- **Recycling**. Magnesium is considered well suited to recycling, with recovery rates in excess of 90 percent (Ehrenberger 2013), comparing favorably with recovery rates for steel and aluminum, which demonstrate lower recycling rates. Approximately 5 percent of the energy used in production of virgin materials is needed for remelting. Two types of materials are recycled: manufacturing scraps and post-consumer materials (Sivertsen et al. 2003). Emissions associated with repurposing magnesium from virgin materials are estimated to range from 20 to 47 kilograms (44 to 103 pounds) of CO_2e per kilogram of magnesium, while the emissions associated with recovering recycled magnesium from vehicle disposal are estimated to average 1.1 kilogram (2 pounds) CO_2e per kilogram of magnesium (Ehrenberger 2013). Therefore, the degree of recycling can have a great impact on LCA results.

6.3.3 Vehicle Batteries

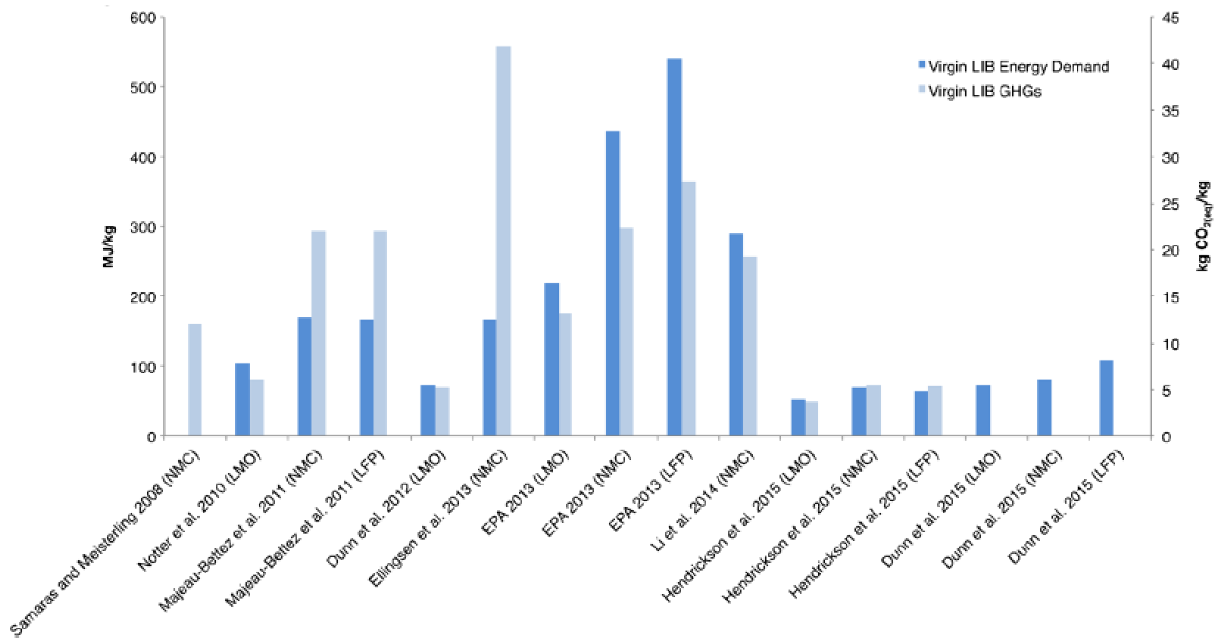
Historically, battery manufacturers for passenger cars and light trucks have used lead-acid chemistries for internal combustion engine vehicles. EV, PHEV, and HEV manufacturers have begun using new battery chemistries based on the results of research to increase energy storage capacity.

The lithium ion (Li-ion) battery is the preferred battery technology for EVs because of its electrochemical potential, lightweight properties, comparatively low maintenance requirements, and minimal self-discharge characteristics, the latter of which enables Li-ion batteries to stay charged longer (Notter et al. 2010). However, Li-ion batteries are an evolving technology. Researchers and manufacturers are continually developing new battery chemistries to increase energy density while reducing costs.

Li-ion batteries primarily consist of stacked battery cells. Cells represent the bulk of material weight, which includes the cathode, anode, binder, and electrolyte. Anodes typically are composed of graphite, and cathodes (active materials) can vary based on the specific battery chemistry used. LCA literature has focused on three cathode types: lithium manganese oxide, lithium iron phosphate, and lithium nickel manganese cobalt oxide (Nealer and Hendrickson 2015). Each cell is sealed in a casing, typically aluminum or steel. The stacked cells are combined with other components, including wiring and electronic parts for the battery management system (EPA 2013a).

The relative impact of the Li-ion battery production process for PHEVs and EVs becomes greater when the vehicle is operated with a greater renewable-based grid mix (Dunn et al. 2015a). HEVs are not impacted by grid mix variations during use, as the vehicle is not consuming grid electricity as a fuel. Estimates for the relative contribution of Li-ion batteries can vary significantly both between and within LCAs. Ranges in results are large, where studies have shown batteries can contribute 10 percent or less (Notter et al. 2010, EPA 2013a) or almost 25 percent of total GHG emissions (Dunn et al. 2015b, EPA 2013a, Hawkins et al. 2013). LCAs and LCA reviews have highlighted this, but focus on different drivers of results. Kawamoto et al. (2019) also noted the importance of the electricity mix of the battery production facility in addition to the use-phase electricity mix. Three articles focused on LCA scope and vehicle lifetime/mileage assumptions (Hawkins et al. 2012, Kawamoto et al. 2019, Held and Schücking 2019), while another study details battery design and specific LCA methods (Nealer and Hendrickson 2015). Detailed LCAs of EV Li-ion battery production highlight specific materials in results (Notter et al. 2010, EPA 2013a, Li et al. 2014), while others closely analyze battery manufacturing and assembly processes as drivers of impacts (Ellingsen et al. 2014, Dunn et al. 2015a, Dai et al. 2019). Figure 6.3.3-1 shows the variations in LCA Li-ion battery results for energy consumption and GHG emissions from a literature review for three common battery chemistries ($LiMn_2O_4$ [LMO], $LiFePO_4$ [LFP], and $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ [NMC]) (Nealer and Hendrickson 2015). In addition to the studies cited in the following figure, Kawamoto et al. (2019) recently found that GHG emissions from battery production were 160 kilograms of CO_2 per kilowatt-hour for NMC and 161 kilograms of CO_2 per kilowatt-hour for LFP, which is on the lower end of the range of results in Figure 6.3.3-1.

Figure 6.3.3-1. Greenhouse Gas Emissions and Energy Consumption of Electric Vehicle Lithium-Ion Battery Production (per kilogram of battery)



Source: Nealer and Hendrickson 2015
MJ/kg = megajoule per kilogram; kg $CO_{2(eq)}$/kg = kilograms of carbon dioxide equivalent per kilogram; LIB = lithium-ion battery; GHG = greenhouse gas

Beyond GHG emissions and energy consumption, the production of Li-ion batteries from virgin materials can have adverse environmental impacts locally. Pollution of local resources can occur in the mining and processing stages of material development for battery cathodes and other components (Dunn et al. 2015a).

Lead-acid batteries (LABs) in internal combustion engine vehicles have negligible GHG emissions relative to the rest of the vehicle's life cycle (Hawkins et al. 2012, Samaras and Meisterling 2008). However, mishandling these batteries in disposal and end-of-life can lead to exposure to toxic and hazardous materials, specifically lead and sulfuric acid (Los Angeles County 2015, Kentucky Division of Waste Management 2017). Because of these risks, more than 40 states have some form of purchase fee, disposal requirement, or recycling requirement designed to address the end-of-life handling of LABs (BCI 2017).

In North America, the recycling rate for LABs is almost 100 percent, and recycled lead from LABs contributed to more than 85 percent of total U.S. lead production in 2011 (Commission for Environmental Cooperation 2013, USGS 2014). U.S. secondary lead from LABs is recycled through a smelting process and totaled almost 1.1 million metric tons in 2011. The United States exported more than 300,000 metric tons of lead contained in used LABs in 2011, where 67 percent of this went to

Mexico and 25 percent to Canada (USGS 2014). Secondary lead recycling through smelting can generate toxic lead emissions, which are regulated by ambient air standards domestically. U.S. exports of LABs for secondary lead production have increased in recent years to countries with less stringent lead emission standards, primarily Mexico (Commission for Environmental Cooperation 2013).

EV Li-ion batteries pose significant environmental challenges in solid waste management, particularly for regions with aggressive recycling goals such as California and New York. Rapid expansion of EV adoption would create large battery waste flows for solid waste infrastructure not designed for reuse and recovery of Li-ion battery materials (Hendrickson et al. 2015). Recycling technologies are limited and evolving, and LCAs have focused on this aspect of the battery life cycle to better understand the potential adverse impacts (Dunn et al. 2012, EPA 2013a, Hendrickson et al. 2015).

LCAs of Li-ion battery recycling have focused on three recycling technologies: pyrometallurgy, hydrometallurgy, and physical processes (Dunn et al. 2012, EPA 2013a, Hendrickson et al. 2015, Zwolinski and Tichkiewitch 2019). Pyrometallurgy uses a combination of smelting followed by leaching to recover slag and valuable metals. Hydrometallurgy uses chemical leaching, capable of recovering valuable metals and lithium. Physical processes offer advantages over the other two alternatives through lower energy use and higher recovery rates. Of the three, pyrometallurgy is currently most widely used (Nealer and Hendrickson 2015). All three options offer benefits in reduced life-cycle energy demands and avoided material waste flows, although estimates for total savings can vary significantly (5.0 to 70.5 megajoule per kilogram battery recovered). Increasing Li-ion battery recycling with pyrometallurgy could have adverse air pollution and human health impacts, depending on the location and implementation of the recycling technology (Hendrickson et al. 2015).

Other end-of-life alternatives for EV batteries include reuse applications for energy storage. Currently, when EV batteries are removed from vehicle operation, significant battery capacity remains, although to an uncertain degree (Sathre et al. 2015). LCAs have analyzed the potential for renewable energy storage for these second life applications, and the estimated GHG emission reduction when substituted for fossil fuel electricity generation. Results are highly dependent on assumptions for battery performance in energy storage and grid mixes. However, when replacing fossil fuel generation with renewable sources, GHG emission reduction benefits can be significant both in reducing impacts in electricity generation and overall EV life-cycle emissions (Ahmadi et al. 2014, Faria et al. 2014, Sathre et al. 2015).

6.3.4 Vanadium Redox Flow Batteries

Vanadium redox flow batteries (VRFBs) are an emerging technology where energy is stored in the electrolyte, rather than a typical battery design (e.g., lead-acid, Li-ion, fuel cell) where a cathode discharges energy to supply power. VRFBs are attractive for EV use because of fast recharge rates relative to other battery designs. A VRFB design would only need to replenish electrolytes that have been charged off-site, whereas a typical battery design would take significantly longer to recharge the active material. VRFBs can also have long lifetimes, around 20 years, providing the potential for reduced life-cycle costs to consumers. However, VRFBs have a low-energy density, which could lead to increased weight and reduced efficiency and range of EVs (IDTechEx 2016). It is currently unclear whether VRFBs will be a commercially viable technology for EV batteries within the timeframe of the rule.

LCAs have assessed the associated GHG emissions with VRFB use in energy storage systems. While these studies do not specifically address VRFBs in EV applications, the studies analyze similar battery production methods and designs that could be adapted for vehicle use. One study analyzed the life-cycle GHG emissions associated with a wind-turbine energy storage system using VRFBs, finding that battery production and infrastructure emissions ranged from 18 to 21 g CO_2e/kWh of electricity produced, depending on the number of wind turbines used. The overall energy storage system emissions ranged from 92 to 437 g CO_2e/kWh, making the VRFB components about 4 to 23 percent of total system emissions (Arbabzadeh et al. 2015). Another study analyzed VRFBs used to store surplus wind electricity for multiple countries, which occurs at times when demand is too low to use a wind system's entire output. The authors found that battery-related products emitted 25 to 55 g CO_2e/kWh of surplus energy stored, varying by country (Sternberg and Bardow 2015).

6.3.5 Tires

Tires affect vehicle fuel economy through rolling resistance. Rolling resistance is the force that resists the movement of the tire. To overcome this resistance, the vehicle's engine converts the chemical energy in the fuel into mechanical energy, which is transmitted through the drivetrain to turn the wheels. Tires are continuously deformed while rolling by the weight of the vehicle, which causes energy to dissipate in the form of heat. As a result, the engine must consume additional fuel to overcome the rolling resistance of the tires when propelling the vehicle (NAS 2006). Tires consume about 20 to 30 percent of vehicle drivetrain net energy output, and improving the rolling resistance of replacement tires by 10 percent can reduce fuel consumption by 1 to 2 percent (ICCT 2011). Some tests have shown that a 30 percent reduction in rolling resistance results in a 5 percent reduction of fuel consumption (Saur et al. 1997). According to a life-cycle analysis performed by Continental, 20.9 percent of a vehicle's fuel consumption can be attributed to tires, with 16 percent attributed specifically to rolling resistance (Continental 1999). Changes to the physical design of tires can reduce the energy needed to overcome rolling resistance, leading to reductions in fuel consumption.

Approximately 88 percent of all resources and 95 percent of the cumulative energy input consumed in the life of a tire are consumed in the use phase (Continental 1999, Boustani et al. 2010). Roughly 6.9 percent of resources are consumed in the process of extracting the raw materials, which include mostly silica, synthetic rubber, carbon black, and steel. Approximately 4.8 percent of resources is expended in the production phase of the tire, and the remaining 0.2 percent is consumed in the transport phase (Continental 1999). Thus, the environmental impacts from the life cycle of a tire mostly occur because of fuel consumption during the use phase. By comparison, the impacts from production and end-of-life phases are less significant.

Vehicle rolling resistance is expected to decrease over time. The National Research Council (NRC 2013c) projected scenarios for reductions in light-duty new-vehicle fleet rolling resistance to 2030. In the midrange case, the authors projected a 26 percent decrease in rolling resistance for passenger cars and a 15 percent decrease in rolling resistance for light trucks (NRC 2013c).

One mechanism for lowering rolling resistance in tires is increasing the use of silica to replace carbon black (Lutsey et al. 2006), especially in combination with natural rubber. The properties of natural rubber contribute to lower rolling resistance but provide decreased traction compared to synthetic rubber. Losses in traction can be overcome with increased use of silica (Pike and Schneider 2013). Discussion in the NHTSA/EPA rulemaking support documents concluded that tire technologies that enable improvements of 10 and 20 percent have been in existence for many years (EPA 2012b). Achieving improvements up to 20 percent involves optimizing and integrating multiple technologies, with a primary contributor being the adoption of a silica tread technology (NRC 2015).

According to Continental's LCA, substituting silica for carbon black filler leads to a reduction in the global warming potential of around 9.5 percent due to a drop in CO_2 and carbon monoxide of approximately 9.5 and 9.8 percent respectively, with a decrease of sulfur dioxide, nitrogen oxides, and ammonia released as well. Partially substituting silica for carbon black as filler can reduce the cumulative energy input over the entire life of the tire by up to 9.3 percent. In total, a reduction of approximately 8.7 percent in the consumption of resources is achieved, due to petroleum savings of approximately 9.8 percent (Continental 1999).

Another LCA compared a carbon black tire to a silica/silane tire (which has lower rolling resistance). The primary energy demand for the production of the carbon black tire was 197 megajoule and for the silica/silane tire was 84 megajoule. This corresponded to emissions of 9.2 kilograms (20 pounds) of CO_2 from the production phase of the carbon black tire and 6.0 kilograms (13 pounds) of CO_2 from the production phase of the silica/silane tire. Because of increases in the quantities of solid and liquid waste and of ash and slag, a silica tire would produce approximately 3.4 percent more waste than a carbon black tire. Additionally, production of filler silica increases the negative impact on wastewater (Continental 1999). Given the limited availability of LCAs in recent literature, further research is needed to better quantify environmental impacts of low-rolling resistance tires across the entire life cycle.

NHTSA subjected five tire models to on-vehicle tread wear testing and found no clear relationship between tread wear and rolling resistance levels (NHTSA 2009). For six tire models subjected to significant wear during indoor tests (i.e., in a laboratory setting when not attached to a vehicle), the results did show a trend toward faster wear for tires with lower rolling resistance. Other anecdotal and qualitative sources indicate that production and use of tires designed to reduce rolling resistance may affect tire manufacturing energy, durability, and opportunities for retread. A reduction in durability and retread opportunities could decrease the effective life of the tires, creating more waste and requiring additional tire manufacturing; however, improving technologies for tire design and rubber compounds are reducing concerns over tread life with each new tire model (NACFE 2015).

6.3.6 Aerodynamics and Drag

Drag is a function of the frontal area of the vehicle, the density of the air, the coefficient of drag of the vehicle, and the vehicle speed squared. The relation between drag and speed shows that aerodynamics of vehicles have less impact at lower speeds but much greater effect at highway speeds (Pandian 2012). At low speeds (e.g., the EPA city driving cycle) about 25 percent of the energy delivered by the drivetrain is used to overcome aerodynamic drag; at high speeds, about 50 percent or more of the energy is used to overcome drag (NRC 2013c).

Argonne National Laboratory estimated that, without engine modifications, a 10 percent reduction in aerodynamic drag would result in about a 0.25 percent reduction in fuel consumption for the urban cycle and a 2.15 percent reduction for the highway cycle (NRC 2015). Under average driving conditions, a 10 percent reduction in drag resistance will reduce fuel consumption by about 2 percent. The coefficient of drag is a figure that measures the force of air drag resistance on an object, such as a car, where the lower the drag coefficient, the more aerodynamic the vehicle.

Vehicle drag can be reduced with more aerodynamic vehicle shapes, smoothing the underbody, wheel covers, active cooling aperture control (radiator shutters), and active ride height reduction (NRC 2013c). Reducing the height and width of the car can reduce the frontal area, but there is a limit to how small this area can be while still allowing people to sit comfortably inside the vehicle. Designers can change specific aspects of the shape of the body of the vehicle to reduce the total aerodynamic drag and increase fuel economy (Pandian 2012). Reducing the size of the separation zone, which is the area behind the car containing the vortices behind the car, is another predominant method of decreasing aerodynamic drag and can be done by slightly tapering the rear end of a car (Pandian 2012).

Another large source of drag is the underside of the vehicle and the wheel wells. Drag from air that flows through the gaps between the wheels and the body of the car can contribute to up to one sixth of the total drag on the vehicle. Wheel skirts can be attached to the rear wheels of a car and underside paneling can be used to prevent air from being caught in mechanical devices under the car (Pandian 2012).

The *Assessment of Fuel Economy Technologies for Light Duty Vehicles* 2015 report determined that, to achieve a 10 percent reduction in aerodynamic drag, vehicles would require significant changes, including wind deflectors (spoilers) and possibly the elimination of side view mirrors (NRC 2015). While vehicles with higher drag coefficients (e.g., trucks, vans, and boxlike vehicles) can reduce drag, vehicle functionality could be diminished. If vehicle functionality (including curbside appeal) is compromised, then the vehicle’s appeal to the consumer would be reduced (NRC 2015).

Average reductions in new-vehicle-fleet aerodynamic drag resistance for the midrange case are estimated as 21 percent in 2030, leading to a 4 percent reduction in fuel consumption. The midrange case also estimated a 35 percent average reduction in new-vehicle-fleet aerodynamic drag in 2050, leading to a 7 percent reduction in fuel consumption (NRC 2013c).

Additional research is needed to determine the life-cycle impacts of applying aerodynamic technologies. Life-cycle impacts are associated with the manufacturing, transport, and disposal of aerodynamic technologies, but this literature review did not locate any studies that specifically assessed impacts from manufacturing, transport, and disposal of aerodynamic technology. Most of the available scientific literature is focused on technologies for reductions in aerodynamic drag for trucking fleet tractors and trailers.

6.4 Conclusions

The information in this chapter helps the decision-maker by identifying the net life-cycle environmental reductions in environmental impacts achievable by various fuels, materials, and technologies, and the factors that contribute to increases or decreases in environmental impacts at other life-cycle phases beyond the vehicle use phase. These changes in environmental impacts are, therefore, proportional to the degree to which vehicle manufacturers use the various fuels, materials, and technologies in response to the alternatives under consideration. As discussed in Section 6.1, *Introduction*, NHTSA does not know how manufacturers will rely on the different technologies, materials, and fuel sources assessed in this chapter, and as a result, cannot quantitatively distinguish between alternatives.

The overarching conclusion based on this synthesis of the LCA literature is that most material and technology options would reduce GHG emissions, energy use, and most other environmental impacts when considered on a life-cycle basis. However, some technologies show uncertainty about environmental impacts from upstream production, which may, in some cases, counterbalance some portion of the environmental benefits when evaluated on a life-cycle basis.

6.4.1 Energy Sources

The LCA literature synthesis revealed qualitative information about upstream natural gas, petroleum, and electricity emissions to supplement the analyses in Chapter 3, *Energy*, Chapter 4, *Air Quality,* and Chapter 5, *Greenhouse Gas Emissions and Climate Change*. In general, the LCA literature synthesis found that upstream emissions make up less than 20 percent of total life-cycle GHG emissions and less than 20 percent of total non-GHG emissions. The following tentative findings emerged from the LCA literature synthesis related to vehicle energy production and use:

- **Hydraulic fracturing.** Gasoline and natural gas domestic resources have become more dependent on hydraulic fracturing of shale formations. These sources, especially shale gas, have been shown to have similar or higher life-cycle GHG emissions compared to conventional sources, although results can vary based on study assumptions and scopes. Hydraulic fracturing has also been linked with increased water pollution.
- **Renewable energy.** Electricity will decline in carbon intensity if renewable energy and natural gas replace existing coal power.
- **Charging location and timing.** EVs can offer significant life-cycle GHG emission savings over conventional passenger cars and light trucks, but this is highly dependent on the location of charge. EVs from regions with high portions of coal electricity (i.e., the Midwest) often have life-cycle impacts similar to conventional vehicles. EV emissions can be influenced by when operators choose to charge their vehicles (i.e., during times of peak use or during low demand), but results vary considerably between energy utilities.
- **Biofuel.** Recent research on land use change impacts and upgrades to production facility efficiency have reduced estimates of life-cycle GHG emissions from biofuels, especially for ethanol. Continued improvements to production could further reduce emissions with respect to conventional vehicles.

6.4.2 Materials and Technologies

The magnitude of life-cycle impacts associated with materials and technologies is small in comparison with the emissions reductions from avoided fuel consumption during vehicle use. The LCA literature synthesis revealed the following trends for materials and technologies:

- **Light-weight materials.** Light-weight materials manufactured using aluminum, high-strength steel, composites, and magnesium require more energy to produce than similar conventional steel components, but offer overall life-cycle energy and emissions benefits through fuel efficiency improvements.
- **Weight-reducing technologies for vehicle manufacturing.** Weight-reducing manufacturing—such as hydroforming, laser welding, and aluminum casting—improves efficiencies in manufacturing and reduces overall vehicle weight, reducing impacts in the manufacturing and vehicle use phases.
- **Net environmental benefits of materials and technologies.** Upstream energy requirements for the manufacture of light-weight materials are small relative to efficiencies achieved. Although the production of weight-reducing materials requires more upstream energy, the operating efficiencies gained can be significant, leading to a net decrease in environmental impacts and in GHG emissions.
- **Lithium-ion batteries.** Lithium-ion batteries have become the standard in EV designs, but active-material chemistries continue to evolve. Studies found that energy consumption and GHG emissions from battery production were lower than those in the vehicle use phase, but results varied based on electricity grid mix and other factors. Emerging research has focused on battery recycling

technologies, as new processes are being developed to mitigate concerns over increasing solid waste flows.

- **Further LCA research.** Scientific understanding of aerodynamic features, low-rolling resistance tires, and other technologies is still evolving. More research is needed to assess impacts upstream and downstream of these products.

CHAPTER 7 OTHER IMPACTS

This chapter describes the affected environment and environmental consequences of the Proposed Action and alternatives on resources other than those described in Chapter 3, *Energy*, Chapter 4, *Air Quality*, Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*. These additional resources are described in the following sections: Section 7.1, *Land Use and Development*, Section 7.2, *Hazardous Materials and Regulated Waste*, Section 7.3, *Historical and Cultural Resources*, Section 7.4, *Noise*, and Section 7.5, *Environmental Justice*. With respect to each of these issues, because the magnitude of the changes that the Proposed Action and alternatives would generate is too small to address quantitatively, impacts on the resources and topics discussed in this chapter are described qualitatively in relation to the No Action Alternative. In addition, many of the impacts of the Proposed Action and alternatives discussed in the following sections have a considerable degree of variability and uncertainty given that manufacturers have flexibility to choose how they will comply with the final standards.

In this EIS, NHTSA has not analyzed some resource areas because the action alternatives would have negligible or no impact on these resource areas (i.e., endangered species and Section 4(f)) or because they are discussed in other documents that are available for public review (i.e., safety impacts on human health). These resource areas are as follows:

- **Endangered Species Act (ESA).** NHTSA has concluded that consultation pursuant to Section 7(a)(2) of the Endangered Species Act[1] is not required for this action. The agency's discussion of its responsibilities under the ESA are addressed in the preamble to the final rule in Section X.E.6.
- **Section 4(f) Resources.** Section 4(f) (49 U.S.C. 303/23 U.S.C. 138) limits the ability of DOT agencies to approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historic sites unless certain conditions apply. Because the action alternatives are not a transportation program or project requiring the use of Section 4(f) resources, a Section 4(f) evaluation has not been prepared.
- **Safety Impacts on Human Health.** In developing the final standards, NHTSA analyzed how future changes in fuel economy might affect human health and welfare through vehicle safety performance and the rate of traffic fatalities. To estimate the possible safety impacts of the final standards, NHTSA analyzed impacts from mass reduction, fleet turnover, and the rebound effect. NHTSA used statistical analyses of historical crash data and a fleet simulation study using an engineering approach to investigate the cost and feasibility of mass reduction of vehicles while maintaining safety and other desirable qualities. NHTSA also examined the safety impacts that would result from delayed purchases of safer, newer model year vehicles due to higher vehicle prices resulting from CAFE. Finally, NHTSA examined the impact on vehicle miles traveled (VMT) due to changes in the cost of driving, also known as the rebound effect. These effects are discussed in both the preamble to the final rule in Section VII.A.4 and Section VI.D of the Final Regulatory Impact Analysis (FRIA).

[1] 16 U.S.C. § 1536(a)(2).

7.1 Land Use and Development

7.1.1 Affected Environment

Land use and development refer to human activities that alter land (e.g., industrial and residential construction or clearing of natural habitat for agricultural or industrial use). This section discusses changes in mining practices, agricultural practices, and development land use patterns that may occur as a result of the Proposed Action and alternatives. This section focuses on the greatest sources of environmental impacts from land use and development that could result from NHTSA's Proposed Action. Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, also examines life-cycle environmental impacts related to electric vehicle and battery manufacturing, changes in which could also affect land use and development.

7.1.2 Environmental Consequences

Shifts toward or away from more efficient, lighter vehicles, either because of consumer preference for fuel-efficient vehicles or manufacturers' decisions to reduce or increase vehicle mass, could result in changes in mining land use patterns. Mining for the minerals needed to construct lighter vehicles (primarily aluminum and magnesium) could shift some metal-extraction activities to areas rich in these resources. Tonn et al. (2003) note that such a shift in materials "could reduce mining for iron ore in the United States, but increase the mining of bauxite [aluminum ore], magnesium, titanium, and other materials in such major countries as Canada, China, and Russia, and in many small, developing countries, such as Guinea, Jamaica, and Sierra Leone." Relocating mining to new sites for these alternative resources could result in environmental impacts, such as destruction of natural habitat from altered land cover. In contrast, a shift away from lighter-weight vehicles would not require new sites for these resources and would not involve the potential environmental impacts associated with the relocation of mining sites. Under the Proposed Action and alternatives, as well as the No Action Alternative, a shift toward or away from lighter-weight materials is possible. Because the No Action Alternative is the most stringent of the alternatives, it is likely that more lighter-weight materials would be used under this alternative, potentially leading to new mining sites, as discussed. Because the Proposed Action and alternatives are less stringent than the No Action Alternative, shifts toward lighter vehicles and the associated new mining activities seem less likely, but still possible, under these alternatives.

Manufacturers could also incorporate a number of technologies for electrification to comply with the final standards, including hybrid electric vehicles (HEVs), electrified accessories, fully electric power trains, electrified power take-off units, plug-in HEVs, external-power-to-electric-power trains for zero-emissions vehicle corridors, and alternative fuel/hybrid combinations (NRC 2014). See Section 6.2.3, *Electricity*, for a discussion of the environmental impacts associated with vehicle electrification, and Section 6.3.3, *Vehicle Batteries*, for additional information on the production and end-of-life management of vehicle batteries.

The Proposed Action and alternatives are not anticipated to affect the production or use of biofuel technology in MY 2021–2026 light-duty vehicles in any predictable way. Depending on how manufacturers choose to comply with the standards, an increase or decrease in biofuel production and use is possible. The current production of ethanol is affected primarily by the EPA renewable fuel standard program, a separate program that establishes targets for several categories of renewable fuels consumption. The most recent standard issued (in 2018) caps the renewable fuel target at more than 19 billion gallons per year. Because the alternatives are not expected to affect the use or production of renewable fuels in any predictable way, NHTSA does not anticipate distinguishable land use impacts related to biofuel production.

By increasing fuel costs per mile, lower fuel economy standards under the Proposed Action and alternatives could provide an incentive for decreased driving, which could lead to lower VMT. In areas where the highway network, infrastructure availability, and housing market conditions allow, this could decrease demand for low-density residential development beyond existing developed areas and increase demand for residences in more densely populated areas that are less dependent on automobiles for travel and are associated with lower VMT per household (FHWA 2014, DOT 2016c). Many agencies are implementing measures, such as funding smart-growth policies, to influence settlement patterns to reduce VMT and fuel use to meet climate change goals (Moore et al. 2010, EPA 2017a). See Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, for more information regarding VMT and the rebound effect.

Under the Proposed Action and alternatives, fuel consumption is anticipated to increase compared to the No Action Alternative, with increases ranging from a total of 226 billion gasoline gallon equivalents (GGE) under Alternative 1 to 85 billion GGE under Alternative 8 from 2020 to 2050 (Chapter 3, *Energy*). This represents a 3 to 7 percent increase in aggregate fuel consumption compared to the No Action Alternative. This increase in fuel consumption is likely to result in additional oil extraction and refining, along with a potential need for new pipelines, especially where new forms of extraction target new locations further from existing recovery sites and pipelines. To the extent that existing oil extraction and refining sites could not accommodate the production increase, some former land uses may be converted. The establishment of new pipelines, if necessary, would also affect land use falling in the right-of-way of existing or proposed pipeline routes. Because the Proposed Action and alternatives represent a small percentage of increased fuel consumption over a long period, however, impacts on land use are likely to be minimal.

7.2 Hazardous Materials and Regulated Waste

7.2.1 Affected Environment

Hazardous waste is defined as any item or agent (biological, chemical, or physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Hazardous waste is generally designated as such by individual states or EPA under the Resource Conservation and Recovery Act of 1976. Additional federal and state legislation and regulations, such as the Federal Insecticide, Fungicide, and Rodenticide Act, determine handling and notification standards for other potentially toxic substances. For the Proposed Action and alternatives, the relevant sources of impacts from hazardous materials and waste are oil extraction and refining processes, agricultural production and mining activities, and vehicle batteries. This section focuses on the greatest sources of and environmental impacts from hazardous materials and regulated wastes. Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, also examines life-cycle environmental impacts of electric vehicle-related hazardous materials (e.g., lithium-ion [Li-ion] batteries) and waste management practices. For hazardous waste impacts associated with electric vehicle-related hazardous materials, see Section 6.2.3, *Electricity*, and Section 6.3.3, *Vehicle Batteries*.

Hazardous waste produced from oil and gas extraction and refining can present a threat to human and environmental health. Onshore environmental impacts are most commonly caused by the improper disposal of saline water produced with oil and gas (referred to as produced water), the accidental releases of hydrocarbons and produced water, and the improper sealing of abandoned oil wells (Kharaka and Otton 2003, Pichtel 2016). Produced water from oil and gas wells often contains high concentrations of total dissolved solids in the form of salts. These wastewaters could also contain various organic chemicals, inorganic chemicals, metals, and naturally occurring radioactive materials (EPA 2017d).

The development of new techniques, such as hydraulic fracturing, has opened vast new energy reserves in the United States. Hydraulic fracturing provides approximately two-thirds of U.S. natural gas production (EIA 2016b) and half of U.S. oil production (EIA 2016d). Oil supplies contained in low-permeability rocks, such as shale, can be accessed with hydraulic fracturing (EIA 2017e). Increased use of hydraulic fracturing introduces new potential environmental impacts on U.S. drinking water. The extraction of natural gas from shale can affect drinking water quality because of gas migration, contaminant transport through fractures, wastewater discharge, and accidental spills (Vidic et al. 2013, EPA 2016g).

In 2016, EPA published a final report on *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States*. EPA found scientific evidence that hydraulic fracturing activities can affect drinking water resources under some circumstances. EPA identified certain conditions under which impacts from hydraulic fracturing activities could be more frequent or severe, such as water withdrawals in times or areas of low water availability, spills that result in large volumes or high concentrations of chemicals, problems with hydraulic fracturing fluid injections, discharges of inadequately treated wastewater to surface water, and disposal of wastewater in unlined pits (EPA 2016i). A recent study analyzed the toxicity of certain chemicals in wastewater produced from hydraulic fracturing and found that, of 240 chemicals analyzed, 157 chemicals were associated with either developmental or reproductive toxicity (Elliott et al. 2016). The authors further noted that 67 of these chemicals were of particular concern because they had an existing federal health-based standard or guideline, although it was not determined whether levels of chemicals exceeded the guidelines. Hydraulic fracturing has also been shown to potentially induce earthquakes in Canada (Bao and Eaton 2016), although the U.S. Geological Survey attributes induced earthquakes in the United States to wastewater disposal (USGS 2017).

Offshore environmental impacts from oil and gas extraction can result from the release of improperly treated produced water into the water surrounding an oil platform (EPA 1999b, Bakke et al. 2013, OSPAR Commission 2014). Offshore platform spills, although rare,[2] can have devastating environmental impacts. According to the American Petroleum Institute, oil and gas production generate more than 18 billion barrels of waste fluids, including produced water and associated waste, annually in the United States (EPA 2012e, 2016l).

The oil extraction process used to produce motor vehicle fuel generates emissions from the combustion of petroleum-based fuels. These emissions, which include volatile organic compounds (VOCs), sulfur oxides (SO_X), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM), and other air pollutants, can affect air quality (NAP 2015). In the atmosphere, SO_X and NO_X contribute to the formation of acid deposition (the deposition of SO_X and NO_X under wet, dry, or fog conditions, commonly known as acid rain), which enters bodies of water either directly or as runoff from terrestrial

[2] Historically, there were six spills per 100 billion barrels of oil produced from offshore oil platforms between 1964 and 2010 (Anderson et al. 2012).

systems with adverse impacts on water resources, plants, animals, and cultural resources. Oil extraction activities could also affect biological resources through habitat destruction and encroachment.

7.2.2 Environmental Consequences

The projected increase in fuel production and combustion resulting from the Proposed Action and alternatives (Section 3.4, *Environmental Consequences*) could lead to an increase in petroleum extraction and refining for the transportation sector compared to the No Action Alternative. Waste produced during the petroleum refining process is released primarily into the air (75 percent of total waste) and water (24 percent of total waste) (EPA 1995a). EPA defines a release as the "on-site discharge of a toxic chemical to the environment…emissions to the air, discharges to bodies of water, releases at the facility to land, as well as contained disposal into underground injection wells" (EPA 1995a, EPA 2016g). Some of the most common toxic substances released by the petroleum refining industry are volatile chemicals (highly reactive substances that are prone to state changes or combustion, including benzene, toluene, ethylbenzene, xylene, cyclohexane, ethylbenzene, and 1,2,4-trimethylbenzene) (EPA 1995a, EPA 2003a). These substances are present in crude oil and finished petroleum products. Other potentially dangerous substances commonly released during the refining process include ammonia, gasoline additives (methanol, ethanol, and methyl tert-butyl ether), chemical feedstocks (propylene, ethylene, and naphthalene), benzene, toluene, ethylbenzene, xylene, and n-hexane (EPA 2014g).[3] Spent sulfuric acid is by far the most commonly produced toxic substance; however, it is generally reclaimed rather than being released or transferred for disposal (EPA 1995a). Because oil and gas extraction and refining are expected to increase under the Proposed Action and alternatives, associated emissions of volatile chemicals and other potentially dangerous substances are expected to increase as well, compared to the No Action Alternative. The impact analysis in Chapter 4, *Air Quality*, includes emissions from extraction and refining. See Chapter 4, *Air Quality*, for an in-depth discussion of the health impacts of hazardous air pollutants.

Spills of oil or other hazardous materials during oil and gas extraction and refining can also lead to surface water and groundwater contamination and result in impacts on drinking water and marine and freshwater ecosystems. Because the Proposed Action and alternatives have the potential to increase overall petroleum extraction and refining levels due to decreased fuel efficiency, the total number of hazardous material spills that result from extraction and refining may increase compared to the No Action Alternative.

Oil exploration and extraction also result in intrusions into onshore and offshore natural habitats and can involve construction within natural habitats. Ecosystems that experience encroachment may have

[3] Ammonia is a form of nitrogen and can contribute to eutrophication (the process by which an aquatic ecosystem becomes enriched in nitrates or phosphates that help stimulate the growth of plant life, resulting in the depletion of dissolved oxygen) in surface water bodies. Once present in a surface water body, SO_X and NO_X can cause acidification of the water body, changing the pH of the system and affecting the function of freshwater ecosystems. Plants and animals in a given ecosystem are interdependent; therefore, changes in pH or aluminum levels can severely affect biodiversity (EPA 2017b). As lakes and streams become more acidic, the numbers and types of fish as well as aquatic plants and animals in these water bodies could decrease. Benzene exposure could cause short-term eye and skin irritation as well as blood disorders, reproductive and developmental disorders, and cancer (EPA 2017b). Long-term exposure to toluene emissions could cause nervous system effects, skin and eye irritation, dizziness, headaches, difficulty sleeping, and birth defects (EPA 2011). Short-term exposure to ethylbenzene emissions could cause throat and eye irritation, chest pain and pressure, and dizziness; long-term exposure could cause blood disorders (EPA 2017b). Short-term exposure to xylene emissions could cause nose, eye, throat, and gastric irritation; nausea; vomiting; and neurological effects. Long-term exposure could affect the nervous system. Short-term exposure to n-hexane emissions could cause dizziness, nausea, and headaches, and long-term exposure could cause numbness in extremities, muscular weakness, blurred vision, headaches, and fatigue (EPA 2017b).

significant effects from drilling on benthic (bottom-dwelling) populations, migratory bird populations, and marine mammals (Borasin et al. 2002, USFWS 2009, NOAA 2012, Bakke et al. 2013). The increase in oil and gas extraction and refining that could occur under the Proposed Action and alternatives is also likely to result in an increase in these types of impacts on natural habitats compared to the No Action Alternative.

Acid deposition associated with the release of SO_X and NO_X affects forest ecosystems negatively, both directly and indirectly. Potential impacts include stunted tree growth and increased mortality, primarily due to the leaching of soil nutrients (EPA 2012a, 2017b). Declines in the biodiversity of aquatic species and changes in terrestrial habitats have most likely had ripple effects on wildlife species that depend on these resources. Acid deposition contributes to the eutrophication of aquatic systems, which can ultimately result in the death of fish and aquatic animals (Lindberg 2007, EPA 2017b). The potential increase in fuel production and combustion resulting from the Proposed Action and alternatives could increase pollutant emissions that cause acid deposition, compared to those emissions under the No Action Alternative.

Motor vehicles, the motor vehicle equipment industry, and businesses engaged in the manufacture and assembly of cars and trucks produce hazardous materials and toxic substances. To the extent that the final standards would reduce vehicle prices by requiring lower fuel economy, thereby leading to greater vehicle production and sales, the amount of hazardous materials and toxic substances produced by vehicle manufacturing could increase. EPA reports that solvents (e.g., xylene, methyl ethyl ketone, acetone) are the most commonly released toxic substances of those that the agency tracks for this industry (EPA 1995a). These solvents are used to clean metal and are used in the vehicle finishing process during assembly and painting (EPA 1995a). Other wastes from the motor vehicle equipment industry include metal paint and component-part scrap. Physical contact with solvents can present health hazards such as toxicity to the nervous system, reproductive damage, liver and kidney damage, respiratory impairment, cancer, and dermatitis (OSHA 2016).

To comply with the final standards, some manufacturers could choose to substitute lighter-weight materials (e.g., aluminum, high-strength steel, magnesium, titanium, or plastic) for conventional vehicle materials (e.g., conventional steel and iron). This could increase the total waste stream from automobile manufacturing, as well as waste streams resulting from mining and other production wastes. See Section 6.3.1, *Vehicle Mass Reduction by Manufacturing Technologies,* and Section 6.3.2, *Vehicle Mass Reduction by Material Substitution*, for a discussion of the environmental impacts associated with the use of lighter-weight materials in vehicles. Manufacturers could also incorporate a number of technologies for electrification to comply with the final standards, including hybrid electric vehicles (HEVs), electrified accessories, fully electric power trains, electrified power take-off units, plug-in HEVs, external-power-to-electric-power trains for zero-emissions vehicle corridors, and alternative fuel/hybrid combinations (NRC 2014). See Section 6.2.3, *Electricity*, and Section 6.3.3, *Vehicle Batteries*, for a discussion of the environmental impacts associated with the use of vehicle electrification.

In summary, the potential increase in fuel production and consumption under the Proposed Action and alternatives could lead to an increase in the amount of hazardous materials and waste created by the oil extraction and refining industries compared to the No Action Alternative. NHTSA expects corresponding increases in the associated environmental and health impacts of these substances. The Proposed Action and alternatives could also lead to the decreased use of some lighter-weight materials and advanced technologies, depending on the mix of methods the manufacturers use to meet the fuel efficiency standards, economic demands from consumers and other manufacturers, and technological developments. Because there is still substantial uncertainty regarding how manufacturers would choose to comply with the standards, including whether they would use lighter-weight materials and other technological developments associated with electric vehicles, this EIS does not quantify impacts related to waste produced during the refining process due to mass reduction or wastes associated with electric vehicle production and use. See Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, for a discussion of the environmental impacts associated with down-weighting and electric vehicle technologies.

7.3 Historical and Cultural Resources

7.3.1 Affected Environment

Section 106 of the National Historic Preservation Act of 1966[4] and its implementing regulations[5] state that agencies of the Federal Government must take into account the impacts of their actions on historical properties. This process, known as the Section 106 process, is intended to support historic preservation and mitigate impacts on significant historical or archaeological properties through the coordination of federal agencies, states, and other affected parties. Historical properties are generally identified through the National Register of Historic Places, which lists properties of significance to the United States or a particular locale because of their setting or location, contribution to or association with history, or unique craftsmanship or materials.

NHTSA addresses its obligations under the Section 106 process in Section X.E.3 of the preamble to the final rule. The analysis in this section is intended to provide additional information in order to disclose impacts under NEPA.

7.3.2 Environmental Consequences

The corrosion of metals and the deterioration of paint and stone, which can reduce the cultural value of buildings, statues, cars, and other historically significant materials, can be caused by both acid rain and the dry deposition of pollution (EPA 2017b). Deposition of dry acidic compounds found in acid rain can also dirty historical buildings and structures, causing visual impacts and increased maintenance costs (EPA 2017b). EPA established the Acid Rain Program under Title IV of the 1990 Clean Air Act Amendments in 1995 requiring major emissions reductions of sulfur dioxide and NO_X from electric generating units (EPA 1995a).

The potential increase in fuel production and combustion under the Proposed Action and alternatives could lead to an increase in pollutant emissions that cause acid deposition compared to the No Action Alternative. An increase in the emissions of such pollutants could result in a corresponding increase in damage to historical and other structures caused by acid deposition. In terms of specific pollutant emissions, total SO_X emissions are anticipated to decrease slightly under the Proposed Action and alternatives compared to the No Action Alternative, while total NO_X emissions would increase slightly (Chapter 4, *Air Quality*, Table 4.2.1-2). Downstream (tailpipe) emissions of both NO_X and SO_X are projected to increase, except under Alternate 1 and Alternative 2, which would result in a slight decrease in NO_X emissions. Upstream (refinery and power plant) emissions of NO_X are projected to increase, while upstream emissions of SO_X would decrease. This means that the impacts of the Proposed

[4] 54 U.S.C. § 100101 et seq. (codified in 2014).

[5] 36 CFR Part 800.

Action and alternatives would differ by location across the country. However, because NO_X and SO_X emissions that lead to acid deposition can travel long distances in the atmosphere, the specific location of impacts is difficult to predict. In general, impacts under the Proposed Action and alternatives are not quantifiable because it is not possible to distinguish between acid deposition deterioration impacts and natural weathering (rain, wind, temperature, and humidity) impacts on historical buildings and structures and the varying impact of a specific geographic location on any particular historical resource (Striegel et al. 2003).

7.4 Noise

7.4.1 Affected Environment

Vehicle noise is composed primarily of the interaction between the engine/drivetrain, tire/road surface, and vehicle aerodynamics. Vehicle aerodynamic noise levels are generally low at typical roadway speeds. Tire/road surface noise increases with increasing vehicle speed. Vehicle noise exposure can affect noise-sensitive receptors such as residents along roadways (environmental noise) as well as vehicle passengers. No recent studies have been conducted in the United States on the extent of highway traffic noise, but in 1981, EPA estimated that 19.3 million people were exposed to day-night average sound levels of 65 decibels (EPA 1981). At a day-night average sound level of 65, approximately 14 percent of people exposed to this noise level would be highly annoyed (ANSI S12.9-2005/Part 4). Traffic noise levels are greatly influenced by the vehicle fleet mix traveling over the highway or roadway. Based on Federal Highway Administration traffic noise measurements, noise levels for automobiles traveling at speeds of 50 miles per hour are between 70 and 75 A-weighted decibels[6] (measured 50 feet from the vehicles) (Fleming et al. 1996).

The noise generated from air flowing over a vehicle, or wind noise, is directly related to the aerodynamics of a vehicle. For example, abrupt vehicle features that increase aerodynamic drag also contribute to noise. However, at typical highway speeds, aerodynamic noise is low—in terms of impacts on people adjacent to highways—compared to tire and engine/drive train noise. To reduce wind noise, some vehicle features can be redesigned to lower aerodynamic drag, in some cases by being incorporated into the interior of the vehicle (Jiang et al. 2011). This method of reducing wind noise by improving vehicle aerodynamics is referred to as aero-acoustics.

Noise from motor vehicles is one of the primary causes of noise disturbance in homes (Ouis 2001, Theebe 2004, Henshaw 2016). Excessive amounts of noise can disturb and affect human health at certain levels. Potential health hazards related to noise range from annoyance (sleep disturbance, lack of concentration, and stress), to headaches and migraines, to hearing loss at high levels (Passchier-Vermeer and Passchier 2000, Henshaw 2016). Primary sources of noise in the United States include road and rail traffic, air transportation, and occupational and industrial activities. Noise generated by vehicles can cause inconvenience, irritation, and potentially even discomfort for occupants of other vehicles, pedestrians and other bystanders, and residents or occupants of surrounding property.

Wildlife exposure to chronic noise disturbances from motor vehicles can impair senses; change the habitat use, density, and occupancy patterns of species; increase stress response; modify pairing and reproduction; increase predation risk; and degrade communication (Barber et al. 2010, Bowles 1995,

[6] A-weighted decibels, commonly used to describe environmental noise, express the relative loudness of sound to the human ear.

Larkin et al. 1996, Brown et al. 2013, Francis and Barber 2013). Although noise can affect wildlife, it does not mean the impact is always adverse. Wildlife species are exposed to many different noises in the environment and can adapt, and species differ in their level of sensitivity to noise exposure (Francis and Barber 2013). Even without human-generated noise, natural habitats have patterns of ambient noise resulting from, among other things, wind, animal and insect sounds, and noise-producing environmental factors, such as streams and waterfalls (California Department of Transportation 2007).

7.4.2 Environmental Consequences

Less fuel-efficient vehicles could decrease VMT, resulting in potential decreases in vehicle road noise. In general, noise levels from vehicles are location-specific, meaning that factors such as the time of day when increases in traffic occur, existing ambient noise levels, the presence or absence of noise abatement structures, and the location of schools, residences, and other sensitive noise receptors all influence whether there would be noise impacts. While a truly local analysis (i.e., at the individual roadway level) is impractical for a nationwide EIS, NHTSA believes the potential noise impacts described below would apply to roadways and sensitive locations in general.

The Proposed Action and alternatives could lead to an increase or decrease in use of hybrid and electric technologies, depending on the methods manufacturers use to meet the new requirements, economic demands from consumers and manufacturers, and technological developments. In general, more stringent alternatives are associated with greater use of hybrid and electric vehicle technologies compared to less stringent alternatives. A reduced percentage of hybrid technologies under the Proposed Action and alternatives could result in increased road noise, potentially offsetting some of the decreases in road noise predicted to result from decreased VMT compared to the No Action Alternative. In addition, noise reductions associated with the use of hybrid technologies could be offset at low speeds by manufacturer installation of pedestrian safety-alert sounds, as required by NHTSA (NHTSA 2016b).

7.5 Environmental Justice

Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*,[7] directs federal agencies to "promote nondiscrimination in federal programs substantially affecting human health and the environment, and provide minority and low-income communities access to public information on, and an opportunity for public participation in, matters relating to human health or the environment." EO 12898 also directs agencies to identify and consider any disproportionately high and adverse human health or environmental effects that their actions might have on minority and low-income communities and provide opportunities for community input in the NEPA process. CEQ has provided agencies with general guidance on how to meet the requirements of the EO as it relates to NEPA (CEQ 1997).

DOT Order 5610.2(a), *Department of Transportation Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*,[8] describes the process for DOT agencies to incorporate environmental justice principles in programs, policies, and activities. It also defines the terms *minority* and *low-income* in the context of DOT's environmental justice analyses. *Minority* is

[7] Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations, 59 FR 7629 (Feb. 16, 1994).

[8] Department of Transportation Updated Environmental Justice Order 5610.2(a), 77 FR 27534 (May 10, 2012).

defined as a person who is black, Hispanic or Latino, Asian American, American Indian or Alaskan Native, or Native Hawaiian or other Pacific islander. *Low-income* is defined as a person whose household income is at or below the Department of Health and Human Services poverty guidelines. DOT also recently reviewed and updated its environmental justice strategy to ensure that it continues to reflect its commitment to environmental justice principles and integrating those principles into DOT programs, policies, and activities (DOT 2016b).

7.5.1 Affected Environment

The affected environment for environmental justice is nationwide, with a focus on areas that could contain minority and low-income communities who would most likely be exposed to the environmental and health effects of oil production, distribution, and consumption or the impacts of climate change. This includes areas where oil production and refining occur, areas near roadways, coastal flood-prone areas, and urban areas that are subject to the heat island effect.[9] As part of the literature review conducted for this analysis, NHTSA did not locate any studies that specifically assessed disproportionate impacts on communities located near power generation, distribution facilities, or mining sites for vehicle materials.

There is evidence that proximity to oil refineries could be correlated with incidences of cancer and leukemia (Pukkala 1998, Chan et al. 2006, Bulka et al. 2013). Proximity to high-traffic roadways could result in adverse cardiovascular and respiratory impacts, among other possible impacts (HEI 2010, Heinrich and Wichmann 2004, Salam et al. 2008, Samet 2007, Adar and Kaufman 2007, Wilker et al. 2013, Hart et al. 2013). Climate change affects overall global temperatures, which could, in turn, affect the number and severity of outbreaks of vector-borne illnesses (GCRP 2014, 2016). Chapter 3, *Energy*, Chapter 4, *Air Quality*, Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, discuss the connections between oil production, distribution, and consumption and their health and environmental impacts. The following paragraphs describe the extent to which minority and low-income populations could be more exposed or vulnerable to such effects.

7.5.1.1 Proximity to Oil Production and Refining

Numerous studies have found that some environmental hazards are more prevalent in areas where minority and low-income populations represent a higher proportion of the population compared with the general population. For example, Mohai et al. 2009 found that survey respondents who were black and, to a lesser degree, had lower income levels, were significantly more likely to live within 1 mile of an industrial facility listed in the EPA's 1987 Toxic Release Inventory national database.

Ringquist 2005 conducted a meta-analysis of 49 environmental equity studies and concluded that evidence of race-based environmental inequities is statistically significant (although the average magnitude of these inequities is small), while evidence supporting the existence of income-based environmental inequities is substantially weaker. Considering poverty-based class effects, Ringquist 2005 found an inverse relationship between environmental risk and poverty, concluding that environmental risks are less likely to be located in areas of extreme poverty. However, individual studies may reach contradictory conclusions in relation to race- and income-based inequities across a range of environmental risks. Therefore, the meta-analysis also sought to examine the reasons why conclusions vary across studies of environmental inequity. Possible explanations for why studies reach contrary

[9] The heat island effect refers to developed areas having higher temperatures than surrounding rural areas. See Section 8.6.5.2, *Urban Areas*, for further discussion of the heat island effect.

conclusions include variability in the source of potential environmental risk that the study considers (e.g., the type of facility or the associated level of pollution or risk); variability in the methodology applied to aggregate demographic data and to define the comparison population; and the degree to which statistical models control for other variables that may explain the distribution of potential environmental risk.

To test whether there are disparate impacts from hazardous industrial facilities on racial/ethnic minorities, the disadvantaged, the working class, and manufacturing workers, Sicotte and Swanson 2007 tested the relationship between hazard scores of Philadelphia-area facilities in EPA's Risk-Screening Environmental Indicators database and the demographics of populations near those facilities using multivariate regression. This study concludes that racial/ethnic minorities, the most socioeconomically disadvantaged, and those employed in manufacturing suffer a disparate impact from the highest-hazard facilities (primarily manufacturing plants).

Other commissioned reports and case studies (UCC 2007, NAACP and CATF 2017, Ash et al. 2009, Kay and Katz 2012) provide additional evidence of the presence of low-income and minority populations near industrial facilities and of racial or socioeconomic disparities in exposure to environmental risk, although these sources were not published in peer-reviewed scientific journals.

Few studies address disproportionate exposure to environmental risk associated with oil refineries specifically. O'Rourke and Connolly 2003 find the populations surrounding oil refineries are more often minorities, finding "56 percent of people living within three miles of [oil] refineries in the United States are minorities – almost double the national average." Graham et al. 1999 examined whether findings of environmental inequity varied between coke production plants and oil refineries, both of which are significant sources of air pollution. This study concluded that census tracts near coke plants had a disproportionate share of poor and nonwhite residents, and that existing inequities were primarily economic in nature. However, the findings for oil refineries did not strongly support an environmental inequity hypothesis. A more recent study of environmental justice in the oil refinery industry (Carpenter and Wagner 2019) found evidence of environmental injustice as a result of unemployment levels in areas around refineries and, to a slightly lesser extent, as a result of income inequality. This study did not test for race-based environmental inequities.

Overall, the body of scientific literature points to disproportionate representation of minority and low-income populations in proximity to a range of industrial, manufacturing, and hazardous waste facilities that are stationary sources of air pollution, although results of individual studies may vary. While the scientific literature specific to oil refineries is limited, disproportionate exposure of minority and low-income populations to air pollution from oil refineries is suggested by other broader studies of racial and socioeconomic disparities in proximity to industrial facilities generally.

7.5.1.2 Proximity to High-Traffic Roadways

Studies have more consistently demonstrated a disproportionate prevalence of minority and low-income populations living near mobile sources of pollutants. In certain locations in the United States, for example, there is consistent evidence that populations or schools near roadways typically include a greater percentage of minority or low-income residents (Green et al. 2004, Wu and Batterman 2006, Chakraborty and Zandbergen 2007, Depro and Timmins 2008, Marshall 2008, Su et al. 2010, Su et al. 2011). In California, studies demonstrate that minorities and low-income populations are disproportionately likely to live near a major roadway or in areas of high traffic density compared to the general population (Carlson 2018, Gunier et al. 2003). A study of traffic, air pollution, and socioeconomic status inside and outside the Minneapolis-St. Paul metropolitan area similarly found that populations on the lower end of the socioeconomic spectrum and minorities are disproportionately exposed to traffic and air pollution and at higher risk for adverse health outcomes (Pratt et al 2015). Near-road exposure to vehicle emissions can cause or exacerbate health conditions such as asthma (Carlson 2018, Gunier et al. 2003, Meng et al. 2008, Khreis et al. 2017). Kweon et al. (2016) demonstrate that students at schools in Michigan closer to major highways had a higher risk of respiratory and neurological disease and were more likely to fail to meet state educational standards, after controlling for other variables. In general, studies such as these demonstrate trends in specific locations in the United States that may be indicative of broader national trends.

Fewer studies have been conducted at the national level, yet those that do exist also demonstrate a correlation between minority and low-income status and proximity to roadways (Tian et al. 2013, Boehmer et al. 2013, Rowangould 2013, Kingsley et al. 2014). For example, Rowangould (2013) found that greater traffic volumes and densities at the national level are associated with larger shares of minority and low-income populations living in the vicinity. Similarly, Kingsley et al. (2014) found that schools with minority and underprivileged[10] children were disproportionately located within 250 meters of a major roadway.

As detailed in Section 10.3.8 of the PRIA and Section X.E of the FRIA, NHTSA and EPA analyzed two national databases that allowed evaluation of whether homes and schools were located near a major road and whether disparities in exposure may be occurring in these environments. The American Housing Survey (AHS) includes descriptive statistics of over 70,000 housing units across the nation. The study survey is conducted every 2 years by the U.S. Census Bureau. The second database the agencies analyzed was the U.S. Department of Education's Common Core of Data, which includes enrollment and location information for schools across the United States.

In analyzing the 2009 AHS, the focus was on whether or not a housing unit was located within 300 feet of a "4-or-more lane highway, railroad, or airport."[11] Whether there were differences between households in such locations compared with those in locations farther from where these transportation facilities were analyzed (Bailey 2011). Other variables, such as land use category, region of country, and housing type were included. Homes with a nonwhite householder were found to be 22 to 34 percent more likely to be located within 300 feet of these large transportation facilities than homes with white householders. Homes with a Hispanic householder were 17 to 33 percent more likely to be located within 300 feet of these large transportation facilities than homes with non-Hispanic householders. Households near large transportation facilities were, on average, lower in income and educational attainment, more likely to be a rental property, and more likely to be located in an urban area compared with households more distant from transportation facilities.

In examining schools near major roadways, the Common Core of Data from the U.S. Department of Education, which includes information on all public elementary and secondary schools and school

[10] Public schools were determined to serve predominantly underprivileged students if they were eligible for Title I programs (federal programs that provide funds to school districts and schools with high numbers or high percentages of children who are disadvantaged) or had a majority of students who were eligible for free/reduced-price meals under the National School Lunch and Breakfast Programs.

[11] This variable primarily represents roadway proximity. According to the Central Intelligence Agency's World Factbook, in 2010, the United States had 6,506,204 km of roadways, 224,792 km of railways, and 15,079 airports. Highways, thus, represent the overwhelming majority of transportation facilities described by this factor in the AHS.

districts nationwide, was examined.[12] To determine school proximities to major roadways, a geographic information system (GIS) to map each school and roadways based on the U.S. Census's TIGER roadway file was used (Pedde and Bailey 2011). Minority students were found to be overrepresented at schools within 200 meters of the largest roadways, and schools within 200 meters of the largest roadways also had higher-than-expected numbers of students eligible for free or reduced-price lunches. For example, Black students represent 22 percent of students at schools located within 200 meters of a primary road, whereas Black students represent 17 percent of students in all U.S. schools. Hispanic students represent 30 percent of students at schools located within 200 meters of a primary road, whereas Hispanic students represent 22 percent of students in all U.S. schools. Overall, there is substantial evidence that the population who lives or attends school near major roadways are more likely to be minority or low income.

7.5.1.3 Other Vulnerabilities to Climate Change and Health Impacts of Air Pollutants

Some areas most vulnerable to climate change tend to have a higher concentration of minority and low-income populations, potentially putting these communities at higher risk from climate variability and climate-related extreme weather events (GCRP 2014). For example, urban areas tend to have pronounced social inequities that could result in disproportionately larger minority and low-income populations than those in the surrounding nonurban areas (GCRP 2014). Urban areas are also subject to the most substantial temperature increases from climate change because of the urban heat island effect (Knowlton et al. 2007, GCRP 2014, EPA 2017g). Taken together, these tendencies demonstrate a potential for disproportionate impacts on minority and low-income populations in urban areas. Low-income populations in coastal urban areas, which are vulnerable to increases in flooding as a result of projected sea-level rise, larger storm surges, and human settlement in floodplains, could also be disproportionately affected by climate change because they are less likely to have the means to evacuate quickly in the event of a natural disaster and, therefore, are at greater risk of injury and loss of life (GCRP 2009, 2014).

Independent of their proximity to pollution sources or climate change, locations of potentially high impact, minority and low-income populations could be more vulnerable to the health impacts of pollutants and climate change. Reports from the U.S. Department of Health and Human Services have stated that minority and low-income populations tend to have less access to health care services, and the services received are more likely to suffer with respect to quality (HHS 2003, 2013, 2017). Other studies show that low socioeconomic position can modify the health effects of air pollution, with higher effects observed in groups with lower socioeconomic position (O'Neill et al. 2003, Finkelstein et al. 2003). Possible explanations for this observation include that low socioeconomic position groups may be differentially exposed to air pollution or may be differentially vulnerable to effects of exposure (O'Neill et al. 2003).

In terms of climate change, increases in heat-related morbidity and mortality because of higher overall and extreme temperatures are likely to affect minority and low-income populations disproportionately, partially because of limited access to air conditioning and high energy costs (EPA 2009, O'Neill et al. 2005, Harlan and Ruddell 2011, GCRP 2014). Native American tribes and Alaskan Native villages are also more susceptible to the impacts of climate change, as these groups often disproportionately rely on natural resources for livelihoods, medicines, and cultural and spiritual purposes (NTAA 2009). Moreover, coastal tribal communities may have to relocate because of sea-level rise, erosion, and permafrost thaw

[12] http://nces.ed.gov/ccd/.

(IPCC 2014a citing Maldonado et al. 2013). See Section 8.6.5.2, *Sectoral Impacts of Climate Change*, under *Human Health* and *Human Security*, for additional discussion of health and societal impacts of climate change on indigenous communities.

Together, this information indicates that the same set of potential environmental effects (e.g., air pollutants, heat increases, sea-level rise) may disproportionately affect minority and low-income populations because of socioeconomic circumstances or histories of discrimination and inequity.

7.5.2 Environmental Consequences

The potential increase in fuel production and consumption projected as a result of the Proposed Action and alternatives compared to the No Action Alternative could lead to an increase in upstream emissions of criteria and toxic air pollutants due to increased extraction, refining, and transportation of fuel. As shown in Table 4.2.1-2 and Table 4.2.2-2, total upstream emissions of criteria and toxic air pollutants in 2035 are projected to increase under all action alternatives compared to the No Action Alternative, with the exception that total upstream emissions of SO_2 are projected to decrease under all action alternatives. To the extent that minority and low-income populations live closer to oil refining facilities, these populations may be more likely to be adversely affected by the Proposed Action and alternatives. As noted, a correlation between proximity to oil refineries and the prevalence of minority and low-income populations is suggested in the scientific literature. To the extent that minority and low-income populations live closer to oil-refining facilities, these populations may be more likely to be adversely affected by these emissions. However, the magnitude of the change in emissions relative to the baseline is minor and would not be characterized as high and adverse.

As is shown in Table 4.2.1-2 and Table 4.2.2-2, total downstream (tailpipe) emissions of criteria and toxic air pollutants for cars and trucks in 2035 are projected to increase under all action alternatives compared to the No Action Alternative, with the exception that downstream VOC and diesel particulate matter (DPM) emissions under all action alternatives, and downstream NO_X emissions under Alternative 1 and Alternative 2, would decrease compared to the No Action Alternative. To the extent that minority and low-income populations disproportionately live or attend schools near major roadways, these populations may be more likely to be adversely affected by the Proposed Action and alternatives.

Overall, projected changes in both upstream and downstream emissions of criteria and toxic air pollutants are mixed, with emissions of most pollutants remaining constant or increasing and emissions of some pollutants decreasing. These increases are associated with both upstream and downstream sources and, therefore, may disproportionately affect minority and low-income populations that reside in proximity to these sources. However, the magnitude of the change in emissions relative to the No Action Alternative is minor and would not be characterized as high and adverse.

As described in Chapter 5*, Greenhouse Gas Emissions and Climate Change*, the Proposed Action and alternatives are projected to increase carbon dioxide (CO_2) emissions from passenger cars and light trucks by 4 to 10 percent by 2100, compared to the No Action Alternative (Table 5.4.1-1). Impacts of climate change could disproportionately affect minority and low-income populations in urban areas that are subject to the most substantial temperature increases from climate change. These impacts are largely because of the urban heat island effect. Additionally, minority and low-income populations that live in flood-prone coastal areas could be disproportionately affected. However, the contribution of the Proposed Action and alternatives to climate change impacts would be very minor rather than high and adverse. Compared to the annual U.S. CO_2 emissions of 7,193 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) from all sources by the end of the century projected by the Global Climate

Change Assessment Model (GCAM) Reference scenario (Thomson et al. 2011), the Proposed Action and alternatives are projected to increase annual U.S. CO_2 emissions by 0.4 to 1.2 percent in 2100. Compared to annual global CO_2 emissions, the Proposed Action and alternatives would represent an even smaller percentage increase and ultimately, by 2100, are projected to result in percentage increases in global mean surface temperature, atmospheric CO_2 concentrations, and sea level, and decreases in ocean pH, ranging from 0.09 percent to less than 0.01 percent (Table 5.4.2-2). Any impacts of this rulemaking on low-income and minority communities would be attenuated by a lengthy causal chain; but if one could attempt to draw those links, the changes to climate values would be very small and incremental compared to the expected changes associated with the emissions trajectories in the GCAM Reference scenario.

Adverse health impacts in 2025 and 2035 are projected to increase nationwide under each of the action alternatives (except Alternative 6, which shows decreases) compared to the No Action Alternative (Table 4.2.3-1). Although emissions of SO_X in 2035 would decrease under all action alternatives, emissions of particulate matter 2.5 microns or less in diameter (PM2.5), DPM, and NO_X, in particular, would increase in 2035 under all of the action alternatives, thus resulting in the anticipated adverse health impacts. Increases in these pollutant emissions, however, would be primarily the result of increases in upstream emissions (emissions near refineries, power plants, and extraction sites), while downstream emissions (tailpipe emissions near roadways) are anticipated to decrease or increase by smaller amounts. In 2050, however, adverse health impacts are projected to decrease nationwide under each of the action alternatives compared to the No Action Alternative, primarily because of decreases in upstream SO_X emissions. The projected changes in adverse health impacts in 2035 under the action alternatives compared to the No Action Alternative would range from a decrease of 0.2 percent (under Alternative 6) to an increase of 0.4 percent (under Alternative 1). These increases would be incremental in magnitude and would not be characterized as high.

Based on the foregoing, NHTSA has determined that the Proposed Action and alternatives would not result in disproportionately high and adverse human health or environmental effects on minority or low-income populations. The final rulemaking would set standards nationwide, and although minority and low-income populations may experience some disproportionate effects, impacts of the Proposed Action and alternatives on human health and the environment would not be high and adverse.

CHAPTER 8 CUMULATIVE IMPACTS

8.1 Introduction

Under the CEQ NEPA implementing regulations, when preparing an EIS, NHTSA must consider the direct and indirect effects, as well as the cumulative impacts, of the Proposed Action and alternatives. CEQ defines direct effects as impacts "which are caused by the action and occur at the same time and place."[1] By contrast, indirect effects are impacts "which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable."[2] A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."[3] The purpose of analyzing cumulative impacts is to ensure that federal decision-makers consider the full range of consequences of the Proposed Action and alternatives within the context of other actions, regardless of what agency or person undertakes them, over time.

Section 8.2, *Methods*, outlines NHTSA's approach to defining the scope for the cumulative impact analysis and identifying the relevant past, present, and reasonably foreseeable actions that contribute to cumulative impacts. The following sections focus on cumulative effects in key impact areas analyzed in the EIS: Section 8.3, *Energy*; Section 8.4, *Air Quality*; Section 8.5, *Other Impacts*; and Section 8.6, *Greenhouse Gas Emissions and Climate Change.*

8.2 Methods

This section describes NHTSA's approach to defining the temporal and geographic scope of the cumulative impact analysis and to identifying other past, present, and reasonably foreseeable future actions.

8.2.1 Temporal and Geographic Scope of Analysis

The timeframe for this analysis of cumulative impacts extends from 2020 through 2050 for energy, air quality, and other impacts, and through 2100 for greenhouse gas (GHG) and climate impacts. As noted in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, the inherently long-term nature of the impacts of increasing GHG accumulations on global climate requires that GHG emissions for the Proposed Action and alternatives be estimated over a longer period than other environmental impacts. The geographic focus of this analysis for energy use and air quality impacts is national in scope while the analysis of climate impacts is global in scope, because GHG emissions in the United States may cause impacts around the world. This temporal and geographic focus is consistent with the analysis of direct and indirect impacts in Chapter 3, *Energy*, Chapter 4, *Air Quality*, Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 7, *Other Impacts*. This focus and the impact analysis are based on the

[1] 40 CFR § 1508.8(a).

[2] 40 CFR § 1508.8(b).

[3] 40 CFR § 1508.7.

reasonable ability of NHTSA to model or describe fuel consumption and emissions for the light-duty vehicle sector.

8.2.2 Identifying Past, Present, and Reasonably Foreseeable Future Actions

The cumulative impact analysis evaluates the impact of the Proposed Action and alternatives in combination with other past, present, and reasonably foreseeable future actions that affect the same resources. The range of actions considered includes other actions that have impacts that add to, or offset, the anticipated impacts of the proposed fuel economy standards on resources analyzed in this EIS. The other actions that contribute to cumulative impacts can vary by resource and are defined independently for each resource. However, the underlying inputs, models, and assumptions of the CAFE model (Section 2.3.1, *CAFE Model*) already take into account many past, present, and reasonably foreseeable future actions that affect U.S. transportation sector fuel use and U.S. mobile source air pollutant emissions. For example, the CAFE model incorporates the 2019 Annual Energy Outlook (AEO), which includes assumptions and projections relating to fuel prices. The CAFE model also uses data generated by the Greenhouse Gases, Emissions, and Energy Use in Transportation (GREET) model, which incorporates U.S. air pollutant emissions regulations applicable to upstream processes. Further, the baseline of analysis for measuring the climate impacts of the Proposed Action and alternatives is based on a global emissions scenario that includes assumptions about known policies and initiatives that affect global GHG emissions. Therefore, analysis of direct and indirect impacts of the Proposed Action and alternatives inherently (and appropriately) incorporates projections about the impacts of past, present, and reasonably foreseeable future actions to develop a realistic baseline. Because the universe of other reasonably foreseeable actions that would combine with the Proposed Action and alternatives on the relevant resource areas is limited, this chapter supplements the earlier chapters in analyzing the incremental impacts of the Proposed Action and alternatives when added to other past, present, and reasonably foreseeable future actions.

For energy, air quality, and other impacts, the other actions considered in their respective cumulative impact analyses are predictable actions where meaningful conclusions on impacts or trends relative to impacts of the Proposed Action and alternatives can be discerned. For these impact areas, the impacts described in Chapters 3, 4, and 7 are related to the widespread use of gasoline and diesel fuel to power light-duty vehicles. Some evidence, however, suggests that manufacturers may introduce a higher proportion of electric vehicles (EV) into their fleets, which would affect the impacts reported in those chapters. This potential change in fuel source for light-duty vehicles is therefore a focus of the analysis in this chapter. In addition, NHTSA considers impacts related to new federal policies regarding energy production and use.

The cumulative impact analysis for GHG emissions and climate impacts is based on a global-scale emissions scenario because it is not possible to individually identify and define the incremental impact of each action during the analysis period (2020 through 2100) that could contribute to global GHG emissions and climate change. Instead, examples of some known actions that contribute to the underlying emissions scenario provide a national and an international perspective.

8.3 Energy

8.3.1 Scope of Analysis

The timeframe for this analysis of cumulative energy impacts extends from 2020 through 2050, and the geographic area of interest is consumption of light-duty vehicle fuels within the United States. This temporal and geographic focus is consistent with the analysis of direct and indirect energy impacts in Chapter 3, *Energy*.

8.3.2 Analysis Methods

NHTSA's EIS for the MY 2017–2025 CAFE standards, which included analysis of the augural standards for MYs 2022–2025, evaluated cumulative impacts by estimating fuel economy improvements resulting directly or indirectly from the CAFE standards, plus additional improvements from actions taken by manufacturers, including potential over-compliance with CAFE standards through MY 2025 and ongoing fuel economy improvements after MY 2025. For this EIS, improvements by manufacturers, including over-compliance with CAFE standards and ongoing fuel economy improvements, are incorporated in the CAFE model outputs and included in Chapter 3, *Energy*.

For this EIS, NHTSA has taken a fresh look at its analytical approach regarding the cumulative impacts of the Proposed Action and alternatives on energy. First, NHTSA considers recent federal policies that affect future energy production and use, thereby affecting fuel use. Second, while many combinations of individual technologies might be used to reduce fossil fuel use in light-duty vehicles, many vehicle manufacturers are looking beyond the internal combustion engine (ICE) to comply with CAFE standards. The CAFE model, which produces the estimates that underlie the analysis of impacts on energy, considers EV technologies among the various technologies that manufacturers may incorporate to improve fuel economy. However, global EV market trends may provide additional insights about the future and could affect energy use beyond the impacts identified in Chapter 3, *Energy*. These trends provide insight on future actions that, in combination with the Proposed Action and alternatives, could further affect U.S. light-duty vehicle fuel consumption through 2050.

8.3.3 Other Past, Present, and Reasonably Foreseeable Future Actions

The following sections discuss reasonably foreseeable future actions related to transportation sector fuel use, including some federal policies that affect future energy production and use, and some global EV policies and market trends that may affect energy production and use.

Presidential Executive Order on Promoting Energy Independence and Economic Growth (EO 13783, issued March 28, 2017) could substantively affect energy supply. The stated goal of this ongoing initiative is to "promote clean and safe development of our Nation's vast energy resources, while at the same time avoiding regulatory burdens that unnecessarily encumber energy production, constrain economic growth, and prevent job creation." EO 13783 also recognizes that "prudent development of these natural resources is essential to ensuring the Nation's geopolitical security."

Global EV market share targets, quotas, and associated manufacturer investments to improve EV technologies and increase the scale of EV manufacturing may affect U.S. transportation sector fuel use in the future. Global investments to comply with EV requirements outside the United States could reduce the cost of EVs and thereby increase U.S. EV demand beyond levels anticipated in the analysis of direct and indirect energy impacts. However, the magnitude of the cumulative impacts associated with increased EV demand cannot be quantified with precision, and uncertainties surrounding the impacts of future government policies and subsidies and market-related factors make it difficult to predict how fleet mix shifts may actually affect transportation sector fuel use. Accordingly, this section presents a qualitative analysis of the impact on transportation fuel type and use attributable to potential EV adoption, with quantifiable estimates for U.S. cumulative fuel consumption impacts presented where available.

Section 8.3.3.1, *Global Electric Vehicle Market, Future Quotas, and Vehicle Industry Response*, explains how the global EV market trends may affect U.S. light-duty vehicle fuel consumption from 2020 through 2050. Section 8.3.3.2, *Recent Plug-In Electric Vehicle Market Forecasts and Potential Decline in Electric Vehicle Costs*, describes how these trends have increased forecasts for the EV share of global and U.S. light-duty vehicle sales through 2050, with associated declines in EV costs. Section 8.3.3.3, *Electric Vehicle Fuel Economy by Drive Cycle and Related Trends*, describes how an increase in U.S. EV sales could have an especially large impact on fuel use due to substantially higher EV fuel economy at slower speeds in congested traffic.

8.3.3.1 Global Electric Vehicle Market, Future Quotas, and Vehicle Industry Response

Currently available electric-drive vehicles are commonly categorized as follows:

- Battery electric vehicles (BEVs) are charged by plugging the vehicle into an electric power source such as the energy grid. BEVs have an electric motor, rather than an ICE, and produce zero tailpipe emissions.
- Hybrid electric vehicles (HEVs) are powered by an ICE in combination with an electric motor that uses energy stored in a battery. HEVs achieve higher fuel economy and lower tailpipe emissions by capturing energy normally lost during braking. This “regenerative braking” technology stores captured energy in the battery, but the battery cannot be recharged by plugging into the electric grid (AFDC 2018a).
- Plug-in hybrid electric vehicles (PHEVs) are HEVs that can also use electricity from an electric power source, such as the energy grid, that is stored in battery packs to run the vehicle. PHEVs generally have larger battery packs than other HEVs, which allow PHEVs to drive moderate distances using just electricity from the grid, producing zero tailpipe emissions during those intervals. When stored energy from the grid runs low, PHEVs run as HEVs, relying on an ICE in combination with an electric motor.
- Plug-in electric vehicles (PEVs) include BEVs and PHEVs, as both may be plugged into an electric power source.
- Fuel cell electric vehicles (FCVs) are powered by hydrogen and produce only water vapor and warm air as tailpipe emissions. FCVs and the hydrogen infrastructure to fuel them are still in an early stage of deployment (AFDC 2018b); FCVs accounted for 0.06 percent of light duty vehicles sold in the United States in 2018, and AEO 2019 forecasts that FCVs will account for less than 0.6 percent of light duty vehicles sold in 2040 (IEA 2019).

Over 2 million PEVs were sold worldwide in 2018, and the global PEV stock surpassed 5.1 million vehicles in 2018; however, this amounted to less than 1 percent of all light-duty vehicles in use in 2018 (IEA 2019). PEV sales have been constrained by higher initial costs compared to ICE vehicles (primarily due to battery costs), the limited driving range on a fully charged battery, the limited infrastructure of public recharging stations, the length of time required for recharging, limited consumer options, uncertain resale value of EVs, and recent shifts in the market toward light trucks, among other factors.

The 2018 PEV share of new light-duty vehicle sales was 46 percent in Norway, 17 percent in Iceland, 8 percent in Sweden, 4.5 percent in China, 2.0 percent in Germany, and 2.5 percent in the United States. China, the world’s largest light-duty vehicle market, accounted for nearly 1.1 million PEVs sold in 2018 (55 percent of global PEV sales and an 86 percent increase from the previous year). The United States accounted for 361,000 PEVs sold in 2018, up from 198,000 in 2017 (IEA 2019). The growth in PEV sales has also been associated with BEVs accounting for an increasing share of the total PEV stock, with BEVs accounting for 58 percent of the global PEV stock in 2014 and 64 percent in 2018 (IEA 2019).

Private and publicly accessible charging infrastructure for PEVs has grown at a rate similar to the annual growth rate of PEV sales (IEA 2019). PEVs outnumber public charging stations by more than six to one, indicating that most drivers rely primarily on private (home) charging. The expanding PEV charging infrastructure has also been associated with increases in the power output of PEV recharging equipment (reducing the time required for recharging) and the emergence of global interoperability objectives to use specific standards for sockets and connectors for normal and high-power recharging outlets.[4]

China has now established a program that effectively sets quotas for PEVs and FCVs, which are expected to make up at least 10 percent of each automaker's sales in China in 2019 and 12 percent in 2020, with higher annual targets expected to be established for sales after 2020. China has not yet set a timetable to reach 100 percent EV sales but is expected to join other nations in phasing out sales of ICE vehicles by 2040 (McDonald 2017).

The high PEV market share in Norway reflects substantial incentives to promote PEV sales, and the Norwegian Parliament has now set a goal that all new cars sold by 2025 should be zero- or low-emissions vehicles (PEVs and FCVs) (Norsk elbilforening 2018). The Netherlands is also considering a ban on new ICEs by 2025 (Staufenberg 2016). In July 2017, France announced plans to end sales of new ICEs by 2040 (Chrisafis and Vaughan 2017). Just a few weeks later, Britain pledged that it would also ban new ICE cars and vans after 2040 (Asthana and Taylor 2017). Some federal states in Germany are also calling for a European Union phase-out of new ICE vehicles by 2030 (Sven Böll 2016), and India is considering a possible phase-out of new ICE vehicles by 2030 (Times of India 2017). Other nations with PEV sales targets include Austria, Denmark, Ireland, Japan, Portugal, Korea, and Spain (Petroff 2017).

Manufacturers have announced investments to meet higher EV targets in 2020 and beyond (Business Insider 2020[5]):

- Toyota, which currently accounts for more than 80 percent of the global HEV market, has announced that it will generate half of its sales from EVs by 2025.
- Volkswagen plans for EVs to make up 40 percent of its sales by 2030.
- General Motors expects that the majority of Cadillac models will be electric by 2030, and says that the Cadillac lineup could go entirely electric by then.
- Ford has announced EV investments expected to result in 40 EV models in 2022.
- Nissan launched the longer-range Leaf Plus in 2019, and plans to introduce eight new EVs by 2022.
- Volvo has pledged to generate 50 percent of its global sales from EVs by 2025.
- Honda has said that every model it sells in Europe will be at least partially electrified by 2022 (accelerating its earlier commitment to achieve this goal in 2025).
- BMW projects that EVs will account for 15 to 25 percent of its sales by 2025.
- Fiat Chrysler plans to offer at least 12 hybrid and all-electric powertrain options in 2022.

[4] U.S. recharging infrastructure will also increase because of EPA partial settlements that require Volkswagen to invest $2 billion in PEV charging infrastructure over the next decade.

[5] Unless otherwise noted.

- Daimler (parent company to Mercedes-Benz) aims to introduce more than 10 EVs by 2022.
- Tesla increased its global BEV deliveries by 50 percent to 367,000 passenger cars in 2019, largely due to the launch of Tesla Model 3 sales outside the United States. Tesla expects to achieve EV sales of around 500,000 in 2020 (Randall 2020).

These public announcements may not fully or accurately reflect manufacturers' future product plans. In addition, if consumer demand for EVs does not meet expectations, manufacturers may reduce investments in their development, production, and availability. Changes in fuel prices, U.S. and global economic activity, consumer purchasing behavior, and government regulations could cause manufacturers to revise product and investment plans over time.

Specifically, other domestic policies, like EPA's revocation of California's waiver for the Advanced Clean Car (ACC) program applicable to MYs 2021–2025,[6] may affect the number of PEVs and FCVs that manufacturers produce. Because programs like California's ZEV mandate force investment in specific technology (electric and fuel cell technology) by incentivizing production through the use of credits, eliminating that incentive may allow manufacturers to employ other fuel saving and carbon dioxide (CO_2) emissions-reducing technologies to build fleets compliant with federal standards. Similarly, NHTSA's assertion of preemption under the Energy Policy and Conservation Act of 1975 (EPCA) and the Energy and Independence Security Act of 2007 (EISA) in regards to state laws or regulations relating to fuel economy standards, which touches the ZEV mandate and any state GHG standards that limit mobile source CO_2 emissions, may reduce the number of PEVs or FCVs that manufacturers build to produce fleets compliant with federal standards. While all manufacturers previously mentioned have a global presence, it is unclear to what extent any domestic policies that affect the adoption of EVs will have on broader global EV adoption. The Final Rule for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program[7] provides a comprehensive discussion of these preemption policies.

8.3.3.2 Recent Plug-In Electric Vehicle Market Forecasts and Potential Decline in Electric Vehicle Costs

In January 2018, Moody's forecast that BEVs will reach a 7 to 8 percent share of global light-duty vehicle sales by the mid-2020s, rising to 17 to 19 percent by 2030 "as battery costs drop, driving range improves and charging infrastructure expands" (Moody's 2018). Bloomberg forecasts that new PEV sales will be close to 10 percent of global light-duty vehicle sales by 2025 and projects that PEV sales will surpass ICE sales in 2038 (Shankleman 2017a) (Figure 8.3.3-1). Morgan Stanley forecasts BEV market share will rise to 16 percent of world light-duty vehicle sales in 2030, 51 percent by 2040, and 69 percent by 2050 (Lambert 2017) (Figure 8.3.3-2).

[6] 84 FR 51310 (Sep. 27, 2019).

[7] 84 FR 51310 (Sep. 27, 2019).

Figure 8.3.3-1. Bloomberg Forecast for Global Plug-In Electric Vehicle and Internal Combustion Engine Light-Duty Vehicle Sales

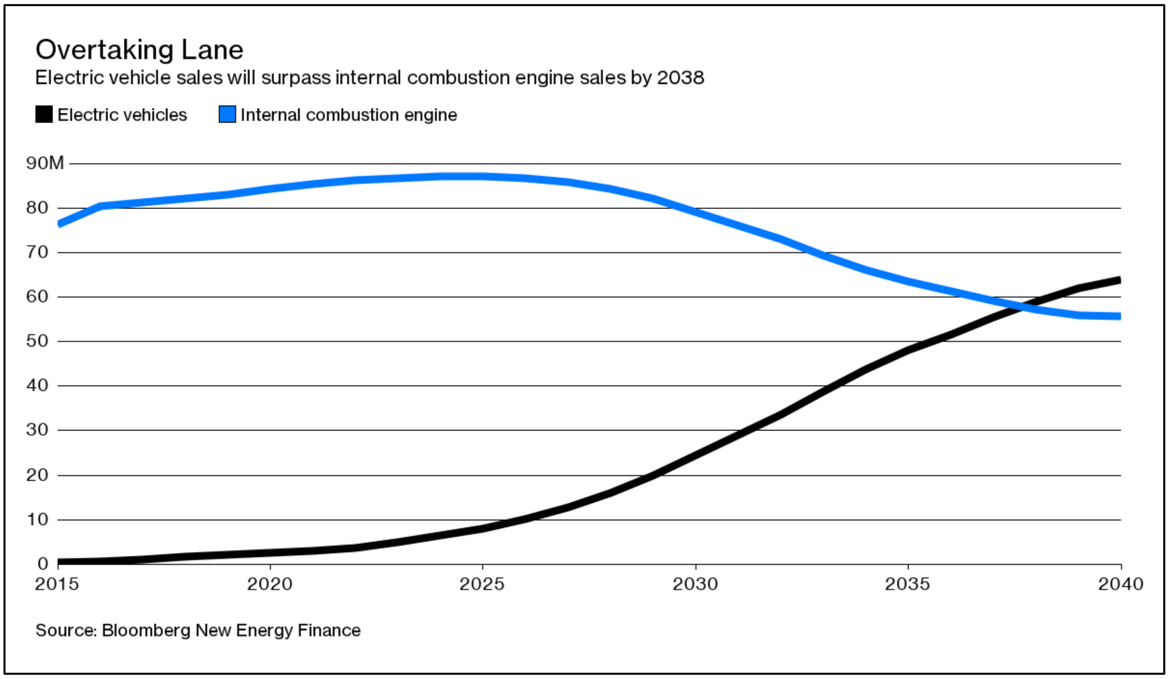
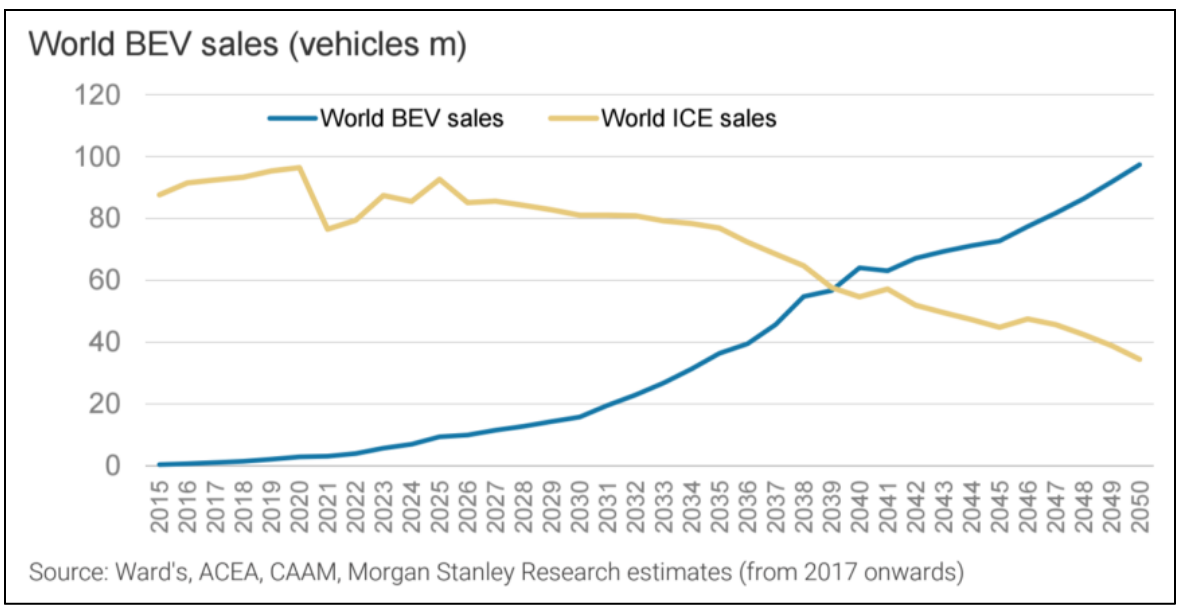


Figure 8.3.3-2. Morgan Stanley Forecast for Global Battery-Operated Vehicle and Internal Combustion Engine Light-Duty Vehicle Sales

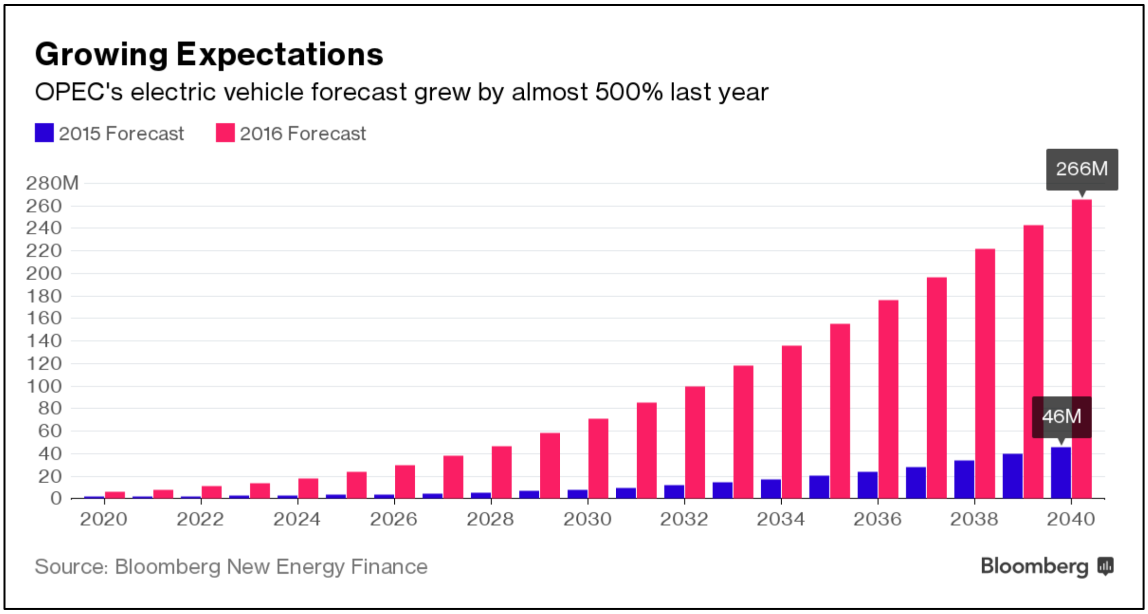


BEV = battery electric vehicle; ICE = internal combustion engine

Bloomberg also expects that the total world stock of PEVs in use will rise to 530 million by 2040, accounting for a third of the global light-duty vehicle stock, and Bloomberg notes that many other forecasts have announced sharp upward revisions in the expected growth of the global PEV stock (Shankleman 2017b). The International Energy Agency raised its 2030 estimate of PEV stocks to

58 million from 23 million. Exxon Mobil boosted its 2040 estimate to about 100 million from 65 million. British Petroleum anticipates 100 million PEVs on the road by 2035, a 40 percent increase in its prior outlook. The largest revision is from OPEC, which raised its 2040 forecast to 266 million, up from 46 million in its prior year forecast (Figure 8.3.3-3). These sharp upward revisions reflect continuing uncertainty in long-term PEV sales and could be subject to future revisions upward or downward over time.

Figure 8.3.3-3. OPEC 2015 and 2016 Forecasts for Global Plug-In Electric Vehicle Stock

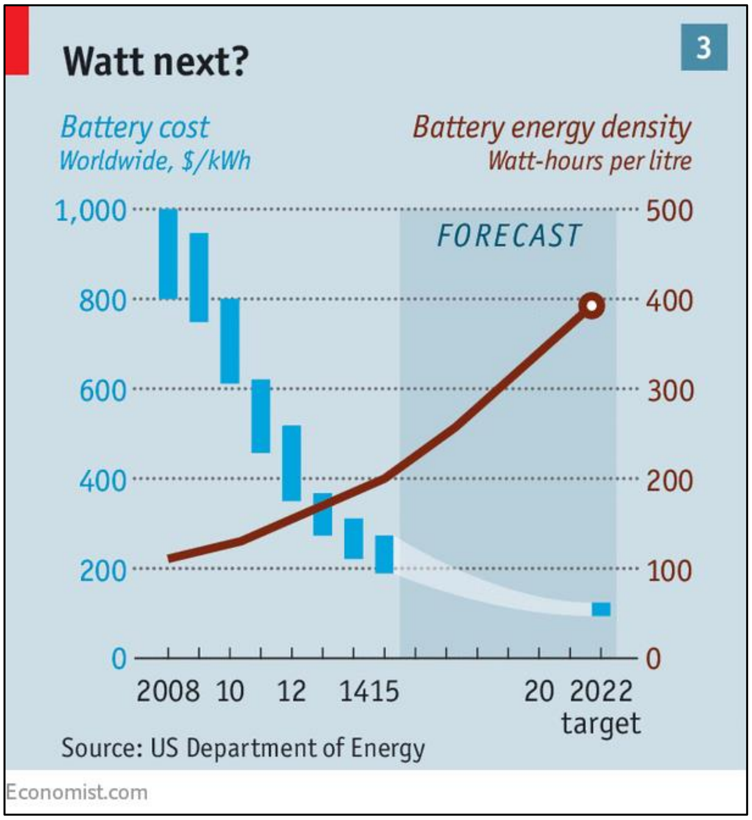


M = million

Moody's estimates that light-duty vehicle manufacturers are currently losing about $7,000 to $10,000 per PEV sold but expects PEVs to become profitable as the increasing scale of production lowers battery prices (Yoney 2018). Plans for at least 10 new lithium-ion battery gigafactories (capable of producing a billion batteries) were announced in the first half of 2016 (Deign 2017). Bloomberg reports that global battery-making capacity is set to reach 278 gigawatt-hours by 2021, compared to 103 gigawatt-hours in 2017 (Bloomberg New Energy Finance 2017). The potential for ongoing declines in battery costs is consistent with declines recorded over the past decade (Figure 8.3.3-4). *The Economist* reports that average lithium-ion cell costs have fallen from more than $1,000 per kilowatt-hour in 2010 to $130 to $200 per kilowatt-hour in 2016, as battery energy density has increased from 100 to 200 watt-hours per liter (San Diego and Sunderland 2017).

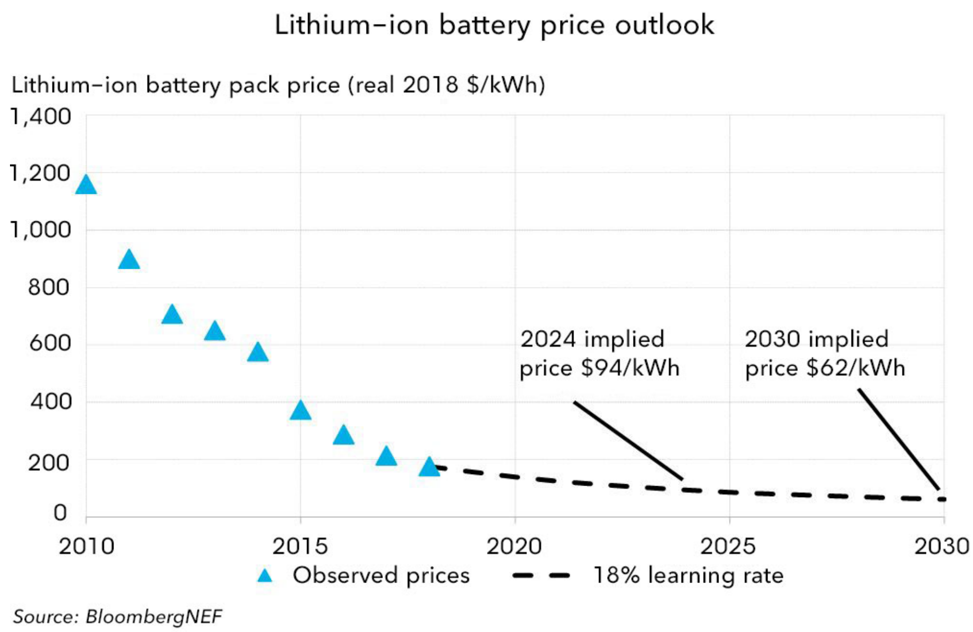
Bloomberg New Energy Finance (2019) reports EV battery price surveys for 2010–2018 showing battery pack prices (in real 2018 dollars) fell from $1,160 per kilowatt-hour (kWh) in 2010 to $176/kWh in 2018 due to falling prices for both battery cells and other pack costs: Cell costs fell from $446/kWh in 2013 to $127/kWh in 2018 as other battery pack costs fell from $204/kWh in 2013 to $49/kWh in 2018. Bloomberg New Energy Finance forecasts continuing declines in total battery pack prices (including cell costs) from $176/kWh in 2018 to $94/kWh by 2024 and $62/kWh by 2030, based on an observed historical learning curve relationship between price and volume, with every doubling of cumulative battery volume resulting in an 18 percent reduction in price/kWh (Figure 8.3.3-5). While some analysts question whether these forecasts are achievable, battery manufacturers have already surpassed a 2012 AEO forecast under a High-Technology Battery case scenario that projected battery costs of $150 per kilowatt-hour in 2030, and a 2012 AEO Reference case forecast of battery costs above $500 per kilowatt-hour through 2020 and well above $250 per kilowatt-hour in 2035 (EIA 2012b) (Figure 8.3.3-6).

Figure 8.3.3-4. Past and Forecast Trends in Battery Cost and Energy Density



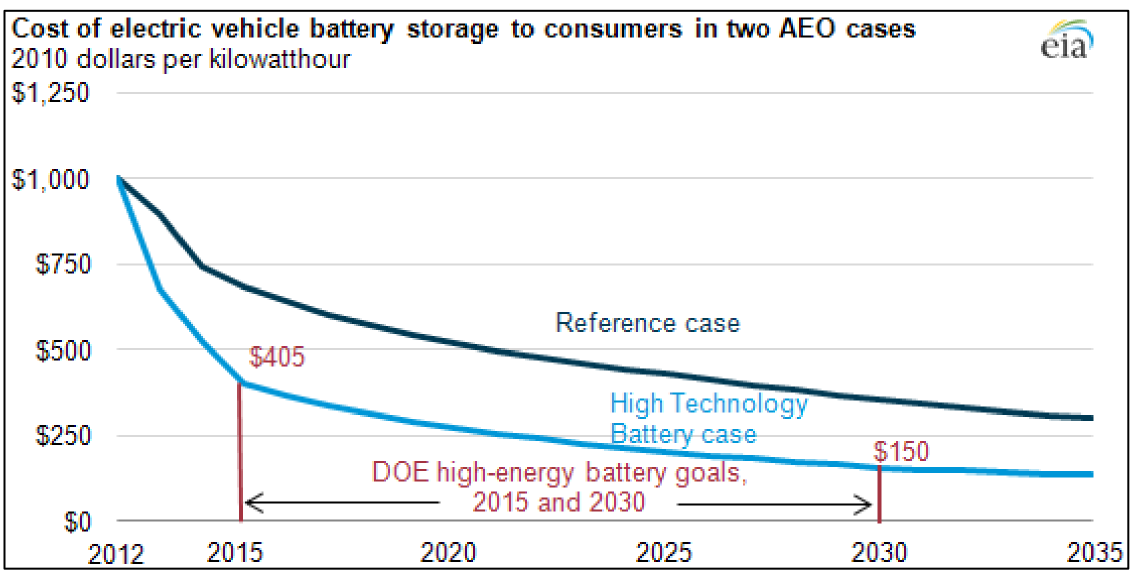
kWh = kilowatt hour

Figure 8.3.3-5. Bloomberg Forecast for Battery Costs through 2030



kWh = kilowatt hour

Figure 8.3.3-6. Annual Energy Outlook 2012 Battery Cost Forecasts for Reference Case and High Technology Battery Case



Source: EIA 2012a

AEO = Annual Energy Outlook; DOE = Department of Energy

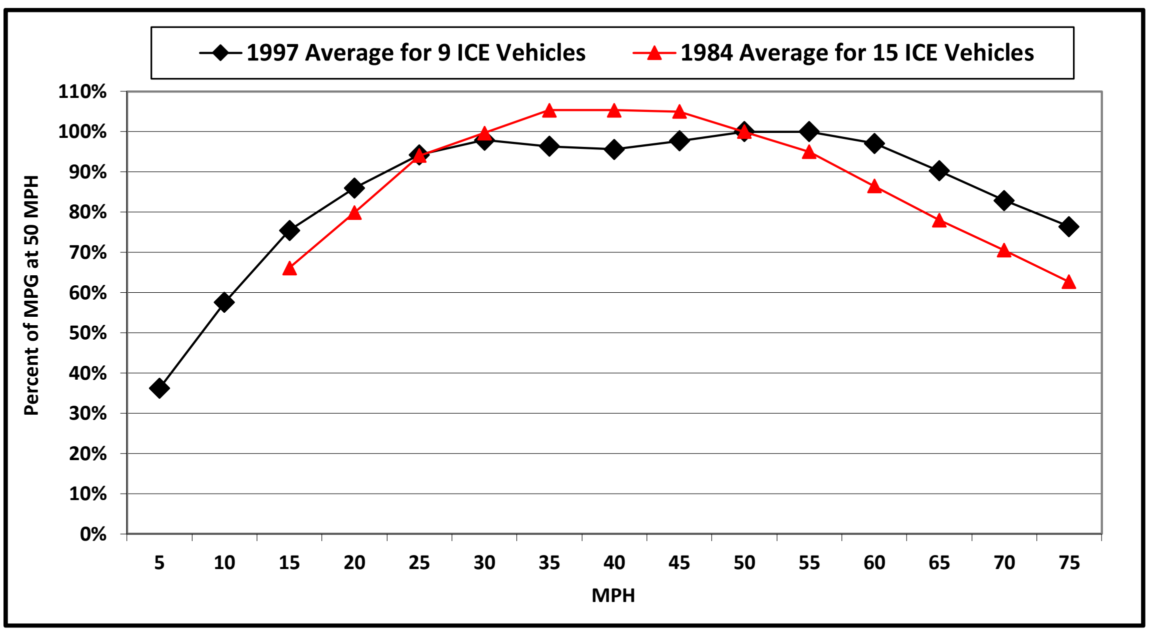
8.3.3.3 Electric Vehicle Fuel Economy by Drive Cycle and Related Market Trends

Global industry investments in PEVs and declines in PEV battery costs indicate that the cost of PEVs to consumers may decline over time. These global market forces could increase market demand for PEVs. An increase in the PEV share of light-duty vehicle sales would increase overall light-duty vehicle fuel economy due to the higher miles-per-gallon equivalent (MPGe) for PEVs. Additionally, EVs are likely to be used more intensively in congested traffic where regenerative braking further increases EV fuel economy compared to ICEs.

For comparable cars, HEVs achieve better highway mpg than ICEs, and BEVs achieve much higher highway MPGe; however, the gap in city mpg is much higher when comparing an EV to an ICE vehicle. HEVs and BEVs achieve much better city mpg because regenerative braking recharges batteries during the frequent stops associated with city driving. The EPA city drive cycle test (a component of EPA fuel economy ratings) has 23 stops, resulting in EV city mpg that is higher than highway mpg. For ICE vehicles, EPA highway mpg is always higher than city mpg because the highway drive cycle test has no stops.

Comparing ICE city mpg with BEV city MPGe also understates the BEV advantage for drivers who frequently travel in slower stop-and-go traffic. Studies of mpg by steady miles per hour (mph) show that ICE mpg is similar at speeds of 30 to 60 mph, but mpg falls by 10 to 25 percent at speeds of 15 to 20 mph, and by 40 to 60 percent at 5 to 10 mph (Figure 8.3.3-7). The EPA highway test is almost entirely in the peak mpg speed range of 30 to 60 mph, and more than 99 percent of highway test miles are at speeds above 20 mph. The EPA city mpg is based on a drive cycle with a significant percentage of miles at speeds below 30 mph but with less than 20 percent of test miles at speeds below 20 mph. Therefore, even the EPA city mpg ratings may overstate mpg for ICE vehicles used by drivers with daily commutes in congested stop-and-go traffic at speeds below 20 mph.

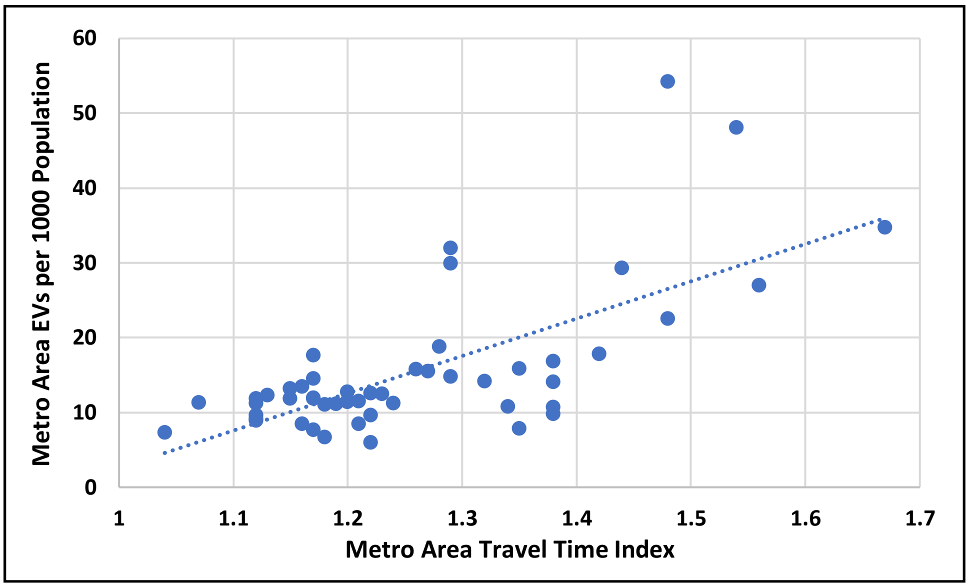
Figure 8.3.3-7. Internal Combustion Engine Vehicle Miles per Gallon by Steady Speed Miles per Hour



Source: Oak Ridge National Laboratory 2020
ICE = internal combustion engine; MPH = miles per hour; MPG = miles per gallon

EVs with regenerative braking (HEVs, PHEVs, and BEVs) are also more concentrated in areas with the worst traffic congestion, as measured by travel time index (TTI) (FHWA 2017). TTI is a ratio of peak-period travel time to free-flow travel time during the AM (6 am to 9 am) and PM (4 pm to 7 pm) peak traffic times on weekdays (weighted by VMT). A TTI of 1.5 means that a commute distance that would take 40 minutes in free-flow traffic would stretch to 60 minutes during peak commuter traffic times, with an associated reduction in average speed. Figure 8.3.3-8 shows a scatter plot of EV registrations per 1,000 population and TTI for 51 U.S. metro areas, and the trend line shows that metro areas with the worst commuter traffic congestion (highest TTIs) have a much higher concentration of EV registrations per 1,000 population. The possible implication is that consumers recognize the greater fuel economy of EVs in congested traffic, resulting in EVs being especially concentrated in metro areas with the most congested traffic.[8]

Figure 8.3.3-8. Travel Time Index and Electric Vehicle Registrations per 1,000 population by Metro Area



Source: FHWA 2017
EV= electric vehicle

8.3.4 Cumulative Impacts on Energy

With regard to federal energy policy, ongoing efforts to eliminate unnecessary regulatory burdens that restrain oil exploration, production, and refining could increase U.S. oil production and thereby reduce the price of gasoline and diesel fuel. Consequently, these lower fuel prices could increase U.S. vehicle operation (similar to the rebound effect) and thereby increase use of these fuels independent of average fuel economy. It is also possible that eliminating regulatory burdens that increase the cost of electricity could reduce the electricity cost of operating EVs and thereby increase demand for EVs. The cumulative impacts of deregulation could also vary over time. For example, many vehicle manufacturers have stated that they expect substantial growth in the EV share of light-duty vehicles over the next 10 to 20 years (Section 8.3.3.3, *Electric Vehicle Fuel Economy by Drive Cycle and Related Market Trends*), but many of those same manufacturers are relying on robust sales of ICE vehicles, including light trucks, to

[8] Other possible contributors to this effect, which may be correlated with large metro areas, include range anxiety, EV incentives, affluence, and environmental concerns.

generate the profits they expect to invest in new EV technologies and manufacturing over the next decade. This perspective suggests that eliminating unnecessary regulatory burdens could increase gasoline and diesel fuel use over the next decade, while supporting economic growth and light-duty ICE vehicle sales at levels that could allow manufacturers to fund longer-term growth in the EV share of future light-duty vehicle sales.

With regard to EV market trends, the 2019 AEO reflects significant projected growth in EVs. Other sources discussed previously suggest that growth in the PEV share of new U.S. light-duty vehicle sales could be faster than previously anticipated, but there is considerable uncertainty associated with all the forecasts through 2050.

8.4 Air Quality

8.4.1 Scope of Analysis

The timeframe for the cumulative air quality impact analysis extends from 2020 through 2050. This analysis focuses on potential U.S. air quality impacts associated with changes in the U.S. light-duty vehicle fleet that could result from new federal energy policy and global market trends, but the geographic area of interest is U.S. emissions sources (upstream and downstream). This temporal and geographic focus is consistent with the analysis of direct and indirect air quality impacts in Chapter 4, *Air Quality*.

8.4.2 Analysis Methods

The methods NHTSA used to characterize the impacts of the Proposed Action and alternatives on emissions and air quality are described in Section 4.1.2, *Methods*. The methods and assumptions for the cumulative analysis are qualitative rather than quantitative because of uncertainties in future trends, particularly in the generation mix of the power sector, future energy prices, the rate of adoption of EVs as battery costs continue to decrease, and consumer behavior in EV usage and charging. Changes in the generation mix could affect the emissions associated with fuel feedstock extraction and refining, fuel storage, and fuel distribution, as well as upstream emissions associated with charging EVs.[9]

8.4.3 Other Past, Present, and Reasonably Foreseeable Future Actions

As discussed in Chapter 4, *Air Quality,* aggregate emissions associated with vehicles have decreased substantially since 1970, even as VMT has nearly doubled. The primary actions that have resulted in downstream emissions decreases from vehicles are the EPA Tier 1, Tier 2, and Tier 3 Motor Vehicle Emission and Fuel Standards. EPA has issued similar emissions standards for transportation sources other than motor vehicles, such as locomotives, marine vessels, and recreational vehicles, as well as standards for engines used in construction equipment, emergency generators, and other nonvehicle sources.

Upstream emissions associated with vehicles also have decreased (on a per-gallon fuel basis) since 1970 as a result of continuing EPA and state regulation of stationary emissions sources associated with fuel feedstock extraction and refining, and with power generation (on a per-kilowatt hour basis). EPA regulations relevant to stationary source emissions include New Source Performance Standards,

[9] Increased adoption of EVs would eliminate the tailpipe emissions of conventional vehicles that are displaced but would increase the upstream emissions from power plants generating the electricity that charges the EVs.

National Emissions Standards for Hazardous Air Pollutants, the Acid Rain Program under Title IV of the Clean Air Act, the Cross-States Air Pollution Rule, and the Mercury and Air Toxics Standards Rule. State air quality agencies have issued additional emissions control requirements applicable to stationary sources as part of their State Implementation Plans.

As discussed in Section 8.3, *Energy*, market-driven changes in the energy sector—in particular, the rate of U.S. adoption of EVs as battery costs continue to decrease—are expected to affect U.S. emissions and could result in future increases or decreases in emissions. Potential changes in federal regulation of energy production and emissions from industrial processes and power generation also could result in future increases or decreases in aggregate emissions from these sources.

8.4.4 Cumulative Impacts on Air Quality

Executive Order (EO) 13783 could substantively affect energy supply and use by increasing the production of domestic fossil energy resources and eliminating regulations that inhibit the use of those resources. Additional petroleum extraction and refining could increase supply and lower consumer gas prices, resulting in increased market demand for less fuel-efficient passenger cars and light trucks, increased VMT, or both. This could result in additional emissions of certain criteria and toxic air pollutants. Additional coal, oil, and natural gas production could create more abundant supply, driving down their cost and increasing their use in the power generation sector. As described in Chapter 3, *Energy*, in recent years, the electric utilities have been shifting away from coal toward natural gas and renewable energy due in part to the regulatory costs associated with coal plants and the cheap, abundant supply of natural gas. By reducing regulatory burdens associated with fossil energy production and use, the electrical grid could shift increasingly toward coal and natural gas, increasing emissions of criteria pollutants compared to renewable energy sources. To the degree to which fuel use in the light-duty transportation sector increases, upstream energy use associated with feedstock extraction and refining, distribution, and storage would increase proportionally, thereby increasing emissions associated with that upstream energy use. Upstream emissions associated with sources other than energy use also would increase. For example, increases in oil and gas development would increase emissions from associated processes such as hydraulic fracturing. Changes in other federal rules that affect the oil and gas industry, such as changes to the Bureau of Land Management's methane waste prevention regulations (83 FR 49184, September 29, 2018), which are currently in litigation, would affect the size of these emissions increases.

Additionally, as discussed in Section 8.3, *Energy*, as manufacturers respond to the potential demands of the global market for EVs, the number and variety of EVs and their capabilities and driving ranges available to U.S. customers may increase. To the extent that U.S. EV sales increase at greater rates than forecasted for the direct and indirect impacts analysis in Chapter 4, *Air Quality*, tailpipe emissions would decrease and upstream emissions from electricity generation would increase.

Temporal patterns in charging of EVs by vehicle owners would affect any increase in power plant emissions. Electrical grid operators optimize costs and reliability by dispatching power plants in different combinations depending on the varying demand for electricity. As a result, overall emissions rates from the power plant fleet (the set of power plants as a whole) are different during hours of peak electrical demand, when peak-load power plants are operating, compared to emissions rates during off-peak hours, when predominantly base-load power plants are operating. See Section 6.2.3.2, *Marginal Grid Greenhouse Gas Intensity*, for additional detail on emissions variations from the timing of electricity consumption and EV charging.

Trends in the prices of fossil fuels and the costs of renewable energy sources will affect the generation mix and, consequently, the upstream emissions from EVs. Continuation of the current relatively low prices for natural gas would encourage continued substitution of natural gas for other fossil fuels. Continued decreases in the costs of renewable energy would encourage substitution of renewable energy sources for fossil fuels. Continuation of either of these economic trends likely would lead to lower total emissions from EV charging. Conversely, a reversal of these trends because of new federal energy policies would lead to higher total emissions from EV charging.

The forecasts of power generation emissions used in the CAFE model account for existing legislation and other regulatory actions that affect power plant emissions, such as the Cross-States Air Pollution Rule the Mercury and Air Toxics Rule, the Affordable Clean Energy Rule, the Acid Rain Program, New Source Performance Standards, and National Emission Standards for Hazardous Air Pollutants. To the extent that these requirements may be amended in future years when the EV percentage of light-duty vehicle sales has increased, power sector emissions for EV charging would change accordingly.

Similarly, the forecasts of upstream and downstream emissions that underlie the impact analysis assume the continuation of current emissions standards (including previously promulgated future changes in standards) for vehicles, oil and gas development operations, and industrial processes such as fuel refining. These standards have become more stringent over time as state and federal agencies have sought to reduce emissions to help bring nonattainment areas into attainment. To the extent that the trend toward more stringent emissions standards could change in the future, total nationwide emissions from vehicles and industrial processes could change accordingly.

Cumulative changes in health impacts due to air pollution are expected to be consistent with trends in emissions and population exposure. Higher emissions in a geographic area would be expected to lead to an increase in overall health impacts in that area, while lower emissions would be expected to lead to a decrease in health impacts in that area, compared to conditions in the absence of cumulative impacts. Population distribution varies geographically, and as a result, a given amount of emissions would have greater health impacts in an area with greater population than in an area with less population. The level of population exposure in an area also is affected by the meteorological and topographical conditions in that area because these factors affect the dispersion and transport of emissions in the atmosphere. In addition, populations living or working near roadways could experience relatively greater exposure to tailpipe emissions, while populations living or working near upstream facilities (e.g., refineries) could experience relatively greater exposure to upstream emissions. An individual geographic area could experience either an increase or decrease in cumulative impacts under the proposed standards, depending on the relative magnitudes of effects from tailpipe versus upstream emissions that would affect that area.

8.5 Other Impacts

8.5.1 Scope of Analysis

Resource areas covered in the cumulative analysis are the same as those addressed in the direct and indirect impact analysis (Chapter 7, *Other Impacts*), including land use and development, hazardous materials and regulated wastes, historical and cultural resources, noise, and environmental justice. The timeframe for this analysis of other cumulative impacts extends from 2020 through 2050. This analysis considers potential impacts associated with global light-duty vehicle market trends, but the geographic area of interest is the United States. This temporal and geographic focus is consistent with the analysis of other direct and indirect impacts in Chapter 7.

8.5.2 Analysis Methods

The analysis methods for assessing cumulative impacts on the resource areas described in this section are consistent with the methods for determining direct and indirect impacts (Chapter 7, *Other Impacts*). However, the cumulative impact scenario considers the additional actions described in Section 8.5.3, *Other Past, Present, and Reasonably Foreseeable Future Actions*.

8.5.3 Other Past, Present, and Reasonably Foreseeable Future Actions

The analysis of other cumulative impacts builds upon the cumulative analysis for energy and air quality as described in Section 8.3.3, *Other Past, Present, and Reasonably Foreseeable Future Actions* (energy) and 8.4.3, *Other Past, Present, and Reasonably Foreseeable Future Actions* (air quality).

8.5.4 Cumulative Impacts on Other Resources

8.5.4.1 Land Use and Development

In terms of impacts on land use and development, an increase in petroleum supply or EV usage could result in an increase in VMT due to reduced fuel cost per mile (the rebound effect). In areas where the highway network, infrastructure availability, and housing market conditions allow, this could increase demand for low-density residential development beyond existing developed areas. Undeveloped land could be converted to support low-density suburban sprawl (FHWA 2014, DOT 2016c). Many agencies, however, are implementing measures, such as funding smart-growth policies, to influence settlement patterns in order to reduce VMT and fuel use to meet climate change goals (Moore et al. 2010, EPA 2017a). See Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, for more information regarding VMT.

Additionally, increases in fuel use resulting from reduced fuel costs or lower fleet-wide fuel economy could result in the need for additional oil extraction and refining, along with a potential need for new pipelines. Cumulative increases in EV use, however, may offset these increases in oil use, reducing the need for new capacity. In terms of biofuels, although the Proposed Action and alternatives are not anticipated to directly affect biofuel production and use in any predictable way, cumulative biofuel usage may increase as a result of new federal policies that promote the development of domestic fuel resources. Consequently, additional land use may be devoted to agricultural use and feedstock extraction for the production of biofuels.

8.5.4.2 Hazardous Materials and Regulated Wastes

In terms of impacts on hazardous materials and regulated wastes, an increase in EV usage could decrease fuel production and combustion, offsetting the potential increases that may result from the Proposed Action and alternatives (Chapter 3, *Energy*). This would lead to an overall decrease in wastes generated from fuel extraction, production, and combustion, and a decrease in the number of hazardous material spills from extraction and refining. On the other hand, reduced fuel costs could result in consumer demand for less fuel-efficient vehicles or increased VMT, resulting in the opposite impacts. In addition, increased EV usage may result in an increase in wastes associated with the production and disposal of EV batteries. See Chapter 6, *Life-Cycle Assessment of Vehicle Energy,* *Material, and Technology Impacts*, and Chapter 7, *Other Impacts*, for additional discussions of the waste impacts associated with EV usage.

8.5.4.3 Historical and Cultural Resources

As noted in Chapter 7, *Other Impacts* the main impact on historical and cultural resources associated with the Proposed Action and alternatives is the potential for increased acid rain and deposition. Acid rain and deposition corrodes metals and other building materials, reducing their historic and cultural value. Increases in EV usage have the potential to reduce fuel production and consumption impacts, thereby reducing pollutant emissions that cause acid rain and deposition and decreasing impacts on historical and cultural resources. Conversely, such emissions and impacts would increase if reduced fuel costs result in increased consumer demand for less fuel-efficient vehicles or increased VMT.

8.5.4.4 Noise and Safety Impacts on Human Health

An increase in EV usage could reduce noise levels on roads and highways throughout the United States. However, as discussed in Chapter 7, *Other Impacts*, noise reductions from increased use of hybrid technologies could be offset at low speeds by manufacturer installation of pedestrian safety-alert sounds, as required by NHTSA (NHTSA 2016b). Conversely, decreased EV usage or increased driving associated with reduced fuel costs could result higher noise levels on roads and highways throughout the United States.

8.5.4.5 Environmental Justice

Potential decreases in fuel production and consumption associated with increased EV usage may offset some of the potential increases in fuel production and consumption associated with the Proposed Action and alternatives. This would offset any increases in direct land disturbance resulting from oil exploration and extraction as well as any increases in air pollution produced by oil refineries. To the extent that minority and low-income populations live closer to oil extraction, distribution, and refining facilities or are more susceptible to their impacts (e.g., emissions, vibration, or noise) they are less likely to experience cumulative impacts resulting from these activities. Conversely, to the extent that EO 13783 results in increased oil extraction and refining, as well as increased vehicle operation due to reduced fuel prices, minority and low-income populations may experience increased impacts, but again, only to the extent that such populations are present near emissions sources. As noted in Chapter 7, *Other Impacts*, a correlation between proximity to oil refineries and the prevalence of low-income and minority populations has not been established in the scientific literature. Therefore, disproportionate impacts on minority and low-income populations due to their proximity to oil refineries are not foreseeable. In addition, the magnitude of the change in emissions relative to the baseline would not be characterized as high and adverse.

Increased EV usage also has the potential to reduce criteria and toxic air pollutant impacts, while increased fuel supply and reduced fuel prices could have the opposite effect. Overall cumulative impacts on minority and low-income populations related to criteria and hazardous air pollutant emissions, including human health impacts, would likely be proportional to increases or decreases in such emissions and would not be characterized as high and adverse.

Lastly, there is evidence that minority and low-income populations may be disproportionately susceptible to the cumulative impacts of climate change (GCRP 2018). Because minority and low-income populations might have less of an ability to adapt to these impacts, these populations could be disproportionately affected compared to the overall population. Although the action alternatives would increase CO_2 concentration and temperature under the cumulative impact analysis, the increase would be a small fraction of the total increase in CO_2 concentrations and global mean surface temperature that is anticipated to occur and would not be characterized as high and adverse. See Section 8.6.4, *Cumulative Impacts on Greenhouse Gas Emissions and Climate Change*, for a discussion of the cumulative impacts of the Proposed Action and alternatives. See Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, for a thorough discussion of the cumulative impacts of climate change on minority, low-income, and other vulnerable populations.

8.6 Greenhouse Gas Emissions and Climate Change

Climate modeling conducted for this cumulative impacts analysis applies different assumptions about the effect of broader global GHG policies on emissions outside the U.S. passenger car and light truck fleets. The analysis of cumulative impacts also extends to include not only the immediate effects of GHG emissions on the climate system (atmospheric CO_2 concentrations, temperature, sea level, precipitation, and ocean pH) but also the impacts of past, present, and reasonably foreseeable future human activities that are changing the climate system on key resources (e.g., freshwater resources, terrestrial ecosystems, and coastal ecosystems).

8.6.1 Scope of Analysis

The timeframe for the cumulative GHG and climate change impact analysis extends from 2020 through 2100. This analysis considers potential cumulative GHG and climate change impacts associated with broader global GHG emissions policies in combination with the Proposed Action and alternatives. The geographic area of interest is domestic and global, as cumulative impacts of changes in GHG emissions occur on a domestic and global scale. This temporal and geographic focus is consistent with the analysis of direct and indirect GHG and climate change impacts in Chapter 5, *Greenhouse Gas Emissions and Climate Change*. A medium-high global emissions scenario that takes into account a moderate reduction in global GHG emissions was used in the climate modeling. This is consistent with global actions to reduce GHG emissions; specific actions that support the use of this scenario were included as examples.

8.6.2 Analysis Methods

The methods NHTSA used to characterize the impacts of the Proposed Action and alternatives on climate are described in Section 5.3, *Analysis Methods*. The methods and assumptions for the cumulative analysis are largely the same as those used in the direct and indirect impacts analysis, except 1) the global emissions scenario used for the main cumulative analysis is the Global Climate Change Assessment Model (GCAM)6.0 scenario, and 2) multiple global emissions scenarios are modeled in the sensitivity analysis.

8.6.2.1 Global Emissions Scenarios Used for the Cumulative Impact Analysis

For the GHG and climate change analysis, cumulative impacts were determined primarily by using the GCAM 6.0 scenario as a reference case global emissions scenario that assumes a moderate level of global actions to address climate change. NHTSA chose the GCAM6.0 scenario as a plausible global emissions baseline because of the potential impacts of these reasonably foreseeable actions, yielding a moderate level of global GHG reductions from the GCAM Reference baseline scenario used in the direct and indirect analysis. For the cumulative analysis, the GCAM6.0 scenario serves as a reference scenario against which the climate impacts of the Proposed Action and alternatives can be measured. The

GCAM6.0 scenario is the GCAM representation of a scenario that yields a radiative forcing of approximately 6.0 watts per square meter in the year 2100.

To evaluate the sensitivity of the results to a reasonable range of alternative emissions scenarios, NHTSA also used the Representative Concentration Pathways (RCP)4.5 scenario and the GCAM Reference emissions scenario. The RCP4.5 scenario is a more aggressive stabilization scenario that illustrates the climate system response to stabilizing the anthropogenic components of radiative forcing at 4.5 watts per square meter in 2100.[10] The GCAM Reference scenario is the GCAM representation of a radiative forcing of 7.0 watts per square meter.

The GCAM6.0 scenario is the GCAM representation of the radiative forcing target (6.0 watts per square meter) of the RCP scenarios developed by the MiniCAM model of the Joint Global Change Research Institute. The GCAM6.0 scenario assumes a moderate level of global GHG reductions. It is based on a set of assumptions about drivers such as population, technology, socioeconomic changes, and global climate policies that correspond to stabilization, by 2100, of total radiative forcing and associated CO_2 concentrations at roughly 678 parts per million (ppm). More specifically, GCAM6.0 is a scenario that incorporates declines in overall energy use, including fossil fuel use, as compared to the reference case. In addition, GCAM6.0 includes increases in renewable energy and nuclear energy. The proportion of total energy use supplied by electricity also increases over time due to fuel switching in end-use sectors. CO_2 capture and storage plays an important role that allows for continued use of fossil fuels for electricity generation and cement manufacture, while limiting CO_2 emissions. Although GCAM6.0 does not explicitly include specific climate change mitigation policies, it does represent a plausible future pathway of global emissions in response to substantial global action to mitigate climate change. Consequently, NHSTA believes that GCAM6.0 represents a reasonable proxy for the past, present, and reasonably foreseeable GHG emissions through 2100, and is used for that purpose in this cumulative impact analysis on GHG emissions and climate change.

For the cumulative impact analysis, the difference in annual GHG emissions under the Proposed Action and alternatives compared to the No Action Alternative was calculated. This change was then applied to the GCAM6.0 scenario to generate modified global-scale emissions scenarios, which show the impact of the Proposed Action and alternatives on the global emissions path. For example, emissions from passenger cars and light trucks in the United States in 2020 under the No Action Alternative are estimated to be 1,478 million metric tons of carbon dioxide ($MMTCO_2$); emissions in 2020 under Alternative 3 are estimated to be 1,481 $MMTCO_2$. The difference of 3 $MMTCO_2$ represents the increase in cumulative emissions projected to result from Alternative 3.[11] Cumulative global CO_2 emissions for the GCAM6.0 scenario in 2020 are estimated to be 37,522 $MMTCO_2$ and are assumed to incorporate the level of emissions from passenger cars and light trucks in the United States under the No Action Alternative. Cumulative global emissions under Alternative 3 are, therefore, estimated to be 3 $MMTCO_2$ more than this reference level or 37,525 $MMTCO_2$ in 2020 under the cumulative impacts analysis.

[10] Radiative forcing is the net change in Earth's energy balance and is used in climate modeling to quantify the climate's response to change due to a perturbation. Small changes in radiative forcing can have large implications on surface temperature and sea ice cover. The radiative forcing from scenarios of future emissions projections are benchmarks used to understand the drivers of potential future climate changes and climate response scenarios (IPCC 2013b).

[11] The increase in U.S. CO_2 emissions in 2020 under the Proposed Action and alternatives compared to the No Action Alternative ranges from 3 $MMTCO_2$ (Alternative 1) to 0.3 $MMTCO_2$ (Alternative 7).

8.6.2.2 Sensitivity Analysis

The methods and assumptions for the sensitivity analysis are largely the same as those used in the direct and indirect impacts analysis, with the exception of the climate scenarios chosen. For the cumulative impacts analysis, the sensitivity analysis also assesses the sensitivity around different global emissions scenarios. NHTSA assumed multiple global emissions scenarios, including GCAM6.0 (687 ppm in 2100), RCP4.5 (544 ppm in 2100), and GCAM Reference scenario (789 ppm in 2100).

8.6.3 Other Past, Present, and Reasonably Foreseeable Future Actions

NHTSA chose the GCAM6.0 scenario as the primary global emissions scenario for evaluating climate impacts because regional, national, and international initiatives and programs now in the planning stages or already underway indicate that a moderate reduction in the growth rate of global GHG emissions is reasonably foreseeable in the future. While planned or underway U.S. federal actions can either decrease or increase GHG emissions, NHTSA believes the GCAM6.0 scenario is still representative of broader global emissions trends.

The following initiatives and programs are evidence of the past, present, or reasonably foreseeable actions that will affect GHG emissions. While some U.S. federal actions are likely to increase GHG emissions, other domestic and global actions indicate that a moderate reduction in the growth rate of global GHG emissions is reasonably foreseeable in the future. NHTSA used this scenario to assess the impacts of the Proposed Action and alternatives when reasonably foreseeable increases in global GHG emissions are taken into account. Although it is not possible to quantify the precise GHG effects associated with these actions, policies, or programs when taken together (and NHTSA does not attempt to do so), collectively they illustrate current global efforts toward achieving GHG reductions. These global efforts are likely to continue in parallel to U.S. federal actions that are expected to increase GHG emissions. Therefore, a scenario that accounts for moderate reductions in the rate of global GHG emissions, such as the GCAM6.0 scenario, can be considered reasonably foreseeable under NEPA.

8.6.3.1 United States: Regional and State Actions

The following actions in the United States are already underway or reasonably foreseeable:

- **Regional Greenhouse Gas Initiative (RGGI).** Launched in January 1, 2009, the RGGI was the first mandatory, market-based effort in the United States to reduce GHG emissions (RGGI 2009). Nine Northeast and Mid-Atlantic States (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont)[12] agreed to cap annual emissions from power plants in the region at 188 $MMTCO_2$ for 2009 through 2011, and 165 $MMTCO_2$ for 2012 through 2013 (RGGI 2014, Block 2014). In 2013, the RGGI states lowered the regional emissions cap to 91 $MMTCO_2$ for 2014. The RGGI CO_2 cap then declines 2.5 percent per year from 2015 through 2020 (RGGI 2014). By 2020, the program is projected to reduce annual emissions by 70 to 80 $MMTCO_2$ below 2005 levels (C2ES 2013). In August 2017, RGGI states announced an overall cap reduction of 30 percent between 2020 and 2030 (C2ES 2017). The proposed changes include a cap of 68 $MMTCO_2$ in 2021, which will decline by just more than 2 $MMTCO_2$ per year until 2030 (RGGI 2017).

[12] New Jersey was a part of RGGI at its founding, but dropped out of the program in May 2011. On January 29, 2018, New Jersey Governor Phil Murphy signed an executive order directing the state to rejoin RGGI. On October 3, 2019, Pennsylvania Governor Tom Wolf issued an executive order instructing the state's Department of Environmental Protection to join RGGI.

- **California 2016 Greenhouse Gas Reduction Legislation (Senate Bill 32)**. In 2016, California passed Senate Bill 32, which codifies into law a GHG emissions reduction target of 40 percent below 1990 levels by 2030, equivalent to an absolute level of 260 $MMTCO_2e$ (CARB 2017). Initiatives to support this goal seek to reduce GHGs from cars, trucks, electricity production, fuels, and other sources. GHG-reduction measures under the California Air Resources Board's 2017 proposed scoping plan update include a continuation of the state's cap and trade program, a renewable portfolio standard, reduction of electric sector GHG emissions through the integrated resources plan process, low carbon fuel standards, zero emission and plug-in hybrid light-duty electric vehicle deployment, medium and heavy-duty vehicle GHG regulations, VMT reduction programs, the Short-Lived Climate Plan to reduce non-CO_2 GHGs, and refinery sector GHG regulations (CARB 2017).[13] Each of these measures is a known commitment or already underway or required. The cap-and-trade program took effect in 2013 for electric generation units and large industrial facilities and expanded in 2015 to include ground transportation and heating fuels (C2ES 2014). The known commitments are projected to reduce GHG emissions by 82 $MMTCO_2e$ by 2030 relative to a business-as-usual scenario (CARB 2017).
- **U.S. Climate Alliance.** Twenty-four U.S. governors have committed to reduce GHG emissions in their respective states consistent with the goals of the Paris Agreement. Alliance states have committed to implement policies that will reduce emissions consistent with the U.S. Nationally Determined Contribution under the Paris Agreement, at least 26 to 28 percent below 2005 levels by 2025. In 2005, emissions from these states totaled approximately 2.6 gigatons (Gt) (EIA 2018a, 2018c). Based on policies in place as of June 2018, Alliance states are projected to achieve combined emissions reductions of 18 to 25 percent below 2005 levels in 2025 (U.S. Climate Alliance 2019).

8.6.3.2 United States: Federal Actions

The following federal actions are already underway or reasonably foreseeable:

- **NHTSA and EPA Joint Rule on Fuel Economy and GHG Emissions Standards for Light-Duty Vehicles.** In August 2012, NHTSA and EPA issued joint final rules to further improve the fuel economy of and reduce CO_2 emissions for passenger cars and light trucks, as described in Chapter 1, *Purpose and Need for the Action*. The standards were projected to reduce average CO_2 emissions from new U.S. light-duty vehicles by 3.5 percent per year for MYs 2017–2021 (NHTSA and EPA 2011). Since the implementation of this joint rule, twelve of the thirteen largest vehicle manufacturers selling cars in the U.S. market have made improvements to both fuel economy and CO_2 emissions. As a result, between 2012 and 2017, the industry decreased CO_2 emissions by 21 gallons per mile (g/mi) and increased fuel economy by 1.3 mpg (EPA 2018).
- **NHTSA and EPA Joint Phase 1 Rule on GHG Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles, MYs 2014–2018.** On September 15, 2011, NHTSA and EPA published the Phase 1 joint final rules to establish fuel efficiency and CO_2 standards for commercial medium- and heavy-duty on-highway vehicles and work trucks. The agencies' standards apply to highway vehicles and engines that are not regulated by the light-duty vehicle CAFE and CO_2 standards. NHTSA's Phase 1 mandatory standards for heavy-duty vehicles and engines began for MY 2016 vehicles, with

[13] In September 2019, NHTSA issued a final rule that established regulatory text explicitly preempting state and local laws relating to fuel economy standards established under the Energy Policy and Conservation Act (EPCA). As part of that action, EPA also withdrew the waiver it had previously provided to California for that State's GHG and ZEV programs under section 209 of the Clean Air Act. The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program; Final Rule, 84 FR 51310 (Sept. 27, 2019).

voluntary standards for MYs 2014–2015. EPA's mandatory standards for heavy-duty vehicles began for MY 2014 vehicles. The combined standards were projected to reduce CO_2emissions by approximately 270 $MMTCO_2e$ over the lifetime of vehicles built during MYs 2014–2018 (NHTSA 2011).

- **NHTSA and EPA Joint Phase 2 Rule on GHG Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles, MYs 2018–2027.** In August 2016, NHTSA and EPA published the Phase 2 joint final rule to reduce fuel consumption and GHG emissions from heavy-duty vehicles. As with the Phase 1 standards, the Phase 2 fuel consumption and CO_2 standards apply to highway vehicles and engines that are not regulated by the light-duty vehicle CAFE and CO_2 standards. NHTSA and EPA Phase 2 standards apply to MYs 2018–2027 for certain trailers and to MYs 2021–2027 for heavy-duty vehicle engines, Classes 7–8 tractors (combination heavy-haul tractors), Classes 2–8 vocational vehicles (buses and work trucks), and Classes 2b–3 heavy-duty pickups and vans (large pickup trucks and vans). The combined standards were projected to reduce GHG emissions by approximately 1,100 $MMTCO_2e$ over the lifetime of vehicles sold during MYs 2018–2027 (NHTSA 2016c).
- **Renewable Fuel Standard 2 (RFS2).** Section 211(o) of the Clean Air Act requires that a renewable fuel standard be determined annually that is applicable to refiners, importers, and certain blenders of gasoline and diesel fuel. Based on this standard, each obligated party determines the volume of renewable fuel that it must ensure is consumed as motor vehicle fuel. RFS2, which went into effect July 1, 2010, increases the volume of renewable fuel required to be consumed in the transportation sector from the baseline of 9 billion gallons in 2008 to 36 billion gallons by 2022, as written in 2010. Since 2014, the volumetric requirements have been modified to account for lower-than-expected growth in advanced and cellulosic biofuels (EPA 2015d).[14] The increased use of renewable fuels over 30 years, given a zero percent discount rate, is projected to reduce GHG emissions by 4,500 $MMTCO_2e$.
- **United States Appliance and Equipment Standards Program.** The National Appliance Energy Conservation Act of 1987 established minimum efficiency standards for many household appliances and has been authorized by Congress through several statutes. Since its inception, the program has implemented additional standards for more than 50 products, which represent about 90 percent of home energy use, 60 percent of commercial building use, and 29 percent of industrial energy use (DOE 2014a). The program is expected to reduce GHG emissions by 275 $MMTCO_2e$ annually in 2020, and a total of 800 $MMTCO_2e$ by 2030 (DOE 2015c).
- **Final rule to redefine terms under Department of Energy (DOE) lighting efficiency standards.** In 2007, the EISA directed DOE to conduct a rulemaking on efficiency standards for general service lamps (GSLs) and other incandescent lamps. In January 2017, DOE issued a final rule that revised and expanded the definition for GSL to include a broader range of incandescent lightbulbs, including those used for decorative and less-common purposes than general lighting (EPA 2017e). In February 2019, DOE issued a notice of proposed rulemaking to rescind the 2017 amendments, arguing that the definition revisions were not lawful according to the 2007 rulemaking directive (EPA 2019c). The rule to rescind the amendments was finalized in September 2019. The energy savings potential of the 2017 standards was estimated to be 27 quadrillion BTUs for lamps shipped between 2020 and 2049 (Kantner et al. 2017). The proposal had the potential to reduce GHG emissions by 540 $MMTCO_2e$ by 2030 (Kantner et al. 2017).

[14] https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuel-standards-2014-2015-and-2016-and-biomass-based.

- **Revision of Bureau of Land Management (BLM) Methane Waste Prevention Program.** In 2016, BLM issued the Waste Prevention Rule to reduce venting, flaring, and leak losses of natural gas; clarify when lost gases are subject to royalties; and clarify when onsite oil and gas production can be used royalty free. As a result of EO 13783, BLM revised the rule in November 2018, to remove gas-capture requirements, remove requirements on leak-detection inspections, and rescind other directives set forth in the original rule. As a result of the revisions, BLM estimates increased methane (CH_4) emissions of approximately 50 $MMTCO_2e$ over the 10-year period of evaluation (BLM 2018).
- **Proposal to Extend the Deadlines for State Methane Emission Reduction Plans.** In 2016, EPA published the Emissions Guidelines and Compliance Times for Municipal Solid Waste Landfills (MSW Landfills EG) final rule that established a May 30, 2017 submittal date for state plans intended to reduce landfill CH_4 emissions. In October 2018, EPA issued a proposed rule that extends the MSW Landfills EG deadline to August 29, 2019, in an effort to align timing requirements with EPA's proposed Affordable Clean Energy rule (EPA 2018a). This delay in compliance requirements is likely to result in additional methane emissions in the intervening years when compared to the original rule. EPA estimated that by 2025, the original rule would reduce annual CH_4 emissions by 7.1 $MMTCO_2e$ compared to the baseline scenario, starting in 2025 (EPA 2016h). This delay will result in lower CH_4 reductions.
- **Proposal to Revise the Methane New Source Performance Standards Rule.** In 2016, the New Source Performance Standards (NSPS) rule that targets controlling CH_4 leaks from oil and gas operations on public lands was finalized. In October 2018, EPA proposed to revise the rule to allow for annual (or greater) monitoring of well sites rather than semi-annual frequencies, among other changes.[15] The climate effects from this proposal are estimated to increase CH_4 emissions by 380,000 tons, increase volatile organic compound emissions by 100,000 tons, and increase hazardous air pollutant emissions by 3,800 tons from 2019 to 2025 (EPA 2018c). Overall, the proposal has the potential to increase GHG emissions by 8.5 $MMTCO_2e$.
- **Proposal to Revise the Regulations on Ozone-Depleting Substance (ODS) Substitute Refrigerants Extension.** In 2016, EPA finalized a rule that updated the Clean Air Act Section 608 rule regulating ODS emissions reductions during appliance maintenance and leak repairs to also include substitute refrigerants such as hydrofluorocarbons (HFCs). The rule also listed provisions to lower the threshold for which leaks to repair and required periodic leak inspections for equipment leaking above the threshold, repair verification tests, and record the disposal of appliances containing more than 5 and less than 50 pounds of refrigerants (EPA 2016k). In August 2017, EPA announced that it would revisit the 2016 rule's extension to include more refrigerants (HFCs). In October 2018, a proposed rule was issued to withdraw the extension and additional provisions, arguing whether the agency held the statutory authority to extend the regulations initially (EPA 2018f). For the original rule in 2016, EPA estimated that the extension would reduce emissions by 7.3 $MMTCO_2e$ annually. Therefore, a withdrawal would negate these reductions.
- **Repeal of the Clean Power Plan.** In 2017 Executive Order on Promoting Energy Independence and Economic Growth directed EPA to review the Clean Power Plan and revise it, as needed. In October 2017, EPA proposed to repeal the plan. In June 2019, EPA issued the final Affordable Clean Energy rule to replace the Clean Power Plan. The Clean Power Plan established emissions guidelines for states to follow in developing plans to reduce GHG emissions from existing fossil fuel-fired Electric Utility Generating Units. It is estimated that repealing the plan would increase total sulfur dioxide

[15] Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Reconsideration; Proposed Rule, 83 FR 52056 (Oct. 15, 2018).

(SO_2) emissions by 0.384 MMT and annual nitrogen oxides (NO_X) emissions by 0.231 MMT in 2030. The repeal of the plan is estimated to increase total CO_2 emissions by 348 $MMTCO_2e$ by 2030 compared to emissions levels under the plan (EPA 2017i).

- **Withdrawal of the United States from the Paris Agreement.** In November 2019, the Trump Administration formally notified the United Nations of its intent to withdraw the United States from the 2015 Paris Agreement. The United States' withdrawal will not take effect until November 2020. The goal of the agreement is to develop a framework to achieve reductions in global GHG emissions that will keep temperature increases below 2 degrees Celsius (°C). As the world's second-largest greenhouse gas emitter, this withdrawal would result in increased emissions compared to an agreement that includes the United States. In addition, without the participation of the United States, other countries may withdraw or not be compelled to meet their stated targets.

8.6.3.3 International Actions

The following international actions are already underway or reasonably foreseeable:

- **United Nations Framework Convention on Climate Change and the annual Conference of the Parties (UNFCCC).** This international treaty was signed by many countries around the world (including the United States); it entered into force on March 21, 1994 and sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change (UNFCCC 2002).
- **Kyoto Protocol.** The Kyoto Protocol is an international agreement linked to the UNFCCC. The major feature of the Kyoto Protocol is its binding targets for 37 industrialized countries and the European Community for reducing GHG emissions, which covers more than half of the world's GHG emissions. These reductions amount to approximately 5 percent of 1990 emissions over the 5-year period 2008 through 2012 (UNFCCC 2014a). The December 2011 COP-17 held in Durban, South Africa, resulted in an agreement to extend the imminently expiring Kyoto Protocol. The Second Commitment Period took effect on January 1, 2013, runs through December 2020, and requires parties to reduce emissions by at least 18 percent below 1990 levels by 2020; the parties in the second commitment period differ from those in the first (UNFCCC 2014a).
- **Additional Decisions and Actions.** At COP-16, held in Cancun, Mexico in December 2010, a draft accord pledged to limit global temperature increase to less than 2°C (3.6 degrees Fahrenheit [°F]) above preindustrial global average temperature. At COP-17, the Parties established the Working Group on the Durban Platform for Enhanced Action to develop a protocol for mitigating emissions from rapidly developing countries no later than 2015, and to take effect in 2020 (UNFCCC 2014b). As of April 12, 2012, 141 countries had agreed to the Copenhagen Accord, accounting for the vast majority of global emissions (UNFCCC 2010). However, the pledges are not legally binding, and much remains to be negotiated. At COP-18, held in Doha, Qatar in November 2012, the parties also made a long-term commitment to mobilize $100 billion per year to the Green Climate Fund by 2020, which will operate under the oversight of the Conference of the Parties to support climate change-related projects around the world (UNFCCC 2012). At COP-19, held in Warsaw, Poland in November 2013, key decisions were made towards the development of a universal 2015 agreement in which all nations would bind together to reduce emissions rapidly, build adaptation capacity, and stimulate faster and broader action (UNFCCC 2014b). COP-19 also marked the opening of the Green Climate Fund, which began its initial resource mobilization process in 2014 (UNFCCC 2014c). At COP-20, held in Lima, Peru in December 2014, countries agreed to submit Intended Nationally Determined Contributions (country-specific GHG mitigation targets) by the end of the first quarter of 2015. COP-20 also increased transparency of GHG reduction programs in developing countries through a

Multilateral Assessment process, elicited increased pledges to the Green Climate Fund, made National Adaptation Plans more accessible on the UNFCCC website, and called on governments to increase educational initiatives around climate change (UNFCCC 2014d). At COP-21, the Paris Agreement was adopted, which emphasizes the need to limit global average temperature increase to well below 2°C above preindustrial levels and pursue efforts to limit the increase to 1.5°C. The agreement urges countries to commit to a GHG reduction target by 2020 and to submit a new reduction target that demonstrates progress every 5 years thereafter. The United Nations will analyze progress on global commitments in 2023 and every 5 years thereafter. As of October 2019, 187 countries, including the United States, comprising over 96 percent of global GHG emissions had ratified, accepted, or approved the Paris Agreement (UNFCCC 2019). Initial GHG emissions reduction targets announced by country signatories to the Paris Agreement are expected to result in global emissions that are 3.6 gigatons lower in 2030 than projected from pre-Paris national pledges (UNFCCC 2015). Based on country pledges from the Paris Agreement, global GHG emissions in 2030 are expected to be lower than those under the highest emissions scenario (RCP8.5) but higher than those under RCP4.5 and RCP6.0 (UNFCCC 2015). While the commitments to reduce GHG emissions cannot be extrapolated into a trend (i.e., there is significant uncertainty surrounding emissions before and after 2030), they demonstrate global action to reduce the historical rate of GHG emissions growth. On August 4, 2017, the U.S. Department of State submitted a communication to the United Nations regarding the United States' intention to withdraw from the Paris Agreement as soon as it is eligible to do so. According to Article 28, the earliest that any party can effectively withdraw from the Paris Agreement is 4 years after the agreement has entered into force; thus, the earliest date that the United States can withdraw is November 4, 2020.

- **The European Union GHG Emissions Trading System.** In January 2005, the European Union Emissions Trading System commenced operation as the largest multi-country, multi-sector GHG emissions trading system worldwide (European Union 2014). The aim of the system is to help European Union member states achieve compliance with their commitments under the Kyoto Protocol (European Union 2005). This trading system does not entail new environmental targets; instead, it allows for less expensive compliance with existing targets under the Kyoto Protocol. The scheme is based on Directive 2003/87/EC, which entered into force on October 25, 2003 (European Union 2005) and covers more than 11,000 energy-intensive installations across the European Union. This represents almost half of Europe's emissions of CO_2 (European Union 2014). These installations include commercial aviation, combustion plants, oil refineries, and iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp, and paper (European Union 2014). The European Union projects that emissions from sources covered by this program will decrease by 43 percent in 2030 compared to emissions in 2005 (European Union 2014).
- **Fuel Economy Standards in Asia.** Both Japan and China have taken actions to reduce fuel use, CO_2 emissions, and criteria pollutant emissions from vehicles. Japan has invested heavily in research and development programs to advance fuel-saving technologies, has implemented fiscal incentives such as high fuel taxes and differential vehicle fees, and has mandated fuel economy standards based on vehicle weight class (using country-specific testing procedures [Japan 1015/JC08]). In 2015, Japan's Ministry of Land, Infrastructure, Transport, and Tourism finalized new fuel economy standards for light and medium commercial vehicles sold in 2022 that are a 23 percent increase from the currently prevailing standard (ICCT 2015). Similarly, China has implemented fuel economy standards, modeled after European Union standards (using the New European Driving Cycle testing methods) (UN 2011). In 2014, the Chinese Ministry of Industry and Information Technology proposed increasing the fleet-average fuel efficiency standard through 2020. The regulation is expected to reduce oil consumption by 348 million barrels and reduce CO_2 emissions by 149 $MMTCO_2e$ in 2030 (ICCT 2014). China has

also implemented research and development programs, differential vehicle fees, and technology mandates (UN 2011).

- **China EV Targets.** China has now established a program that effectively sets quotas for PEVs and FCVs, with PEVs and FCVs expected to make up at least 10 percent of each automaker's sales in China in 2019, and 12 percent in 2020, with higher annual targets to be set for years after 2020 (McDonald 2017). China has not yet set a timetable to reach 100 percent EV sales but is expected to join other nations in phasing out sales of ICE vehicles by 2040.

8.6.4 Cumulative Impacts on Greenhouse Gas Emissions and Climate Change

8.6.4.1 Greenhouse Gas Emissions

NHTSA estimated the emissions resulting from the Proposed Action and alternatives using the methods described in Section 5.3, *Analysis Methods*.

8.6.4.2 Cumulative Impacts on Climate Change Indicators

Using the methods described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and Section 8.6.2, *Analysis Methods*, this section describes the cumulative impacts of the alternatives on climate change in terms of atmospheric CO_2 concentrations, temperature, precipitation, sea-level rise, and ocean pH. The impacts of this rulemaking, in combination with other reasonably foreseeable future actions, on global mean surface temperature, precipitation, sea-level rise, and ocean pH are relatively small in the context of the expected changes associated with the emissions trajectories in the GCAM scenarios. Although relatively small, primarily due to the global and multi-sectoral nature of climate change, the impacts occur on a global scale and are long-lasting.

The Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) 6 scenario is a reduced-complexity climate model and well calibrated to the mean of the multi-model ensemble results for four of the most commonly used emissions scenarios (i.e., RCP2.6 [low], RCP4.5 [medium], RCP6.0 [medium-high], and RCP8.5 [high]) from the IPCC RCP series.

The GCAM6.0 scenario (Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact Analysis*) was used to represent the No Action Alternative in the MAGICC runs for the cumulative impacts analysis. Table 8.6.4-1 and Figure 8.6.4-1 through Figure 8.6.4-4 show the mid-range results of MAGICC model simulations for all alternatives for CO_2 concentrations and increase in global mean surface temperature in 2040, 2060, and 2100. As Figure 8.6.4-1 and Figure 8.6.4-3 show, the action alternatives would increase CO_2 concentration and temperature, but the increase would be a small fraction of the total increase in CO_2 concentrations and global mean surface temperature. As shown in Table 8.6.4-1, Figure 8.6.4-1, and Figure 8.6.4-2, the band of estimated CO_2 concentrations as of 2100 is narrow, ranging from 687.3 ppm under the No Action Alternative to 688.0 ppm under Alternative 1. For 2040 and 2060, the corresponding ranges are similar. Because CO_2 concentrations are the key driver of all other climate effects, the small changes in CO_2 would lead to only small differences in climate effects. Compared with projected total global CO_2 emissions of 4,044,005 $MMTCO_2$ from all sources from 2021 to 2100, the incremental impact of this rulemaking is expected to increase global CO_2 emissions between 0.08 (Alternative 7) and 0.22 (Alternative 1) percent by 2100.

Table 8.6.4-1. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increase, and Sea-Level Rise, and Ocean pH by Alternative[a]

	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b]			Sea-Level Rise (cm)[b]			Ocean pH[c]		
Alternative	**2040**	**2060**	**2100**	**2040**	**2060**	**2100**	**2040**	**2060**	**2100**	**2040**	**2060**	**2100**
Alt. 0—No Action	472.56	546.00	687.29	1.216	1.810	2.838	22.16	35.15	70.22	8.4150	8.3609	8.2723
Alt. 1	472.67	546.33	688.04	1.216	1.812	2.841	22.17	35.17	70.30	8.4149	8.3606	8.2719
Alt. 2	472.67	546.32	688.01	1.216	1.812	2.841	22.17	35.17	70.29	8.4149	8.3606	8.2719
Alt. 3	472.66	546.29	687.95	1.216	1.812	2.841	22.16	35.17	70.29	8.4149	8.3607	8.2719
Alt. 4	472.65	546.28	687.91	1.216	1.812	2.841	22.16	35.16	70.28	8.4149	8.3607	8.2719
Alt. 5	472.63	546.21	687.76	1.216	1.812	2.840	22.16	35.16	70.27	8.4149	8.3607	8.2720
Alt. 6	472.62	546.17	687.67	1.216	1.811	2.840	22.16	35.16	70.26	8.4149	8.3607	8.2721
Alt. 7	472.60	546.12	687.55	1.216	1.811	2.839	22.16	35.16	70.25	8.4149	8.3608	8.2721
Increases Under Alternatives												
Alt. 1	0.11	0.33	0.75	0.001	0.002	0.004	0.00	0.02	0.07	-0.0001	-0.0002	-0.0004
Alt. 2	0.11	0.32	0.72	0.001	0.002	0.003	0.00	0.02	0.07	-0.0001	-0.0002	-0.0004
Alt. 3	0.10	0.29	0.66	0.000	0.002	0.003	0.00	0.01	0.07	-0.0001	-0.0002	-0.0004
Alt. 4	0.09	0.27	0.63	0.000	0.001	0.003	0.00	0.01	0.06	-0.0001	-0.0002	-0.0004
Alt. 5	0.07	0.20	0.47	0.000	0.001	0.002	0.00	0.01	0.05	-0.0001	-0.0001	-0.0003
Alt. 6	0.06	0.17	0.38	0.000	0.001	0.002	0.00	0.01	0.04	0.0000	0.0001	-0.0002
Alt. 7	0.04	0.12	0.26	0.000	0.001	0.001	0.00	0.01	0.03	0.0000	-0.0001	-0.0001

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the reductions might not reflect the exact difference of the values in all cases.
[b] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986–2005.
[c] Ocean pH changes reported as 0.0000 are less than zero but more than -0.0001.
CO_2 = carbon dioxide; ppm = parts per million; °C = degrees Celsius; cm = centimeters

Atmospheric Carbon Dioxide Concentrations

As Figure 8.6.4-1 and Figure 8.6.4-2 show, the increases in projected CO_2 concentrations under the Proposed Action and alternatives compared to the No Action Alternative amount to a small fraction of the projected total increases in CO_2 concentrations. However, the relative impact of the action alternatives is demonstrated by the increases of CO_2 concentrations under the range of action alternatives. As shown in Figure 8.6.4-2, the increase in CO_2 concentrations by 2100 under Alternative 1 compared to the No Action Alternative is more than twice that of Alternative 7 compared to the No Action Alternative.

Figure 8.6.4-1. Atmospheric Carbon Dioxide Concentrations by Alternative

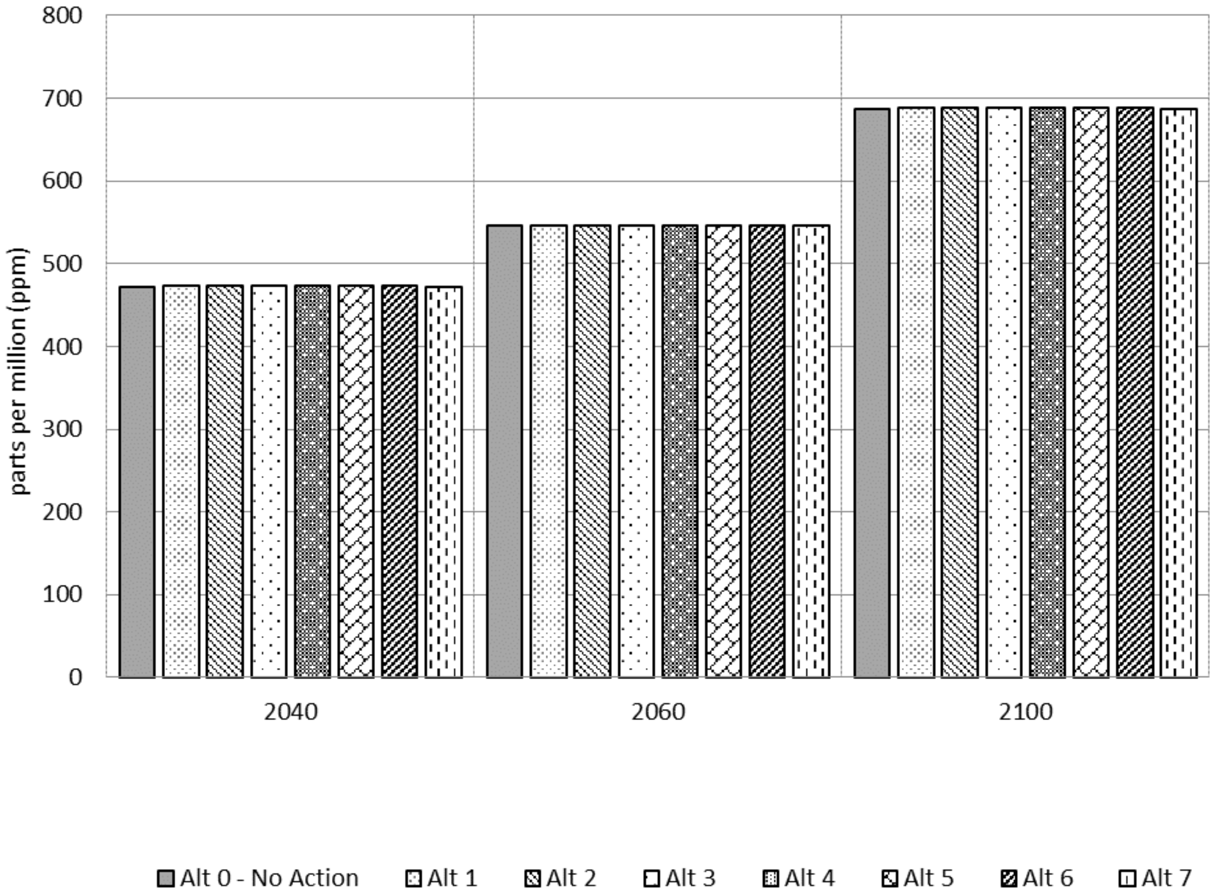
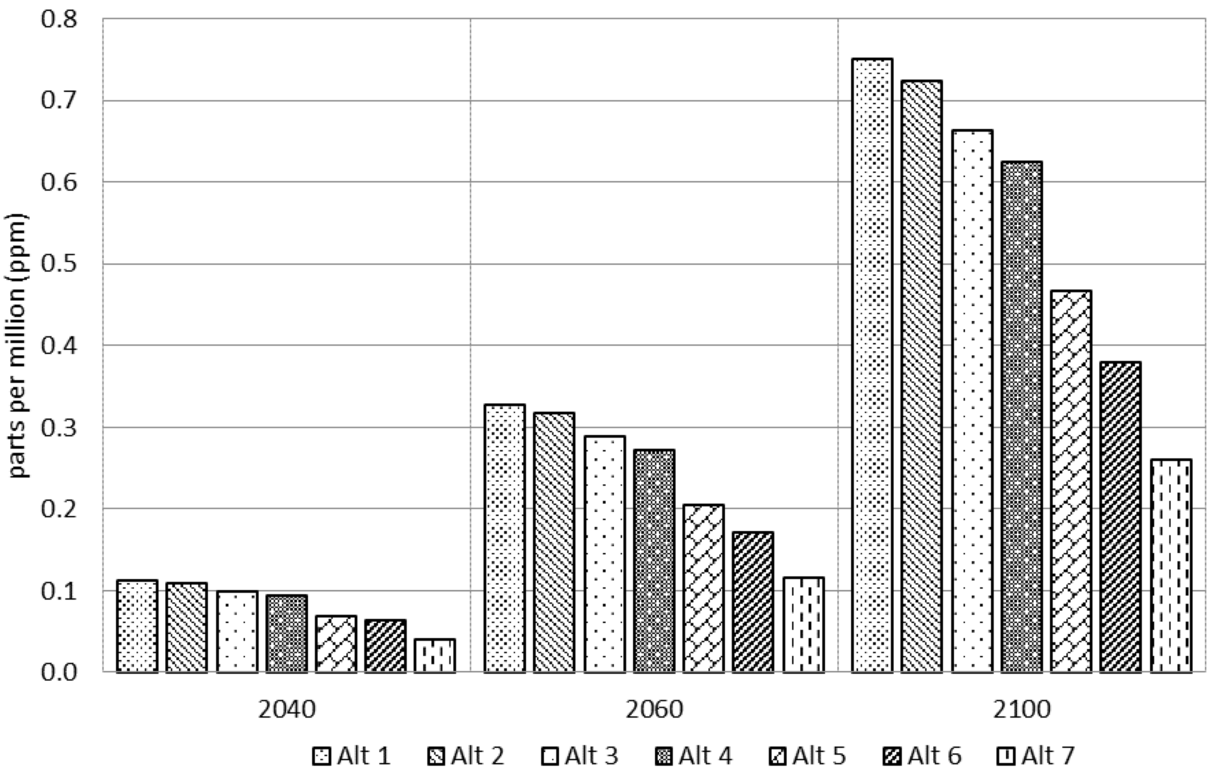


Figure 8.6.4-2. Increase in Atmospheric Carbon Dioxide Concentrations Compared to the No Action Alternative



Temperature

MAGICC simulations of mean global surface air temperature increases are shown in Figure 8.6.4-3 and Figure 8.6.4-4. Under the No Action Alternative, assuming an emissions scenario that considers a moderate global effort to reduce GHG emissions, the cumulative global mean surface temperature is projected to increase by 1.216°C (2.189°F) by 2040, 1.810°C (3.260°F) by 2060, and 2.838°C (5.108°F) by 2100.[16] The differences among the increases in baseline temperature projected to result from the action alternatives are small compared to total projected temperature increases (Figure 8.6.4-3). For example, in 2100, the increase in temperature under the action alternatives would range from approximately 0.001°C (0.002°F) under Alternative 7 to 0.004°C (0.006°F) under Alternative 1. Quantifying the changes to regional climate from this rulemaking is not possible because of the limitations of existing climate models. However, the action alternatives would be expected to increase the changes in regional temperatures roughly in proportion to the increase in global mean surface temperature. Regional changes to warming and seasonal temperatures as described in the IPCC Fifth Assessment Report are summarized in Table 5.4.2-3.

[16] Because the actual increase in global mean surface temperature lags the commitment to warming, the impact on global mean surface temperature increase is less than the impact on the long-term commitment to warming. The actual increase in surface temperature lags the commitment due primarily to the time required to heat the oceans.

Figure 8.6.4-3. Global Mean Surface Temperature Increase by Alternative

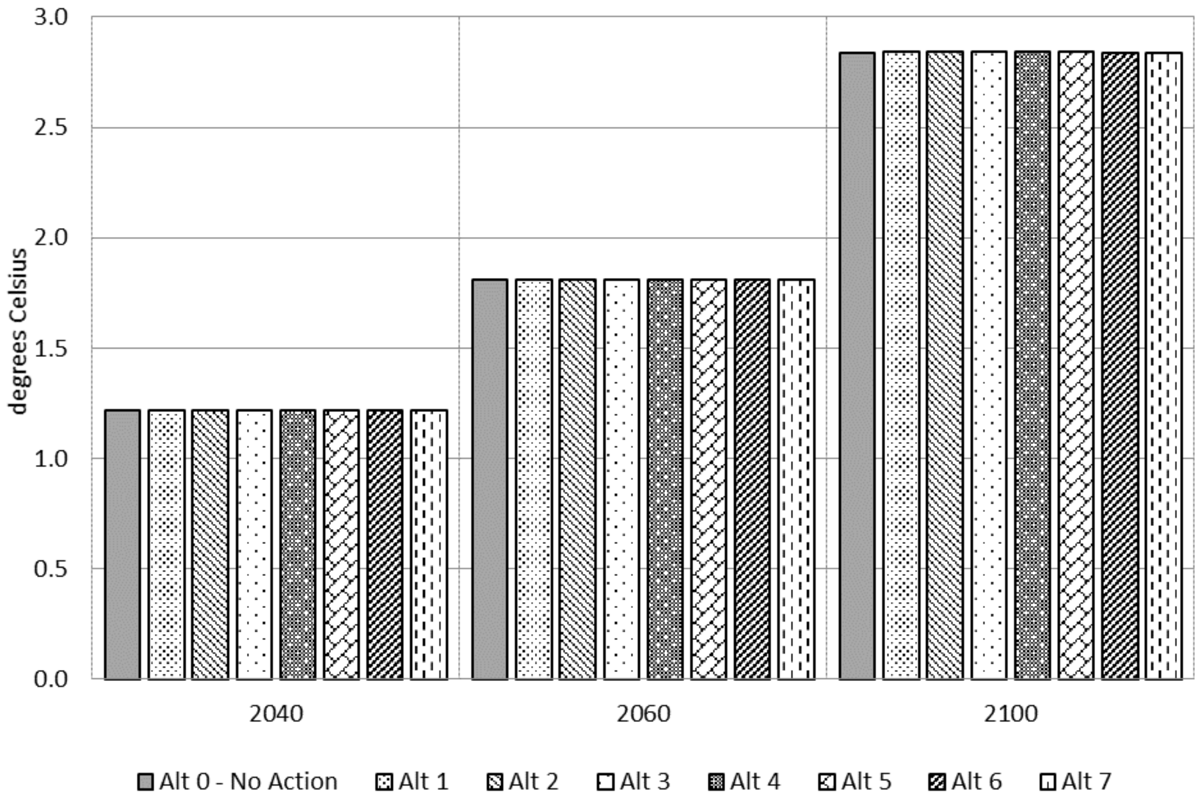
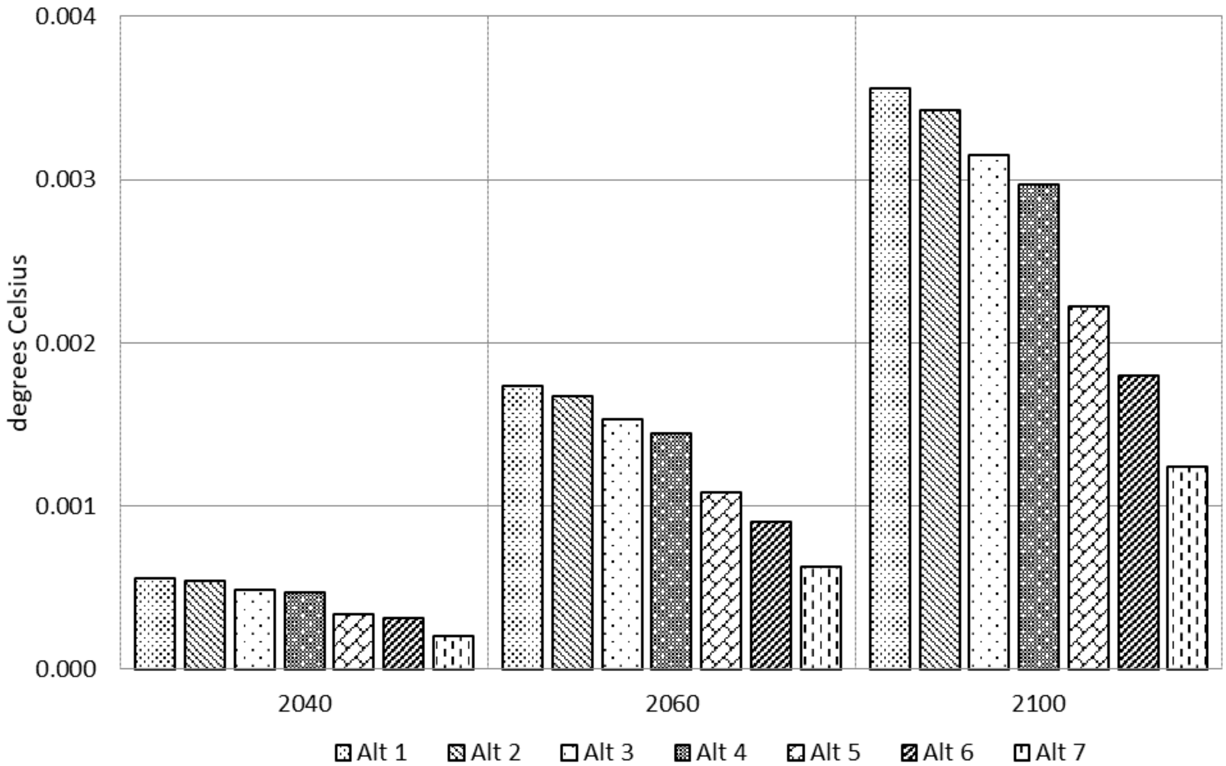


Figure 8.6.4-4. Increase in Global Mean Surface Temperature Compared to the No Action Alternative



Precipitation

The effects of higher temperatures on the amount of precipitation and the intensity of precipitation events, as well as the IPCC scaling factors to estimate global mean precipitation change, are discussed in Section 5.4.2.2, *Climate Change Attributes, Precipitation*. Applying these scaling factors to the increase in global mean surface warming provides estimates of changes in global mean precipitation. Given that the Proposed Action and alternatives would increase temperatures slightly compared to the No Action Alternative, they also would increase predicted increases in precipitation slightly; however, as shown in Table 8.6.4-2, the increase would be less than 0.01 percent.

Regional variations and changes in the intensity of precipitation events cannot be quantified further. This inability is due primarily to the lack of availability of atmospheric-ocean general circulation models (AOGCMs) required to estimate these changes. AOGCMs are typically used to provide results among scenarios with very large changes in emissions, such as the RCP2.6 (low), RCP4.5 (medium), RCP6.0 (medium-high) and RCP8.5 (high) scenarios; very small changes in emissions profiles produce results that would be difficult to resolve. Also, the various AOGCMs produce results that are regionally consistent in some cases but inconsistent in others.

Table 8.6.4-2. Global Mean Precipitation (Percent Increase) Based on GCAM6.0 Scenario Using Increases in Global Mean Surface Temperature Simulated by MAGICC, by Alternative[a]

Scenario	2040	2060	2100
Global Mean Precipitation Change (scaling factor, % change in precipitation per °C change in temperature)		1.68%	
Global Temperature Above Average 1986–2005 Levels (°C) for the GCAM6.0 Scenario			
Alternative 0—No Action	1.216	1.810	2.838
Alternative 1	1.216	1.812	2.841
Alternative 2	1.216	1.812	2.841
Alternative 3	1.216	1.812	2.841
Alternative 4	1.216	1.812	2.841
Alternative 5	1.216	1.812	2.840
Alternative 6	1.216	1.811	2.840
Alternative 7	1.216	1.811	2.839
Increase in Global Temperature (°C) Compared to the No Action Alternative[b]			
Alternative 1	0.001	0.002	0.004
Alternative 2	0.001	0.002	0.003
Alternative 3	0.000	0.002	0.003
Alternative 4	0.000	0.001	0.003
Alternative 5	0.000	0.001	0.002
Alternative 6	0.000	0.001	0.002
Alternative 7	0.000	0.001	0.001
Global Mean Precipitation Increase (%)			
Alternative 0—No Action	2.04%	3.04%	4.77%
Alternative 1	2.04%	3.04%	4.77%
Alternative 2	2.04%	3.04%	4.77%
Alternative 3	2.04%	3.04%	4.77%
Alternative 4	2.04%	3.04%	4.77%
Alternative 5	2.04%	3.04%	4.77%
Alternative 6	2.04%	3.04%	4.77%
Alternative 7	2.04%	3.04%	4.77%
Increase in Global Mean Precipitation Increase Compared to the No Action Alternative[c]			
Alternative 1	0.00%	0.00%	0.01%
Alternative 2	0.00%	0.00%	0.01%
Alternative 3	0.00%	0.00%	0.01%
Alternative 4	0.00%	0.00%	0.00%
Alternative 5	0.00%	0.00%	0.00%
Alternative 6	0.00%	0.00%	0.00%
Alternative 7	0.00%	0.00%	0.00%

Notes:

[a] The numbers in this table have been rounded for presentation purposes. As a result, the reductions might not reflect the exact difference of the values in all cases.

[b] Precipitation changes reported as 0.000 are more than zero but less than 0.001.

[c] The increase in precipitation is less than 0.005% and thus is rounded to 0.00%.

GCAM = Global Change Assessment Model; MAGICC = Model for the Assessment of Greenhouse-gas Induced Climate Change; °C = degrees Celsius

Quantifying the changes in regional climate that would result from the action alternatives is not possible, but the action alternatives would increase regional changes in precipitation roughly in proportion to the increase in global mean precipitation. Regional changes to precipitation as described by the IPCC Fifth Assessment Report are summarized in Table 5.4.2-6.

Sea-Level Rise

The components of sea-level rise, treatment of these components, and recent scientific assessments are discussed in Section 5.4.2.2, *Sea-Level Rise*. Table 8.6.4-1 presents the cumulative impact on sea-level rise from the scenarios and show sea-level rise in 2100 ranging from 70.22 centimeters (27.65 inches) under the No Action Alternative to 70.30 centimeters (27.67 inches) under Alternative 1, for a maximum increase of 0.07 centimeter (0.03 inch) by 2100.

Ocean pH

As Table 8.6.4-1 shows, the projected decrease of ocean pH under each action alternative compared to the No Action Alternative would amount to a small fraction of the projected total decrease in ocean pH. However, the relative impact of the action alternatives is demonstrated by the decrease of ocean pH under the range of action alternatives. As shown in Table 8.6.4-1, the decrease of ocean pH by 2100 under Alternative 1 would be more than four times that of Alternative 7.

Climate Sensitivity Variations

NHTSA examined the sensitivity of climate impacts on key assumptions used in the analysis. This examination reviewed the impact of various climate sensitivities and global emissions scenarios on the climate effects of three of the alternatives—the No Action Alternative, Alternative 1, and Alternative 7. This range of alternatives was deemed sufficient to assess the effect of various climate sensitivities on the results. Table 8.6.4-3 presents the results of the sensitivity analysis for cumulative impacts.

Table 8.6.4-3. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increases, Sea-Level Rise,[a] and Ocean pH for RCP4.5 for Selected Alternatives[b]

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[c]			Sea-Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Alt. 0—No Action	1.5	454.05	494.89	510.15	0.619	0.859	1.040	31.58	8.3864
	2.0	457.30	500.90	521.85	0.793	1.114	1.389	40.80	8.3779
	2.5	460.23	506.45	533.11	0.952	1.352	1.729	50.33	8.3699
	3.0	462.88	511.57	543.93	1.097	1.573	2.059	60.04	8.3623
	4.5	469.44	524.72	573.71	1.464	2.152	2.978	89.27	8.3421
	6.0	474.49	535.31	599.95	1.752	2.627	3.797	117.62	8.3250
Alt. 1	1.5	454.19	495.26	510.89	0.619	0.860	1.042	31.62	8.3860
	2.0	457.45	501.28	522.60	0.793	1.115	1.392	40.85	8.3775
	2.5	460.38	506.83	533.89	0.952	1.353	1.733	50.41	8.3694
	3.0	463.03	511.96	544.73	1.098	1.575	2.063	60.13	8.3618
	4.5	469.59	525.11	574.57	1.465	2.154	2.983	89.40	8.3416
	6.0	474.63	535.71	600.86	1.753	2.630	3.804	117.81	8.3245

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[c]			Sea-Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Alt. 7	1.5	454.09	495.00	510.37	0.619	0.859	1.040	31.59	8.3863
	2.0	457.34	501.02	522.07	0.793	1.114	1.390	40.81	8.3778
	2.5	460.27	506.56	533.34	0.952	1.352	1.730	50.36	8.3697
	3.0	462.92	511.68	544.17	1.097	1.574	2.060	60.07	8.3621
	4.5	469.48	524.83	573.96	1.464	2.152	2.979	89.31	8.3419
	6.0	474.53	535.43	600.22	1.752	2.627	3.799	117.68	8.3248
Increase Under Alternative 1 Compared to the No Action Alternative									
Alt. 1	1.5	0.14	0.37	0.73	0.001	0.001	0.003	0.04	-0.0005
	2.0	0.15	0.38	0.76	0.001	0.002	0.003	0.06	-0.0005
	2.5	0.15	0.38	0.78	0.001	0.002	0.004	0.07	-0.0005
	3.0	0.15	0.39	0.80	0.001	0.002	0.004	0.09	-0.0005
	4.5	0.15	0.39	0.85	0.001	0.003	0.006	0.14	-0.0005
	6.0	0.15	0.40	0.90	0.001	0.003	0.007	0.18	-0.0005
Increase Under Alternative 7 Compared to the No Action Alternative									
Alt. 7	1.5	0.04	0.11	0.22	0.000	0.000	0.001	0.01	-0.0002
	2.0	0.04	0.11	0.22	0.000	0.000	0.001	0.02	-0.0002
	2.5	0.04	0.11	0.23	0.000	0.001	0.001	0.02	-0.0002
	3.0	0.04	0.11	0.24	0.000	0.001	0.001	0.03	-0.0002
	4.5	0.04	0.12	0.25	0.000	0.001	0.002	0.04	-0.0002
	6.0	0.04	0.12	0.27	0.000	0.001	0.002	0.05	-0.0002

Notes:
[a] Sea-level rise results are based on the regression analysis described in Section 5.3.3, *Methods for Estimating Climate Effects*.
[b] The numbers in this table have been rounded for presentation purposes. As a result, the reductions do not reflect the exact difference of the values.
[c] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986–2005.
ppm = parts per million; °C = degrees Celsius; CO_2 = carbon dioxide; cm = centimeters; RCP = Representative Concentration Pathways

The use of alternative global emissions scenarios can influence the results in several ways. Emissions increases under higher emissions scenarios can lead to larger increases in CO_2 concentrations in later years. Under higher emissions scenarios, anthropogenic emissions levels exceed global emissions sinks (e.g., plants, oceans, and soils) by a greater extent. As a result, emissions increases under higher emissions scenarios are avoiding more of the anthropogenic emissions that are otherwise expected to stay in the atmosphere (are not removed by sinks) and contribute to higher CO_2 concentrations. The use of different climate sensitivities (the equilibrium warming that occurs at a doubling of CO_2 from preindustrial levels) could affect not only projected warming but also indirectly affect projected sea-level rise, CO_2 concentration, and ocean pH. Sea level is influenced by temperature. CO_2 concentration and ocean pH are affected by temperature-dependent effects of ocean carbon storage (higher temperature results in lower aqueous solubility of CO_2).

As shown in Table 8.6.4-4 and Table 8.6.4-5, the sensitivity of simulated CO_2 emissions in 2040, 2060, and 2100 to assumptions of global emissions and climate sensitivity is low; the incremental changes in

CO_2 concentration (i.e., the difference between Alternative 7 and Alternative 1) are insensitive to different assumptions on global emissions and climate sensitivity. For 2040 and 2060, the choice of global emissions scenario has little impact on the results. By 2100, Alternative 1 would have the greatest impact on CO_2 concentration in the global emissions scenario with the highest CO_2 emissions (GCAM Reference scenario), and Alternative 7 would have the least impact in the scenario with the lowest CO_2 emissions (RCP4.5) of the action alternatives. The total range of the impact of Alternative 7 on CO_2 concentrations in 2100 is roughly 0.13 to 0.19 ppm across all three global emissions scenarios. Alternative 7, using the GCAM6.0 scenario and a 3.0°C (5.4°F) climate sensitivity, would have a 0.15 ppm increase compared to Alternative 1, which would have a 0.62 ppm increase in 2100.

Table 8.6.4-4. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increases, Sea-Level Rise,[a] and Ocean pH for GCAM6.0[a] for Selected Alternatives[b]

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[c]			Sea-Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Alt. 0—No Action	1.5	463.33	527.73	643.45	0.694	1.005	1.506	36.94	8.2980
	2.0	466.74	534.33	658.72	0.885	1.294	1.971	47.83	8.2889
	2.5	469.80	540.41	673.33	1.058	1.562	2.415	58.97	8.2803
	3.0	472.56	546.00	687.29	1.216	1.810	2.838	70.22	8.2723
	4.5	479.39	560.37	725.55	1.611	2.456	3.998	103.79	8.2510
	6.0	484.62	571.96	759.36	1.920	2.984	5.037	136.36	8.2329
Alt. 1	1.5	463.44	528.04	644.13	0.694	1.006	1.508	36.98	8.2976
	2.0	466.85	534.65	659.43	0.885	1.295	1.974	47.87	8.2884
	2.5	469.91	540.73	674.05	1.059	1.564	2.418	59.02	8.2799
	3.0	472.67	546.33	688.03	1.216	1.812	2.841	70.29	8.2719
	4.5	479.50	560.71	726.34	1.612	2.458	4.003	103.90	8.2505
	6.0	484.74	572.30	760.19	1.921	2.987	5.043	136.51	8.2325
Alt. 7	1.5	463.37	527.84	643.68	0.694	1.005	1.507	36.96	8.2978
	2.0	466.78	534.45	658.96	0.885	1.295	1.972	47.84	8.2887
	2.5	469.84	540.52	673.58	1.058	1.563	2.416	58.99	8.2802
	3.0	472.60	546.12	687.54	1.216	1.811	2.839	70.25	8.2721
	4.5	479.43	560.49	725.82	1.611	2.456	4.000	103.83	8.2508
	6.0	484.67	572.08	759.64	1.921	2.985	5.039	136.41	8.2328
Increase Under Alternative 1 Compared to the No Action Alternative									
Alt. 1	1.5	0.11	0.32	0.69	0.000	0.001	0.002	0.03	-0.0004
	2.0	0.11	0.32	0.71	0.000	0.001	0.002	0.04	-0.0004
	2.5	0.11	0.32	0.73	0.001	0.001	0.003	0.06	-0.0004
	3.0	0.11	0.33	0.74	0.001	0.002	0.003	0.07	-0.0004
	4.5	0.11	0.33	0.79	0.001	0.002	0.004	0.11	-0.0004
	6.0	0.11	0.34	0.83	0.001	0.002	0.006	0.15	-0.0004

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[c]			Sea-Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Increase Under Alternative 7 compared to the No Action Alternative									
Alt. 7	1.5	0.04	0.11	0.24	0.000	0.000	0.001	0.01	-0.0001
	2.0	0.04	0.11	0.24	0.000	0.000	0.001	0.02	-0.0001
	2.5	0.04	0.12	0.25	0.000	0.001	0.001	0.02	-0.0001
	3.0	0.04	0.12	0.26	0.000	0.001	0.001	0.02	-0.0001
	4.5	0.04	0.12	0.27	0.000	0.001	0.002	0.04	-0.0001
	6.0	0.04	0.12	0.28	0.000	0.001	0.002	0.05	-0.0001

Notes:
[a] Sea-level rise results are based on the regression analysis described in Section 5.3.3, *Methods for Estimating Climate Effects*, using GCAM6.0.
[b] The numbers in this table have been rounded for presentation purposes. As a result, the reductions do not reflect the exact difference of the values.
[c] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986–2005.
ppm = parts per million; °C = degrees Celsius; CO_2 = carbon dioxide; cm = centimeters; GCAM = Global Change Assessment Model

Table 8.6.4-5. Carbon Dioxide Concentrations, Global Mean Surface Temperature Increases, Sea-Level Rise,[a] and Ocean pH for GCAM Reference for Selected Alternatives[b]

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b]			Sea Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Alt. 0—No Action	1.5	469.61	546.10	737.48	0.741	1.128	1.890	41.05	8.2445
	2.0	473.09	553.09	755.49	0.941	1.446	2.451	52.74	8.2350
	2.5	476.22	559.52	772.69	1.123	1.738	2.981	64.52	8.2260
	3.0	479.04	565.44	789.11	1.287	2.008	3.484	76.28	8.2176
	4.5	486.00	580.62	834.28	1.699	2.707	4.868	110.93	8.1952
	6.0	491.34	592.87	874.88	2.020	3.279	6.171	144.70	8.1759
Alt. 1	1.5	469.72	546.42	738.20	0.741	1.129	1.892	41.07	8.2441
	2.0	473.20	553.42	756.23	0.942	1.447	2.453	52.78	8.2346
	2.5	476.33	559.85	773.45	1.123	1.740	2.984	64.57	8.2256
	3.0	479.15	565.77	789.88	1.288	2.010	3.487	76.34	8.2172
	4.5	486.11	580.96	835.13	1.699	2.709	4.872	111.03	8.1948
	6.0	491.46	593.22	875.76	2.021	3.282	6.177	144.84	8.1755
Alt. 7	1.5	469.65	546.21	737.73	0.741	1.128	1.891	41.06	8.2444
	2.0	473.13	553.21	755.74	0.941	1.446	2.452	52.76	8.2348
	2.5	476.26	559.64	772.95	1.123	1.739	2.982	64.54	8.2259
	3.0	479.08	565.56	789.37	1.287	2.009	3.485	76.30	8.2175
	4.5	486.04	580.74	834.57	1.699	2.708	4.870	110.97	8.1951
	6.0	491.38	593.00	875.16	2.020	3.280	6.173	144.75	8.1758

Alternative	Climate Sensitivity (°C for 2 × CO_2)	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)[b]			Sea Level Rise (cm)[c]	Ocean pH
		2040	2060	2100	2040	2060	2100	2100	2100
Increase Under Alternative 1 Compared to the No Action Alternative									
Alt. 1	1.5	0.11	0.32	0.72	0.000	0.001	0.002	0.03	-0.0004
	2.0	0.11	0.32	0.74	0.000	0.001	0.002	0.04	-0.0004
	2.5	0.11	0.33	0.76	0.001	0.001	0.003	0.05	-0.0004
	3.0	0.11	0.33	0.78	0.001	0.002	0.003	0.06	-0.0004
	4.5	0.11	0.34	0.85	0.001	0.002	0.004	0.10	-0.0004
	6.0	0.11	0.34	0.88	0.001	0.002	0.006	0.14	-0.0004
Increase Under Alternative 7 Compared to the No Action Alternative									
Alt. 7	1.5	0.04	0.11	0.25	0.000	0.000	0.001	0.01	-0.0001
	2.0	0.04	0.12	0.26	0.000	0.001	0.001	0.01	-0.0001
	2.5	0.04	0.12	0.26	0.000	0.001	0.001	0.02	-0.0001
	3.0	0.04	0.12	0.27	0.000	0.001	0.001	0.02	-0.0001
	4.5	0.04	0.12	0.29	0.000	0.001	0.002	0.03	-0.0001
	6.0	0.04	0.12	0.28	0.000	0.001	0.002	0.05	-0.0001

Notes:
[a] Sea-level rise results are based on the regression analysis described in Section 5.3.3, *Methods for Estimating Climate Effects*, using a hybrid relation based on RCP6.0 and RCP8.5.
[b] The numbers in this table have been rounded for presentation purposes. As a result, the reductions do not reflect the exact difference of the values.
[c] The values for global mean surface temperature and sea-level rise are relative to the average of the years 1986-2005.
ppm = parts per million; °C = degrees Celsius; CO_2 = carbon dioxide; cm = centimeters; GCAM = Global Change Assessment Model

The sensitivity of the simulated global mean surface temperatures for 2040, 2060, and 2100 varies over the simulation period, as shown in Table 8.6.4-5. In 2040, the impact would be low due primarily to the rate at which global mean surface temperature increases in response to increases in radiative forcing. In 2100, the impact would be larger due to climate sensitivity and change in emissions. The impact on global mean surface temperature due to assumptions concerning global emissions of GHGs is also important. Under Alternative 1, the scenario with the highest global emissions of GHGs, the GCAM Reference scenario, has a higher increase in global mean surface temperature than the scenario with lowest global emissions, RCP4.5. This is due to the nonlinear and near-logarithmic relationship between radiative forcing and CO_2 concentrations. At high emissions levels, CO_2 concentrations are high; therefore, a fixed increase in emissions yields a higher increase in radiative forcing and global mean surface temperature.

The sensitivity of simulated sea-level rise to change in climate sensitivity and global GHG emissions mirrors that of global temperature, as shown in Table 8.6.4-3 through Table 8.6.4-5. Scenarios with lower climate sensitivities have lower increases in sea-level rise; the increase in sea-level rise is lower under Alternative 1 than it would be under scenarios with higher climate sensitivities. Conversely, scenarios with higher climate sensitivities have higher sea-level rise; the increase of sea-level rise would be higher under Alternative 1 than it would be under scenarios with lower climate sensitivities. Higher global GHG emissions scenarios have higher sea-level rise, but the impact of Alternative 1 would be less than in scenarios with lower global emissions. Conversely, scenarios with lower global GHG emissions have lower sea-level rise, although the impact of Alternative 1 is greater than in scenarios with higher global emissions.

The sensitivity of the simulated ocean pH to change in climate sensitivity and global GHG emissions mirrors that of global CO_2 concentrations.

8.6.5 Health, Societal, and Environmental Impacts of Climate Change

8.6.5.1 Introduction

As described in Section 5.4 *Environmental Consequences* and Section 8.6.4, *Cumulative Impacts on Greenhouse Gas Emissions and Climate Change,* ongoing emissions of GHGs from many sectors, including transportation, affect global CO_2 concentrations, temperature, precipitation, sea level, and ocean pH. This section describes how these effects can translate to impacts on key natural and human resources.

Although the action alternatives would affect growth in GHG emissions as discussed in Section 5.4 and Section 8.6.4, they alone would neither cause nor prevent climate change. Instead, they would result in marginal increases in the already anticipated increases of global CO_2 concentrations and associated impacts, including changes in temperature, precipitation, sea level, and marginal decreases in ocean pH that are otherwise projected to occur under the No Action Alternative. NHTSA's assumption is that increases in climate effects relating to temperature, precipitation, sea level, and ocean pH would increase impacts on affected resources described in this section. However, the climate change impacts of the Proposed Action and alternatives would be too small to address quantitatively in terms of impacts on the specific resources.[17] Consequently, the discussion of resource impacts in this section does not distinguish between the alternatives; rather, it provides a qualitative review of projected impacts (where the potential incremental increases in GHG emissions would result in incremental increases in these impacts). This section also briefly describes ongoing efforts to adapt to climate change to increase the resilience of human and natural systems to the adverse risks of such change.

The health, societal, and environmental impacts are discussed in two parts: Section 8.6.5.2, *Sectoral Impacts of Climate Change*, discusses the sector-specific impacts of climate change, while Section 8.6.5.3, *Regional Impacts of Climate Change*, discusses the region-specific impacts of climate change.

8.6.5.2 Sectoral Impacts of Climate Change

This section discusses how climate change resulting from global GHG emissions (including the U.S. light-duty transportation sector under the Proposed Action and alternatives) could affect certain key natural and human resources: freshwater resources; terrestrial and freshwater ecosystems; ocean systems, coasts, and low-lying areas; food, fiber, and forest products; urban areas; rural areas; human health; human security; and stratospheric ozone. In addition, this section discusses compound events, tipping points, and abrupt climate change.

NHTSA's analysis draws largely from recent studies and reports, including the IPCC *Fifth Assessment Report* (IPCC 2013a, 2013b, 2014a, 2014c), the IPCC *Special Study: Global Warming of 1.5° C* (IPCC 2018), the IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate* (IPCC 2019a), the IPCC

[17] Additionally, it is inappropriate to identify increases in GHG emissions associated with a single source or group of sources as the single cause of any particular climate-related impact or event.

Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems (IPCC 2019b), and the Global Climate Research Program (GCRP) *National Climate Assessment* (NCA) *Reports* (GCRP 2014, 2017, 2018). The IPCC and GCRP reports, in particular, provide a comprehensive overview of the state of scientific, technical, and socioeconomic knowledge on climate change, its causes, and its potential impacts. To reflect the likelihood of climate change impacts accurately for each sector, NHTSA references and uses the IPCC uncertainty guidelines (Section 5.1.1, *Uncertainty within the IPCC Framework*). This approach provides a consistent method to define confidence levels and percent probability of a projected outcome or impact. This is primarily applied for key IPCC and GCRP findings where IPCC or GCRP has defined the associated uncertainty with the finding (other sources generally do not provide enough information or expert consensus to elicit uncertainty rankings).

Recent reports from GCRP and such agencies as the National Research Council (NRC) are also referenced in this chapter. NHTSA relies on major international or national scientific assessment reports because these reports have assessed numerous individual studies to draw general conclusions about the potential impacts of climate change. This material has been well vetted, both by the climate change research community and by the U.S. government. In addition, NHTSA has supplemented the findings from these reports with recent peer-reviewed information, as appropriate.

Freshwater Resources

This section provides an overview of the recent findings regarding observed and projected impacts of climate change on freshwater resources in the United States and globally. More than 70 percent of the surface of the Earth is covered by water, but only 2.5 percent is fresh water. Respectively, freshwater contributions include permanent snow cover in the Antarctic, the Arctic, and mountainous regions (68.7 percent); groundwater (29.9 percent); and fresh water in lakes, reservoirs, and river systems (0.26 percent) (UNESCO 2006).

Potential risks to freshwater resources are expected to increase with increasing GHG emissions; for example, higher emissions are projected to result in less renewable water at the same time as continued population growth (IPCC 2014a). Although some positive impacts are anticipated, including reductions in water stress and increases in water quality in some areas because of increased runoff, the negative impacts are expected to outweigh positive impacts (IPCC 2014a; GCRP 2014, 2018).

Observed and Projected Climate Impacts

In recent decades, annual average precipitation increases have been observed across the Midwest, Great Plains, Northeast, and Alaska, while decreases have been observed in Hawaii, the Southeast and the Southwest (GCRP 2017, Walsh et al. 2014, Huang et al. 2017). Nationally, there has been an average increase of 4 percent in annual precipitation from 1901 to 2016 (GCRP 2017). According to GCRP, globally, for mid-latitude land areas of the Northern Hemisphere, annual average precipitation has *likely* increased since 1901 (GCRP 2017). For most other latitudinal zones, long-term trends in average precipitation are uncertain due to data quality, data completeness, or disagreement among available estimates (IPCC 2014c).

Detected trends in streamflow and runoff are generally consistent with observed regional changes in precipitation and temperature (IPCC 2014a). Globally, in regions with seasonal snow storage, warming has led to earlier occurrence of the maximum streamflows from snowmelt during the spring and increased winter streamflows because more winter precipitation falls as rain instead of snow (IPCC

2014a citing Clow 2010, Korhonen and Kuusisto 2010, Tan et al. 2011). These reduced snow-to-rain ratios are leading to significant differences between the timing of water supply and demand (*medium confidence)*. Changes in the timing of flows and temperatures of freshwater bodies *likely* impact local wildlife populations through phenological and distribution/range shifts (*high confidence*) (GCRP 2018). Average global precipitation is projected to increase over the next century; generally, wet places are expected to get wetter and dry places are expected to get drier (IPCC 2014c).

The number and intensity of very heavy precipitation events have been increasing significantly across most of the United States (U.S. Bureau of Reclamation 2016a). According to the NCA report, river floods have been increasing in parts of the central United States (GCRP 2017). However, GCRP (2017) cites IPCC AR5 (2013a) in concluding that there are no detectable changes in observed flooding magnitude, duration, or frequency in the United States. There is limited evidence that anthropogenic climate change has affected the frequency and magnitude of floods at a global scale (Kundzewicz et al. 2013).

The frequency and magnitude of the heaviest precipitation events is projected to increase everywhere in the United States (GCRP 2017 citing Janssen et al. 2014, U.S. Bureau of Reclamation 2016a, GCRP 2014 citing Kharin et al. 2013). Floods that are closely tied to heavy precipitation events, such as flash floods and urban floods, as well as coastal floods related to sea-level rise and the resulting increase in storm surge height and inland impacts, are expected to increase (GCRP 2014). Across a range of emissions scenarios and models, flooding could intensify in many U.S. regions by the 2050s, even in areas where total precipitation is projected to decline (U.S. Bureau of Reclamation 2016a, 2016b). There is *medium confidence* that global warming of 1.5°C would lead to a lesser expansion of the area with significant increases in runoff than under a 2°C increase (IPCC 2018).

The risk faced from heavy precipitation and flooding events is compounded by aging water infrastructure such as dams and levees across the United States. The scope of the nation's exposure to this risk has not yet been fully identified; however, the estimated reconstruction and maintenance costs for the totality of American water infrastructure is estimated in the trillions of dollars (GCRP 2018a). It can be said with *high confidence* that extreme precipitation events are projected to increase in a warming climate, and that our deteriorating water infrastructure compounds the risk climate change poses to our society (*high confidence*).

In the United States, there is mixed information on the historical connection between climate change and drought. GRCP found that there is little evidence of a human influence on past precipitation shortages (i.e., meteorological or hydrological droughts); however, there is *high confidence* of a human influence on surface soil moisture deficits due to higher temperatures and the resultant increase in evapotranspiration (i.e., agricultural droughts) (GCRP 2017). This increased evapotranspiration has also increased the need for human use of water in many areas. Over the past three decades, efficiency gains in irrigation methods have generally kept pace with this increased usage; however, without further improvements in this area, future human demand could outpace supply in many regions (GCRP 2018a). In fact, due to limitations on surface water storage and trading of water across basins and usages, certain U.S. aquifers have experienced significant depletion (GCRP 2018 citing Russo et al. 2017). Globally, meteorological and agricultural droughts have become more frequent since 1950 in some regions, including southern Europe and western Africa (IPCC 2014a citing Seneviratne et al. 2012). Drought hazards are projected to be less severe at 1.5°C of warming compared to 2°C (IPCC 2018 citing Smirnov et al. 2016, Sun et al. 2017, Arnell et al. 2018, and Liu et al. 2018; IPCC 2019b).

Dry spells are also projected to increase in length in most regions, especially in the southern and northwestern portions of the contiguous United States (EPA 2015b). Projected changes in total average annual precipitation are generally small in many areas, but both wet and dry extremes (heavy precipitation events and length of dry spells) are projected to increase substantially almost everywhere. Long-term (multi-seasonal) drought conditions are also projected to increase in parts of the Southwest (GCRP 2017). Furthermore, trends of earlier spring melt and reduced snow water equivalent are expected to continue, and analyses using higher emissions scenarios project with *high confidence* that the western United States will see chronic, long-duration hydrological droughts (GCRP 2017).

Rising temperatures across the United States have reduced total snowfall, lake ice, seasonal snow cover, sea ice, glaciers, and permafrost over the last few decades (GCRP 2017, EPA 2016d citing Mote and Sharp 2016). Both globally and in the United States, attribution of observed changes in groundwater level, storage, or discharge to climatic changes is difficult due to additional influences of land use changes and groundwater abstractions (IPCC 2014a citing Stoll et al. 2011), and the extent to which groundwater abstractions have already been affected by climate change is not known. Groundwater recharge impacts vary globally (IPCC 2014a citing Allen et al. 2010b, Crosbie et al. 2013b, Ng et al. 2010, Portmann et al. 2013). Both globally and in the United States, sea-level rise, storms and storm surges, and changes in surface water and groundwater use patterns are expected to compromise the sustainability of coastal freshwater aquifers and wetlands (U.S. Bureau of Reclamation 2016b, GCRP 2017). These effects are of particular concern in Hawaii and U.S. territories in the Caribbean and Pacific, threatening previously dependable and safe water supplies. The freshwater supplies in these same areas also face increased potential for contamination from increasingly frequent extreme weather events that damage freshwater infrastructure (GCRP 2018).

Globally, most observed changes of water quality attributed to climate change are known from isolated, short-term studies, mostly of rivers or lakes in high-income countries. The most frequently reported change is more intense eutrophication (i.e., an increase in phosphorus and nitrogen in freshwater resources) and algal blooms (i.e., excessive growth of algae) at higher temperatures, or shorter hydraulic retention times and higher nutrient loads resulting from increased storm runoff. Changes in the amount of water flow in surface water bodies due to climate change presents chronic problems, such as increased cost of water treatment and greater risk to public health due to pollutant concentrations (GCRP 2018). Positive reported impacts include reductions in the risk of eutrophication when nutrients were flushed from lakes and estuaries by more frequent storms and hurricanes (IPCC 2014a citing Paerl and Huisman 2008). For rivers, all reported impacts on water quality are negative, and surface water quality as a whole is declining as water temperature increases (*high confidence*) (GCRP 2018). Studies of impacts on groundwater quality are limited and mostly report elevated concentrations of fecal coliforms during the rainy season or after extreme rain events (IPCC 2014a citing Auld et al. 2004, Curriero et al. 2001, Jean et al. 2006, Seidu et al. 2013, Tumwine et al. 2002, 2003).

Changes in sediment transport are expected to vary regionally and by land-use type, with potentially large increases in some areas (GCRP 2014 citing Nearing et al. 2005), resulting in alterations to reservoir storage and river channels, affecting flooding, navigation, water supply, and dredging.

Adaptation

Given the uncertainty associated with climate change, adaptation planning often involves anticipatory scenario-based planning and the identification of flexible, low-regrets strategies (e.g., water conservation and demand-side management) to maximize resilience. In the United States and globally, current and projected impacts of climate change on water resources have sparked several responses by water resource managers. In 2011, federal agencies, which manage most of the freshwater resources in the United States, worked with stakeholders to develop a National Action Plan for managing freshwater resources in a changing climate to help ensure adequate freshwater supplies, while also protecting water quality, human health, property, and aquatic ecosystems (ICCATF 2011). Water utilities are determining ways to adjust planning, operational, and capital infrastructure strategies (EPA 2015c, Abt Associates 2016). Water conservation and demand management are also being promoted as important nonstructural, low-regrets approaches for managing water supply.

However, the Fourth National Climate Assessment states that management of surface water and groundwater sources across federal agencies has been hampered by a lack of coordination, creating inefficiencies in the response to climate change. Climate change mitigation policies, if not designed with careful attention to water resources, could increase the magnitude, spatial coverage, and frequency of water deficits given potential increased demand for irrigation water for bioenergy crops (Hejazia et al. 2015).

Terrestrial and Freshwater Ecosystems

This section provides an overview of the recent findings regarding observed and projected impacts of climate change on the terrestrial and freshwater ecosystems in the United States and globally. Ecosystems include all living organisms and their environs that interact as part of a system (GCRP 2014 citing Chapin et al. 2011). These systems are often delicately balanced and sensitive to internal and external pressures due to both human and nonhuman influences. Ecosystems are of concern to society because they provide beneficial ecosystem services such as jobs (e.g., from fisheries and forestry), fertile soils, clean air and water, recreation, and aesthetic value (GCRP 2014 citing Millennium Ecosystem Assessment 2005). Terrestrial and freshwater ecosystems in the United States and around the world are experiencing rapid and observable changes. The ecosystems addressed in this section include terrestrial ecosystems, such as forests, grasslands, shrublands, savanna, and tundra; aquatic ecosystems, such as rivers, lakes, and ponds; and freshwater wetlands, such as marshes, swamps, and bogs.

Observed and Projected Climate Impacts

The impacts of climate change on terrestrial and freshwater ecosystems have been observed at a variety of scales, including individuals (e.g., changes in genetics and physical characteristics), populations (e.g., changes in timing of life cycle events), and species (e.g., changes in geographic range) (GCRP 2018a citing Scheffers et al. 2016). Several reviews of climate change impacts on ecosystem services indicate that 59 to 82 percent of ecosystem services have experienced impacts from climate change (Runting et al. 2016, Scheffers et al. 2016).

Recent global satellite and ground-based data have identified phenology[18] shifts, including earlier spring events such as breeding, budding, flowering, and migration, which have been observed in hundreds of plant and animal species (IPCC 2014a citing Menzel et al. 2006, Cleland et al. 2007, Parmesan 2007, Primack et al. 2009, Cook et al. 2012a, Peñuelas et al. 2013). In particular, migratory species that rely on one primary food source are particularly vulnerable to climate change due to phenological mismatch (GCRP 2018a citing Both et al. 2010, Mayor et al. 2017, Ohlberger et al. 2014). In the United States from 1981 to 2010, leaf and bloom events shifted to earlier in the year in northern and western regions, but later in southern regions (EPA 2016e citing Schwartz et al. 2013). Phenological mismatches that result in unfavorable breeding conditions could cause significant negative impacts on species' breeding processes (GCRP 2014 citing Lawler et al. 2010, Todd et al. 2011; Little et al. 2017 citing McNab 2010, Potti 2008; Pecl et. al 2017 citing CAFF 2013, Mustonen 2015). In some ecosystems, higher trophic levels may be

[18] Phenology refers to the relative timing of species' life-cycle events.

more sensitive to climate change than lower trophic levels, which can affect the energy demands and mortality rates of prey, affect overall ecosystem functioning, and alter energy and nutrient flow (GCRP 2018a citing Laws and Joern 2013, McCluney and Sabo 2016, Verdeny-Vilalta and Moya-Laraño 2014, Miller et al. 2014, Zander et al. 2017).

Species respond to stressors such as climate change by phenotypic[19] or genotypic[20] modifications, migrations, or extinction (IPCC 2014a citing Dawson et al. 2011, Bellard et al. 2012, Peñuelas et al. 2013). Changes in morphology[21] and reproductive rates have been attributed to climate change. For example, the egg sizes of some bird species are changing with increasing regional temperatures (Potti 2008). At least one study indicates that birds in North America are experiencing decreased body size due to changes in climate (Van Buskirk et al. 2010).

Over the past several decades, a pole-ward (in latitude) and upward (in elevation) extension of various species' ranges has been observed that may be attributable to increases in temperature (IPCC 2014a). Climate change has led to range contractions in almost half of studied terrestrial animals and plants in North America (GCRP 2018a citing Wiens 2016). In both terrestrial and freshwater ecosystems, plants and animals are moving up in elevation—at approximately 36 feet per decade—and in latitude—at approximately 10.5 miles per decade (GCRP 2014 citing Chen et al. 2011). Over the 21st century, species range shifts, as well as extirpations, may result in significant changes in ecosystem plant and species mixes, creating entirely new ecosystems (GCRP 2014 citing Staudt et al. 2013, Sabo et al. 2010, Cheung et al. 2009, Lawler et al. 2010, Stralberg et al. 2009). A recent study suggests that species redistribution is linked to reduced terrestrial productivity, impacts on marine community assembly, and threats to the health of freshwater systems from toxic algal blooms (Pecl et al. 2017).

IPCC concluded with *high confidence* that climate change will exacerbate the extinction risk for terrestrial and freshwater species over the 21st century (IPCC 2014a). A recent study suggests that local extinctions related to climate change are already widespread, with 47 percent of 976 species reviewed having experienced climate-related local extinctions (Wiens 2016). However, there is low agreement on the proportion of current species that are at risk from climate-related extinctions (ranging from 1 to 50 percent) (IPCC 2014a). For example, regional warming puts some bird populations at risk when increased predatory populations or declines in available habitat (resulting in fewer appropriate nesting and egg-laying spots) leads to increased vulnerability of their eggs to predators (Wormworth and Mallon 2010). Additionally, an increase in phosphorus and nitrogen in freshwater resources (eutrophication) from increased agricultural runoff is probable in the Northeast, California, and Mississippi Basin, especially in areas that experience heavier or more frequent precipitation events (GCRP 2014 citing Howarth et al. 2012, Howarth et al. 2006, Sobota et al. 2009, Justić et al. 2005, McIsaac et al. 2002). The effects of eutrophication include excessive growth of algae (algal blooms), which reduce dissolved oxygen in the water, causing some plants, fish, and invertebrates to die.

Climate change may result in more uniform population structures, leading to increased competition and potentially resulting in extinctions (GCRPa 2018 citing Ohlberger et al. 2014, Lancaster et al. 2017). For example, extreme weather events can benefit invasive species by decreasing native communities'

[19] Referring to an organism's observable traits, such as color or size.

[20] Referring to an organism's genetic makeup.

[21] Referring to an organism's structural or anatomical features (e.g., egg size, wing shape, or even of the organism as a whole).

resistance and by occasionally putting native species at a competitive disadvantage (GCRP 2018a citing Diez et al. 2012, Kats et al. 2013, Tinsley et al. 2015, Wolf et al. 2016).

Diverse observations suggest that global terrestrial primary production increased over the latter 20th and early 21st centuries due to a combination of the fertilizing effect of increasing atmospheric CO_2, nutrient additions from human activities, longer growing seasons, and forest regrowth (GCRP 2018a citing Campbell et al. 2017, Graven et al. 2013, Wenzel et al. 2016, Zhu et al. 2016, Domke et al. 2018). Conversely, in areas experiencing extended drought (such as the western United States in 2014), water stress results in decreased tree growth (IPCC 2014a). A more intense hydrological cycle, including more frequent droughts, may reduce photosynthesis and therefore reduce ecosystem productivity and carbon storage (GCRP 2017). Alternatively, as plants gain more biomass, their net storage of carbon might be limited by nutrient availability in soils (Finzi et al. 2011). Within a few decades, it is possible that changes in temperature and precipitation patterns will exceed nitrogen and CO_2 as key drivers of ecosystem productivity (IPCC 2014a).

Elevated CO_2 concentrations have physiological impacts on plants, which can result in changes in both plant water utilization and local climate. A process referred to as CO_2-physiological forcing (Cao et al. 2010) occurs when increased CO_2 levels cause plant stomata (pores in plant leaves, which allow for gas exchange of CO_2 and water vapor) to open less widely, resulting in decreased plant transpiration (Cao et al. 2010). Reduced stomata opening increases water use efficiency in some plants, which can increase soil moisture content, thus mitigating drought conditions (McGrath and Lobel 2013 citing Ainsworth and Rogers 2007, Leakey 2009, Hunsaker et al. 2000, Conley et al. 2001, Leakey et al. 2006, Leakey et al. 2004, and Bernacchi et al. 2007). Reduced plant transpiration can also cause a decrease in evapotranspiration, which may trigger adjustments in water vapor, clouds, and surface radiative fluxes. These adjustments could ultimately drive macroclimatic changes in temperature and the water cycle (Cao et al. 2010). However, an observational study indicates minimal change in transpiration from increased CO_2 due to competing forces (Tor-ngern et al. 2014). Elevated CO_2 concentrations may also affect soil microbial growth rates and their impact on terrestrial carbon pools; however, these effects are complex and not well understood (Wieder et al. 2014, Bradford et al. 2016).

Ecological tipping points[22] begin with initial changes in a biological system (for example, the introduction of a new predatory animal species to the system due to changes in climate that are favorable to the newly introduced species), which are then amplified by positive feedback loops and can lead to cascading effects throughout the system. The point at which the system can no longer retain stability is a threshold known as a tipping point. Changes in such situations are often long- lasting and hard to roll back; managing these conditions is often very difficult (IPCC 2014a citing Leadley et al. 2010). Leadley et al. (2010) evaluated the potential tipping point mechanisms and their impacts on biodiversity and ecosystem services for several ecosystems. Examples include warming tundra that will reduce albedo, providing a warming feedback that will result in further thawing of tundra; and the large-scale changes in Amazonian rainforests to agricultural lands, resulting in decreased local and regional rains, promoting further decline of trees.

Forest ecosystems and services are at risk of greater fire disturbance when they are exposed to increased warming and drying, as well as declines in productivity and increases in insect disturbances (such as pine beetles). Boreal fire regimes have become more intense in terms of areas burned, length

[22] An ecological tipping point is described by IPCC (2014a), in reference to the potential for Amazonian ecosystem shifts, as “a large-scale, climate-driven, self-reinforcing transition” of one ecosystem into another type.

of fire season, and hotter, more energetic fires (IPCC 2014a citing Girardin and Mudelsee 2008, Macias and Johnson 2008, Kasischke et al. 2010, Turetsky et al. 2011, Mann et al. 2012, Girardin et al. 2013a). Cascading effects in forests are possible when fire-related changes in forest composition result in reduced capacity as a carbon sink and reduced albedo, both of which factor into further warming, putting forests at even greater risk of fire and dieback (IPCC 2014a citing Bond-Lamberty et al. 2007, Goetz et al. 2007, Welp et al. 2007, Euskirchen et al. 2009, Randerson et al. 2006, Jin et al. 2012, O'Halloran et al. 2012).

Limiting warming to 2.7°F (1.5°C) compared to 3.6°F (2°C) may benefit terrestrial and wetland ecosystems through avoidance or reduction of changes, such as biome transformation, species range losses, and increased extinction risks (all *high confidence*) (IPCC 2018 citing Hoegh-Guldberg et al. 2018).

Adaptation

In the context of natural resource management, adaptation is about managing changes (GCRP 2014 citing Staudinger et al. 2012, Link et al. 2010, West et al. 2009). The ability or inability of ecosystems to adapt to change is referred to as adaptive capacity. There could be notable regional differences in the adaptive capacity of ecosystems, and adaptive capacity is moderated by anthropogenic influences and capabilities. The ultimate impact of climate change on ecosystems depends on the speed and extent to which these systems can adapt to a changing climate. Rapid rather than gradual climate change may put populations at risk of extinction before beneficial genes are able to enhance the fitness of the population and its ability to adapt (Staudinger et al. 2013 citing Hoffmann and Sgro 2011).

Some adaptation strategies include habitat manipulation, conserving populations with more genetic diversity or behaviors, relocation (or assisted migration), and offsite conservation (such as seed banking and captive breeding) (GCRP 2014 citing Weeks et al. 2011, Peterson et al. 2011, Cross et al. 2013, Schwartz et al. 2012). EPA (2016b) stresses the enhancement of natural buffers to protect and help ecosystems increase adaptive capacity. Anthropogenic stressors can compound climate change impacts, so reducing these effects, such as nutrient pollution or invasive species introduction, can bolster resilience (NPS 2016). The 2018 NCA report indicates the effectiveness of existing adaptation strategies and approaches may be significantly reduced in the face of a changing climate (GCRP 2018a).

Ocean Systems, Coasts, and Low-Lying Areas

This section provides an overview of recent findings regarding observed and projected impacts of climate change on ocean systems, coasts, and low-lying areas in the United States and globally. Ocean systems cover approximately 71 percent of the Earth's surface and include many habitats that are vital for coastal economies. Coastal systems and low-lying areas include all areas near the mean sea level. Coastal systems consist of both natural systems (i.e., rocky coasts, beaches, barriers, sand dunes, estuaries, lagoons, deltas, river mouths, wetlands, and coral reefs) and human systems (i.e., the built environment, institutions, and human activities) (IPCC 2014a).

In general, global ocean surface temperatures have risen at an average rate of 1.3°F ± 0.1°F (0.7°C ± 0.08°C) per century and have risen at a higher rate from 2000 to 2016 than from 1950 to 2016 (GCRP 2018a citing Jewett and Romanou 2017; Blunden and Arndt 2017). IPCC concludes that ocean temperatures are *very likely* to increase in the future, with impacts on climate, ocean circulation, chemistry, and ecosystems (IPCC 2013b). From 1971 to 2010, global oceans have absorbed 93 percent of all extra heat stored in earth's systems (UN 2016, Cheng et al. 2019). Ocean systems absorb approximately 25 percent of anthropogenic CO_2 emissions, leading to changes in ocean pH, which affects the formation of some marine species that are crucial to ocean health (GCRP 2014, UN 2016). The combination of warming and acidification across water bodies has adverse impacts on key habitats such as coral reefs and results in changes in distribution, abundance, and productivity of many marine species.

Observed and Projected Climate Impacts

Approximately 600 million people globally live in the Low Elevation Coastal Zone (IPCC 2014a citing McGranahan et al. 2007), with approximately 270 million people exposed to the 1-in-100-year extreme sea level (Jongman et al. 2012). Globally, there has been a net migration to coastal areas, largely in flood- and cyclone-prone regions, increasing the number of individuals at risk (IPCC 2014a citing de Sherbinin et al. 2011). Without adaptation, hundreds of millions of people may be displaced due to episodic localized flooding associated with storm surge and coastal flooding and land loss from sea-level rise by 2100, with the majority from eastern, southeastern, and southern Asia (Jongman et al. 2012, GCRP 2018a).

Even under the RCP2.6 low emissions scenario, the frequency, depth, and extent of high tide and more-severe and damaging coastal flooding in the United States are projected to increase rapidly over the coming decades (GCRP 2018a). In the United States, 133.2 million people live in coastal zone counties (GCRP 2018a citing Kildow et al. 2016), and analysis indicates that 4.2 million Americans could be at risk under a scenario of 3 feet of sea-level rise, and 13.1 million people under 6 feet of sea-level rise, which could drive mass migration and societal disruption (Hauer 2017, Hauer et al. 2016).[23] New high-resolution digital elevation models improve estimates of potential future population exposure to sea-level rise. For example, assuming sea-level rise projections under RCP 8.5, these new models reveal that up to 630 million people live on land that could be exposed to annual coastal flood levels in 2100 (Kulp and Strauss 2019). Such increases in sea-level rise and annual flooding present dramatic risks to coastal communities. Those at risk include a substantial number of individuals in a high social vulnerability category, with less economic or social mobility and who are less likely to be insured (GCRP 2014).

Coastal inundation and flooding is the product of both long-term sea-level rise and dynamic short-term processes such as storm surge, erosion, and ocean tides (GCRP 2018a, Barnard et al. 2019). Climate change is expected to exacerbate all of these coastal processes, potentially altering coastal life and disrupting coast-dependent economic activities and services such as coastal energy, water, and transportation infrastructure (GCRP 2014, IPCC 2014a citing Handmer et al. 2012, Horton et al. 2010, Hanson and Nicholls 2012, and Aerts et al. 2013). Increased sea surface temperature and ocean heat content are projected to facilitate additional tropical storm activity and increase the probability of high rainfall tropical cyclones (Trenberth et al. 2018, Emanuel 2017). In turn, extreme storms can erode or remove sand dunes and other land elevations, exposing them to inundation and further change (GCRP 2014). Rising water temperatures and other climate-driven changes (e.g., salinity, acidification, and altered river flows) will affect the survival, reproduction, and health of coastal plants and animals (GCRP 2014, UN 2016). Shifts in the distribution of species and ranges, changes in species interactions, and reduced biodiversity cause fundamental changes in ecosystems and can adversely affect economic activities such as fishing (GCRP 2014). For instance, major marine heat wave events along the Northeast Coast of the United States in 2012 and the entire West Coast in 2014 through 2016 caused ocean

[23] The NOAA Sea Level Rise visualization tool shows inundation footprints associated with different sea-level rise simulations along the continental U.S. coast (NOAA, Office for Coastal Management, DigitalCoast, Sea Level Rise Viewer, https://coast.noaa.gov/digitalcoast/tools/slr.html). This and other tools can be used to understand and assess risks from sea-level rise.

temperatures to increase greater than 2°C above the normal range, a level similar to average conditions expected later this century under future climate scenarios (GCRP 2017). These events caused changes in the coastal ecosystems, including the appearance of warm-water species, increased mortality of marine mammals, and an unprecedented harmful algal bloom, all of which contributed to economic stress for the fisheries in these regions.

Species with narrow physiological tolerance to change, low genetic diversity, specific resource requirements, or weak competitive abilities will be particularly vulnerable to climate change (GCRP 2014 citing Dawson et al. 2011, Feder 2010). For example, during the end-Permian mass extinction, a change in ocean pH of approximately 0.3, which is consistent with current projections for pH changes over the next 100 years, resulted in a loss of approximately 90 percent of known species (NRC 2013b). Under the RCP8.5 scenario, the Atlantic, Pacific, and Indian Oceans are projected to see a 15 to 30 percent decrease in total marine animal biomass by 2100. Meanwhile, polar oceans are projected to see a 20 to 80 percent decrease (Bryndum-Buchholz et al. 2019). Overall, projected shifts in fish and species distribution and decreases in their population due to climate change pose risks to income, food security and livelihoods of marine-based communities (IPCC 2019a).

Studies indicate that 75 percent of the world's coral reefs are threatened due to climate change and localized stressors (GCRP 2014 citing Burke et al. 2011, Dudgeon et al. 2010, Hoegh-Guldberg et al. 2007, Frieler et al. 2013, Hughes et al. 2010). There are already 25 coral species listed under the Endangered Species Act (NOAA 2019). Further, IPCC projects that when average global warming reaches 1.3°C above pre-industrial levels, tropical coral reefs are *virtually certain* to experience high risks of impacts, such as frequent mass mortalities, and at 2°C, most available evidence (*high agreement, robust evidence*) suggests that coral-dominated ecosystems will be nonexistent (Alvarez-Filip et al. 2009). The potential for coastal ecosystems to pass a tipping point threshold is of particular concern, as these changes can be irreversible (GCRP 2014 citing Hoegh-Guldberg et al. 2007, Hoegh-Guldberg and Bruno 2010).

Several studies have analyzed the impact of climate change on historical and future coral bleaching. According to an analysis of bleaching records at 100 globally distributed reef locations from 1980 to 2016, the time between recurrent severe coral bleaching events has decreased steadily to 6 years during this period, and coral bleaching is occurring more frequently in all El-Niño-Southern Oscillation phases. These trends prevent the full recovery of mature coral assemblages between bleaching events (Hughes et al. 2018). Based on the high emissions scenario (RCP8.5), by 2055, 90 percent of reef locations are projected to experience annual severe bleaching events, and by 2034, all reef locations are projected to experience 5 percent declines in calcification. In general, the projected year of onset for annual severe bleaching events varies based on latitude, with reefs at lower latitudes expected to experience these events earlier than those at higher latitudes (van Hooidonk et al. 2014, Sully et al. 2019).

NOAA concluded that there is *very high confidence* that global average sea level has risen by 0.16 to 0.21 meters since 1900, with a 0.07-meter rise occurring since 1993 (Sweet et al. 2017b). GCRP notes that it is *very likely* that global average sea level will rise by 0.09 to 0.18 meter by 2030, 0.15 to 0.38 meter by 2050, and 0.3 to 1.2 meters by 2100, relative to 2000 (Sweet et al. 2017b). NOAA extends the upper limits of these estimates to a rise of 0.16 to 0.63 meter by 2050 and a rise of 0.3 to 2.5 meters by 2100 (Sweet et al. 2017a). GCRP concluded it is *extremely likely* that temperature increases account for 59 percent of the rise in global sea level during the 20th century (GCRP 2017 citing Kopp et al. 2016). The change in sea level is attributed to thermal expansion of ocean water, thawing of permafrost, and mass loss from mountain glaciers, ice caps, and ice sheets. Sea-level rise was found to be non-uniform around the world, which might result from variations in thermal expansion; exchanges of water, ocean, and atmospheric circulation; and geologic processes (IPCC 2014a, UN 2016). Higher sea levels cause greater coastal erosion; changes in sediment transport and tidal flows; landward migration of barrier shorelines; fragmentation of islands; and saltwater intrusion into aquifers, croplands, and estuaries (GCRP 2014 citing Burkett and Davidson 2012, CCSP 2009, IPCC 2007a, Irish et al. 2010, Rotzoll and Fletcher 2013; Nicholls and Cazenave 2010). Higher sea levels also result in the loss of coastal wetland environments; it was estimated that the United States lost an average of about 80,160 acres of U.S. coastal wetland environments per year between 2004 and 2009 (GCRP 2018 citing Dahl and Stedman 2013). At this rate, the United States would lose an additional 16 percent of coastal wetlands by 2100. Sea-level rise will expand floodplain areas and place more individuals in high-hazard zones; coastal communities could face increased flooding and erosion. Coastal systems and low-lying areas are expected to experience more submergence, flooding, and erosion of beaches, sand dunes, and cliffs (IPCC 2014a).

Oceans have absorbed approximately 28 percent of the human-caused CO_2 over the last 250 years, resulting in a decrease in pH of 0.11 unit[24] since preindustrial times and an expected further decrease of from 0.3 to 0.4 unit by 2100 (Feely et al. 2009; GCRP 2014 citing NRC 2010, Sabine et al. 2004, Feely et al. 2009; Longo and Clark 2016 citing Guinotte and Fabry 2008; EPA 2016c). IPCC concluded there is *very high confidence* that coastal areas experience considerable temporal and spatial variability in seawater pH compared to the open ocean due to additional natural and human influences (IPCC 2014a). Increased CO_2 uptake in the oceans makes it more difficult for organisms to form and maintain calcium carbonate shells and skeletal structures; increases erosion and bleaching of coral reefs and their biodiversity; and reduces growth and survival of shellfish stocks globally (GCRP 2014 citing Tribollet et al. 2009, Wisshak et al. 2012, Doney et al. 2009b, Hönisch et al. 2012, Lemasson et al. 2017. For instance, the GCRP notes that under the high emissions scenario (RCP8.5), by 2100, nearly all coral reefs are projected to be surrounded by acidified seawater that will challenge coral growth (GCRP 2018 citing Ricke 2013). IPCC concluded there is *high confidence* that coastal acidification will continue into the 21st century but with large, uncertain regional variation (IPCC 2014a). Further, the GCRP notes that under the RCP8.5 emissions scenario, by 2050, 86 percent of ecosystems will experience combinations of temperature and pH that have never before been experienced by modern species (GCRP 2018 citing Henson et al. 2017).

Hypoxia in ocean environments is a condition under which the dissolved oxygen level in the water is low enough to be detrimental to resident aquatic species. Oxygen solubility decreases as temperatures increase, with greater sensitivity at lower temperatures. As a result, warming sea surface temperatures will decrease oxygen concentrations in the ocean, especially at high latitudes where predicted rates of warming are higher. In addition, warmer sea surface temperatures enhance stratification, which prevents oxygen-rich surface water from mixing with deeper water where hypoxia typically occurs. Stratification can also be a result of sea-level rise, which increases the overall volume of shallow coastal water that is susceptible to hypoxia (Altieri 2015). Global ocean oxygen content has decreased by more than 2 percent since 1960, with large variations in oxygen loss across ocean basins and depths (Schmidtko 2017). Global oxygen content in the upper ocean (0 to 1,000 meters) is also estimated to have changed at the rate of $-243 \pm 124\ 10^{12}$ mol oxygen per decade between 1958 and 2015 (Ito et al. 2017). Accordingly, oxygen-minimum zones have been growing and are projected to continue expanding to temperate and subpolar regions with future warming (IPCC 2014a). Models project that oxygen levels in the oceans will continue to decline through 2100 by 2.4 to 3.5 percent under the RCP4.5 and RCP8.5 emissions scenarios, respectively, with greater losses regionally and in deep sea areas (Jewett and Romanou 2017 citing Bopp et al. 2013). Decreased oxygen concentrations and hypoxia affect the physiology, behavior, and ecology of marine organisms. For instance, hypoxia has the potential to affect

[24] The pH scale is logarithmic; therefore, each whole unit decrease in pH is equivalent to a 10-fold increase in acidity.

the visual behavior of organisms as visual tissues have high oxygen demands (McCormick and Levin 2017). Hypoxia may also cause deterioration in the reproductive systems of both male and female fish, leading to a significant decrease in hatching success (Lai et al. 2019). The ability of marine organisms to survive in hypoxic conditions is further strained by warming ocean temperatures. Marine benthic organisms (i.e., organisms that live on or near the ocean floor) have been shown to have significantly shortened survival times when subjected to warmer hypoxic conditions (Vaquer-Sunyer and Duarte 2011).

Ocean salinity levels can be affected by freshwater additions, ocean evaporation, and the freezing or thawing of ice caps and glaciers. Marine organisms are adapted to specific levels of ocean salinity and often become stressed by changing salinity levels. Additionally, changing ocean salinity levels affect the density of water, which in turn affects factors such as the availability of local drinking water and, potentially, global ocean circulation patterns. Although the globally averaged salinity change is small, changes in regional basins have been significant. Salinity in ocean waters has decreased in some tropical and higher latitudes due to a higher precipitation-to-evaporation ratio and sea-ice melt (IPCC 2014a citing Durack et al. 2012). Evaporation-dominated subtropical regions are exhibiting definite salinity increases, while regions dominated by precipitation are undergoing increasing freshening in response to intensification of the hydrological cycle. These effects are amplified in regions that are experiencing increasing precipitation or evaporation. Findings through surface water analyses of the Atlantic Ocean show increased salinity, while the Pacific Ocean demonstrates decreased salinity, and the Indian Ocean has observed minimal changes (Durack and Wijffels 2010).

Net primary production refers to the net flux of carbon from the atmosphere into organic matter over a given period.[25] Ocean systems provide approximately half of global net primary production. Net primary production is influenced by physical and chemical gradients at the water surface, light, and nutrient availability. A changing climate alters the mixed layer depth, cloudiness, and sea-ice extent, thus altering net primary production. Open-ocean net primary production is projected to reduce globally, with the magnitude of the reduction varying depending on the projection scenario (IPCC 2014a). Impacts on primary productivity vary significantly across regions. While primary productivity in the tropics and temperate zones is projected to decrease, primary productivity in high-latitude regions, particularly the Arctic, showed positive trends from 2003 to 2016 in all but one of nine regions, with statistically significant trends occurring in five regions (NOAA 2016a).

Adaptation

The primary adaptation options for sea-level rise are retreat, accommodation, and protection (IPCC 2014a citing Nicholls 2011), which are all widely used around the world (IPCC 2014a citing Boateng 2010 and Linham and Nicholls 2010). Retreat allows the impacts of sea-level rise to occur unobstructed as inhabitants pull back from inundated coastlines. Accommodation is achieved by increasing the flexibility of infrastructure and adjusting the use of at-risk coastal zones (IPCC 2014a). Protection is the creation of barriers against sea intrusion with replenished beaches and seawalls. Ecosystem-based protection strategies, which include the protection and restoration of relevant coastal natural systems (IPCC 2014a citing Schmitt et al. 2013), oyster reefs (IPCC 2014a citing Beck et al. 2011), and salt marshes (IPCC 2014a citing Barbier et al. 2011) are increasingly attracting attention (IPCC 2014a citing Munroe et al. 2011). In addition, reducing nonclimate stresses (e.g., coastal pollution, overfishing, development) may increase

[25] Net primary production is estimated as the amount of carbon synthesized via photosynthesis minus the amount of carbon lost via cellular respiration.

the climate resilience of framework organisms (i.e., tropical corals, mangroves, and seagrass) (World Bank 2013, Ellison 2014, Anthony et al. 2015, Sierra-Correa and Cantera Kintz 2015, Kroon et al. 2016, O'Leary et al. 2017, Donner 2009).

Advances have been made in the United States in the past few years in terms of coastal adaptation, science, and practice, but most coastal managers are still building their capacities for adaptation (GCRP 2014 citing NRC 2010, Carrier et al. 2012, Moser 2009, and Poulter et al. 2009). Some examples of coastal adaptation include integrating natural landscape features with built infrastructure (green and gray infrastructure[26]) to reduce stormwater runoff and wave attack, constructing seawalls around wastewater treatment plants and pump stations, pumping effluent to higher elevations as sea levels rise, pumping freshwater into coastal aquifers to mitigate salt water infiltration, developing flood-proof infrastructure, relocation of coastal infrastructure away from the coast, and relocation of communities away from high-hazard areas (GCRP 2014). Some examples of ocean adaptation include reducing overfishing, establishing protected areas, and conserving habitat to increase resilience; culturing acid-resistant strains of shellfish; oyster reef and mangrove restoration; coral reef restoration and protection; and developing alternative livelihood options for marine food-producing sectors (GCRP 2014).

Food, Fiber, and Forest Products

Increases in atmospheric CO_2, combined with rising temperatures and altered precipitation patterns, have begun to affect both agricultural and forest systems (Walthall et al. 2013, GCRP 2014, IPCC 2014c, USDA 2015, USFS 2016, FAO 2015, GCRP 2015). These impacts are expected to become more severe and to affect food security (FAO 2015, GCRP 2015).

Observed and Projected Climate Impacts

Climate disruptions to agricultural production have increased over the past 40 years and are projected to further increase over the next 25 years. Crop and livestock production projections indicate that climate change effects through 2030 will be mixed (IPCC 2014a, Walthall et al. 2013); however, most predictions for climate change impacts on crop yields by 2050 are negative (Nelson et al. 2014, IPCC 2014a, Müller and Robertson 2014). Currently, yields for some crops are increasing; however, climate change could be diminishing the rate of these increases, inducing a 2.5 percent decrease in yield growth rates per decade (GCRP 2015 citing Porter et al. 2014). Generally, yields and food security are at greater risk in poor, low-latitude countries (FAO 2015, GCRP 2015).

Specific climate impacts on agriculture will vary based on the species, location, timing, and current productivity of agricultural systems (including crops, livestock, and fish) at local, national, and global scales (GCRP 2014, USDA 2015). Bench- and field-scale experiments have found that over a certain range of concentrations, greater CO_2 levels have a fertilizing impact on plant growth (e.g., Long et al. 2006, Schimel et al. 2000) with considerable variability among regions and species (McGrath and Lobel 2013). However, climate change is projected to cause multiple abiotic (nonliving) stressors (such as temperature, moisture, extreme weather events), and biotic (living) stressors (such as disease, pathogens, weeds and insects) on crop production (Thornton et al. 2014, IPCC 2014a, GCRP 2017, GCRP 2018a). Increased frequency and intensity of extreme weather events (including extreme heat, precipitation, and storm events) is expected to negatively influence crop, livestock, and forest

[26] Green infrastructure refers to sustainable pollution reducing practices that also provide other ecosystem services (e.g., permeable pavements, green roofs). Gray infrastructure refers to traditional practices for stormwater management and wastewater treatment, such as pipes and sewers.

productivity and increase the vulnerability of agriculture and forests to climate risks (Walthall et al. 2013, GCRP 2014, IPCC 2014a, USDA 2015, EPA 2016c, USFS 2016, GCRP 2018a, Vogel et al. 2019). Additionally, climate change is projected to affect a wide range of ecosystem processes, including maintenance of soil quality and regulation of water quality and quantity (GCRP 2014, USDA 2015, GCRP 2018a). Changes in these and other ecosystem services will exacerbate stresses on crops, livestock, and forests (Walthall et al. 2013, GCRP 2014, GCRP 2018a). Major staple crops (wheat, rice, maize, and soybean) could suffer reduced yields between 3 and 7.4 percent for each degree-Celsius increase in global mean temperature (Zhao et al. 2017). Livestock are vulnerable as climate change is affecting the nutritional quality of pastures and grazing lands; affecting the production, availability, and price of feed-grains; stressing animals; hurting overall animal wellbeing (i.e., animal health, growth, and reproduction and distribution of animal diseases and pests); and decreasing livestock productivity (e.g., meat, milk, and egg production) (IPCC 2014a; IPCC 2014a citing André et al. 2011, Renaudeau et al. 2011; GCRP 2015; GCRP 2014 citing Rötter and Van de Geijn 1999, Nardone et al. 2010, Walthall et al. 2013, and West 2003; GCRP 2018a citing Key et al. 2014, Amundson et al. 2006, Dash et al. 2016, Rojas-Downing et al. 2017, Giridhar and Samireddypalle 2015, Lee et al. 2017, Paul et al. 2007, and Zhorov 2013). Overall, climate change is predicted to negatively affect livestock on almost all continents (IPCC 2014a).

Studies have concluded that climate change is affecting aquatic ecosystems, including marine and freshwater fisheries (IPCC 2014a, Groffman et al. 2014). Climate change impacts on marine fisheries have primarily been linked to increasing temperatures (including both mean and extreme temperatures) but are also affected by increasing CO_2 concentrations and ocean acidification (IPCC 2014a, GCRP 2018a). Fisheries are affected by increases in ocean temperatures, resulting in many marine fish species migrating to deeper or colder water, additional stress to already-strained coral reefs, and an expansion in warm freshwater habitats and a shrinkage of cool- and cold freshwater habitats (IPCC 2014a, NOAA 2015a). The Food and Agriculture Organization of the United Nations estimates that by 2050, the average total marine maximum catch potential in the world's Exclusive Economic Zones could decline by 7 to 12 percent (relative to 2000) under a higher emissions scenario (RCP8.5); by 2100, this decrease could be as much as 16 to 25 percent (Bell and Bahri 2018 citing FAO 2018). However, these decreases would not be consistent around the globe. Another study found that fisheries productivity could experience a decline in maximum catch potential of 10 to 47 percent as compared to the 1950–1969 level under RCP8.5 in the contiguous United States and increase in potential of 10 percent in the Gulf of Alaska and 46 percent in the Bering Sea (GCRP 2018a citing Cheung et al. 2016).

Climate change threatens forests by increasing tree mortality and forest ecosystem vulnerability due to fire, insect infestations, drought, disease outbreaks, increasing temperatures, and extreme weather events (Joyce et al. 2014, IPCC 2014a, USFS 2016, GCRP 2018a, Aleixo et al. 2019, Williams et al. 2019). Currently, tree mortality is increasing globally due in part to high temperatures and drought (IPCC 2014a). IPCC concludes there is *medium confidence* that this increased mortality and forest dieback (high mortality rates at a regional scale) will continue in many regions around the globe through 2100 (IPCC 2014a). However, due to the lack of models and limited long-term studies, projections of global tree mortality are currently highly uncertain (IPCC 2014a citing McDowell et al. 2011). GCRP estimates that water-limited forests will be further constrained by a warmer climate, while energy-limited forests may experience an increase in growth due to climate change (GCRP 2018a).

Other climate change induced direct and indirect effects, such as changes in the distribution and abundance of insects and pathogens, fire, changes in precipitation patterns, invasive species, and extreme weather events (e.g., high winds, ice storms, hurricanes, and landslides) are also affecting forests (GCRP 2017, Thornton et al. 2014, IPCC 2014a, GCRP 2014, IPCC 2014a citing Allen et al. 2010a).

A dramatic increase in the area burned by wildfire and risk of wildfire is projected in the contiguous United States through 2100, especially in the West (EPA 2015b, Halofsky et al. 2017, Tett et al. 2018). Tree species are predicted to shift their geographic distributions to track future climate change (Zhu et al. 2014, USFS 2016).

IPCC concludes that while there is currently *high confidence* that forests are serving as a net carbon sink globally, it is unclear if this trend will continue (IPCC 2014a). GCRP expects carbon storage to generally decrease in the future due to increased temperatures, more frequent droughts, and increased disturbances (GCRP 2018a). In recent years, excess carbon sequestered by intact and newly growing forests appears to have stabilized (IPCC 2014a citing Canadell et al. 2007 and Pan et al. 2011). Warming, changes in precipitation, pest outbreaks, and current social trends in land use and forest management are projected to affect the rate of CO_2 uptake in the future (Joyce et al. 2014, IPCC 2014a citing Allen et al. 2010a), making it difficult to predict whether forests will continue to serve as net carbon sinks in the long term (IPCC 2014a). In addition, historic land uses have a legacy effect on patterns of carbon uptake in forests, further complicating the calculation of future CO_2 sequestration patterns (Thom et al. 2018).

Climate change impacts on food security and food systems are predicted to be widespread, complex, geographically and temporally variable, and greatly influenced by socioeconomic conditions (IPCC 2014a citing Vermeulen et al. 2012). An additional challenge for food security will be future population growth, with global population projected to reach 9.8 billion by 2050 (GCRP 2018a citing Hallström et al. 2015, Harwatt et al. 2017, U.N. Department of Economic and Social Affairs 2017). Food security comprises four key components: production; processing, packaging, and storage; transportation; and utilization and waste (GCRP 2014 citing FAO 2001), all of which are closely tied to poverty (IPCC 2014a). Projected rising temperatures, changing weather patterns, and increases in the frequency of extreme weather events will affect food security by potentially altering agricultural yields, post-harvest processing, food and crop storage, transportation, retailing, and food prices (GCRP 2014). Many of these impacts are expected to be negative, including decreasing production yields; harming pollinators; increasing costs and spoiling during processing, packaging, and storage; inhibiting water, rail, and road transportation; and increasing food safety risks (GCRP 2015, Giannini et al. 2017). The negative consequences of climate change—decreased crop yields, nutrition, and food security—are projected to be more severe under 2°C of warming than under 1.5°C of warming (*high confidence)* (IPCC 2018).

Currently, the vast majority of undernourished people live in developing countries (IPCC 2014a). Both due to the nature of the direct impacts and the means to implement adaptation strategies, climate change poses the greatest food security risks to poor and tropical region populations, and the least risk to wealthy, temperate, and high-latitude region populations (GCRP 2015, FAO 2015). As most countries import at least some of their domestic food consumed, climate change has the potential to affect not just food production but also the amount of food countries import and export. Import demand is expected to increase for developing nations lacking advanced technologies and practices and producing low agricultural yields (GCRP 2015).

Adaptation

Over the past 150 years, the agricultural and forestry sectors have demonstrated an impressive capacity to adapt to a diversity of growing conditions amid dynamic social and economic changes (Walthall et al. 2013, Joyce et al. 2014, FAO 2015, GCRP 2015). Recent changes in climate, however, threaten to outpace the current adaptation rate and create challenges for the agricultural sector and associated socioeconomic systems (GCRP 2014, IPCC 2014a). Economic literature indicates that in the short term, producers will continue current adaptation practices for weather changes and shocks (e.g., by changing timing of field operations, shifts in crops grown, changing tillage/irrigation practices) (GCRP 2014 citing Antle et al. 2004). In the long term, however, current adaptation technologies are not expected to buffer the impacts of climate change sufficiently (GCRP 2014, GCRP 2018a).

To minimize these impacts, a variety of resilience actions can be implemented, including management and policy, engineering, and insurance responses. Management practices associated with sustainable agriculture, such as diversifying crop rotations and crop varieties, integrating livestock with crop production systems, improving soil quality, and minimizing off-farm flows of nutrients and pesticides can increase resiliency to climate change (GCRP 2014 citing Easterling 2010, Lin 2011, Tomich et al. 2011, and Wall and Smit 2005, Li et al. 2019). Furthermore, the use of heat- and stress-tolerant and other adaptively advantageous varieties of crops can aid in yield increases in the face of climate change (Zhang and Zhao 2017, GCRP 2018a). Enhancing genetic resources via genetic modification and improved breeding systems also has great potential to enhance crop resilience (GCRP 2015 citing Jacobsen et al. 2013, Lin 2011).

For livestock, adaptive capacity is limited by high costs and competition. Possible adaptation measures include breeding livestock to genetically adapt to local conditions, improving the design of livestock housing, and implementing management strategies that cool livestock and reduce stress (GCRP 2018a). However, cooling strategies are not always economically feasible due to high infrastructure and energy demands (GCRP 2015). Furthermore, increased shade and moisture can heighten pathogen risk (Fox et al. 2015). Irrigation strategies to improve feed quality and quantity could also be limited by competition with other water users, especially in arid climates (GCRP 2015 citing Elliott et al. 2014). To enhance resilience against increased pathogen risk, adaptation strategies include no-regrets strategies, disease surveillance and response, disease forecast capacity, animal health service delivery, eradication of priority diseases, increased diversification and integration of livestock with agriculture, breeding resilient animals, and monitoring impacts of land-use change on disease (Grace et al. 2015). Fisheries have developed a number of adaptation practices as well. For example, NOAA's Climate Science Strategy (2015b) sets forth the objective of designing adaptive decision processes to enable fisheries to enhance fishery resilience.

Forest management responses to climate change will be influenced by the changing nature of private forestland ownership, globalization of forestry markets, emerging markets for bioenergy, and climate change policy (Walthall et al. 2013, Joyce et al. 2014). The emerging market for bioenergy—the use of plant-based material to produce energy—has the potential to aid in forest restoration (Joyce et al. 2014). At the same time, possible projected declines in a skilled forest sector workforce and timber product output (and lower prices for timber) could pose a challenge to climate change adaptation of forests (GCRP 2018a citing USDA Forest Service 2016). Flexible policies that are not encumbered with legally binding regulatory requirements can facilitate adaptive management where plants, animals, ecosystems, and people are responding to climate change (Joyce et al. 2014 citing Millar and Swanston 2012). Ultimately, maintaining a diversity of tree species could become increasingly important to maintain the adaptive capacity of forests (Duveneck et al. 2014). Carbon sequestration losses can be mitigated using sustainable land-management practices (GCRP 2015 citing Branca et al. 2013).

In terms of food security, global undernourishment dropped from 19 percent in 1990 through 1992 to 11 percent in 2014 (GCRP 2015). However, it is questionable whether this progress will continue given challenges posed by climate change (GCRP 2015). Developing and implementing new agricultural methods in low-yield regions, reducing waste in the food system, making food distribution systems more resilient to climate risks, protecting food quality and safety at higher temperatures, and policies to ensure food access for disadvantaged populations during extreme events are all adaptation strategies to mitigate the effects of climate change (GCRP 2014 citing Walthall et al. 2013, Ericksen et al. 2009, Misselhorn et al. 2012, Godfray et al. 2010, and FAO 2011; GCRP 2015). Ultimately, adaptation will become more difficult as physiological limits of plants and animal species are exceeded more frequently and the productivity of crop and livestock systems becomes more variable (GCRP 2014).

Urban Areas

This section defines urban areas and describes the existing conditions and their potential vulnerability to climate change impacts. Urban centers are now home to more than half of the global population, and this percentage continues to increase every year (IPCC 2014a citing UN DESA Population Division 2013, World Bank 2008). In the United States, approximately 85 percent of the population lives in metropolitan areas[27] (GCRP 2018a). In addition to large numbers of people, urban centers also contain a great concentration of the world's economic activity, infrastructure, and assets (IPCC 2014a citing UN DESA Population Division 2013, World Bank 2008, GCRP 2018a). However, definitions of urban centers and their boundaries vary greatly between countries and between various pieces of academic literature (IPCC 2014a).

Wealthy nations are predominantly urbanized, and low- and middle-income nations are rapidly urbanizing. The rate of urbanization is outstripping the rate of investment in basic infrastructure and services, which is creating urban communities with high vulnerability to climate change (IPCC 2014a citing Mitlin and Satterwaite 2013). Across urban communities, there are very large differences in the extent to which economies are dependent on climate-sensitive resources, but in general, a high proportion of people most at risk of extreme weather events are located in urban areas (IPCC 2014a citing IFRC 2010, UNISDR 2009, and UNISDR 2011).

Observed and Projected Climate Impacts

The risks of climate change to urban communities and their populations' health, livelihood, and belongings are increasing. Such risks include rising sea levels, storm surges, extreme temperatures, extreme precipitation events leading to inland and coastal flooding and landslides, drought leading to increased aridity and water scarcity, and various combinations of stressors exacerbating air pollution (IPCC 2014a). It cannot be assumed that climate change impacts will be the same or even similar in different cities (Silver et al. 2013). In addition, certain population groups may be more directly affected by climate change than other groups. For example, the very young and elderly are both more sensitive to heat stress, those with preexisting health issues could be more sensitive to a range of stressors, and low-income groups and women could be more sensitive due to a lack of resources and discrimination in access to support services (IPCC 2014a; Cutter et al. 2014; GCRP 2014 citing Bates and Swan 2007, NRC 2006, and Phillips et al. 2009).

Cities that are projected to experience rising temperatures are apt to experience temperatures even higher than projected due to the urban heat island effect (whereby the volume of paved land in urban areas absorbs and holds heat along with other causes) (GCRP 2018 citing Hibbard et al. 2017, IPCC 2014a, IPCC 2019b). This could lead to increased health impacts, air pollution, and energy demand, disproportionately affecting low-income, young, and elderly populations (IPCC 2014a citing Hajat et al. 2010, Blake et al. 2011, Basagaña 2019, Campbell-Lendrum and Corvalan 2007, and Lemonsu et al. 2013;

[27] Metropolitan areas include urbanized areas of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration (Office of Management and Budget 2009).

IPCC 2014b citing Akbari et al. 2016). Urbanization, through increased impermeable surfaces and microclimatic changes, can also increase flooding. Climatic trends, such as increased frequency of extreme precipitation and sea-level rise, will stress existing flood infrastructure (GCRP 2017).

Drought and reduced snowpack will have many effects in urban areas, including water shortages, electricity shortages (from decreased hydropower operation), water-related diseases (which could be transmitted through contaminated water), and food insecurity. Changes in precipitation due to climate change could create water demand conflicts between residential, commercial, agricultural, and infrastructure use (IPCC 2014a citing Roy et al. 2012 and Tidwell et al. 2012). Sea-level rise will result in "saline ingress, constraints in water availability and quality, and heightened uncertainty in long-term planning and investment in water and waste water systems" (IPCC 2014a citing Fane and Turner 2010, Major et al. 2011, and Muller 2007). Additionally, urban populations could be affected by "reductions in groundwater and aquifer quality…, subsidence, and increased salinity intrusion" (IPCC 2014a). Increased eutrophication from warming water temperatures will incur costs related to the upgrading of municipal drinking water treatment facilities and purchase of bottled water. Additionally, sea-level rise poses an additional risk to water treatment facilities (Baron et al. 2013).

In developed and developing countries, stormwater systems will be increasingly overwhelmed by extreme short-duration precipitation events if they are not upgraded (IPCC 2014a citing Howard et al. 2010, Mitlin and Satterthwaite 2013, and Wong and Brown 2009). If storm drains for transportation assets are blocked, then localized flooding can cause delays (GCRP 2014).

Climate change will have direct impacts on both the production and the demand side of the energy system by increasing risk of direct physical damage to generation as well as transmission and distribution systems, reducing the efficiency of water cooling for large thermoelectric electricity generating facilities, changing hydropower and wind power potential, and changing demands for heating and cooling in developed countries (GCRP 2014, IPCC 2014a citing Mideksa and Kallbekken 2010, DOE 2015a). Many power supply facilities such as power plants, refineries, pipelines, transmission lines, substations, and distribution networks are located in coastal environments and are thus subject to direct physical damage and permanent and temporary flooding from sea-level rise, higher storm surge and tidal action, increased coastal erosion, and increasingly frequent and intense storms and hurricanes (GCRP 2014, DOE 2015a citing CIG 2013, GCRP 2014). They may also be negatively impacted by the vulnerability of transportation systems that provide feedstocks such as coal (EIA 2017f, DOE 2015a citing DOE 2013c, Ingram et al. 2013).

Climate change impacts that decrease the reliability of or cause disruptions to the energy supply network could have far-reaching consequences on businesses, infrastructure, healthcare, emergency services, residents, water treatment systems, traffic management, and rail shipping (GCRP 2018a, IPCC 2014a citing Finland Safety Investigations Authority 2011, Halsnæs and Garg 2011, Hammer et al. 2011, and Jollands et al. 2007). Oil and gas availability for transportation in the United States would also be affected by increased energy demand in global markets as well as by climate change events. For example, DOE (2015a) concluded that 9 percent of U.S. refining capacity could be exposed to sea-level rise and storm surge in 2050 (assuming 23 inches of sea-level rise and a Category 3 storm), and strategic petroleum reserves may be exposed to flooding during lower-intensity storms.

The daily and seasonal operation of most transportation systems is already sensitive to fluctuations in precipitation, temperature, winds, visibility, and for coastal cities, rising sea levels (GCRP 2014 citing Ball et al. 2010, Markolf et al. 2019, Cambridge Systematics Inc. and Texas Transportation Institute 2005, and Schrank et al. 2011; IPCC 2014a citing Love et al. 2010). With climate change, the reliability and capacity of the transportation network could be diminished from an increased frequency of flooding and heat events and an increased intensity of tropical storms (GCRP 2014 citing NRC 2008; DOT 2014). Telecommunication systems are also sensitive to flooding of electrical support systems, wind damages to cellular phone towers, corrosion due to flooding and sea-level rise, and unstable foundations due to permafrost melt (IPCC 2014a citing Zimmerman and Farris 2010 and Larsen et al. 2008).

Housing in urban areas is one of the pieces of infrastructure most heavily affected by extreme weather events such as cyclones and floods (IPCC 2014a citing Jacobs and Williams 2011). Housing that is constructed out of informal building materials (usually occupied by low-income residents) and without strict building codes is particularly vulnerable to extreme events (IPCC 2014a citing UNISDR 2011). Increased weather variability, including warmer temperatures, changing precipitation patterns, and increased humidity, accelerates the deterioration of common housing building materials (IPCC 2014a citing Bonazza et al. 2009, Grossi et al. 2007, Smith et al. 2008, Stewart et al. 2011, and Thornbush and Viles 2007). Loss of housing due to extreme events and shifts in climate patterns is linked to displacement, loss of home-based businesses, and health and security issues (IPCC 2014a citing Haines et al. 2013).

Climate change will also affect urban public services such as healthcare and social care services, education, police, and emergency services (IPCC 2014a citing Barata et al. 2011). The links between city sectors can mean that climate stressors have cascading impacts across sectors; these impacts increase risk to urban dwellers' health and well-being and make urban areas more vulnerable to disruptions (GCRP 2018a, GCRP 2018a citing Torres and Maletjane 2015). Water shortages can lead to reliance on poorer quality water sources and can increase the likelihood of contracting waterborne illnesses. Changes in temperature extremes will also impact health through heat stress (IPCC 2014a) and changes in air quality (IPCC 2014a citing Athanassiadou et al. 2010); however, impacts of climate change on air quality in particular locations are highly uncertain (IPCC 2014a citing Jacob and Winner 2009 and Weaver et al. 2009).

Adaptation

Adapting urban centers will require substantial coordination between the private sector, multiple levels of government, and civil society (GCRP 2018a, GCRP 2018a citing Department of the Interior Strategic Sciences Group 2013, C40 Cities and Arup 2015, and Arup et al 2013), but early action by urban governments is key to successful adaptation since adaptation measures need to be integrated into local investments, policies, and regulatory frameworks (IPCC 2014a). Existing risk reduction plans, such as public health and natural hazard mitigation plans, provide strong foundations for the development of more comprehensive and forward-thinking documents that address increasing exposure and vulnerability (IPCC 2014a). Embedding adaptation into existing plans and decision-making processes (e.g., multi-hazard mitigation plans, long-term water plans, permitting review processes) helps to institutionalize adaptation (Aylett 2015, GCRP 2018a citing Bierbaum et al. 2013, Hughes 2015, Rosenzweig et al. 2015). Taking a long-term view toward planning is important so that future climate impacts do not undermine plans put in place now (GCRP 2018a).

Financing adaptation strategies could be one of the largest hurdles to overcome; however, urban adaptation can enhance the economic competitiveness of an area by reducing risks to businesses, households, and communities (IPCC 2014a). Additionally, there are emerging synergistic options for urban adaptation measures that also deliver GHG emissions reductions co-benefits (IPCC 2014a).

Rural Areas

This section defines rural areas and describes the existing conditions and potential vulnerability to climate change impacts. There is no clear definition of rural areas—frequently, rural areas are simply defined as areas that are not urban (IPCC 2014a citing Lerner and Eakin 2010). A consistent definition is difficult to reach because human settlements exist along a continuum from urban to rural with many varied land use forms in-between and varying development patterns between developed and developing countries. In general, IPCC and this EIS accept the definitions of urban and rural used by individual countries and individual academic authors in their work.

Rural areas account for almost half of the world's total population and an even greater percentage of people in developing countries (IPCC 2014a citing UN DESA Population Division 2013). The U.S. Census Bureau classifies more than 95 percent of the land area in the United States as rural but only 19 percent of the population calls these areas home (GCRP 2014 citing HRSA 2012, U.S. Census Bureau 2012a, 2012b, USDA 2012). In the United States, modern rural populations are generally more vulnerable to climate change impacts due to various socioeconomic factors (e.g., age, income, education) (GCRP 2014).

Rural areas are subject to unique vulnerabilities to climate change due to their dependence on natural resources, their reliance on weather-dependent activities, their relative lack of access to information, and the limited amount of investment in local services (GCRP 2018a, IPCC 2014a). These rural vulnerabilities also have the potential to affect urban areas significantly; for example, rural areas in the United States provide much of the rest of the country's food, energy, water, forests, and recreation (GCRP 2014 citing ERS 2012).

Observed and Projected Climate Impacts

Rural livelihoods are less diverse than their urban counterparts are and are frequently dependent on natural resources that have unknown future availability such as agriculture, fishing, and forestry (GCRP 2018a, IPCC 2014a, GCRP 2014). In addition, communities that rely on mining and extraction will be affected by changes in the water, energy, and transportation sectors (IPCC 2014a, GCRP 2014). Due to this lack of economic diversity, climate change will place disproportionate stresses on the stability of these rural communities (GCRP 2014). The impacts of climate change will be amplified by the impacts on surrounding sectors within rural communities' spheres of life, such as impacts on economic policy, globalization, environmental degradation, human health, trade, and food prices (IPCC 2014a citing Morton 2007, Anderson et al. 2010).

Events that have a negative impact on rural areas include tropical storms that can lead to sudden flooding and wind damage, droughts and temperature extremes that can increase water scarcity and thus kill livestock and affect agricultural yields (IPCC 2014a citing Handmer et al. 2012, Ericksen et al. 2012), inland flooding, and wildfires (Hales et al. 2014).

Rural areas frequently depend on groundwater extraction and irrigation for local agriculture (IPCC 2014a citing Lobell and Field 2011). Reduced surface water would increase the stress on groundwater and irrigation systems (GCRP 2014). Around the world, competition for water resources will increase with population growth and other uses such as energy production (IPCC 2014a, GCRP 2014). For example, high temperatures increase energy demand for air conditioning, which leads to increased water withdrawal for energy production. At the same time, the heat also dries out the soil, which increases irrigation demands (GCRP 2014).

For more information on climate impacts on livestock, fisheries, and agriculture, see the section entitled *Food, Fiber, and Forest Products*. Nonfood crops and high-value food crops such as cotton, rice, corn, wheat, wine grapes, beverage crops (coffee, tea, and cocoa), and other cash crops contribute to an important source of income to rural locations. While these crops tend to receive less study than staple food crops (IPCC 2014a), negative impacts of climate change on a variety of crop types have already been documented (GCRP 2014).

Impacts of climate change on rural infrastructure are similar to those in urban areas (see the section entitled *Urban Areas*) but frequently there is less redundancy in the system, so assets are more vulnerable to hydroclimatic events (GCRP 2018a, GCRP 2014, IPCC 2014a citing NRC 2008). Rural communities are becoming more connected to urban ones, but human migration from rural to urban areas is not necessarily any greater due to climate change than under regular conditions. This diverges from previous assumptions of increased migration (IPCC 2014a). Migration will increase following extreme events that lead to the desertion of local communities (e.g. extreme storms), but migration from slow environmental degradation (e.g., sea-level rise) is anticipated to be minimal. Generally, more migration is linked to additional stressors such as political instability and socioeconomic factors (IPCC 2014a citing van der Geest 2011). It is possible that factors such as increased temperatures and natural disasters will spur migration, but the underlying force may be the adverse consequences of climate change on agriculture (Bohra-Mishra et al. 2017).

There is a strong link between biodiversity, tourism, rural livelihoods, and rural landscapes in both developed and developing countries (IPCC 2014a citing Nyaupane and Poulde 2011, Scott et al. 2007, Hein et al. 2009, Wolfsegger et al. 2008, and Collins 2008). Tourism patterns could be affected by changes to the length and timing of seasons, temperature, precipitation, and severe weather events (GCRP 2014). Changes in the economic values of traditional recreation and tourism locations will affect rural communities because tourism makes up a significant portion of rural land use (IPCC 2014a citing Lal et al. 2011). Coastal tourism is vulnerable to cyclones and sea-level rise (IPCC 2014a citing Klint et al. 2012 and Payet and Agricole 2006) as well as beach erosion and saline intrusion (IPCC 2014a). Nature-based tourism may be affected by declining biodiversity and harsher conditions for trekking and exploring (IPCC 2014a citing Thuiller et al. 2006 and Nyaupane and Chhetri 2009). Winter sport tourism may be affected by declining snow packs and precipitation falling more frequently as rain rather than snow due to warmer temperatures (IPCC 2014a).

Adaptation

Rural adaptation will build on community responses to past climate variability; however, this could not be enough to allow communities to fully cope with climate impacts (IPCC 2014a). Temporary responses to food and water shortages or extreme events could even increase the long-term vulnerability of a community. For example, in Malawi, forest resources are used for coping with food shortages, but this deforestation enhances the community's vulnerability to flooding (IPCC 2014a citing Fisher et al. 2010). Successful adaptation should allow for the development of long-term strategies that not only respond to climate events but also minimize future vulnerabilities (IPCC 2014a citing Vincent et al. 2013).

Adaptation in rural communities also faces challenges posed by the lack of economic diversity, relatively limited infrastructure and resources, and decreased political influence (GCRP 2018a citing US House of Representatives 2017, Kuttner 2016, Williamson et al. 2012). Funding for adaptation in rural areas could be linked to other development initiatives that aim to reduce poverty or generally improve rural areas (IPCC 2014a citing Nielsen et al. 2012, Hassan 2010, and Eriksen and O'Brien 2007).

Human Health

This section provides an overview of the recent findings regarding observed and projected impacts of climate change on the human health sector in the United States and globally. This section describes the climate impacts related to extreme events, heat and cold events, air quality, aeroallergens, water- and food-borne diseases, vector-borne diseases, cancer, and indirect impacts on health. Effects of climate change on human health range from direct impacts from extreme temperatures and extreme weather events to changes in prevalence of diseases, and indirect impacts from changes to agricultural productivity, nutrition, conflict, and mental health. Across all potential impacts, disadvantaged groups such as children, elderly, sick, and low-income populations are especially vulnerable (Watts et al. 2019). Climate change is expected to exacerbate some existing health threats and create new challenges, and a greater number of people could be exposed (GCRP 2018a). At the same time, climate change could decrease the capacity of health systems to manage changes in health outcomes due to climate shifts.

Observed and Projected Climate Impacts

Health impacts associated with climate-related changes in exposure to extreme events (e.g., floods, droughts, heat waves, severe storms) include death, injury, illness, or exacerbation of underlying medical conditions. Climate change will increase exposure risk in some regions of the United States due to projected increases in frequency and intensity of drought, wildfires, and flooding related to extreme precipitation, rising temperatures, and hurricanes (EPA 2016j).

Many types of extreme events related to climate change cause disruption to infrastructure—including power, heating, ventilation and air conditioning systems, water, transportation, and communication systems—that are essential to maintaining access to health care and emergency response services that safeguard human health (EPA 2016j, GCRP 2016). The damage caused by extreme events can disrupt transportation and access to health services, which exacerbates health conditions of those chronically sick (GCRP 2016).

One direct way that climate change is projected to affect human health is through increasing exposure to extreme heat, which is the leading source of weather-related deaths in the United States (Nahlik et al. 2017, Sailor et al. 2019). Hospital admissions and emergency room visits tend to increase during hot days with heat-related illnesses, including cardiovascular and respiratory complications, renal failure, electrolyte imbalance, and kidney stones (GCRP 2018a). These hospitalizations come at a monetary cost to patients, who are more likely to be adults over 65 years, African-Americans, Asians/Pacific Islanders, and women (Schmeltz et al. 2016). Higher than usual temperatures can cause heat exhaustion and heat stroke, and exacerbate other cardiovascular and pulmonary conditions (Mora et al. 2017a, Tianqi et al. 2017 citing Borden and Cutter 2008, Bouchama et al. 2007, and Wilker et al. 2012).

Certain populations are more vulnerable to extreme heat events than others. In general, those with pre-existing conditions are more vulnerable to heat-related illness (Kuehn and McCormick 2017). In all parts of the world, the youngest, oldest, and poorest members of society are most vulnerable to health impacts from heat and cold events (EPA 2016j, GCRP 2016). Pregnant women and their fetuses are particularly vulnerable to the impacts of heat exposure because their thermoregulatory abilities are limited. Increased heat events could increase preterm birth, decrease birth weights, and increase the rate of stillbirths (Kuehn and McCormick 2017). Higher temperatures and humidity can create negative health outcomes for people engaging in physical activity, or for those who work outside (IPCC 2018). Worker safety and productivity during the hottest days and months will be a greater challenge under a changing climate (IPCC 2018). Certain geographic areas are more likely to experience damaging heat events. For example, the risk of heat waves will be higher in cities as a result of the urban heat island effect (IPCC 2018; GCRP 2018a). Additionally, increased mortality from extreme heat exposure will be more marked in regions that are currently warmer and poorer, particularly around the equator (Gasparrini et al. 2017, Mora et al. 2017a). With 1.5°C of warming, twice as many megacities will be exposed to heat stress, which would expose approximately 350 million additional people to dangerous heatwave conditions by 2050 (IPCC 2018). Globally, roughly 30 percent of the world's population is exposed to potentially deadly heat conditions. This is projected to increase to about 48 percent under a moderate emissions scenario (RCP4.5) and up to 74 percent under a high emissions scenario (RCP8.5) by 2100 (Mora et al. 2017).

The reduction in cold-related deaths has not been studied as thoroughly as heat-related deaths, although such events have become less frequent and intense, and they are expected to continue to decrease (GCRP 2016). Warming associated with climate change could contribute to a decline in cold-related deaths, but evidence suggests that the impacts from extreme heat events greatly outweigh any benefits from decreases in cold-related deaths (GCRP 2018a; EPA 2016j, 2015b; IPCC 2014a citing Ebi and Mills 2013, Kinney et al. 2012; Medina-Ramón and Schwartz 2007; GCRP 2014 citing Yu et al. 2011 and Li et al. 2013; Hajat et al. 2014; GCRP 2016 citing Mills et al. 2012, Deschênes and Greenstone 2011, Barreca 2012, and Honda et al. 2014).

Although CO_2 emissions do not directly affect air quality, increased temperatures and related climate changes due to emissions of CO_2 and other GHGs could increase the formation of ozone and PM2.5 and affect their dispersion and transport, affecting ozone and PM2.5 concentrations. Climate change could increase ground-level concentrations of ozone or particulate matter in some locations, thus degrading air quality and negatively affecting human health (Section 4.1.1.1, *Health Effects of Criteria Pollutants*), as well as being associated with developmental problems such as childhood attention deficit hyperactivity disorder (Perera 2017 citing Newman et al. 2013, Perera et al. 2014). Ozone formation is temperature-dependent and increases in ozone levels could result in more ozone-related mortality (IPCC 2018). Climate change may result in meteorological conditions more favorable for the formation of ozone, including higher temperatures, less relative humidity, and altered wind patterns (Jacob and Winner 2009, GCRP 2016). Ozone production could increase with rising temperatures, especially in urban areas (IPCC 2014a citing Chang et al. 2010, Ebi and McGregor 2008, Polvani et al. 2011, and Tsai et al. 2008). These climate-driven increases in ozone could cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms (GCRP 2016, Silva et al. 2017).

As with ozone, climate change is expected to alter several meteorological factors that affect PM2.5, including precipitation patterns, wind patterns and atmospheric mixing, and humidity, although there is less consensus regarding the effects of meteorological changes on PM2.5 than on ozone (Jacob and Winner 2009, GCRP 2016 citing Dawson et al. 2014). Because of the strong influence of changes in precipitation and atmospheric mixing on PM2.5 levels and because of the high variability in projected changes to those variables, it is not yet clear whether climate change will lead to a net increase or decrease in PM2.5 levels in the United States (GCRP 2016 citing Dawson et al. 2014, Fiore et al. 2012, Penrod et al. 2014, Tai et al. 2012, Val Martin et al. 2015, Dawson et al. 2009, Trail et al. 2014). Overall, however, eastern, midwestern, and southern states are projected to experience degraded air quality associated with climate change (EPA 2015b, GCRP 2016). Because the impact of the Proposed Action and alternatives on global average temperature and other climate indicators is expected to be minimal, the impact of the GHG emissions from the Proposed Action and alternatives on ozone and air quality is also expected to be minimal.

Climate change can also affect air quality through an increasing number of wildfires and changing precipitation patterns. Wildfires produce particulate matter pollutants and ozone precursors that diminish both air quality and human health (EPA 2016j, GCRP 2016, Reid et al. 2016, Reid et al. 2019). The public health burden (in terms of number and economic value of wildfire morbidity and mortality) is "considerable," with an economic value of up to $20 billion from short-term exposure cases and up to $130 billion for long-term exposure cases (in 2010 dollars) (Fann et al. 2018). Climate change could also affect air quality through changes in vegetative growth, increased summertime stagnation events, and increased absolute humidity (GCRP 2014 citing Peel et al. 2013). Further, climate change is projected to increase flooding in some locations both in the United States (GCRP 2014 citing IPCC 2007b and IPCC 2012) and around the world (IPCC 2014a citing IPCC 2012). Combined with higher air temperatures, this could foster the growth of fungi and molds, diminishing indoor air quality, particularly in impoverished communities (GCRP 2014 citing Fisk et al. 2007, Institute of Medicine 2011, Mudarri and Fisk 2007, and Wolf et al. 2010).

Increased temperatures and CO_2 concentrations can shift or extend plant growing seasons, including those of plants that produce allergens and pollen (EPA 2016j, GCRP 2014 citing Sheffield et al. 2011a, Emberlin et al. 2002, Pinkerton et al. 2012, Schmier and Ebi 2009, Shea et al. 2008, Sheffield and Landrigan 2011, Ziska et al. 2011, and Hjort et al. 2016). These effects already occur worldwide and are projected to continue with climate change (D'Amato et al. 2013, GCRP 2014, IPCC 2014a). Increases in pollen and other aeroallergens can exacerbate asthma and other health problems such as conjunctivitis and dermatitis (EPA 2016j, IPCC 2014a citing Beggs 2010). Exposure to air pollutants such as increased ozone or particulate matter levels could also exacerbate the effects of aeroallergens (GCRP 2016 citing Cakmak et al. 2012). Increases in aeroallergens has also been known to reduce school and work productivity (GCRP 2014 citing Ziska et al. 2011, Sheffield et al. 2011b, and Staudt et al. 2010).

Climate—both temperature and precipitation—can influence the growth, survival, and persistence of water- and food-borne pathogens (EPA 2016j, IPCC 2014a). Also, changing weather patterns may shift the geographic range, seasonality, and intensity of climate-sensitive infectious disease transmission (IPCC 2018). For example, heavy rainfall and increased runoff promote the transmission of water-borne pathogens and diseases in recreational waters, shellfish-harvesting waters, and sources of drinking water with increased pathogens and toxic algal blooms (GCRP 2018a, 2016j; GCRP 2016). Diarrheal disease rates are also linked to temperatures (IPCC 2014a). More frequent and intense rainfall and storm surge events could lead to combined sewer overflows that can contaminate water resources, (GCRP 2018a, EPA 2016j, IPCC 2014a citing Patz et al. 2008) and changes in streamflow rates can precede diarrheal disease outbreaks like salmonellosis and campylobacteriosis (GCRP 2014 citing Harper et al. 2011 and Rizak and Hrudey 2008; GCRP 2016). In general, heavy rainfall, flooding, and high temperatures are associated with higher rates of diarrheal disease (GCRP 2018a). Rising water temperatures could also increase the growth and abundance of pathogens in coastal environments that cause illnesses and deaths from both water contact and ingestion of raw or undercooked seafood. Changes in ocean pH may also increase virulent strains of pathogens prevalent in seafood, particularly because acidification can increase the proliferation of microbes that affect shellfish, whose immune responses and shells are weakened, making them more susceptible to infection (NIH 2010). Higher temperatures are expected to increase Vibrio, a temperature-sensitive and dangerous marine pathogen (GCRP 2018a, Muhling et al. 2017). Climate change-induced drought may increase the spread of pests and mold that can produce toxins dangerous to consumers (NIH 2010 citing Gregory et al. 2009). Similar to other climate change health impacts, children and the elderly are most vulnerable to serious health consequences from water- and food-borne diseases that could be affected by climate change (GCRP 2014). In 2015, an estimated 688 million illnesses and 499,000 deaths of children under 5 years of age were attributed to diarrheal diseases worldwide, making it the second leading cause of death for this age group (Kotloff et al. 2017 citing GBD 2015).

Climate change, particularly changes in temperatures, could change the range, abundance, and disease-carrying ability of disease vectors such as mosquitoes or ticks (GCRP 2018a, EPA 2016j, IPCC 2014a, Bouchard et al. 2019, and GCRP 2016). This, in turn, could affect the prevalence and geographic distribution of diseases such as Rocky Mountain spotted fever, plague, tularemia, malaria, dengue fever, chikungunya virus, Lyme disease, West Nile virus, and Zika virus in human populations (Watts et al. 2017, GCRP 2014 citing Mills et al. 2010, Diuk-Wasser et al. 2010, Ogden et al. 2008, Keesing et al. 2009, Centers for Disease Control 2013, Degallier et al. 2010, Johansson et al. 2009, Jury 2008, Kolivras 2010, Lambrechts et al. 2011, Ramos et al. 2008, Gong et al. 2011, Morin and Comrie 2010, Centers for Disease Control 2012, and Nakazawa et al. 2007). Some of these changes are already occurring, although the interactions between climate changes and actual disease incidence are complex and multifaceted (Altizer et al. 2013, Deichstetter 2017). Climate change could also alter temperature, precipitation, and cloud cover, which can affect sun exposure behavior and change the risk of ultraviolet (UV) ray-related health outcomes. However, UV exposure is influenced by several factors, and scientists are uncertain whether it will increase or decrease because of climate change (IPCC 2014a citing van der Leun et al. 2008, Correa et al. 2013, Belanger et al. 2009).

Climate change can influence mental health. People can experience adverse mental health outcomes and social impacts from the threat of climate change, the perceived direct experience of climate change, and changes to the local environment (EPA 2016j). Climate change is associated with mental health consequences ranging from stress to clinical disorders, such as anxiety, depression, post-traumatic stress disorder, and thoughts and acts of suicide (GCRP 2018a, Burke et al. 2018, Khafaie et al. 2019). Extreme weather conditions can increase stress population-wide, which can exacerbate preexisting mental health problems and even cause such conditions (EPA 2016j, IPCC 2014a). For example, individuals experiencing loss due to flood or risk of flood report high levels of depression and anxiety, which could persist for years after the event (GCRP 2018a). Children, the elderly, women, people with preexisting mental illness, the economically disadvantaged, Indigenous communities, the homeless, and first responders are at higher risk for distress and adverse mental health consequences from exposure to climate-related disasters (GCRP 2018a, EPA 2016j, GCRP 2016 citing Osofsky et al. 2011, Schulte et al. 2016).

Environmentally motivated migration and displacement may lead to disruption of social ties and community bonds, which may negatively affect mental health, for both those displaced and those who stay behind (Torres and Casey 2017). Stress, induced by climate change or other factors, can also result in pregnancy-related problems such as preterm birth, low birth weight, and maternal complications (Harville et al. 2009, GCRP 2014 citing Xiong et al. 2008, GCRP 2016 citing Sheffield and Landrigan 2011 and Rylander et al. 2013). Heat can also affect mental health and has been known to increase aggressive behaviors, in addition to increasing suicide rates, dementia, and problems for patients with schizophrenia and depression (GCRP 2018a; EPA 2016j; GCRP 2014 citing Bouchama et al. 2007, Bulbena et al. 2006, Deisenhammer 2003, Hansen et al. 2008, Maes et al. 1994, Page et al. 2007, Basu and Samet 2002, Martin-Latry et al. 2007, and Stöllberger et al. 2009; GCRP 2016 citing Ruuhela et al. 2009, Dixon et al. 2007, Qi et al. 2009, and Preti et al. 2007).

Climate change can also affect human exposure to toxic chemicals such as arsenic, mercury, dioxins, pesticides, pharmaceuticals, algal toxins, and mycotoxins through several pathways (Balbus et al. 2013).

Adaptation

IPCC (2014a) characterizes three tiers of adaptation: incremental adaptation, transitional adaptation, and transformational adaptation. Incremental adaptation covers improvements to basic public health and healthcare services, such as vaccination programs and post-disaster initiatives (IPCC 2014a). Transitional adaptation refers to policies and measures that incorporate climate change considerations, such as vulnerability mapping, while transformational adaptation involves more drastic system-wide changes and has yet to be implemented in the health sector (IPCC 2014a).

The public health community has identified several potential adaptation strategies to reduce the risks to human health from climate change. The Centers for Disease Control and Prevention has established the Building Resilience against Climate Effects Framework, which can help health officials assess how climate impacts could affect disease burdens and develop a Climate and Health Adaptation Plan. The framework aligns with the Climate-Ready States and Cities Initiative, which, as of June 2018, is working with 16 states and two cities to project future health impacts and develop programs to address them. The program provides resources for states, cities, and municipalities to develop their own climate and health adaptation plans, including concept documents, toolkits, webinars, and data resources.

At the state level, governments can conduct vulnerability and adaptation assessments, develop emergency response plans for climate events, develop climate-proof healthcare infrastructure, and integrate surveillance systems for infectious disease (IPCC 2018).

In terms of specific adaptation measures, early warning programs can be cost-effective ways to reduce human health impacts from extreme weather events (GCRP 2014 citing Chokshi and Farley 2012, Kosatsky 2005, Rhodes et al. 2010, and The Community Preventive Services Task Force 2013). Heatwave early-warning systems can also be used to reduce injuries, morbidity, and mortality due to heatwaves (IPCC 2018). A local adaptation strategy may include opening a community cooling center during heat waves to accommodate vulnerable and at-risk populations (Nayak et al. 2017). In the long term, strategies to reduce the urban heat island effect such as cool roofs and increased green space can reduce health risks from extreme heat (GCRP 2014 citing Stone et al. 2010; EPA 2012b; Boumans et al. 2014; McDonald et al. 2016). GHG reduction policies can also create co-benefits for air pollution by reducing pollutants, such as particulate matter, SO_2, nitrogen dioxide, and other harmful pollutants (IPCC 2018). Thus, mitigation strategies can have health benefits by improving air quality and promoting active transportation, which can reduce rates of obesity, diabetes, and heart disease (GCRP 2014 citing Markandya 2009 and Haines et al. 2009).

Human Security

This section provides an overview of the recent findings regarding observed and projected impacts of climate change on human security in the United States and globally. IPCC defines human security in the context of climate change as “a condition that exists when the vital core of human lives is protected, and when people have the freedom and capacity to live with dignity” (IPCC 2014a). As there are multiple drivers of human security, it can be difficult to establish direct causation between climate change and impacts on human security. The connections between climate and national security are complex because national security can be affected by a variety of secondary impacts such as resource scarcity and competition (GCRP 2018a). Rather than directly causing conflict, climate stress could drive changes in commodity prices or food and water insecurity, which are drivers of conflict (GCRP 2018a). Overall, the research literature finds that climate change has negative impacts on various dimensions of human security, including livelihoods, food, water, cultures, migration, and conflict. However, some dimensions of human security are driven more by economic and social forces rather than by climate change (IPCC 2014a). As the Department of Defense concluded in a 2015 report to Congress, climate change may have far-reaching impacts on existing problems, such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions both nationally and internationally (DOD 2015).

Observed and Projected Climate Impacts

Economic and livelihood security includes access to food, clean water, shelter, employment, and avoidance of direct risks to health. Climate change poses significant risks to all of these aspects and can thereby threaten the economic and livelihood security of individuals or communities (IPCC 2014a). Even with an increase of approximately 1.5°C by 2030, climate change will be a "poverty multiplier" that increases levels of poverty and the number of people living in poverty (IPCC 2018 citing Hallegatte et al. 2016 and Hallegatte and Rozenberg 2017). In particular, climate change will affect those whose livelihoods depend on natural resources (Brzoska and Frohlich 2015, Reyer et al. 2017). There are well-documented impacts of climate variability and change on agricultural productivity and food insecurity, water stress and scarcity, and destruction of property and residence (IPCC 2014a citing Carter et al. 2007, Leary et al. 2008, Peras et al. 2008, Paavola 2008, and Tang et al. 2009). Populations that are most at risk of food insecurity include the urban poor and the rural and indigenous communities whose livelihoods are highly dependent upon natural resources (GCRP 2018a, GCRP 2014).

Around the world, it is increasingly challenging for indigenous communities to maintain cultures, livelihoods, and traditional food sources in the face of climate change (IPCC 2014a citing Crate and Nuttall 2009 and Rybråten and Hovelsrud 2010; GCRP 2014 citing Lynn et al. 2013). The impacts of climate change are expected to be more significant in places where indigenous people live and on traditional ecological knowledge (IPCC 2018 citing Olsson et al. 2014). Many studies indicate that further significant changes in the natural resource base would negatively affect indigenous cultures, particularly if people are confined to particular territories created by treaties; if natural resources are lost within that territory, that is a permanent loss to the tribe and their culture (GCRP 2018a; IPCC 2014a citing Crate 2008, Gregory and Trousdale 2009, and Jacka 2009). For example, climate change is causing changes in the range and abundance of culturally important plant and animal species, reducing the availability of and access to traditional foods, and increasing damage to tribal homes and cultural sites (GCRP 2014 citing Lynn et al. 2013, Voggesser et al. 2013, and Karuk Tribe 2010). Ultimately, this could make life on ancestral lands untenable (IPCC 2018). In addition, traditional practices are already facing multiple stressors, such as changing socioeconomic conditions and globalization, which undermine their ability to adapt to climate change (IPCC 2014a citing Green el al. 2010). Climate change can also cause loss of land and displacement, such as in small island nations or coastal communities, which have well-documented negative cultural and well-being impacts (IPCC 2014a citing Bronen 2011, Johnson 2012, Arnall 2013, Bronen 2010, Bronen and Chapin 2013, and Cunsolo-Willox et al. 2012, 2013).

The efficacy of traditional practices can be eroded "when governments relocate communities" (IPCC 2014a citing Hitchcock 2009, McNeeley 2012, and Maldonado et al. 2013); "if policy and disaster relief creates dependencies" (IPCC 2014a citing Wenzel 2009 and Fernández-Giménez et al. 2012); "in circumstances of inadequate entitlements, rights, and inequality" (IPCC 2014a citing Shah and Sajitha 2009 and Green et al. 2010; GCRP 2014 citing Lynn et al. 2013); and "when there are constraints to the transmission of language and knowledge between generations" (IPCC 2014a citing Forbes 2007) (IPCC 2014a). Lack of involvement in formal government decision-making over resources also decreases the resilience of indigenous peoples and their cultures to climate change impacts (IPCC 2014a citing Ellemor

2005, Brown 2009, Finucane 2009, Turner and Clifton 2009, Sánchez-Cortés and Chavero 2011, and Maldonado et al. 2013).

Climate change is expected to increase internal migration and displacement, in part due to extreme events or long-term environmental changes (IPCC 2018 citing Albert et al. 2017, Heslin et al. 2019). However, the causation and extent of this risk is hard to determine due to the complexity of migration decisions (IPCC 2018). Much of the literature reviewed in the IPCC *Special Report on Extreme Events* suggests that an increase in the incidence and/or severity of extreme events due to climate change will directly increase the risks of displacement and amplify its impacts on human security (IPCC 2014a). Projections indicate that 4.2 million Americans could be at risk with 3 feet of sea-level rise, and 13.1 million people with 6 feet of sea-level rise, which could drive mass migration and societal disruption (Hauer 2017, Hauer et al. 2016). In the past, major extreme weather events have led to significant population displacement (IPCC 2014a). For example, after Hurricane Katrina, refugees from coastal areas spread to all 50 states, which resulted in economic and social costs around the country (GCRP 2018a). Following rapid-onset events such as floods or storms, such displacement is usually short-term (Brzoska and Frohlich 2015). Most displaced people try to return to their original residence and rebuild as soon as circumstances allow (IPCC 2014a). As a result, only a portion of displacement leads to permanent migration (IPCC 2014a citing Foresight 2011 and Hallegatte 2012).

Climate-driven migration outside of the United States could have implications for national security, either due to immigrants to the United States or instability abroad. For example, there could be significant population displacement in the tropics due to warming. Tropical populations may have to move more than 1,000 kilometers by the end of the century, which could lead to a concentration of displaced persons on the margins, contributing to higher population densities in destination areas (IPCC 2018 citing Hsiang and Sobel 2016). Some of these refugees could come to the United States. For example, the United States granted Temporary Protected Status to 57,000 Honduran and 2,550 Nicaraguan nationals after Hurricane Mitch (GCRP 2018a).

Long-term changes in climate conditions, such as droughts or land degradation, have greater potential to result in permanent migration (Brzoska and Frohlich 2015). For example, higher temperatures have contributed to outmigration in 163 countries, specifically for those dependent on agriculture (IPCC 2018 citing Cai et al. 2016). According to the International Migration Database of the Organisation for Economic Co-operation and Development, a 1°C increase in temperature contributed to a 1.9 percent increase in migration flows from 142 countries moving to 19 receiving countries, and an additional increase in precipitation of 1 millimeter could increase migration by 0.5 percent (IPCC 2018 citing Backhaus et al. 2015).

A number of studies have found that migrants can face increased risks due to climate change impacts in their new destinations, such as in cities (IPCC 2014a citing Black et al. 2011). Climate change-induced mass migration threatens to adversely affect the humanitarian assistance requirements of the U.S. military, as well as strain its ability to respond to conflict (DOD 2015, NRC 2011c). Displacement affects human security by affecting housing, health, and economic outcomes (IPCC 2014a citing Adams et al. 2009 and Hori and Shafer 2010). A large influx of migrants can also encourage violence, especially if the refugees differ from the native population in ethnicity, nationality, and/or religion; have had previous conflicts with the receiving area; or want to settle long term (Brzoska and Frohlich 2015). In other cases, migration to more prosperous and resource-rich areas can dissolve conflicts (Brzoska and Frohlich 2015).

Conversely, extreme events can sometimes be associated with immobility or in-migration instead of displacement. For example, Paul (2005) found that little displacement occurred following floods in

Bangladesh and there was in-migration due to reconstruction activities (IPCC 2014a citing Paul 2005). As migration is resource-intensive, in some cases migration flows decreased when the households had limited resources, such as in drought years (IPCC 2014a citing Findley 1994, van der Geest 2011, and Henry et al. 2004). Often, lack of mobility is associated with increased vulnerability to climate change, as vulnerable populations frequently do not have the resources to migrate from areas exposed to the risks from extreme events. When migration occurs among vulnerable populations, it is usually an "emergency response that creates conditions of debt and increased vulnerability, rather than reducing them" (IPCC 2014a citing Warner and Afifi 2013).

The association between short-term warming and deviations in rainfall (including floods and droughts) with armed conflict is contested, with some studies finding a relationship while others finding no relationship (Schleussner et al. 2016, Buhaug et al. 2015, IPCC 2014a). Most studies find that climate change impacts on armed conflict is negligible in situations where other risk factors are extremely low, such as where per capita incomes are high or governance is effective and stable (IPCC 2014a citing Bernauer et al. 2012, Koubi et al. 2012, Scheffran et al. 2012, and Theisen et al. 2013). Many studies, however, argue that reduced availability and changes in the distribution of water, food, and arable land from a changing climate are factors prone to triggering violent conflicts (Brzoska and Frohlich 2015 citing Hsiang et al. 2013). Rather than a causal relationship between climate change and conflict, climate change is identified as a "threat multiplier" that exacerbates existing or arising threats to stability and peace and may trigger armed conflict (Buhaug 2016 citing CNA 2007). In summary, "there is justifiable common concern that climate change or changes in climate variability increases the risk of armed conflict in certain circumstances […] even if the strength of the effect is uncertain" (IPCC 2014a citing Bernauer et al. 2012, Gleditsch 2012, Scheffran et al. 2012, and Hsiang et al. 2013). It is, however, not possible to make confident statements regarding the impacts of future climate change on armed conflict due to the lack of "generally supported theories and evidence about causality" (IPCC 2014a).

The potential impacts of climate change on accelerating instability in volatile regions of the world have profound implications for national security of the United States. The U.S. Department of Defense 2014 Quadrennial Defense Review indicates that the projected effects of climate change "… are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence" (DOD 2015). For example, drought may increase the likelihood of sustained conflict, particularly for groups dependent on agricultural livelihoods, which are more vulnerable to climate change (IPCC 2018). With a 1°C increase in temperature or a greater intensity of extreme rainfall events, intergroup conflicts could increase in frequency by 14 percent (IPCC 2018 citing Hsiang et al. 2013).

Climate change can compromise state integrity by affecting critical infrastructure, threatening territorial integrity, and increasing geopolitical rivalry (IPCC 2014a). Climate change impacts on critical infrastructure will reduce the ability of countries to provide the economic and social services that are important to human security (IPCC 2014a). For example, extreme heat, storms and floods, and sea-level rise could directly affect military assets, such as roads, airport runways, and coastal infrastructure; disrupt supply chains; endanger personnel; inhibit training; and increase operating costs (GCRP 2018a). In addition, climate change can also affect military logistics, energy, water, and transportation systems, compromising the ability of the U.S. military to conduct its missions (NRC 2011c, CNA Corporation 2014, NRC 2013a). Power outages and fuel shortages could affect the energy system, which could have cascading impacts on critical sectors that support the economy and national security (GCRP 2018a). Furthermore, the U.S. military could become overextended as it responds to extreme weather events and natural disasters at home and abroad, along with current or future national security threats (NRC 2011c, CNA Corporation 2014).

Sea-level rise, storm surge, and coastal erosion can threaten the territorial integrity of small island nations or countries with significant areas of soft low-lying coasts (IPCC 2014a citing Hanson et al. 2011, Nicholls et al. 2011, Barnett and Adger 2003, and Houghton et al. 2010). These changes can also have negative implications for navigation safety, port facilities, and coastal military bases (DOD 2015). Open access to resources and new shipping routes due to significant reductions in Arctic sea ice coverage could increase security concerns because of territorial and maritime disputes, if equitable arrangements between countries cannot be agreed to (DOD 2015, IPCC 2014a, GCRP 2014). A variety of maritime boundary disputes in the Arctic could be exacerbated by the increased accessibility of the region due to warmer temperatures (Smith and Stephenson 2013 citing Brigham 2011 and Elliot-Meisel 2009). Furthermore, nations bordering the Arctic maintain unresolved sea and economic zone disputes (Smith and Stephenson 2013 citing Liu and Kronbak 2010, Gerhardt et. al. 2010, NRC 2011b). Other transboundary impacts of climate change such as changing shared water resources and migration of fish stocks can increase geopolitical rivalry between countries (IPCC 2014a). Additionally, climate change could increase tension and instability over energy supplies (CNA Corporation 2014).

Adaptation

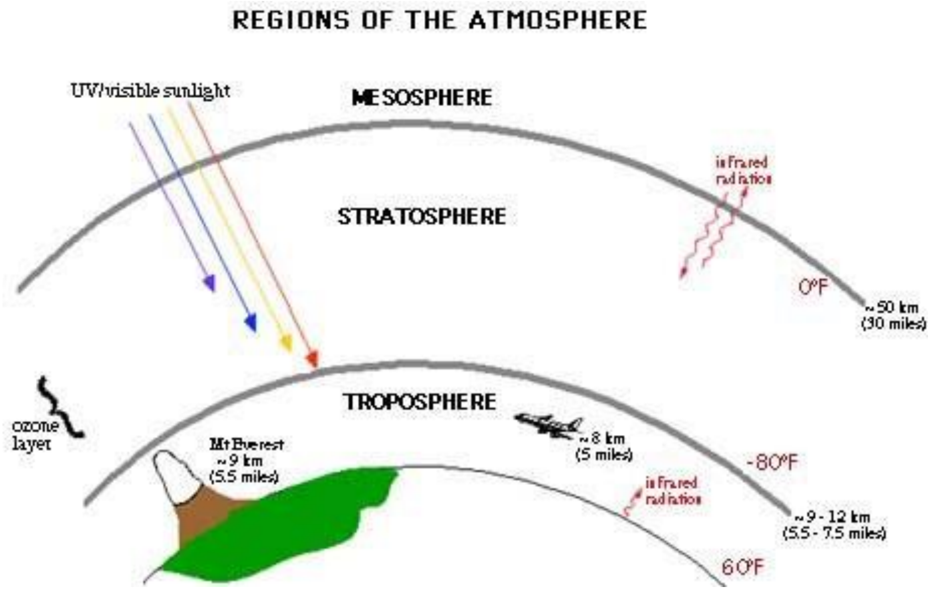
Adaptation strategies can reduce vulnerability and thereby increase human security. Examples of adaptation measures to improve livelihoods and well-being include diversification of income-generating activities in agricultural and fishing systems, development of insurance systems, and provision of education for women. Integration of local and traditional knowledge is found to increase the effectiveness of adaptation strategies. Improvements in entitlements and rights, as well as engagement of indigenous peoples in decision-making, increase their social and cultural resilience to climate change (IPCC 2014a). There is not enough evidence on the effectiveness of migration and resettlement as adaptation. Migration is costly and disruptive and is thus often perceived as an adaptation of last resort (IPCC 2014a citing McLeman 2009). Poorly designed adaptation strategies can increase the risk of conflict and amplify vulnerabilities in certain populations, if they exacerbate existing inequalities or grievances over resources (IPCC 2014a).

Local and traditional knowledge is a valuable source of information for adapting to climate change (IPCC 2014a, GCRP 2014). There is high agreement in the literature that the integration of local and traditional and scientific knowledge increases adaptive capacity (IPCC 2014a citing Kofinas et al. 2002, Oberthür et al. 2004, Tyler et al. 2007, Anderson et al. 2007, Vogel et al. 2007, West et al. 2008, Armitage et al. 2011, Frazier et al. 2010, Marfai et al. 2008, Flint et al. 2011, Ravera et al. 2011, Nakashima et al. 2012, and Eira et al. 2013). While being an important resource for adaptation, traditional knowledge may be insufficient to respond to rapidly changing ecological conditions or unexpected or infrequent risks (IPCC 2014a, GCRP 2014). As a result, current traditional knowledge strategies could be inadequate to manage projected climate changes (IPCC 2014a citing Wittrock et al. 2011). While adaptation is possible to avoid some losses of cultural assets and expressions, cultural integrity will still be compromised if climate change erodes livelihoods, sense of place, and traditional practices (IPCC 2014a).

Stratospheric Ozone

This section presents a review of stratospheric ozone and describes how CO_2 and climate change are projected to affect stratospheric ozone concentrations. Ozone is a molecule consisting of three oxygen atoms. Ozone near Earth's surface is considered an air pollutant that causes respiratory problems in humans and adversely affects crop production and forest growth (Fahey and Hegglin 2011). Conversely, ozone in Earth's stratosphere (approximately 9 to 28 miles above Earth's surface) acts as a shield to block UV rays from reaching Earth's surface (Ravishankara et al. 2008).[28] This part of the atmosphere is referred to as the *ozone layer*, and it provides some protection to humans and other organisms from exposure to biologically damaging UV rays that can cause skin cancer and other adverse impacts for humans and other organisms (Fahey and Hegglin 2011, Fahey et al. 2008, Figure 8.6.5-1).

Figure 8.6.5-1. The Three Lowest Layers in Earth's Atmosphere and the Location of the Ozone Layer



Source: NOAA 2011
UV = ultraviolet; km = kilometers; °F – degrees Fahrenheit

Ozone in the stratosphere is created when a diatomic oxygen molecule absorbs UV rays at wavelengths less than 240 nanometers, causing the molecule to dissociate into two very reactive free radicals that then each combine with an available diatomic oxygen molecule to create ozone (Fahey and Hegglin 2011). Through this process, heat is released, warming the surrounding environment. Once ozone is formed, it absorbs incoming UV rays with wavelengths from 220 to 330 nanometers (Fahey and Hegglin 2011). Ozone, which is a very reactive molecule, could also react with such species as hydroxyl radical, nitric oxide, or chlorine (Fahey et al. 2008).

The concentration of ozone in the stratosphere is affected by many factors, including concentrations of ozone-depleting substances and other trace gases, atmospheric temperatures, transport of gases between the troposphere and the stratosphere, and transport within the stratosphere. Specifically, ozone is depleted in reactions that involve halogens, such as chlorine and bromine, which result from the decomposition of some halocarbons (GCRP 2017 citing WMO 2014). Alterations to the carbon cycle, including climate-driven ecosystem changes, influence atmospheric concentrations of CO_2 and CH_4. In turn, atmospheric aerosols affect clouds and precipitation rates, which change the removal rates,

[28] These height measurements defining the bottom and top of the stratosphere vary depending on location and time of year. Different studies might provide similar but not identical heights. The heights indicated for the stratosphere and the layers within the stratosphere are provided in this section as defined by each study.

lifetimes, and abundance of the aerosols themselves (GCRP 2017 citing Nowack et al. 2015). Also, stratospheric ozone abundance can be affected by climate-driven circulation changes and longwave radiation feedbacks (GCRP 2017 citing Nowack et al. 2015).

IPCC reports it is *very likely* that anthropogenic contributions, particularly to GHGs and stratospheric ozone depletion, have led to the detectable tropospheric warming and related cooling in the lower stratosphere since 1961 (IPCC 2014a). Satellite and ground observations demonstrated clearly that stratospheric ozone was decreasing in the 1980s. There is an international consensus that human-made ozone-depleting substances (such as gases emitted by air conditioners and aerosol sprays) are responsible, which has prompted the establishment of international agreements to reduce the consumption and emissions of these substances (Fahey and Hegglin 2011, Langematz 2019). In response to these efforts, the rate of stratospheric ozone reduction has slowed. Although there are elements of uncertainty, stratospheric ozone concentrations are projected to recover to pre-1980 levels over the next several decades (Fahey and Hegglin 2011, WMO 2011), with further thickening of the ozone layer possible by 2100 in response to climate change (IPCC 2014a citing Correa et al. 2013).

Stratospheric ozone levels influence the surface climate in both the Northern and Southern Hemispheres. In the Northern Hemisphere, stratospheric ozone extremes over the Arctic contribute to spring surface temperatures, particularly linking low Arctic ozone in March with colder polar vortex and circulation anomalies (Ivy et al. 2017). March stratospheric ozone can be used as an indicator of spring climate in certain regions (Ivy et al. 2017). In the Southern Hemisphere, comparison of the 1979-2010 climate trends shows that stratospheric ozone depletion drives climate change (Li et al. 2016). Interactive chemistry causes cooling in the Antarctic lower stratosphere and acceleration of the circumpolar westerly winds (Li et al. 2016). In turn, this impacts overturning circulation in the Southern Ocean, leading to stronger ocean warming near the surface and increased ice melt around the Antarctic (Li et al. 2016). Changes in stratospheric ozone influence the climate by affecting the atmosphere's temperature structure and circulation patterns (Ravishankara et al. 2008). Conversely, climate change could aid in the recovery of stratospheric ozone. Although GHGs, including CO_2, warm the troposphere (the lower layer of the atmosphere), this process actually cools the stratosphere. Consequently, it slows the chemical reactions between stratospheric ozone and ozone-depleting substances, assisting in ozone recovery. Climate change could enhance atmospheric circulation patterns that affect stratospheric ozone concentrations, assisting in ozone recovery in the extra-tropics. However, for polar regions, cooling temperatures can increase winter polar stratospheric clouds, which are responsible for accelerated ozone depletion. In summary, reduced stratospheric ozone may contribute to climate change while climate change has been projected to have a direct impact on stratospheric ozone recovery, although there are large elements of uncertainty within these projections.

Human-Made Ozone-Depleting Substances and Other Trace Gases

Until the mid-1990s, stratospheric ozone concentrations had been declining in response to increasing concentrations of human-made ozone-depleting substances (WMO 2014). Since the year 2000, ozone has been slowly increasing in the upper stratosphere (Steinbrecht et al. 2017). Examples of ozone-depleting substances include chlorofluorocarbons and compounds containing chlorine and bromine (Ravishankara et al. 2008, Fahey and Hegglin 2011). These ozone-depleting substances are chemically inert near Earth's surface but decompose into very reactive species when exposed to UV radiation in the stratosphere.

In 1987, an international agreement, the Montreal Protocol on Substances that Deplete the Ozone Layer, was established to reduce the consumption and production of human-made ozone-depleting substances to protect and heal the ozone layer and rebuild the ozone hole.[29] Subsequent agreements have followed that incorporate more stringent reductions of ozone-depleting substances and expand the scope to include additional chemical species that attack ozone. Some ozone-depleting substances such as chlorofluorocarbons are potent GHGs; therefore, reducing the emissions of these gases also reduces radiative forcing and hence reduces the heating of the atmosphere. However, HFCs were not included in the Montreal Protocol. Evidence shows that HFCs could contribute to anthropogenic climate change and, in 2016, the Kigali Amendment to the Montreal Protocol introduced a treaty on managing and phasing out HFCs (Hurwitz et al. 2016).

Increases in the emissions of other trace gases (e.g., CH_4 and nitrous oxide [N_2O]) and CO_2 affect stratospheric ozone concentrations (Fahey et al. 2008). When CH_4 is oxidized by hydroxyl radicals in the stratosphere, it produces water and the methyl radical. Increases in stratospheric water lead to an increase in reactive molecules that assist in the reduction of ozone and an increase in polar stratospheric clouds that accelerate ozone depletion. Increases in N_2O emissions cause a reduction of ozone in the upper stratosphere as N_2O breaks down into reactive ozone- depleting species.

Changes in Atmospheric Temperature

Since the observational record began in the 1960s, global stratospheric temperatures have been decreasing in response to ozone depletion, increased tropospheric CO_2, and changes in water vapor (Fahey et al. 2008). Natural concentrations of GHGs increase the warming in the troposphere by absorbing outgoing infrared radiation; increasing GHG concentrations in the troposphere traps more heat in the troposphere, which translates to less incoming heat into the stratosphere. In essence, as GHGs increase, the stratosphere is projected to cool. However, model simulations suggest reductions in ozone in the lower to middle stratosphere (13 to 24 miles) create a larger decrease in temperatures compared to the influence of GHGs (Fahey et al. 2008 citing Ramaswamy and Schwarzkopf 2002). Above a height of about 24 miles, both the reductions of ozone and the impact of GHGs can contribute significantly to stratospheric temperature decreases.

The cooling temperatures in the stratosphere could slow the loss of ozone (Fahey et al. 2008, Reader et al. 2013) because the dominant reactions responsible for ozone loss slow as temperatures cool. For example, ozone in the upper stratosphere is projected to increase by 15 to 20 percent under a doubled CO_2 environment (Fahey et al. 2008 citing Jonsson et al. 2004). In the lower stratosphere, where day-night energy transport plays an important role both within the stratosphere and between the troposphere and stratosphere, cooling temperatures have less influence on ozone concentrations (except in the polar regions). Since 1993, ozone in the lower stratosphere above the Arctic has been greatly affected by cooling temperatures, as cooling has led to an increase in polar stratospheric clouds (Fahey et al. 2008). Polar stratospheric clouds play a significant role in reducing ozone concentrations. Ozone in the lower stratosphere above the Antarctic does not demonstrate such a significant response to cooling temperatures because this region already experiences temperatures cold enough to produce these clouds.

[29] The polar regions experience the greatest reduction in total ozone, with about a 5 percent reduction in the Arctic and 18 percent reduction in the Antarctic (Fahey and Hegglin 2011). Significant thinning in the ozone layer has been observed above the Antarctic since the spring of 1985, to such a degree it is termed the *ozone hole* (Ravishankara et al. 2008). This location is particularly susceptible to ozone loss due to a combination of atmospheric circulation patterns, and the buildup of ozone-depletion precursors during the dark winter months from June to September.

Circulation and Transport Patterns

The large-scale Brewer-Dobson circulation represents the transport between the troposphere and stratosphere: an upward flux of air from the troposphere to the stratosphere occurs in the tropics balanced by a downward flux of air in the extratropics (the middle latitudes that extend beyond the tropics). This circulation carries stratospheric ozone from the tropics poleward. It is suggested that the ozone in the lower stratosphere has experienced an acceleration in this transport over the past century, particularly in the Northern Hemisphere—potentially explaining the larger increase in total atmospheric ozone per area (i.e., column ozone) observed in the Northern Hemisphere compared to the Southern Hemisphere (Reader et al. 2013). According to many chemistry-climate models and observational evidence, climate change is thought to accelerate the Brewer-Dobson circulation, thus extending the decline of ozone levels in the tropical lower stratosphere through the 21st century (WMO 2014).

Models suggest that the reduction of ozone above Antarctica is responsible for strengthening the circulation of stratospheric circumpolar winds of the wintertime vortex (i.e., the establishment of the vortex leads to significant ozone loss in late winter/early spring) (Fahey et al. 2008 citing Gillet and Thompson 2003 and Thompson and Solomon 2002).[30] Observations have shown that these winds can extend through the troposphere to the surface, leading to cooling over most of Antarctica. These studies suggest changes in stratospheric ozone can affect surface climate parameters.

Trends and Projections

Observations of global ozone concentrations in the upper stratosphere have shown a strong and statistically significant decline of approximately 6 to 8 percent per decade from 1979 to the mid-1990s (WMO 2011, Pawson and Steinbrecht 2014). Observations of global ozone within the lower stratosphere demonstrate a slightly smaller but statistically significant decline of approximately 4 to 5 percent per decade from 1979 to the mid-1990s (WMO 2014). An updated study from 2000 to 2016 found that ozone increased in the upper stratosphere by about 1.5 percent per decade in the tropics and by 2.5 percent per decade in the mid latitudes (35 to 60 degrees) (Steinbrecht et al. 2017). From 2000 to 2016 in the lower stratosphere, the trends are not statistically significant (Steinbrecht et al. 2017). The depletion of stratospheric ozone has been estimated to cause a slight radiative cooling of approximately -0.05 watts per square meter with a range of -0.15 to 0.05 watts per square meter, although there is great uncertainty in this estimate (Ravishankara et al. 2008).

WMO (2011) used 17 coupled chemistry-climate models to assess how total column ozone (i.e., the total ozone within a column of air from Earth's surface to the top of the atmosphere) and stratospheric ozone will change in response to climate change and reductions in ozone-depleting substances. Under a moderate (A1B) emissions scenario, the model ensemble suggests changes in climate will accelerate the recovery of total column ozone. The model ensemble suggests the northern mid-latitudes total column ozone will recover to 1980 levels from 2015 to 2030, and the southern mid-latitudes total column ozone will recover from 2030 to 2040. Overall, the recovery of total ozone to 1980 levels in the mid-latitudes is projected to occur 10 to 30 years earlier because of climate change. The Arctic has a similar recovery time to 1980 conditions, while the Antarctic will regain 1980 concentrations around mid-century (because the chemistry-climate models underestimate present-day Arctic ozone loss, the modeled Arctic

[30] During the polar winter, a giant vortex with wind speeds exceeding 300 kilometers (186 miles) per hour can establish above the South Pole, acting like a barrier that accumulates ozone-depleting substances. In Antarctic springtime, temperatures begin to warm and the vortex dissipates. The ozone-depleting substances, now exposed to sunlight, release large amounts of reactive molecules that significantly reduce ozone concentrations (Fahey and Hegglin 2011).

recovery period might be optimistic). The recovery is linked to impacts of climate that affect total column ozone, including: increased formation of ozone in the mid-to-upper stratosphere in response to cooling temperatures, accelerated ground-level ozone formation in the troposphere as it warms, and an accelerated Brewer-Dobson circulation increase in ozone transport in the lower stratosphere from the tropics to the mid-latitudes (WMO 2014 citing WMO 2011).

In another study, doubled CO_2 concentrations simulated by 14 climate-change models project a 2 percent increase per decade in the annual mean troposphere-to-stratosphere exchange rate. This acceleration could affect long-lived gases such as chlorofluorocarbons, CH_4, and N_2O by reducing their lifetime and increasing their removal from the atmosphere. In addition, this could increase the vertical transport of ozone concentrations from the stratosphere to the troposphere over mid-latitude and polar regions (Fahey et al. 2008 citing Butchart and Scaife 2001).

Compound Events

According to the IPCC, compound events consist of two or more extreme events occurring simultaneously or in sequence, the combination of one or more extreme events with underlying conditions that amplify the impact of the events, or combinations of events that are not themselves extremes but that collectively lead to extreme impacts when combined (IPCC 2012, IPCC 2019b). While some compound events may involve individual components that cancel one another out, others may include components with additive or even multiplicative effects (GCRP 2017). Compound events can also have societal impacts even if they occur across separate regions; for example, droughts in multiple agricultural areas could have amplifying effects on food shortages (GCRP 2017).

The underlying probability of compound events occurring may increase because of climate change, as underlying climate variables shift (GCRP 2017). Examples of shifting underlying conditions that could contribute to compound event frequency or severity include higher temperatures (of both surface and sea), increased drought risk, increased overall precipitation, and changes to oceanic circulation patterns (Cook et al. 2015, GCRP 2017, Swain et al. 2016). Climate change could also facilitate the emergence of new types of compound events by combining previously unseen physical effects (GCRP 2017). An example of this is Hurricane Sandy, which was affected by sea-level rise, anomalously high temperatures, and a so-called “blocking ridge” around Greenland that steered the storm toward the mainland and may have been caused by reduced summer sea ice in the region (GCRP 2017).

The interconnectedness of the ocean and cryosphere can also lead to a type of compounding event called a cascade, where changes in one event trigger and increase the likelihood of secondary changes in different but connected elements of the system (IPCC 2019a). For example, enhanced melting and mass loss from ice sheets creates a huge flux of freshwater and iron to the ocean, which can, in turn, have dramatic effects on ocean productivity. Similarly, increasing ocean temperatures and sea level can affect ice shelf, ice sheet, and glacier stability because of the nonlinear response of ice melt, and calving, to ocean temperatures (IPCC 2019a). In this case, small increases in ocean temperature have the potential to destabilize large sections of ice sheets and contribute to large sea-level rise changes (IPCC 2019a).

Climactic extremes in opposite directions can also form harmful compound events when occurring in sequence. For example, two major livestock and agricultural die-off events in Mongolia occurred in 1999–2002 and 2009–2010 when summer drought was immediately followed by extreme cold and heavy snowfall (IPCC 2012 citing Batjargal et al. 2001). Overall impacts of these events in Mongolia included a 33 percent loss in livestock and a 40 percent reduction in gross agricultural output as compared to previous years (IPCC 2012).

The impact of climate change on the frequency and severity of compound events remains uncertain because many climate models only address certain aspects of the climate system and cannot forecast compound events that involve combined forces from different subsystems (GCRP 2017, AghaKouchak et al. 2014). This makes the risks posed by compound events to be undervalued in modeled estimates of future climate conditions (GCRP 2017, AghaKouchak et al. 2014 citing Gräler et al. 2013).

To the extent the Proposed Action and alternatives would increase the rate of CO_2 emissions relative to the No Action Alternative, they would contribute to the general increased risk of extreme compound events. While this rulemaking alone would not cause increases in compound event frequency and severity from climate change, it would be one of many global actions that, together, could heighten these effects.

Tipping Points and Abrupt Climate Change

Tipping points refer to thresholds within Earth systems that could be triggered by continued increases in the atmospheric concentration of GHGs, incremental increases in temperature, or other relatively small or gradual changes related to climate change. Earth systems that contain a tipping point exhibit large or accelerating changes or transitions to a new physical state, which are significantly different from the rates of change or states that have been exhibited in the past, when the tipping point is crossed. A recent study suggests that passing some tipping points may increase the likelihood of occurrence of other tipping points (Cai et al. 2016). The following discussion provides examples of tipping points in Earth systems.

Atlantic Meridional Overturning Circulation (AMOC)

The AMOC is the northward flow of warm, salty water in the upper layers of the Atlantic Ocean coupled to the southward flow of colder water in the deep layers, which transports oceanic heat from low to high latitudes. If enough freshwater enters the North Atlantic (such as from melting sea ice or the Greenland ice sheet), the density-driven sinking of North Atlantic waters might be reduced or even stopped, as apparently occurred during the last glacial cycle (approximately 22,000 years ago) (Lenton et al. 2008 citing Stocker and Wright 1991). This is expected to reduce the northward flow of thermal energy in the Gulf Stream and result in less heat transport to the North Atlantic. At the same time, reduced formation of very cold water may slow global ocean circulation, leading to impacts on global climate and ocean currents. A 2018 study indicates that these effects are underway, quantifying a 15 percent weakening since the mid-20th century and an overall weakening over the past 150 years (GCRP 2018 citing Caesar et al. 2018, Thornalley et al. 2018)

IPCC reports it is *very likely* that the AMOC will weaken over the 21st century; further, it reports it is *likely* that there will be some decline in the AMOC by about 2050, but the AMOC could increase in some decades because of large natural internal variability (IPCC 2013b). IPCC also reports that it is *very unlikely* that the AMOC will undergo an abrupt transition or collapse in the 21st century (for the scenarios considered), and there is *low confidence* in assessing the evolution of the AMOC beyond the 21st century because of the limited number of analyses and equivocal results (IPCC 2013b). However, IPCC (2013b) concludes that a collapse beyond the 21st century for large sustained warming cannot be excluded.

Greenland and West Antarctic Ice Sheets

The sustained mass loss by ice sheets would cause a significant increase in sea level, and some part of the mass loss might be irreversible (IPCC 2013b). For example, under 2°C (3.6°F), about one-third of the Antarctic ice sheet and three-fifths of the Greenland ice sheet would be lost (GCRP 2018a citing Clark et al. 2016). Similarly, there is *high confidence* that sustained warming greater than some threshold would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea-level rise of up to 7 meters (29 feet). Current estimates indicate that the threshold is more than about 1°C (1.8°F) (*low confidence*) but less than about 4°C (7.2°F) (*medium confidence*) global mean warming with respect to preindustrial levels. The temperature range of 1.5-2°C (2.7-3.6°F) presents a moderate risk of triggering marine ice sheet instability in Antarctica or irreversible loss of the Greenland ice sheet (IPCC 2018).

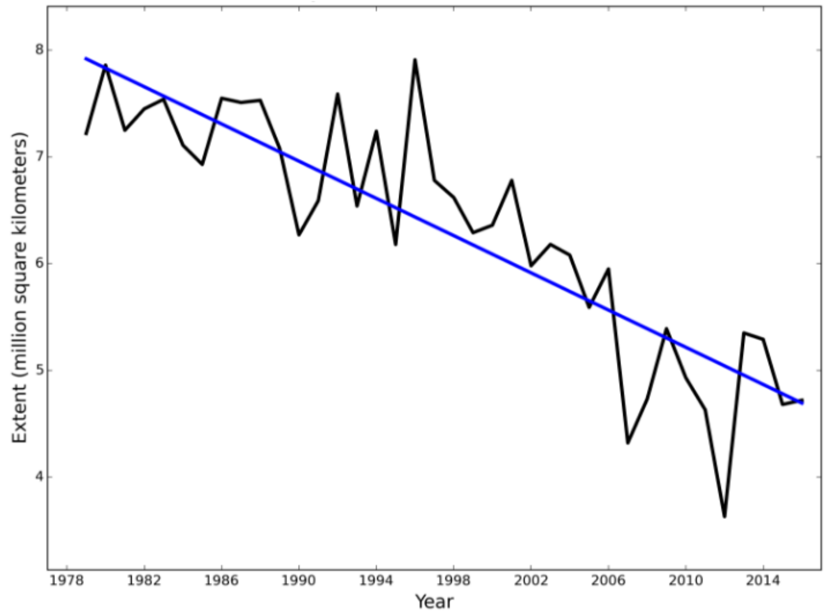
Of particular concern is the potential for abrupt increases in sea-level rise from rapid destabilization and ice loss from glaciers and ice streams grounded on bedrock below sea level. For these glaciers, warming oceans melt and erode the base and cause the ice to float, accelerating losses. In Greenland, most areas of deep water contact between ice sheets and the ocean are limited to narrow troughs and fjord systems that constrict rapid flow into ocean basins, making the likelihood of rapid destabilization during this century low (NRC 2013b).

Abrupt and irreversible ice loss from a potential instability of marine-based (as opposed to land-based) sectors of the Antarctic ice sheet (i.e., ice shelves) in response to climate change is possible, but current evidence and understanding is insufficient to make a quantitative assessment (IPCC 2013b, NRC 2013b, Hansen et al. 2013). That said, two studies (Joughin et al. 2014, Rignot et al. 2014) published since the IPCC (2013a) assessment report indicate that West Antarctic ice shelves have been accelerating their melt in recent decades, that this increase is projected to continue, and that there is little in the regional geography to stop them from an eventual full decline (i.e., an irreversible collapse) as they retreat into deeper water. A recent study by Mengel and Levermann (2014) demonstrates the potential irreversibility of marine-based ice sheet loss and the presence of thresholds beyond which ice loss becomes self-sustaining.

Arctic Sea Ice

Since satellite observations of Arctic sea ice began in 1978, a significant decline in the extent of summer sea ice has been observed, with the record minimum extent—a decrease of more than 40 percent in September, i.e., the month when the minimum in the sea-ice extent typically occurs—recorded in 2012 (Figure 8.6.5-2) (GCRP 2017). IPCC (2013b) suggests that anthropogenic influences have *very likely* contributed to these Arctic sea-ice losses since 1979, and that it is *very likely* that the Arctic sea-ice cover will continue to shrink and thin.

Figure 8.6.5-2. Average Monthly Arctic Sea-Ice Extent (September 1979–2016)[a]



Source: NSIDC 2016
[a] Ice extent for each September plotted as a time series based on the 1979 to 2016 data. The black line connects the ice extent data points and the trend line is plotted with a blue line.

Rising temperatures are reducing ice volume and surface extent on land, lakes, and sea, with this loss of ice expected to continue. The Arctic Ocean is expected to become essentially ice free in summer before mid-century under future scenarios that assume continued growth in global emissions, although sea ice would still form in winter (GCRP 2017 citing IPCC 2013a and Snape and Forster 2014; NRC 2013b). Based on an assessment of the subset of models that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea-ice extent, a nearly ice-free Arctic Ocean in September before mid-century is *likely* for the higher (RCP8.5) scenario (*medium confidence*). A projection of when the Arctic might become nearly ice-free in September in the 21st century cannot be made with confidence for the other scenarios (IPCC 2013b).

Sea ice loss contributes to positive feedback by changing the albedo of the Arctic's surface, affecting formation of ice the next winter (GCRP 2018a citing Abe et al. 2016, Pedersen et al. 2016, and Post et al. 2013). Larger areas of open water in the Arctic during the summer will affect the Arctic climate, ecosystems, and human activities in the Northern Hemisphere; these impacts on the Arctic could potentially be large and irreversible. Less summer ice could disrupt the marine food cycle, alter the habitat of certain marine mammals, and exacerbate coastline erosion. For instance, sea ice is the primary habitat for polar bears. Polar bear movements are closely tied to the seasonal dynamics of sea-ice extent, and the loss of sea-ice habitat due to climate change is a primary threat to polar bears (USFWS 2016). Reductions in summer sea ice will also increase the navigability of Arctic waters, opening up opportunities for shipping and economic activities, but also creating new political and legal challenges among circumpolar nations (NRC 2013b).

Irreversibility of Anthropogenic Climate Change Resulting from Carbon Dioxide Emissions

A large fraction of anthropogenic climate change resulting from CO_2 emissions (e.g., global mean temperature increase, and a decrease in ocean pH) is irreversible on a multi-century to millennial time scale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period (IPCC 2013b). Surface temperatures will remain approximately constant at elevated levels for many centuries after a complete cessation of net anthropogenic CO_2 emissions. Because of the long time scales of heat transfer from the ocean surface to depth, ocean warming will continue for centuries (IPCC 2013a). A recent study indicates that the Earth may be approaching an approximate 2°C threshold after which the system as a whole would be locked into a rapid pathway toward much hotter conditions that would be accelerated by self-reinforcing feedbacks (Steffen et al. 2018).

Delaying Mitigation

Several studies have shown that delaying mitigation of GHG emissions results in a greater accumulation of CO_2 in the atmosphere, thereby increasing the risk of crossing tipping points and triggering abrupt changes (Anderson and Bows 2011, Friedlingstein et al. 2011, UNEP 2011, van Vuuren et al 2011, Ranger et al. 2012).

Increases in the Risk of Extinction for Marine and Terrestrial Species

The rate of climate change is increasing the risk of extinction for a number of marine and terrestrial species (NRC 2013b). Climate change can cause abrupt and irreversible extinctions through four known mechanisms (NRC 2013b):

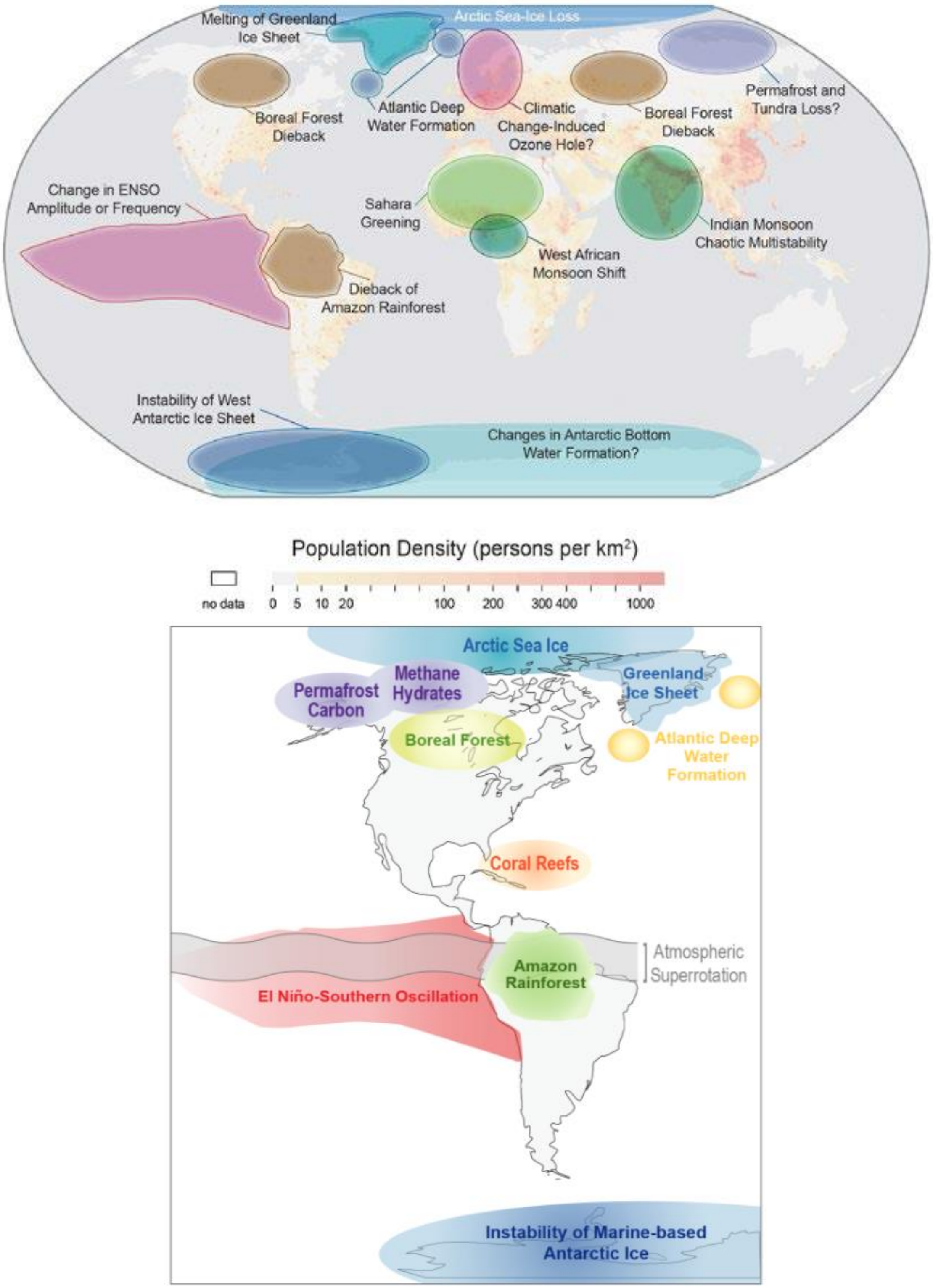
- Direct impacts from an abrupt event, such as flooding of an ecosystem through a combination of storm surge and sea-level rise.
- Incremental climatic changes that exceed a threshold beyond which a species enters decline, for example, pikas and ocean coral populations are close to physiological thermal limits.
- Adding stress to species in addition to nonclimatic pressures such as habitat fragmentation, overharvesting, and eutrophication.
- Biotic interactions, such as increases in disease or pests, loss of partner species that support a different species, or disruptions in food webs after the decline of a keystone species.

It is expected that some species will become extinct or fall below viable numbers in the next few decades (NRC 2013b). IPCC states that there is *high confidence* that a large fraction of species faces increased extinction risk due to climate change during the 21st century and beyond (IPCC 2014a).

Additional Tipping Points

GCRP (2017) and NRC (2013b) indicate a number of other potential tipping points (Figure 8.6.5-3), which are described in this section.

Figure 8.6.5-3. Potential Tipping Points



Source: GCRP 2017 adapted from Lenton et al. 2008
km^2 = square kilometer

- **El-Niño-Southern Oscillation (ENSO).** It is *likely* that regional rainfall variability due to ENSO will increase over the 21st century; however, confidence in the amplitude and spatial pattern of ENSO remains low (IPCC 2013b). In the United States, the rainfall variability associated with ENSO events will *likely* move eastward in the future (IPCC 2013a). Research indicates that the frequency of extreme El Niño events increases linearly with global mean temperature; under 1.5°C of temperature warming, the number of extreme El Niño events could double (IPCC 2018 citing Wang et al. 2017).
- **Amazon rainforest.** Deforestation, reductions in precipitation, a longer dry season, and increased summer temperature could contribute to accelerated forest dieback. Important additional stressors also include forest fires and human activity (such as land clearing) (Lenton et al. 2008). In general, studies agree that future climate change increases the risk of the tropical Amazon forest being replaced by seasonal forest or savannah (IPCC 2013a citing Huntingford et al. 2008, Jones et al. 2009, Malhi et al. 2009).
- **Boreal forest.** The dieback of boreal forest could result from a combination of increased heat stress and water stress, leading to decreased reproduction rates, increased disease vulnerability, and subsequent fire. Although highly uncertain, studies suggest a global warming of 3°C (5.4°F) could be the threshold for loss of the boreal forest (Lenton et al. 2008). Models indicate that under a high emissions scenario (RCP8.5), even without water stress, additional heat could transition the boreal forests into a net CO_2 source (Helbig et al. 2017).
- **Release of methane hydrates and permafrost and tundra loss.** A catastrophic release of CH_4 to the atmosphere from clathrate hydrates[31] in the seabed and permafrost, and from northern high-latitude and tropical wetlands, has been identified as a potential cause of abrupt climate change (GCRP 2017). The size of the CH_4 hydrate reservoir in the arctic is estimated to be between 500 and 3,000 gigatons of carbon potentially being equivalent to 82,000 gigatons CO_2 (assuming the hydrates are released in that state) (GCRP 2017). However, uncertainty exists in the sensitivity of these carbon reservoirs—as measured by the rate of carbon release from stored hydrates per unit of warming—to a changing climate (Mestdagh et al. 2017). These reserves will probably not reach the atmosphere in sufficient quantity to affect climate significantly over the next century (GCRP 2017). Permafrost stores hold an additional estimated 1,300 to 1,600 gigatons of carbon, about 5 to 15 percent of which is vulnerable to being released in the coming century (GCRP 2017 citing Schuur et al. 2015). It is very likely that emissions from thawing permafrost are amplifying carbon emissions and will continue to do so (GCRP 2018a citing Schaefer et al. 2014, Koven et al. 2015, Schuur et al. 2015; Yumashev et al. 2019). Past research warns that these tundra sources could cause an abrupt release of carbon, causing dramatic warming in the atmosphere (Hansen et al. 2013, NRC 2013b), but more recent literature suggests that the most probable process is a gradual and prolonged release of carbon (Schuur et al. 2015, Mestdagh et al. 2017). These estimates of a slow emissions rate from permafrost and hydrates may be incorrect if anthropogenic GHG emissions cause the Earth to warm at a faster rate than anticipated (GCRP 2017).

To the extent that the Proposed Action and alternatives would increase the rate of CO_2 emissions relative to the No Action Alternative, they could contribute to the marginal increase or acceleration of reaching these tipping-point thresholds. Moreover, while this rulemaking alone would not cause CO_2

[31] Clathrate hydrates are *inclusion compounds* in which a hydrogen-bonded water framework—the host lattice—traps guest molecules (typically gases) within ice cages. Naturally occurring gas hydrate on Earth is primarily methane hydrate and forms under high pressure–low temperature conditions in the presence of sufficient methane (GCRP 2014 citing Brook et al. 2008).

emissions to reach the tipping-point thresholds, it would be one of many global actions that, together, could contribute to abrupt and severe climate change.

8.6.5.3 Regional Impacts of Climate Change

In response to the MY 2017–2025 CAFE Standards Draft EIS, NHTSA received a public comment on Section 9.3.2.1 noting that, "with regard to climate change, regional impacts are likely to be particularly relevant to the public." The comment further encouraged NHTSA to include regional models and information contained in state or regional assessments for each region of the U.S. to illustrate how changes in transportation-related GHG emissions can influence regional climate impacts. In addressing the health, societal, and environmental impacts of climate change in the MY 2017–2025 CAFE Standards Final EIS (NHTSA 2012) and in the Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS (NHTSA 2016c), NHTSA included a qualitative assessment of the regional impacts of climate change.

NHTSA recognizes the public's interest in understanding the potential regional impacts of climate change; these impacts are discussed at length in panel-reviewed synthesis and assessment reports from IPCC (at the continent scale), and GCRP (at the U.S. regional scale). In addition to including this material in NHTSA's prior EISs, the Fourth National Climate Assessments (GCRP 2017, 2018a) provide this very regional analysis, reporting observations and projections for climatic factors (GCRP 2017), and the regional and sectoral impacts of climate change (Section 8.6.5.2, *Sectoral Impacts of Climate Change*) for each region of the United States (GCRP 2014). The regions addressed in the Fourth National Climate Assessment (GCRP 2018) include the Northeast, Southeast, U.S. Caribbean, Midwest, Northern Great Plains, Southern Great Plains, Northwest, Southwest, Alaska, and Hawaii and U.S. Affiliated Pacific Islands. Additionally, individual states, such as California, have completed in-depth local climate change assessments (Bedsworth et al. 2018).

In the NEPA context, there are limits to the utility of drawing from assessments to characterize the regional climate impacts of the Proposed Action and alternatives. The existing assessment reports do not have the resolution necessary to illustrate the effects of this action, because they typically assess climate change impacts associated with emissions scenarios that have much larger differences in emissions—generally between one and two orders of magnitude greater than the difference between the No Action Alternative in 2100 and the emissions increases associated with all the action alternatives in 2100. The differences between the climate change impacts of the Proposed Action and alternatives are far too small to address quantitatively in terms of their impacts on the specific resources of each region. Attempting to do so may introduce uncertainties at the same magnitude or more than the projected change itself (i.e., the projected change in regional impacts would be within the noise of the model). Agencies' responsibilities under NEPA involve presenting impacts information that would be useful, relevant to the decision, and meaningful to decision-makers and the public.

For a qualitative review of the projected impacts of climate change on regions of the United States, readers may consult Section 5.5.2 of the MY 2017–2025 CAFE Standards Final EIS (NHTSA 2012), Section 5.5.2 of the Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS (NHTSA 2016c), and the Third and Fourth National Climate Assessments (GCRP 2014, 2017,2018a). These assessments demonstrate that the impacts of climate change vary at the regional and local level, including in strength, directionality (particularly for precipitation), and particularity. These variations reflect the unique environments of each region, the differing properties of the sectors and resources across regions, the complexity of climatic forces, and the varied degrees of human adaptation across the United States. However, the overall trends and impacts across the United States for each climate parameter and resource area are consistent with the trends and impacts described in Section 8.6.5.2, *Sectoral Impacts of Climate Change.* Because the Proposed Action and alternatives are projected to result in only very minor increases in global CO_2 concentrations and associated impacts, including changes in temperature, precipitation, sea level, and ocean pH, as compared to the No Action Alternative, the climate impacts projected in those reports would be expected to increase only to a marginal degree.

CHAPTER 9 MITIGATION

The CEQ regulations implementing NEPA require that the discussion of alternatives in an EIS "[i]nclude appropriate mitigation measures not already included in the proposed action or alternatives."[1] An EIS should discuss the "[m]eans to mitigate adverse environmental impacts."[2] As defined in the CEQ regulations, mitigation includes the following actions:[3]

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

Under NEPA, an agency does not have to formulate and adopt a complete mitigation plan[4] but should analyze and consider all reasonable measures that could be adopted. This chapter provides an overview of the impacts associated with the Proposed Action and alternatives (Section 9.1, *Overview of Impacts*) and then discusses potential mitigation measures that would reduce those impacts (Section 9.2. *Mitigation Measures*). The chapter also addresses those impacts that would remain after mitigation (Section 9.3, *Unavoidable Adverse Impacts*), short-term commitments of resources and implications for long-term productivity (Section 9.4, *Short-Term Uses and Long-Term Productivity*), and commitments of resources to comply with the standards (Section 9.5, *Irreversible and Irretrievable Commitments of Resources*).

9.1 Overview of Impacts

Compared to the No Action Alternative, the Proposed Action and alternatives would increase fuel consumption and greenhouse gas (GHG) emissions. As seen in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, the Proposed Action and alternatives would marginally increase the impacts of climate change that would otherwise occur under the No Action Alternative. As reported in Chapter 4, *Air Quality*, aggregate emissions of criteria air pollutants in 2025 (with the exception of particulate matter less than 2.5 microns in diameter [PM2.5] and volatile organic compounds [VOCs]) are generally anticipated to decrease and aggregate emissions of most hazardous air pollutants (with the exception of diesel particulate matter) are generally expected to decrease under the Proposed Action and alternatives as compared to the No Action Alternative. In 2035 and 2050, aggregate emissions of criteria air pollutants (with the exception of sulfur dioxide) are generally anticipated to increase and aggregate emissions of hazardous air pollutants are generally expected to increase under the Proposed Action and alternatives as compared to the No Action Alternative.

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[1] 40 CFR § 1502.14(f).

[2] 40 CFR § 1502.16(h).

[3] 40 CFR § 1508.20.

[4] *Northern Alaska Environmental Center v. Kempthorne*, 457 F.3d 969, 979 (citing *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989) (noting that NEPA does not contain a substantive requirement that a complete mitigation plan be actually formulated and adopted)). See also *Valley Community Preservation Comm'n v. Mineta*, 231 F. Supp. 2d 23, 41 (D.D.C. 2002) (noting that NEPA does not require that a complete mitigation plan be formulated and incorporated into an EIS).

In 2025, compared to the No Action Alternative, most nonattainment areas would experience decreases in emissions of carbon monoxide (CO) and nitrogen oxides (NOx) and increases in emissions of PM2.5, sulfur oxides (SO_x), and VOCs. In 2035 and 2050, compared to the No Action Alternative, most nonattainment areas would experience decreases in emissions of SO_x and increases in emissions of CO, NO_x, PM2.5, and VOCs.

Compared to the No Action Alternative, adverse health effects under the Proposed Action and alternatives are estimated to increase from 2025 to 2035, but decrease from 2035 to 2050, except that health effects would decrease under Alternative 6 in all years (Chapter 4, *Air Quality*). Nationally, for those pollutant emissions projected to increase under the Proposed Action and alternatives, there would be a slight decrease in the rate of reduction otherwise achieved by implementation of Clean Air Act (CAA) emissions standards for criteria pollutants and toxic air pollutants. Conversely, for those pollutant emissions projected to decrease under the Proposed Action and alternatives, there would be a slight increase in the rate of reduction otherwise achieved through CAA emissions standards. Some nonattainment areas in the United States could experience emissions decreases for some pollutants under certain alternatives and analysis years, while other areas could experience increases. These differences are attributed to the complex interactions between tailpipe emission rates of the various vehicle types, the technologies NHTSA assumes manufacturers will incorporate to comply with the standards, upstream emissions rates, the relative proportion of gasoline and diesel in total fuel consumption, and changes in vehicle miles traveled (VMT) from the rebound effect.

9.2 Mitigation Measures

CEQ regulations concerning mitigation refer to mitigation measures that the lead agency can include to mitigate potential adverse impacts. In this case, NHTSA does not have the jurisdiction to regulate the specified pollutants that are projected to increase as a result of the Proposed Action and alternatives. Furthermore, NHTSA's statutory authority requires balancing several statutory factors to set maximum feasible fuel economy standards (Chapter 1, *Purpose and Need for the Action*). NHTSA considers environmental impacts (as described in this EIS) as part of its balancing of those factors, thereby limiting the degree or magnitude of the action as appropriate.

Still, the potential negative impacts of the Proposed Action and alternatives could be mitigated through other means by other federal, state, or local agencies. Examples of mitigation measures include further EPA criteria pollutant emissions standards for passenger cars and light trucks, incentives for the purchase of more fuel efficient vehicles, mechanisms to encourage the reduction of VMT (such as increases in public transportation or economic incentives similar to increased taxation on fuel consumption), and funding to provide air filtration for residences adjacent to highways. Any of these mitigation actions at the federal and state levels would affect environmental and health impacts by reducing fuel use and/or exposure to associated emissions. A reduction of VMT would decrease fuel usage and emissions of criteria and toxic air pollutants, which would reduce the negative health impacts of the Final Action and alternatives. A reduction in VMT also would decrease GHG emissions, which would lead to an incremental positive impact on global climate change. Programs to encourage reductions in VMT can include pricing strategies (e.g., increases in fuel taxes, higher tolls on bridges and roads, higher tolls during peak hours, and mileage-based fees that some states are considering as a replacement for fuel taxes); infill development (i.e., grants or other efforts to encourage more dense urban housing development in areas that are a short walk from public transit); transportation investments in bicycling and walking paths that can also serve as transportation/commuting routes; transit system investments; and transportation demand management (e.g., programs that encourage ridesharing and teleconferencing and other telework) (Byars et al. 2017).[5]

9.3 Unavoidable Adverse Impacts

As demonstrated in Chapter 3, *Energy*, and Chapter 4, *Air Quality*, the Proposed Action and alternatives are projected to result in an increase in energy consumption, and mixed increases and decreases in criteria pollutant and hazardous air pollutant emissions, compared to the No Action Alternative. Although decreases in VMT under the Proposed Action and alternatives as compared to the No Action Alternative are anticipated, these VMT decreases would be offset by the decreases in fuel economy associated with the Proposed Action and alternatives, resulting in a net increase in energy consumption and a net increase in some pollutant emissions compared to the No Action Alternative. Increases in some pollutant emissions could also have additional adverse impacts on human health; thus, overall U.S. health impacts associated with air quality (e.g., mortality, asthma, bronchitis, emergency room visits, and work-loss days) are anticipated to increase across the Proposed Action and alternatives as compared to the No Action Alternative (except for Alternative 6). These increases in energy consumption, pollutant emissions, and human health impacts are not unavoidable adverse impacts, however, as they could be offset by emissions regulations, changes in consumer behavior (e.g., changing driving patterns or increased consumer demand for electric vehicles [EVs]), fluctuations in the energy market, or other future activities.

As discussed in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, certain impacts, such as increased global mean surface temperature, sea-level rise, and increased precipitation, could occur because of accumulated total GHG emissions in Earth's atmosphere. These impacts could be further exacerbated to a very small degree under the Proposed Action and alternatives as compared to the No Action Alternative. As described in Section 5.4, *Environmental Consequences,* the Proposed Action and alternatives would increase GHG emissions compared to the No Action Alternative, thereby marginally increasing anticipated climate change impacts.

9.4 Short-Term Uses and Long-Term Productivity

The Proposed Action and alternatives would result in an increase in crude oil consumption and a marginal increase in GHG emissions (and associated climate change impacts) compared to the No Action Alternative. To meet the final standards, manufacturers may apply various fuel-saving technologies during the production of passenger cars and light trucks. NHTSA cannot predict with certainty which specific technologies and materials manufacturers would apply or in what order. Some vehicle manufacturers may commit additional resources to existing, redeveloped, or new production facilities to meet the standards, although NHTSA cannot predict with certitude what actions manufacturers may take. For further discussion of the costs and benefits of the final rule, consult NHTSA's Final Regulatory Impact Analysis (FRIA).

[5] As none of these potential mitigation strategies are within the statutory jurisdiction of NHTSA, the agency takes no position on their relative merits or appropriateness. NHTSA provides these mitigation strategies for informational purpose only.

9.5 Irreversible and Irretrievable Commitments of Resources

As noted in Chapter 7, *Other Impacts*, some vehicle manufacturers may commit additional resources to existing, redeveloped, or new production facilities to meet the fuel economy standards. In some cases, this could represent an irreversible and irretrievable commitment of resources. The specific amounts and types of irretrievable resources (such as electricity or other forms of energy) that manufacturers would expend in meeting the final standards would depend on the technologies and materials manufacturers select.

CHAPTER 10 RESPONSES TO PUBLIC COMMENTS

On August 10, 2018, EPA published a Notice of Availability of the Draft EIS in the *Federal Register* (83 FR 39750). In accordance with CEQ NEPA implementing regulations, the Notice of Availability triggered a public comment period.[1] NHTSA invited the public to submit comments on the Draft EIS to Docket No. NHTSA–2017–0069 until September 24, 2018. The comment period for the Draft EIS was later extended to October 26, 2018, in order to align with the comment period for the rulemaking and provide additional opportunity for public feedback. NHTSA mailed approximately 1,200 letters notifying interested parties of the availability of the Draft EIS. As listed in Draft EIS Chapter 11, *Distribution List*, these parties included federal, state, and local officials and agencies; elected officials; environmental and public interest groups; Native American tribes; manufacturers, and other interested parties.

On August 24, 2018, NHTSA and EPA published in the *Federal Register* the proposed rule for the Safer Affordable Fuel-Efficient (SAFE Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks [83 FR 42986]). Publication of the proposed rule opened a 60-day comment period, and the public was invited to submit comments on or before October 23, 2018, by posting to either the NHTSA or EPA docket (NHTSA–2018–0067 or EPA–HQ–OAR–2018–0283). The comment period for the proposed rulemaking was later extended to October 26, 2018.[2]

NHTSA and EPA also held public hearings on the Draft EIS and the proposed rule on September 24, 2018, in Fresno, California; on September 25, 2018, in Dearborn, Michigan; and on September 26, 2018, in Pittsburgh, Pennsylvania. NHTSA received statements from 109 individuals at the hearing in Fresno, of which 70 provided only oral statements, 3 provided only written statements, and 36 provided both oral and written statements. At the Dearborn hearing, NHTSA received statements from 115 individuals, of which 60 provided only oral statements, 4 provided only written statements, and 51 provided both oral and written statements. The Pittsburgh hearing collected statements from 107 individuals, of which 27 provided oral statements only, one provided only a written statement, and 79 provided both oral and written statements. The agency also received hundreds of thousands of comments in the dockets for the Draft EIS and the NPRM. NHTSA reviewed the oral and written submissions for comments relevant to the EIS.

In preparing this Final EIS, NHTSA reviewed comments received in EIS Docket No. NHTSA–2017–0069 and comments relevant to the EIS submitted to the NHTSA and EPA rulemaking dockets (NHTSA–2018–0067 or EPA–HQ–OAR–2018–0283). NHTSA considered and evaluated all written and oral comments received during the public comment period in the preparation of this Final EIS. In this chapter of the Final EIS, NHTSA has quoted substantive excerpts from these comments and responded to the comments, as required by NEPA (40 CFR § 1503.4). For purposes of republication, NHTSA has removed footnotes from comments except when they contain substantive statements provided by the commenter. Although not republished in this chapter, when footnotes provided citations to relevant reference material, NHTSA reviewed that material and considered whether it warranted revisions to the

[1] In addition, the Draft EIS was made available on NHTSA's fuel economy website on August 2, 2018, and in the agency's rulemaking and EIS dockets (Docket Nos. NHTSA-2018-0067 and NHTSA-2017-0069) on August 3, 2018. This occurred simultaneously with the posting of the NPRM (which also invited public comment) on the agency's website and rulemaking docket, and it received considerable media coverage. The Draft EIS explicitly invited public comments, and the docket was open to receive such comments immediately upon posting of the Draft EIS.

[2] Although the comment periods for the NPRM and Draft EIS formally closed on October 26, 2018, the NHTSA and EPA dockets remained open, and the agencies continued to accept and consider comments, to the extent possible, for more than 1 year after the comment period began.

EIS (see Appendix B, *Sources Identified in Public Comments*). The agency updated the EIS in response to comments on the rule and Draft EIS and based on updated information that became available after the agency issued the Draft EIS.

Those comments submitted to both the NHTSA and EPA dockets that were not substantive to specific aspects of the EIS were approached as follows:

- The agencies received comments directly addressing or otherwise related to the proposed rule or PRIA under the rulemaking dockets (NHTSA–2018–0067 or EPA–HQ–OAR–2018–0283) and the EIS docket (NHTSA–2017–0069). Topics of these comments included technology cost and effectiveness, economic impacts of the rule, harmonization of the agencies' rules, balancing the Energy Policy and Conservation Act of 1975 (EPCA) statutory criteria, and the underlying assumptions in the CAFE model. NHTSA has reviewed all of the comments but includes and addresses only those comments (or portions of those comments) considered substantive to the EIS in this chapter. NHTSA addresses comments that concern the rule but that are not substantive to the EIS in the preamble to the final rule and its associated documents in the public docket.
- The agencies received oral and written comments stating either general support for or general opposition to the proposed rule. NHTSA appreciates those comments, but because they do not raise specific issues or concerns pertaining to the EIS, this chapter does not respond to those comments. This chapter responds to comments specific to the EIS or to those that substantively addressed EIS analytical methods or approaches.

Transcripts from the public hearings and written comments submitted to NHTSA are part of the administrative record and are available on the Federal Docket at http://www.regulations.gov, Reference Docket No.: NHTSA–2017–0069 (EIS) and NHTSA–2018–0067 or EPA–HQ–OAR–2018–0283 (rulemaking).

Table 10-1 lists the topics addressed in this chapter. Sections 10.1 through 10.9 provide relevant comments on the Draft EIS and the proposed rule and NHTSA's responses to those comments.

Table 10-1. Outline of Issues Raised in Public Comments on the Draft EIS

10.1.	**Purpose and Need for the Proposed Action**
10.1.1	Purpose and Need Statement
10.1.2	NEPA Process
10.1.3	Agency Consultation
10.1.4	Public Participation and Comment
10.1.5	Document Structure and Readability
10.2	**Proposed Action and Alternatives**
10.2.1	Proposed Action
10.2.2.1	No Action Alternative/Baseline (Alternative 0)
10.2.2.2	Reasonable Range of Alternatives
10.2.2.2.1	Suggestions for More Stringent Alternatives
10.2.2.3	Suggestions for Other Alternatives
10.2.2.4	Comparison of Alternatives
10.2.2	No Action and Action Alternatives
10.2.3	Analysis Methods

10.1 Purpose and Need for the Proposed Action

10.1.1 Purpose and Need Statement

Comment

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Under NEPA, a federal agency must include a statement explaining the underlying purpose and need to which the agency is responding to in proposing an action and its alternatives. *See* 40 C.F.R. § 1502.13. Generally, the purpose and need statement is dictated by "the views of Congress," based on "the agency's statutory authorization to act, as well as other congressional directives." *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991). A federal agency "must look hard at the factors relevant to the definition of purpose," *ibid*, and define its objectives broadly enough to avoid unreasonably narrowing the scope of the action and alternatives for consideration. *See, e.g., League of Wilderness Defs.-Blue Mountains Biodiversity Project v. U.S. Forest Serv.*, 689 F.3d 1060, 1069 (9th Cir. 2012). Here, in proposing to rollback fuel standards for model years (MY) 2021 to 2026 light-duty vehicles, NHTSA has abdicated its statutory duty to promote energy efficiency and conservation.

The Energy Policy and Conservation Act ("EPCA") was enacted in 1975 to establish a comprehensive and systematic national energy policy to increase domestic energy production and supply, reduce energy demand, foster the more efficient use of energy, and, most importantly, promote energy conservation. *See e.g.*, Pub. L. No. 94-163, §2, 89 Stat. 871 (1975) (stating that the purpose of EPCA is to conserve energy supplies through energy conservation programs, and where necessary, to regulate certain energy uses, and provide for improved energy efficiency of motor vehicles.). EISA, which amended EPCA to provide additional requirements for NHTSA, confirmed that the statute's purpose is "[t]o move the United States toward greater independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles…" Pub. L. No. 110- 140, 121 Stat. 1492 (2007). To further the goal of energy conservation, EPCA requires NHTSA to establish standards for automobiles reflecting the "maximum feasible" average fuel economy level for each vehicle model year considering "technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy." 49 U.S.C. § 32902(a),(f).[3] EPCA does not mandate a specific balancing test; rather, it provides a list of relevant considerations to help inform NHTSA in setting the "maximum feasible" level. In determining what weight to give each factor, NHTSA's discretion is limited by EPCA's fundamental statutory purpose: energy conservation. *See Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1195 (9th Cir. 2008) ("CBD v. NHTSA").

In 2012, NHTSA issued binding CAFE standards for MY 2017 through 2021 vehicles under EPCA. The agency also published "augural" standards for MY2022-2025, which "represent[ed] the agency's current judgment, based on the information available to the agency today, of what levels of stringency would be maximum feasible in those model years." Now, NHTSA states that in accordance with EPCA and EISA,

[3] As discussed in the States and Cities Proposed Rollback Comments and CARB's Proposed Rollback Comments, the rigor of the CAFE standards must also reflect harmonization with EPA's stringent goals in the Clean Air Act context. See *Massachusetts v. EPA*, 549 U.S. 497, 531-532 (2007) ("*Mass v. EPA*").

"the purpose of the rulemaking" is to establish CAFE standards for MY 2021 to 2026 for passenger cars and light trucks at the "maximum feasible average fuel economy level that the Secretary of Transportation decides the manufacturers can achieve in that model year." Further, the Agency states that, "based on different ways the agency could weigh EPCA's four statutory factors, the maximum feasible level of CAFE stringency falls within the range of alternatives under consideration." The DEIS then references the notice of proposed rulemaking for the Proposed Rollback for a "full discussion of the agency's balancing of the statutory factors related to the maximum feasible standards."

As detailed below, NHTSA's balance of the EPCA factors overrides the statute's fundamental purpose through new and erroneous interpretations of those factors in a way that narrowly defines or even redefines its objectives, ignoring crucial aspects of the problem the agency is required by statute to address, reaching conclusions that run counter to the evidence before the agency, and offering explanations that are simply implausible. The States and Cities incorporate by reference Section III. D. of the States and Cities' Proposed Rollback Comments, but emphasize the following:

The Need of the United States to Conserve Energy: Traditionally, NHTSA has evaluated "the need of the Nation to conserve energy" by considering "the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum." In the DEIS, NHTSA arrives at arbitrary conclusions by disregarding environmental impacts (see *infra* Section II.D.) mischaracterizing the United States' exposure to global oil market volatility, failing to accurately consider consumer costs, and ignoring the fundamental fact that the Proposed Rollback will result in greater use of petroleum, thus increasing our nation's dependence on oil.

Technological feasibility: NHTSA concedes that the augural standards are technologically feasible. Nevertheless, NHTSA has unreasonably reinterpreted this statutory factor in a manner contrary to EPCA's purpose of encouraging technological development. Indeed, fuel economy standards under EPCA are "intended to be technology forcing, with the recognition that 'market forces...may not be strong enough to bring about the necessary fuel conservation which a national energy policy demands.'" *Center for Auto Safety*, 793 F.2d at 1339, citing S. Rep. No. 179, 94th Cong., 1st Sess. 2 (1975), U.S.C.C.A.N. 1975 at 9. However, the Proposed Rollback's preferred alternative requires no year-over-year improvement in fuel economy standards for at least six years, resulting in no technology forcing whatsoever. Alternatives 2 through 8, require severely pared back and slightly increased fuel economy over time, also resulting in no technology-forcing given NHTSA's concession that the technology already exists that could meet the augural standards. NHTSA is impermissibly and unreasonably interpreting this factor in a manner contrary to the plain meaning of "feasibility," and ignoring EPCA's technology- forcing purpose.

Economic Practicability: NHTSA has utterly failed to analyze the economic practicability of the Proposed Rollback by failing to consider significant job losses and other economic harms that would result from the proposal, erroneously reinterpreting the factor to put an unreasonable amount of weight on consumer choice, considering unrelated concerns about safety, and relying on fundamentally flawed economic inputs and assumptions.

The Effect of Other Motor Vehicle Standards on Fuel Economy: In the Proposed Rollback, NHTSA has posited an unsupportable interpretation of EPCA that "State tailpipe standards (whether for GHGs or for other pollutants) do not qualify as 'other motor vehicle standards of the Government'" under the statute. This proposed interpretation contravenes the statute, case law, and the agency's past practice.

Safety: NHTSA has historically considered safety impacts when setting maximum feasible standards. *CBD v. NHTSA*, 538 F.3d at 1204. But in the Proposed Rollback, NHTSA departs from its past practice by relying on novel and unsupported theories regarding the linkages between fuel economy and safety that do not reflect reality. In the past, NHTSA has considered the safety of the technologies that improve fuel economy. See 77 Fed. Reg. at 62,670; 75 Fed. Reg. at 25,556-57; 68 Fed. Reg. at 16,870. In the Proposed Rollback, however, NHTSA has linked safety concerns with rebound and scrappage effects of increased fuel standards. 83 Fed. Reg. at 43,209, 43,212. As discussed in Section II.B., these theories are unsupported, implausible, and contradicted by numerous experts—rendering them arbitrary and capricious. The agency has also failed to acknowledge or adequately justify its break with past analyses of safety.

Further, NHTSA's emphasis on safety is inconsistent with the agency's failure to take more direct and effective steps toward improving vehicle safety. According to the Consumers Union, "DOT and NHTSA have failed to finalize numerous safety efforts begun under their own initiative prior to 2017, as well as at least 11 overdue vehicle safety rules required by Congress." In addition, NHTSA's position regarding safety is inconsistent with the agency's apparent lack of concern that automakers might "globalize a vehicle platform" in response to more stringent fuel standards in other countries, which would in theory lead to the same safety risks NHTSA has identified. 83 Fed. Reg. at 43,211. NHTSA does not explain these inconsistencies, which render its analysis arbitrary and capricious.

The Proposed Rollback, and NHTSA's proposed reinterpretation of the "maximum feasible" statutory language that underlies it, flies in the face of the unambiguous text, structure, and purpose of EPCA. And even assuming *arguendo* that some ambiguity exists, NHTSA's interpretation of "maximum feasible" in the Proposed Rollback is "manifestly contrary" to EPCA's primary purpose of energy conservation, and is, therefore, an unreasonable and improper interpretation of the statute. Hence, the DEIS's definition of the purpose and need for the Proposed Rollback is fatally flawed.

Response

The commenters frame their comment as NHTSA having improperly defined the "purpose and need" of its proposed action in its Draft EIS. In actuality, the comment relates entirely to NHTSA's balancing of the EPCA statutory factors on the basis of the analysis supporting its proposal, as explained in the Notice of Proposed Rulemaking (NPRM). Although NHTSA's EIS restated the statutory factors and NHTSA's "interpretation" of those factors (specifically, by providing the definitions in the NPRM that reflect NHTSA's longstanding interpretation of those factors), the commenters do not reference misstatements in any of the text provided in the Draft EIS itself. In fact, NHTSA's discussion of the "purpose and need" of the action does not balance the factors, nor does it provide the substantive analysis to which the commenters refer. Rather, the commenters dispute aspects of the agency's underlying analysis (in almost all cases, elements that are presented in the NPRM and Preliminary Regulatory Impact Analysis (PRIA) and not in the Draft EIS), the weight NHTSA placed on each factor, and the conclusion NHTSA reached in its proposal. As none of these relate to the Purpose and Need statement in the Draft EIS, NHTSA has made no changes to the Purpose and Need statement in the Final EIS.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

d. NHTSA misapplied the "technologically feasible" factor and unlawfully ignored the technology-forcing nature of EPCA and EISA.

In the Proposal, NHTSA states that the purportedly diminished need for energy conservation reduces the need to utilize more efficient technology. 83 Fed. Reg. at 43,216. But, Congress created mandatory vehicle fuel economy standards that are intended to be technology forcing, with the recognition that "market forces ... may not be strong enough to bring about the necessary fuel conservation which a national energy policy demands." *Ctr. for Auto Safety*, 793 F.2d at 1339 (citing S. Rep. No. 179, 94th Cong., 1st Sess. 2 (1975)). Indeed, NHTSA itself has previously recognized that the agency is "not limited in determining the level of new standards to technology that is already being commercially applied at the time of the rulemaking." 77 Fed. Reg. at 62,668.

As comments to the NPRM explain in detail, in proposing the Preferred Alternative and other alternatives, NHTSA has artificially constrained the availability of fuel economy technology and the timing for its deployment so that the model in many instances selects more expensive, less fuel efficient technology while excluding less expensive and more efficient alternatives. That more than sufficient technology is in fact available to achieve the current standards is not reasonably debatable, as NHTSA itself has previously concluded. For example, the International Council on Clean Transportation (ICCT) has found improved current technologies combined with emerging technologies can achieve between 8% - 10% greater efficiency improvements as compared to the 2012 assessment by EPA and NHTSA. The artificial constraints NHTSA has devised in its modeling result in its failure to consider not only technology that will be available in the future but also in its sidelining of existing technology, the artificial inflation of costs, and the complete abandonment of the technology-forcing mandate of CAFE standard setting. The agency's Preferred Alternative of freezing fuel economy standards after 2020 and its additional alternatives, all of which decrease fuel economy when compared to the No Action Alternative, apply faulty factual assumptions and irrational modeling, and are contrary to the technology- forcing character of the statute.

e. NHTSA misinterprets "economic practicability"

NHTSA has interpreted "economic practicability" as referring to whether a standard is within the financial capability of the regulated industry, but not so stringent as to lead to adverse economic consequences such as any job losses, safety impacts or the purported elimination of consumer choice. We note, however, that Congress expected that manufacturers might be challenged by the standards. In 1975 Congress was clear that ''a determination of maximum feasible average fuel economy should not be keyed to the single manufacturer which might have the most difficulty achieving a given level of average fuel economy.'' In past rulemakings, NHTSA has recognized that EPCA does *not* preclude a CAFE standard that poses considerable challenges to individual auto manufacturers, and that EPCA allows it to set standards that exceed the capability of particular manufacturers as long as the standard is economically practicable for the industry as a whole. 77 Fed. Reg. at 62,668. In any event, even assuming NHTSA had applied the correct legal test, NHTSA's factual predicate for rejecting more stringent standards based on this factor is also erroneous. As we explain in our comments to the proposed rulemaking, NHTSA incorporates error-riddled assumptions about consumer preferences, vehicle attributes, and safety that are all aimed at misrepresenting the augural standards as too costly for industry and consumers. Lastly, no test of "economic practicability" can be upheld unless it also examines the benefits of the proposed action. As explained below, NHTSA has not done so.

f. NHTSA has failed to consider the actions of other agencies

NHTSA correctly recognizes that EPA's greenhouse gas standards constitute "other motor vehicle standards of the Government." 83 Fed. Reg. at 43,209. Indeed, Congress has expressly directed NHTSA to consider EPA's standards, Pub. L. No. 94-163, § 502(e), 89 Stat. 871, and NHTSA has previously done so in setting fuel economy standards. But NHTSA now insists that CAFE and greenhouse gas standards must be harmonized in nearly all respects, including by jettisoning EPA credits for actions that decrease greenhouse gas emissions such as the prevention of air conditioning leakage. Under NHTSA's ill-conceived quest for complete harmonization between its and EPA's regulations, any consideration of EPA's standards is reduced to a one- way ratchet that would force the abandonment of EPA's mandate to reduce harmful greenhouse gas emissions. In a departure from prior practice on fuel economy standards for light-duty vehicles, NHTSA has also improperly assumed that California's separate standards are no longer in effect. 83 Fed. Reg. at 43,210. In sum, the DEIS not only fails properly to consider currently effective regulations issued by EPA, California, and the many other states that have adopted California's standards or that are likely to do so in the future, but assumes that these regulations have been permanently reversed (without modeling a different though reasonably foreseeable outcome). The DEIS is invalid for this reason alone.

Response

The commenters frame their comment as addressing NHTSA's Draft EIS. However, the comment relates almost entirely to NHTSA's balancing of the EPCA statutory factors in the NPRM. Although NHTSA's EIS restated the statutory factors and NHTSA's "interpretation" of those factors (specifically, by providing the definitions in the NPRM that reflect NHTSA's longstanding interpretation of those factors), the commenters do not reference misstatements in any of the text provided in the Draft EIS itself. In fact, NHTSA's discussion of the "purpose and need" of the action does not balance the factors, nor does it provide the substantive analysis to which the commenters refer.

The only reference to NHTSA's Draft EIS is with regard to consideration of regulations issued by EPA, California, and other states. Regarding EPA regulations, NHTSA and EPA are joint agencies on this action and typically have issued their respective regulations together to harmonize their programs. If NHTSA's EIS were to assume that EPA's current regulations were independently effective and enforceable under the action alternatives, the action alternatives would be functionally indistinguishable from the No Action Alternative, as EPA's program would remain unchanged in both. This would be inconsistent with the remainder of the commenters' submission, with NHTSA's responsibility to take a "hard look" at the environmental impacts of its action, and with its obligation to represent the reality that the agencies have issued a joint proposal.

Regarding California's waiver, the issues of Clean Air Act waivers of preemption under Section 209 and the EPCA/Energy Independence and Security Act of 2007 (EISA) preemption under 49 U.S.C. § 32919 are not addressed in this Final EIS, as they were the subject of a separate final action and rulemaking by EPA and NHTSA in September 2019. The joint action is available at 84 FR 51310, and comments on these issues have been addressed and responded to in that action and rulemaking process. In that action, EPA withdrew aspects of a Clean Air Act Preemption waiver previously granted to California, and NHTSA concluded that EPCA expressly and impliedly preempted state laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe carbon dioxide (CO_2) emissions from automobiles or automobile fuel economy. Therefore, NHTSA concludes it is inappropriate to assume that California's waiver remains in place or that other States may adopt California's standards.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

In sum, all alternatives that weaken the 2021 CAFE standard, flatline the 2022-2025 augural standards, and fail to increase the fuel efficiency of MY2026 standards over those for MY2025 are directly contrary to the statutory mandate NHTSA must fulfill. As shown in the table below, all of the alternatives would increase fuel consumption with respect to the No Action Alternative, and all therefore are inconsistent with NHTSA's statutory mandate.

> [See original comment for table titled Fuel Consumption and Increase in Fuel Use by Alternative (billion gasoline gallon equivalent total for calendar years 2020-2050).]

NHTSA's unlawful re-weighing of EPCA's statutory factors would nullify, by agency fiat, the Congressional mandate to conserve energy. Accordingly, the DEIS must be withdrawn.

Response

The No Action Alternative in this EIS assumes that NHTSA would not amend the CAFE standards for MY 2021 passenger cars and light trucks and that NHTSA would finalize the MY 2022–2025 augural CAFE standards that were described in the 2012 joint final rule. The No Action Alternative also assumes that the MY 2025 augural CAFE standards would continue indefinitely. NHTSA acknowledges that all of the action alternatives considered in this EIS would increase fuel consumption compared to the No Action Alternative.

However, all action alternatives (except Alternative 1) would result in CAFE standards that increase in stringency year over year from MY 2021 through MY 2026. Currently, there are no enforceable CAFE standards for MYs 2022–2026; if NHTSA could have finalized any of these action alternatives in 2012, they would have clearly resulted in decreased fuel consumption and overall energy conservation consistent with the Congressional mandate and NHTSA's Purpose and Need statement. NHTSA has inherent authority to reconsider its past decision based on updated information and to issue new standards for model years that have not yet begun. Therefore, NHTSA disagrees with the commenter and believes the alternatives being considered are consistent with the purpose and need of this action. For more information regarding NHTSA's weighing of the EPCA statutory factors, see Section VIII of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

When preparing an EIS under NEPA, a federal agency must include a statement explaining the underlying purpose and need to which the agency is responding to in proposing an action and its alternatives. 40 C.F.R. § 1502.13. Although NHTSA, in its "purpose and need" discussion, recites that it must establish corporate average fuel economy (CAFE) standards for MY2022-2026 passenger cars and light duty trucks at "maximum feasible" levels, it fails to disclose, discuss or heed the key point that the conservation of energy is the prime and overriding mandate under which it operates. This fundamental omission leads to a proposal under which far more energy (some 200 billion gallons of additional oil) would be unnecessarily consumed than under the standards it seeks to replace.[4] Badly misinterpreting its Congressional mandate, NHTSA's Proposal produces the opposite of what Congress has instructed it to accomplish.

a. Background

In 2012, NHTSA and EPA issued a joint rule establishing CAFE and greenhouse gas emission standards for light-duty vehicles for MY2017-2025. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012); 40 C.F.R. § 86.181812. NHTSA issued binding CAFE standards for MY2017 through 2021 vehicles under the Energy Policy and Conservation Act (EPCA), as amended by the Energy Independence and Security Act (EISA). 49 U.S.C. § 32902. The agency also published "augural" standards for MY2022-2025 because it was prohibited from issuing CAFE standards spanning more than five years. The augural standards "represent the agency's current judgment, based on the information available to the agency today, of what levels of stringency would be maximum feasible in those model years." 77 Fed. Reg. at 62,639.

b. The DEIS' "purpose and need" section is fatally flawed

An agency must draft the purpose and need statement in light of "the views of Congress," based on "the agency's statutory authorization to act, as well as … other congressional directives." *Citizens Against Burlington, Inc. v. Busey,* 938 F.2d 190, 196 (D.C. Cir. 1991). NHTSA's duty to issue regulations setting fuel efficiency standards is found in EPCA. It provides that the Secretary of Transportation "shall" prescribe average fuel economy standards for automobiles and set those standards at "the *maximum feasible* average fuel economy level that … manufacturers can achieve in that model year." 49 U.S.C. § 32902(a) (emphasis added).

When Congress enacted EPCA in 1975, it emphasized that the Act's key feature is to promote energy conservation. *See e.g.*, Pub. L. No. 94-163, §2, 89 Stat. 871 (1975) (stating that the purpose of EPCA is to conserve energy supplies through energy conservation programs, and where necessary, to regulate

[4] Most of the alternatives the agency is considering, including its Preferred Alternative, would amend the final CAFE standards for MY2021. DEIS, at 1-6. Since the rulemaking is a joint proposal by NHTSA and EPA, if finalized, it would also rescind and replace EPA's greenhouse gas regulations for MY2022–2025 vehicles, which are currently in effect.

certain energy uses, and provide for improved energy efficiency of motor vehicles). In passing the Act, Congress aimed "*to … reduce domestic energy consumption*… to reduce the vulnerability of the domestic economy to increases in import prices, … [to] decrease dependence upon foreign imports, [to] enhance national security, [and to] achieve the efficient utilization of scarce resources." S. Rep. No. 94-516, at 117 (1975) (Conf. Rep.), *as reprinted in* 1975 U.S.C.C.A.N. 1956, 1957 (emphasis added); *Ctr. For Auto Safety v. Thomas*, 847 F.2d 843, 845 (D.C. Cir. 1988) (en banc) (opinion of Wald, C.J.), *vacated on reh'g on other grounds*, 856 F.2d 1557 (D.C. Cir. 1988). EISA, which amended EPCA to provide additional requirements for NHTSA, confirmed that the statute's purpose is "[t]o move the United States toward greater independence and security, *to increase the production of clean renewable fuels*, to protect consumers, [and] *to increase the efficiency of* products, buildings, and *vehicles* …" Pub. L. No. 110-140, 121 Stat. 1492 (2007) (emphasis added).

In determining how to set maximum feasible standards, NHTSA is to consider four factors: "technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy." 40 U.S.C. § 32902(f). However, while NHTSA has discretion in deciding how to weigh these factors, it is settled law that none of them may override the need to conserve energy. *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1195 (9th Cir. 2008) ("The EPCA … gives NHTSA discretion to decide how to balance the statutory factors—as long as NHTSA's balancing does not undermine the fundamental purpose of the EPCA: energy conservation"); *see also Ctr. for Auto Safety v. NHTSA,* 793 F.2d 1322, 1340 (D.C. Cir. 1986) ("Congress intended energy conservation to be a long term effort that would continue through temporary improvements in energy availability. Thus, it would clearly be impermissible for NHTSA to rely on consumer demand to such an extent that it ignored the overarching goal of fuel conservation"). In considering this overriding need for energy conservation, NHTSA must take into account the harmful effects of failing to do so, including "the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum." *See* 77 Fed. Reg. at 62,669.

Response

NHTSA agrees with the commenter on the existence of case law that frames NHTSA's obligations under EPCA when balancing the statutory factors. In response to this comment, NHTSA has added citations to *Center for Biological Diversity v. NHTSA*, 538 F.3d 1172 (9th Cir. 2008), and *Center for Auto Safety v. NHTSA,* 793 F.2d 1322 (D.C. Cir. 1986), to its Purpose and Need statement in Section 1.2, *Purpose and Need*. NHTSA disagrees with the commenter that the omission of these citations in the Draft EIS resulted in a proposal that was inconsistent with the federal statute. NHTSA specifically discusses these cases in the NPRM and in the preamble to the final rule. In Section VIII of the preamble to the final rule, NHTSA explains its balancing of the EPCA statutory factors in light of the relevant case law.

Comment

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

It is undisputable that NHTSA's proposal is inconsistent with EPCA's overriding statutory objective of conserving energy – NHTSA's own estimate of the impact of its proposal on the nation's consumption of petroleum is an increase of approximately 500,000 barrels per day, an amount that NHTSA itself admits is “significant”. As discussed below, this is an underestimate, based on a false, unsupported assumption that manufacturers will voluntarily over-comply with the standards. Compared to the “No action alternative,” NHTSA’s proposed alternative would increase total light-duty vehicle fuel consumption between 2020 to 2050 by 206 billion gasoline gallon equivalents.

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

Congress has given clear direction to NHTSA. By law, NHTSA is required to set fuel economy standards at the “maximum feasible” level for each model year. 49 U.S.C. § 32902(a). NHTSA has determined that it is not feasible for manufacturers to achieve any increase in average fuel economy levels over six future model years (2021-2026). That determination is facially implausible: manufacturers have publicly stated their intention and capability to continue to increase the fuel economy of their fleets. The agencies’ own analysis also predicts that average fuel economy levels will increase in the absence of standards, NPRM at 43179, demonstrating that increased average fuel economy levels are feasible. It is irrational for NHTSA to determine that the maximum feasible fuel economy level is lower than the level that it concludes will be achieved by market forces. Additionally, Congress intended that fuel economy standards would be technology forcing, achieving more than what market forces alone would achieve. *See Ctr. for Auto Safety v. NHTSA*, 793 F.2d 1322, 1339 (D.C. Cir. 1986). The record indicates—and NHTSA has previously determined—that it is feasible for manufacturers to achieve average fuel economy levels above the default market level. NHTSA’s decision to set fuel economy standards below market level is unsupportable.

In determining maximum feasible fuel economy levels, the Energy Policy and Conservation Act (EPCA) requires NHTSA to consider “technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy.” 49 U.S.C.§ 32902(f). NHTSA must consider these factors with regard to the overarching mandate of EPCA: energy conservation. *See Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1197 (9th Cir. 2008). The agency explicitly acknowledges this “overarching purpose,” NPRM at 43206, but nevertheless proposes a rule that significantly increases energy use compared to the augural standards—an additional half a million barrels of petroleum *per day*. NPRM at 42995. NHTSA’s attempt to cast this result as one that conserves energy strains credulity.

Congress has not directed NHTSA to analyze the EPCA factors in an abstract balancing exercise. Rather, these factors are a means to guide the agency to the mandatory end determination: “the maximum feasible average fuel economy level.” 49 U.S.C. § 32902(a). The NPRM makes clear that NHTSA did not undertake to determine maximum feasible standards, but rather undertook an amorphous “appropriateness” determination divorced from the statutory mandate: “NHTSA views the determination of maximum feasible standards as a question of the appropriateness of standards given that their need . . . seems likely to remain low for the foreseeable future.” NPRM at 43226. Congress has not empowered NHTSA to determine the “need” for standards; Congress has directed NHTSA that the needed standards are those that are the maximum feasible in any given model year. NHTSA’s “appropriateness” inquiry is not in accordance with law.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

In the Proposal, NHTSA declares that energy conservation simply is no longer necessary, touting increased domestic oil production achieved through new extraction techniques (such as fracking) that themselves carry with them environmental impacts. But the development of new extraction techniques does not alter Congress' explicit mandate to conserve energy. Historically, energy production is cyclical. The present fracking boom shows considerable financial strains as it struggles to become profitable and shed its over-reliance on debt financing, and oil prices continue to fluctuate considerably. The cyclical nature of the oil business is made apparent by the Ninth Circuit's recognition, in 2008, that as of the date of its writing, "[t]he need of the nation to conserve energy is even more pressing today than it was at the time of EPCA's enactment." *Ctr. for Biological Diversity v. NHTSA*, 538 F. 3d at 1197-98; see also *Ctr. for Auto Safety*, 793 F.2d at 1338. Simply put, the fact that the need for energy conservation was particularly pressing when EPCA was enacted and that the amount of energy produced fluctuates over time does not allow NHTSA discretion to negate Congress' explicitly stated intent.

Moreover, the need for energy conservation and "maximum feasible" fuel efficiency standards is not only mandated legally, but also remains a fact on the ground today. The United States consumes more energy from petroleum than from any other energy source. In 2017, total petroleum consumption was about 19.7 million barrels per day, 71% of which was consumed by the transportation sector. Despite the current near-record levels of domestic oil production, the nation continues to consume more oil than it produces, and high demand for petroleum attributable in large part to automobiles continues to leave the United States dependent on imported oil. Strong and increasingly stringent fuel economy standards continue to be necessary to decrease consumption and dependence on foreign oil imports.

Specifically, transportation is the second largest energy consuming sector in the United States, representing 28.8% of total energy consumption in the country in 2017. Petroleum provides about 71% of the energy used for transportation. Gasoline is the most consumed petroleum product in the United States (about 47% of total U.S. petroleum consumption or 392 million gallons per day), followed by distillate fuel oil, which includes diesel (about 20% of total consumption, including heating oil), hydrocarbon gas liquids used at oil refineries, and propane used for heating and cooking. In 2017, the U.S. imported approximately 10.1 million barrels per day (MMb/d) of petroleum from about 84 countries. Almost 80 percent of such imports were crude oil. The U.S. Energy Information Administration projects that petroleum will continue to contribute the largest share of total U.S. energy consumption through 2040. While the U.S. projects that it will become a net *energy exporter* by 2022, the country is nonetheless projected to remain a net *oil importer*. This is the case even though the EIA bases its projections on the assumption that the Augural Standards will remain in effect;[5] if NHTSA's Proposal to freeze standards as of 2020 were to become final, the reliance on imported oil would necessarily

[5] NHTSA states that the DEIS relies on CAFE model projections of energy consumption and supply that are based on the Annual Energy Outlook. Based on these projections, NHTSA concludes in the NPRM that "the need of the U.S. to conserve energy may no longer function as assumed in previous considerations of what CAFE standards would be maximum feasible." 83 Fed Reg. at 43,216. But NHTSA admits that the Annual Energy Outlook forecast *assumes fleet-wide compliance* with the MY2022-2025 augural standards and EPA's GHG standards. DEIS, at 3-8, fn.5; see also DEIS, at 3-8. The Annual Energy Outlook data which NHTSA claims justifies its assertion that energy consumption will decrease thus relies on the very standards NHTSA proposes to nullify.

increase over EIA's assumptions. To comply with Congress' mandate, NHTSA must continue to set maximum feasible fuel efficiency standards to decrease the U.S.' dependence on oil, whether foreign or domestic.

In sum, NHTSA lacks any authority to override Congressional intent, and its declaration that energy conservation is no longer necessary has no factual predicate. Its DEIS is fundamentally flawed because it misconceives of and abandons the mandate entrusted to it by Congress, and must be withdrawn.

Response

EPCA, as amended by EISA, contains a number of provisions regarding how to set CAFE standards. NHTSA must establish separate CAFE standards for passenger cars and light trucks for each model year, and each standard must be the maximum feasible that NHTSA believes the manufacturers can achieve in that model year. In determining the maximum feasible level achievable by the manufacturers, EPCA requires that NHTSA consider the four statutory factors of technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy. In addition, NHTSA has the authority to consider (and traditionally does) other relevant factors, such as the effect of the CAFE standards on motor vehicle safety and consumer preferences. The ultimate determination of what standards can be considered maximum feasible involves a weighing and balancing of factors, and the balance may shift depending on the information before NHTSA about the expected circumstances in the model years covered by the rulemaking. The agency's decision must also support the overarching purpose of EPCA, energy conservation, while balancing these factors.

The commenters generally argued that NHTSA's proposal was inconsistent with EPCA's purpose: energy conservation. NHTSA addressed its balancing of the EPCA statutory factors, taking into account the goal of energy conservation, in the NPRM preamble, and does so again in the preamble to the final rule. As discussed in detail in Section VIII of the preamble to the final rule, NHTSA has carefully balanced the statutory factors and determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards. Instead, in the final rule, NHTSA has determined that the Preferred Alternative described in this Final EIS (standards for MYs 2021–2026 passenger cars and light trucks that increase in stringency by 1.5 percent per year from the MY 2020 standards) are maximum feasible. While energy conservation will be lower under this final rule than if NHTSA had determined that the augural standards were maximum feasible, it will be higher than it would have been under the proposal. NHTSA believes its final decision is consistent with the purpose and need for its action and the overarching purpose of EPCA.

10.1.2 NEPA Process

Comment

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The DEIS must provide a transparent and thorough analysis of the environmental and health impacts of NHTSA's preferred alternative as well as a full range of alternatives. The DEIS should be a central tool in the decision-making process, not simply a rubber stamp on a pre-determined outcome. This DEIS fails to achieve the standard set forth by the National Environmental Policy Act.

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Our agencies have serious concerns about the quality of the modeling NHTSA is relying on for its environmental decision-making as part of this DEIS. The DEIS analysis relies heavily on assumptions about economics and human behavior that are questionable at best. Additionally, NHTSA has not published sufficient information on the model and the inputs and assumptions on which the modeling is based. This lack of transparency has made it impossible for states and the public to understand and comment on the analysis.

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

We also show that the Department of Justice will be collaterally estopped from defending this rulemaking in court, that the NHTSA rulemaking violates the general conformity provisions of the Clean Air Act, and that both EPA and NHTSA attempt to ground their decisions on considerations of "safety" that are unauthorized by their statutory mandates. In other words, any adverse safety impacts resulting from more vehicle miles traveled or older vehicles remaining on the road for a longer time under the existing rules are not caused by the rules and are not within the statutory authorization for the consideration of vehicle safety.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

As the Joint Commenters state in comments to be submitted to the Proposal's docket, NHTSA- 2018-0067; EPA-HG-OAR-2018-0283, the proposed rulemaking suffers from fundamental legal and technical errors. In direct violation of its Congressional mandate to conserve energy and set the maximum feasible fuel efficiency standards for the nation's passenger and light truck vehicle fleet, NHTSA proposes to weaken its own augural standards for model year ("MY") 2022-2025 vehicles (the "Augural Standards"), in addition to the standard for MY2021 currently in effect. The Proposal would result in increased fuel consumption and increased emissions of greenhouse gases and other pollutants. The DEIS, if finalized as proposed, would be in direct conflict with the National Environmental Policy Act ("NEPA") and the Energy Policy and Conservation Act ("EPCA"), as amended by the Energy Independence and Security Act ("EISA"), and would violate the Administrative Procedure Act. On behalf of our millions of members, we ask that NHTSA withdraw the DEIS and prepare a new DEIS that is consistent with applicable laws and make it available for a new round of public comments.

In summary, the DEIS should be withdrawn because, among other flaws, it:

- fails to consider a reasonable range of alternatives, including alternatives that increase the stringency of the Augural Standards;
- is based on faulty modeling and unsupported assumptions designed to reach a predetermined outcome;

- unlawfully declares that energy conservation is no longer necessary, a pronouncement neither legally permissible nor factually accurate;
- unlawfully attempts to nullify, by administrative fiat, Congress' intent to conserve energy and set maximally feasible fuel efficiency standards as required by EPCA and EISA;
- fails to take a hard look at the direct, indirect, and cumulative impacts of the Proposal and its alternative;
- fails to disclose or discuss any rationale for proposing to vastly increase greenhouse gas emissions from the nation's largest source while acknowledging that without steep reductions of greenhouse gas emissions, temperatures will increase beyond any tolerable range by 2100; and
- fails to consider reasonably available mitigation measures.

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

Under the National Environmental Policy Act ("NEPA"), NHTSA is required to take a hard look at the environmental impacts of the proposed rulemaking. In the attachment, EDF raises a number of procedural concerns with NHTSA's NEPA review, as well as substantive concerns with the analysis in the DEIS. NHTSA's DEIS falls far short of the agency's NEPA obligations. In particular:

- NHTSA based its DEIS on erroneous technical analysis reflecting inaccurate and outdated assumptions and inputs. As a result, NHTSA fell well short of its obligation to take a hard look at the pollution and other harmful implications of the proposal, which would dramatically weaken the existing MY 2021-2025 standards.
- NHTSA also considered an unduly constrained set of alternatives, failing to consider policy options that would be more protective of our health and environment than the existing standards despite ample evidence that such standards are well within EPCA's command to set "maximum feasible" standards.
- Finally, NHTSA improperly circumscribed the public's ability to meaningfully participate and comment on the DEIS.

In light of the procedural and substantive failures identified herein, the current rulemaking is fatally flawed. NHTSA should withdraw this inadequate DEIS, correct its errors, and use an updated, improved analysis to issue a new DEIS and proposed rule; in the alternative, the agency should provide an opportunity for further public comment on a revised EIS before issuing a Final EIS and making a final decision.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

ELPC strongly opposes NHTSA's preferred option to freeze standards at MY2020 levels through 2026, undermining the augural standards for MY2022-2025 and the final MY2021 standard. Under EPCA and EISA, NHTSA is statutorily permitted to set CAFE standards for up to 5 model years. NHTSA is violating that statutory mandate by issuing standards for MY2021-2026. Further, NHTSA turns express congressional mandates to address the need of the nation to conserve oil and set maximum feasible standards on their head.

Therefore, NHTSA should withdraw this DEIS due to the many flaws detailed in the joint comments as well as in our comments below.

1. NHTSA fails to consider a full range of appropriate alternatives.
2. The DEIS fails to address the urgent need to act on climate, including the importance of protecting the Great Lakes and the Midwest.
3. NHTSA's carbon emissions estimates are inconsistent with its own data, rendering the DEIS confusing and flawed.
4. NHTSA's proposal will substantially increase carbon emissions.
5. NHTSA's cumulative impacts analysis is flawed because it fails to account for other actions the administration is taking that will increase climate pollution.
6. The DEIS provides an inadequate analysis of impacts on air quality.
7. NHTSA fails to fully and accurately address the impacts of increased oil consumption.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The proposed rollback departs entirely from the Agencies' governing statutes, on the basis of hastily-assembled and profoundly flawed evidence. EPA is charged with addressing air pollution, including climate change, working with California; instead, the rule vastly increases GHG emissions, worsens air quality, and attacks California authority Congress has preserved and extended. NHTSA is charged with maximizing vehicle fuel economy while paying due regard to other government programs; instead, the proposed rolls back fuel economy standards while proposing to preempt critical public health protections.

Executive agencies are not empowered to rewrite or ignore statutes, much less to reverse their meaning, as the Agencies now propose. That the Agencies rely upon their inverted reading of the statutes to further propose to end a decades-long partnership with California for vehicle regulation that is preserved in both statutes, and reflects a settled Congressional judgment is even more concerning. If the proposal is finalized, Congress cannot be assured that its directives will be followed in any administrative context, and states must be on their guard as to threats from administrative bureaucracies to their sovereign police powers and statutory prerogatives.

*   *   *   *   *

The Agencies have entirely failed to consider important aspects of the problem. For example, they do not assess the public health, environmental, and human costs of the increased criteria, toxic, and GHG emissions as they acknowledge will come from the proposal.

*   *   *   *   *

The statutory mandate of the National Environmental Policy Act (NEPA) requires NHTSA to prepare a DEIS that takes a "hard and honest look" at the environmental impacts of the joint proposed rule, including NHTSA's preferred alternative of rolling back the model year (MY) 2021-26 adopted or existing standards to MY 2020 levels. NEPA also requires that NHTSA adequately inform the public and the decision makers of "the reasonable alternatives" and mitigation measures which would avoid or minimize the impacts of the rollback. NHTSA's DEIS fails to meet any of these requirements, and instead presents a description of alternatives and environmental impacts that is manipulated to affirm a predetermined agency preference.

*   *   *   *   *

Beyond these procedural deficiencies, the DEIS violates NEPA in many other respects, including by using novel and inaccurate modelling inputs, by failing to consider a reasonable range of alternatives, and by attempting to improperly minimize the environmental significance of NHTSA's proposal by burying it within a doomsday reference scenario that assumes catastrophic climate change is essentially unavoidable. Please see the accompanying comments on the DEIS for in-depth discussion regarding the legal deficiencies in the DEIS.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

In the time the States and Cities have had to evaluate the DEIS and without the missing requested information, we have nonetheless identified multiple substantive flaws that render the document legally insufficient. To begin, in direct violation of its congressional mandate to conserve energy and set the maximum feasible fuel efficiency standards for the nation's passenger and light truck vehicle fleet, NHTSA proposes to weaken its own augural standards for model year (MY) 2022 to 2025 vehicles (the "augural standards"), in addition to the standard for model year 2021 currently in effect. The Proposed Rollback would result in increased fuel consumption and increased emissions of air pollutants. Because NHTSA has ignored its statutory mandate under the Energy Policy and Conservation Act (EPCA) and interpreted EPCA and the factors to be considered in a way that eviscerates the energy conservation purposes of EPCA, the DEIS's definition of the purpose and need for the Proposed Rollback is fatally flawed. See States and Cities' Detailed NEPA Comments, Section II.A.

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Nor does NHTSA's DEIS meet another core obligation of NEPA, to take a "hard look" at the environmental impacts of the proposed action and alternatives as well as measures to mitigate those impacts. Relying on NHTSA's flawed modeling, the DEIS erroneously concludes that the Proposed Rollback will result in negligible impacts on air quality. Indeed, CARB's modeling shows that, contrary to the DEIS's findings, the Proposed Rollback will substantially increase air pollution.

*   *   *   *   *

In conclusion, we ask that NHTSA withdraw its inadequate DEIS, correct the multiple errors identified to date, and consider the new results in formulating a new joint proposed rule and DEIS. Absent such a course, we urge NHTSA to adopt the no action alternative to maintain the current CAFE standards for MY 2021 and finalize the augural standards for MY 2022-2026. As further detailed in the States and Cities' Detailed NEPA Comments and our comments on the Proposed Rollback, the MY 2021 standard and MY 2022-2026 augural standards are technologically feasible, economically practicable, and consistent with NHTSA's statutory mandate of energy conservation. Maintaining the fuel efficiency standards that NHTSA previously deemed "maximum feasible" would also help keep our country, and the world, closer to the path necessary to forestall the most severe climate change risks.

Docket Number: NHTSA-2018-0067-12304
Organization: Natural Resource Defense Council
Commenter: David Pettit

NRDC believes that the DEIS is fundamentally flawed and needs to be withdrawn.

First, in direct violation of its Congressional mandate under EPCA and EISA to conserve energy and increase the fuel efficiency of the nation's passenger and light truck vehicle fleet, NHTSA proposes to weaken its augural standards for model year 2022-2025 vehicles, as well as the standard for model year 2021 currently in effect. The entire DEIS is infected by this illegal reading of the governing law.

In addition, the DEIS should be withdrawn because, among other flaws, it:

- Is based on an improperly narrow purpose and need statement;
- fails to consider a reasonable range of alternatives, including alternatives that increase the stringency of the augural standards;
- is based on faulty, unintelligible and result-oriented modeling;
- fails to take a hard look at direct, indirect, and cumulative impacts; and
- contains a factually inaccurate environmental justice analysis.

NEPA is our basic national charter for protection of the environment. NEPA requires federal agencies to take a 'hard look' at how the choices before them affect the environment, and then to place their data and conclusions before the public. Under NEPA, a federal agency is also required to analyze reasonable alternatives to the proposed action in its EIS. This alternatives analysis is often referred to as the heart of the environmental impact statement.

Here, based on a purpose and need statement that ignores governing federal law, the alternatives analysis looks only at reductions in the CAFE standards, not increases. None of these alternatives increases fuel economy with respect to the no action alternative, none conserves energy, and none represents maximum feasible CAFE standards. These are fundamental errors.

NEPA also requires analysis of the direct, indirect and cumulative impacts of the proposed SAFE rules. The analysis in the DEIS is invalid because of result-oriented modeling using new and unrealistic "rebound" factors and a newly-minted scrappage analysis which, together, predict a wildly unrealistic decrease in vehicle miles traveled under the proposed rules. This makes no sense if, as the DEIS assumes, new vehicle costs will be cheaper in the future. Use of phony science violates NEPA.

*   *   *   *   *

I am a grandfather and I want to leave a better world for my grandchildren. This DEIS is a step backwards from that goal and I urge NHTSA to withdraw it.

Response

These portions of the comments received by NHTSA were generally excerpted from cover letters, introductions, or summaries of lengthier, more substantive comments. As they summarize more substantive comments elsewhere, NHTSA has sorted the substantive comments themselves into the various sections in this chapter. In some cases, the issues are addressed in the preamble to the final rule rather than in the Final EIS, and those portions of the comments are not included here. The preamble to the final rule addresses hundreds of thousands of comments received, including comments that NHTSA erred in the underlying technical analysis supporting the rule. As discussed throughout the preamble in the relevant sections (e.g., the technology and economic analyses are discussed in Section VI.C and VI.D, respectively), NHTSA either refined the analysis in response to those comments, or stated reasons why the agency declined to adopt commenters' suggestions or alternative inputs and assumptions. Accordingly, this Final EIS is based on an underlying analysis that reasonably balances public input with the agency's expertise.

In some cases, commenters call for NHTSA to withdraw and reissue the Draft EIS. Based on NHTSA's responses in this chapter and in the preamble to the final rule, NHTSA concludes that reissuance of the Draft EIS is not necessary and has proceeded with this Final EIS.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The Administrative Procedure Act, 5 U.S.C. §§ 701-706, provides that agency action must be set aside if it is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d at 1194 (internal citation omitted). "In the NEPA context, an agency's EIS is arbitrary and capricious if it fails to take a 'hard look' at the environmental effects of the alternatives before it." *Wildearth Guardians v. BLM*, 870 F.3d at 1233 (citation omitted).

An agency rule is arbitrary and capricious "if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983). An "[u]nexplained inconsistency" between agency actions is "a reason for holding an interpretation to be an arbitrary and capricious change." *Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs.*, 545 U.S. 967, 981 (2005). And "an agency changing its course must supply a reasoned analysis." *State Farm*, 463 U.S. at 57 (citation omitted).

FCC v. Fox Television Stations explains that an agency's policy change complies with the APA if the agency (1) displays "awareness that it is changing position," (2) shows that "the new policy is permissible under the statute," (3) "believes" the new policy is better, and (4) provides "good reasons" for the new policy, which, if the "new policy rests upon factual findings that contradict those which underlay its prior policy," must include "a reasoned explanation ... for disregarding facts and circumstances that underlay or were engendered by the prior policy." 556 U.S. at 515- 16 (emphasis omitted). The DEIS fails all of these requirements.

The DEIS fails these principles in every respect, as outlined in more detail above. It does not adhere to basic principles of reasoned decision making because—among numerous other flaws—it does not adequately explain the agency's departure from its 2012 Final EIS or the TAR it issued together with EPA in 2016, less than two years from the date of NHTSA's complete about-face. The DEIS is premised on a number of central assertions, each of which is directly contrary to the positions it held in those earlier actions. Among them are that (1) energy conservation is no longer necessary (and that Congress' intent to the contrary can be ignored); (2) the increases in greenhouse gases are immaterial, but it is unnecessary to explain why that is true; (3) the harmful health effects from the additional criteria pollutants are acceptable; (4) the automotive technology to reach the augural standards is either not available, or is too expensive, or both; (5) consumer safety is assured only when fuel efficiency is reduced, and thousands more people will die if the augural standards were finalized and EPA's MY2017-2025 greenhouse gas emission rules remained in effect; (6) decreased fuel efficiency will decrease the number of cars on the road and the vehicle miles driven; and (7) consumers do not value and not will not buy more efficient vehicles.

Yet, the DEIS does not discuss that these premises differ drastically from the 2012 Final EIS, much less provide a reasoned explanation for that departure. As to the 2016 TAR, NHTSA simply fails to mention it altogether. Both documents, however, and the voluminous factual records that support them, determined that the augural standards through 2025 and EPA's existing greenhouse gas standards were technologically feasible and achievable for the auto industry. The DEIS' failure to explain why that is no longer the case is arbitrary and capricious. *FCC v. Fox Television Stations, Inc.* 556 U.S. 502, 515-16 (2009); *Encino Motorcars v. Navarro*, 136 S. Ct. 2117, 2127 (2016). And in this case, NHTSA must provide a more detailed justification for its Proposal compared to what would suffice for a new policy created on a blank slate, since "its new policy rests upon factual findings that contradict those which underlay its prior policy." Fox at 515. Yet it has provided none, save for its assertion that conservation of energy is no longer needed.

Response

NHTSA disagrees with the commenter's statement that the Draft EIS is premised on changed assertions that NHTSA needed to explain in the Draft EIS under the standard articulated in *FCC v. Fox*, or cases that examine whether an agency action is arbitrary and capricious. Indeed, these "central assertions" are not assertions made in the Draft EIS (and, in fact, these "central assertions" exaggerate or misrepresent NHTSA's discussion in the NPRM). Rather, the Draft EIS informs the decision-maker and the public of the potential environmental impacts of the Proposed Action and alternatives, and does not make conclusions of the sort referenced by the commenter above. The NPRM preamble discussed at length its assumptions and why facts had changed since the Draft TAR, and it provided a reasoned and thorough explanation for its change in policy consistent *with FCC v. Fox.* Similarly, the preamble to the final rule addresses these same points, and this Final EIS frequently refers the reader to that document and incorporates by reference those discussions. NHTSA continues to believe this approach is consistent with the Council on Environmental Quality (CEQ) regulations and relevant case law.

Comment

Docket Number: NHTSA-2017-0069-0588
Organization: Alliance of Automobile Manufacturers
Commenter: John T. Whatley

The Alliance notes that the DEIS adjourns some important issues concerning GHG and non-GHG emissions to its regulatory impact analysis in Docket No. 2018-0067. The Alliance asks that NHTSA include in its NEPA evaluation relevant comments and other materials that the Alliance and others will provide on those issues in that docket.

Response

NHTSA reviewed all relevant comments and other materials submitted by commenters in the rulemaking docket (Docket No. NHTSA-2018-0067), the EIS docket (Docket No. NHTSA-2017-0069), and the EPA docket (Docket No. EPA-HQ-OAR-2018-0283). In accordance with the National Environmental Policy Act (NEPA)'s regulation on incorporation by reference (40 CFR § 1502.21), NHTSA incorporated material into the Draft EIS and Final EIS by reference when the effect was to cut down on bulk without impeding agency and public review of the action. As explained in the introduction to this chapter, comments directly addressing or otherwise related to the proposed rule, PRIA, and CAFE model are addressed in the preamble to the final rule and are not included here. In this chapter, NHTSA only included those comments that relate directly to the Draft EIS.

Comment

Docket Number: NHTSA-2017-0069-0693
Commenter: Rafael Pagán and Madeleine Green

To meet the obligations provided by CEQ § 1502.1 and § 1502.14(a), the Administrator should create a supplementary EIS to the SAFE act pursuant to his authority under CEQ regulation §771.130(1)(b). §771.130(1)(b) provides that "a EIS shall be supplemented whenever the Administration determines that:.. New information or circumstances relevant to environmental concerns and bearing on the proposed action… would result in significant environmental impacts not evaluated in the EIS." Since the release of the DEIS, scientific reports have been published reporting on the social cost of carbon at a global and national scale.

Significantly, the reporting provided by the Fourth National Climate Assessment, a collaborative effort of thirteen US agencies, including USGS, NOAA, and NASA, should be considered "new information or circumstances relevant to environmental concerns" under §771.130(1)(b). The report in summary states that the country will be disrupted by change in physical environment (precipitation and temperature), sea level rising along the coast, and a change in land usage can negatively impact the national economy. The two-volume report should be considered in the EIS since this could drastically change and cost benefit analysis of the alternatives being considered.

Response

The regulations quoted by the commenter (contained in 23 CFR part 771) apply to the Federal Highway Administration, a separate component of the U.S. Department of Transportation, and do not apply to NHTSA. The climate change impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, reflect the best available science regarding climate change and its impacts on health, society, and the environment. NHTSA relied primarily on existing expert panel- and peer-reviewed climate change studies and reports when preparing this EIS, including several of the resources cited by the commenter. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from the Intergovernmental Panel on Climate Change (IPCC) and U.S. Global Change Research Program (GCRP), supplemented with additional peer-reviewed literature. In the Final EIS, NHTSA has integrated the findings of consensus reports and peer-reviewed literature that have been published since the release of the Draft EIS, including the IPCC *Special Report: Global Warming 1.5°C* and the GCRP *Fourth National Climate* Assessment. The findings of these reports (including the information referenced by the commenter) are consistent with the information reported in the Draft EIS and do not reflect "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." (40 CFR § 1502.9(c)(1)(ii).) NHTSA considers the social cost of carbon in Section VI of the preamble to the final rule.

Comment

Docket Number: NHTSA-2018-0067-11154
Organization: InternationalMosaic.com
Commenter: Andrew J. Yamamoto, Esq. et al.

The ongoing production of important scientific information shows that the consideration of any DEIS for the Proposed Repeal be delayed until June 30, 2019. That will be approximately 6 months after an international conference on the issue (to be held in Katowice, Poland).

Docket Number: NHTSA-2017-0069-0706
Organization: InternationalMosaic.com
Commenter: Andrew J. Yamamoto, Esq. & Scott D. Pinsky, Esq.

In sum, the EIS is fatally flawed and cannot be adopted before EPA and NHTSA prepare a new and proper EIS for the mileage regulation. In addition, due to the wealth of information published months after the "close" of the public comment period, EPA and NHTSA should reopen the matter for further public comment.

Response

NHTSA recognizes that research on climate science is ongoing, and academic and intergovernmental conferences on the issue are frequent. NHTSA is unable to delay regulatory action because additional reports or conferences may be forthcoming, as this would effectively paralyze the agency from ever taking action. NHTSA's EIS is based on the best available science, and it has supplemented the Final EIS with new literature that has been published since the release of the Draft EIS, as appropriate.

10.1.3 Agency Consultation

Comment

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

Docket Number: NHTSA-2017-0069-0595
Organization: 1854 Treaty Authority
Commenter: Tyler Kaspar

Docket Number: NHTSA-2017-0069-0616
Organization: National Tribal Air Association
Commenter: Jaime Yazzie

Despite these more severe impacts to Tribes as populations vulnerable to climate change, the agencies completely failed to conduct any outreach or coordination to these populations, ignoring the requirements of Executive Order (EO) 13175, "Consultation and Coordination With Indian Tribal

Governments." The rule also undermines Tribal sovereignty by weakening their power to improve air quality and reduce GHG emissions on Tribal lands, and, as discussed above, will increase air pollution and its accompanying health problems for Tribes. Therefore, the agencies must engage in government-to-government consultation on this and future actions related to GHG emissions and air pollution, especially considering the unique and disproportionate vulnerabilities to climate change experienced by Tribes.

Docket Number: NHTSA-2017-0069-0616
Organization: National Tribal Air Association
Commenter: Jaime Yazzie

NTAA opposes the proposal by USEPA and NHTSA to amend the GHG standards and fuel- efficiency standards under the SAFE Vehicles Rule. We urge the agencies, on behalf of our member Tribes, to uphold the current standards, recognizing the value of those standards in protecting the environment and public health, and avoiding the disproportionate impacts to Tribes and Alaskan Native Villages anticipated by NTAA and described here. Additionally, we ask that the agencies pause this process to engage appropriately in outreach and coordination with Tribes pursuant to EO 13175.

Docket Number: NHTSA-2017-0069-0595
Organization: 1854 Treaty Authority
Commenter: Tyler Kaspar

The 1854 Treaty Authority does not support the proposal by EPA and NHTSA to amend the GHG standards and fuel-efficiency standards under the SAFE Vehicles Rule. We recommend that the current standards be upheld, recognizing the value of those standards in protecting the environment and public health, and avoiding the disproportionate impacts to Tribes and Alaskan Native Villages. Additionally, we ask that the agencies pause this process to engage appropriately in outreach and coordination with Tribes, as this is of the utmost necessity in relation to EO 13175.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The federal Agencies have not consulted and coordinated with Native American Tribal Governments, as required by Executive Order 13175. The rule undermines Tribal sovereignty by weakening their power to improve air quality and reduce GHG emissions on Tribal lands and will increase air pollution and its accompanying health problems for Tribes. Contrary to the federal Agencies' conclusory and unsupported assertions, as shown above, this proposal will impact native peoples. It will hurt tribal health and accelerate climate change. All tribal communities suffer higher rates of health effects from air pollution. Tribes are seeing the effects of climate change through increased storm surge, erosion, flooding, prolonged droughts, wildfires, and insect pest outbreaks in their forests. Tribal peoples' cultures are rooted in the natural environment and closely integrated into the ecosystem. Tribal members hunt and fish, use native flora and fauna for medicinal and spiritual purposes, and associate their identities and histories closely with the land and water. They suffer disproportionately from the effects of climate change on wildlife, fish, and native plants, which they depend on for subsistence and maintaining traditional cultural practices. Native peoples do drive motor vehicles, and thus will incur increased costs for fuel from this proposal. And they, too, are disproportionately disadvantaged by high fuel costs, as such costs make up a higher proportion of demands upon their incomes. This proposal will, in fact, have disproportionately high, adverse impacts, including on native tribes and indigenous populations.

Response

NHTSA has reviewed these comments regarding its obligations to consult with Native American Tribal Governments, as required by Executive Order 13175. In order to engage Native American Tribal Governments, NHTSA circulated the Draft EIS to all Federally Recognized Native American Tribes (Chapter 11, *Distribution List*). Executive Order 13175 requires that agencies consult with tribes when promulgating policies "that have substantial direct effects on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes" (Section 1(a)). As explained in Section X.I of the preamble to the final rule, commenters identified only indirect effects of the standards on tribal interests, and NHTSA concludes there are no substantial direct effects on Native American tribes. Thus, no specific consultation under Executive Order 13175 is required.

Comment

Docket Number: NHTSA-2017-0069-0540
Commenter: Christopher Lish

If the current administration continues to insist that the 2012 clean car standards be changed, I urge the administration to bring the agencies and California back to the negotiating table to hammer out a rule they can all agree to, one that delivers sound, long-term, coordinated standards that sustain America's leadership in technology and manufacturing, protect consumers from swings in gas prices, and protect and grow jobs here, not send our jobs to other countries.

Response

NHTSA refers the commenter to the separate final action and rulemaking by EPA and NHTSA in September 2019 (84 FR 51310). That action addressed the issues of Clean Air Act waivers of preemption under Section 209 and EPCA/EISA preemption under 49 U.S.C. § 32919. In that action, EPA withdrew aspects of a Clean Air Act Preemption waiver previously granted to California, and NHTSA concluded that EPCA expressly and impliedly preempted state laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy.

10.1.4 Public Participation and Comment

Comment

Docket Number: NHTSA-2017-0069-0220
Organization: California Department of Justice et al.
Commenter: David Zonana

The undersigned Attorneys General and State Agencies respectfully request that the United States Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) extend the comment period for the joint proposed rule referenced above by at least 60 days, to a total of 120 days from the date of publication in the Federal Register. A 120-day comment period would be consistent with past practice for matters of similar importance and complexity, including EPA's 2014 proposal to adopt the Clean Power Plan and its 2017 proposal to repeal the Clean Power Plan. As discussed in more detail below, given the complexity and novelty of the legal and technical issues presented by the Agencies' proposal, the voluminous amount of materials accompanying the joint proposed rule which commenters must review, and the profound potential impacts of the proposal on human health and the environment, a 60-day comment period is wholly inadequate.

Secondly, we request that the deadline for comments on NHTSA's draft Environmental Impact Statement (EIS) for the joint proposed rule be extended from the current deadline of September 24, 2018, to align with the requested 120-day comment period for the joint proposed rule. NHTSA's current 45-day comment period on the draft EIS—which ran for 13 days prior to Federal Register publication of the joint proposed rule—clearly prejudices the public's right to notice and comment. The draft EIS and the joint proposed rule are closely intertwined, yet on the current schedule, an already shorter comment period on the draft EIS has been further truncated by not having the published joint proposed rule and all of its supporting data for nearly a third of those 45 days. Such a schedule is both arbitrary and unfair.[6]

Third, and relatedly, we request additional public hearings beyond those announced for Fresno, California, Dearborn, Michigan, and Pittsburgh, Pennsylvania. To begin, we ask that EPA, alone or in conjunction with NHTSA, hold an additional public hearing in California devoted exclusively to EPA's unprecedented proposal to withdraw California's Clean Air Act waiver—a subject not mentioned in the hearing announcement. See 83 Fed. Reg. 42,817-42,818. In light of EPA's proposal to revoke California's waiver, we believe that a hearing in California's capitol is warranted. While we dispute if Section 209 of the Clean Air Act authorizes EPA to revoke a waiver, that statute requires a public hearing for granting a waiver and EPA should provide no less process for its proposed revocation. In addition, we request that the hearing locations included in the pre-publication draft of the proposed joint rule and the August 24th published version as well (see 83 Fed. Reg. 42,986 (Aug. 24, 2018))—in Los Angeles and Washington, D.C.—be re-instated. Los Angeles and Washington, D.C. are widely accessible, large population centers with a history of experience and expertise regarding vehicle pollution. Further, we request more than the current single hearing in a state that has adopted California's vehicle emissions standard (Pennsylvania). The States that have adopted California's standards, pursuant to express congressional authorization in section 177 of the Clean Air Act, will be seriously harmed by the withdrawal of California's waiver, if it is finalized. States, who cannot set their own emissions standards for vehicles, and their residents also deserve to be heard by EPA without the need to expend substantial resources to travel to distant meetings and with the ability to address their specific concerns about the dual threat of rolling back the federal standards while withdrawing California's waiver. Specifically, we request additional hearings be scheduled Portland, Oregon and/or Seattle, Washington; New York State; and Baltimore, Maryland.

As to the comment period for the joint proposed rule, additional time is called for on several grounds. Each of the three actions proposed here—EPA's rollback, NHTSA's rollback, and the waiver revocation—is tremendously significant and would call for a minimum 60-day comment period on their own.

[6] While NHTSA has set a September 24, 2018 draft EIS comment deadline, two of the three public hearings announced by EPA and NHTSA post-date the September 24 deadline. See 83 Fed. Reg. 42,817 (Aug. 24, 2018). The Agencies' announcement for the hearings expressly provides that "oral or written testimony" on the draft EIS will be accepted, and further that the Agencies will "keep the official record of each hearing open for 30 days to allow speakers to submit supplementary information" to the dockets. *Id.* at 42,818. Therefore, it is our understanding that, for example, a speaker at the September 26, 2018, hearing in Pittsburgh may offer oral or written testimony on the draft EIS and that speaker will have until October 26, 2018, to submit supplementary information on the draft EIS.

Notably, the primary documents describing the proposed actions and their impacts total more than 2,000 pages in their pre-publication form. The preliminary regulatory impact analysis is 1,600 pages, and the draft EIS is 1,300 pages, including its appendices. And that does not account for the enormous volume of technical information to be reviewed, including models and data, some of which is not currently available.[7] These proposed actions put our States and our people at risk, and the enormity of the consequences of these proposals alone warrants ensuring that States, and other members of the interested public, have sufficient time to conduct meaningful review and analysis of the available information and to respond fully and completely. Your Agencies' duty under the APA to afford the public an adequate opportunity to review all of this information and to provide informed comments is clearly not met by provision of a 60-day comment period, and a mere 45 days to review NHTSA's draft EIS.

Additional time is also called for due to the fact that the modeling, assumptions, and analysis underlying these proposals are dramatically different from that of previous, similar rulemakings. NHTSA has made numerous, significant changes to the CAFE model, identifying at least eleven "key changes," including multiple new "modules" to the CAFE model as well as many, substantial changes in the inputs, analysis, assumptions, and approaches taken in past rulemakings. Further, EPA has abandoned the models it used in 2010 and 2012 light-duty rulemakings (including ALPHA and OMEGA) in favor of the CAFE model preferred by NHTSA—another development requiring careful consideration and comment from California and other States. Notably, EPA itself had more than five months (from January to June 2018) to review the changes NHTSA made to the CAFE model, yet still had enough questions and concerns to fill more than a hundred pages. It is unreasonable for the agencies to expect our States, and our agencies, to evaluate these massive changes in models, approaches, inputs, and analyses in a 60-day comment period. A minimum of an additional 60 days is required, as evident from EPA's own lengthy review to address NHTSA's changes.

While in 2010 and 2012, the agencies provided 60-day comment periods for their joint rulemakings setting standards for light-duty vehicles, those rulemakings reflected substantial discussions and information-sharing with CARB prior to the notice of proposed rulemaking. Indeed, both previous, similar rulemakings, in 2010 and 2012, reflected an agreement among the three regulatory agencies—EPA, NHTSA, and CARB—as well as the automobile manufacturers. No such advance sharing of comprehensive technical data and information occurred here, and no such agreement exists here. Indeed, the agencies have broken their prior agreement to collaborate with California on these standards —both in proposing to roll back the federal standards and in proposing to withdraw

[7] Two examples illustrate that some important technical information is currently missing. The NPRM and the PRIA reference ANL's BatPaC website and indicate the agencies used "an up-to- date version" of ANL's BatPaC model. See, e.g., 83 Fed. Reg. 43,002 (Aug. 24, 2018). But readers cannot determine which version of BatPaC was used. Similarly, the PRIA references Polk registration data, including survival rates aggregated by model year, calendar year, and body style. These data are needed to verify the coefficients of the new scrappage model, but have not been made available. See, e.g., PRIA at 1010. "In order to allow for useful criticism, it is especially important for the agency to identify and make available technical studies and data that it has employed in reaching the decisions to propose particular rules." *Connecticut Light & Power Co. v. Nuclear Regulatory Com.*, 673 F.2d 525, 530-531 (D.C. Cir. 1982); *see also* 42 U.S.C. § 7607(d)(3) (notice of proposed rulemaking "shall be accompanied by a statement of its basis and purpose" including "the factual data on which the proposed rule is based; the methodology used in obtaining and in analyzing the data; and the major legal interpretations and policy considerations underlying the proposed rule." Courts have found that EPA's failure to make data relating to the basis for its Clean Air Act regulations publicly available made "meaningful comment on the merits of EPA's assertions impossible" and constituted reversible error. *Kennecott Corp. v. EPA*, 684 F.2d 1007 (D.C. Cir. 1982); *see also Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 392-95 (D.C. Cir. 1973) ("It is not consonant with the purpose of a rule-making proceeding to promulgate rules on the basis of inadequate data, or on data that, (in) critical degree, is known only to the agency").

California's waiver. Thus, EPA and NHTSA must allow a minimum of 60 additional days to afford California and the other States adequate opportunity to comment, as required by the APA.

These requests are consistent with important principles of public participation and cooperative federalism. They are, thus, also consistent with the "fishbowl memo" issued by Administrator Wheeler which states that "EPA must provide for the fullest possible public participation in[its] decision making" and must "take affirmative steps to seek out the views of those who will be affected by the decisions, including … the governments of states, cities and towns."

Docket Number: NHTSA-2017-0069-0222
Organization: National Coalition for Advanced Transportation
Commenter: Devin OConnor

The National Coalition for Advanced Transportation (NCAT) requests that the National Highway Traffic Safety Administration (NHTSA) and Environmental Protection Agency (EPA) extend the public comment period by 60 days on the proposed Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42,986 (Aug. 24, 2018) (Proposed Rule), Docket Nos. NHTSA-2018-0067 (RIN: 2127-AL76) and EPA-HQ-OAR-2018-0283 (RIN: 2060-AU09). In addition, NCAT requests that NHTSA extend the public comment period to the same date for the Draft Environmental Impact Statement (DEIS) for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks, Docket No. NHTSA-2017-0069.

NCAT is a coalition of companies and public utilities that support electric and other advanced vehicle technologies and related infrastructure. Its members include businesses engaged in electric vehicle (EV) manufacturing; electricity supply, transmission and distribution; and EV charging infrastructure production, deployment and operation. NCAT advocates for government policies that support deployment of EV technologies and related infrastructure, including NHTSA's and EPA's vehicle standards at issue in the Proposed Rule. Members of NCAT that manufacture electric vehicles are directly subject to regulation under the MY 2021-2026 standards. Other members of NCAT supply fuel and/or fueling infrastructure for vehicles regulated by the standards and thus are directly affected.

It is critically important that NCAT and its members have the additional time requested in order to properly analyze and meaningfully comment on the wide range of complex technical and legal issues presented in the more than 500-page Proposed Rule accompanied by an over 1,600-page Preliminary Regulatory Impact Analysis. The proposal incorporates new proposed CAFE standards for MY 2022-2022, major revisions to existing CAFE standards for MY 2021, major revisions to GHG standards for MY 2021-2025, new GHG standards for MY 2026, a first-ever proposal to rescind an existing waiver of preemption under Section 209(b) of the Clean Air Act, as well as a novel and highly consequential proposed interpretation of the preemption provisions of the Energy Policy and Conservation Act. The modeling, technical and legal analysis underpinning the proposed rule departs significantly from prior analyses and presents extensive, highly complex, and novel information and analytical approaches. Further, this rulemaking could have dramatic effects on the U.S. economy, NCAT members' business interests, and federal-state relations.

In addition, NHTSA's DEIS along with its Summary and Appendices total over 1,300 pages, and of course must be analyzed in conjunction with the Proposed Rule. Accordingly, NCAT requests that the comment period on the DEIS be extended until the close of the extended comment period on the Proposed Rule.

Docket Number: NHTSA-2017-0069-0224
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

The Environmental Law & Policy Center (ELPC) respectfully requests a 60-day extension of the comment deadline on the Safer and Affordable Fuel Efficient Vehicles Proposed Rule for Model Years 2021-2026. ELPC also requests that the deadline for comments on the US Department of Transportation's Draft Environmental Impact Statement ("DEIS") be extended from the current end date of September 24, 2018 to coincide with the same new deadline for comments on the proposal itself.

ELPC is the Midwest's leading public interest environmental legal advocacy organization working to protect human health and the environment. ELPC firmly believes that a strong auto manufacturing base is critical to the states we work to protect from Michigan, Ohio, Indiana, Minnesota, and Wisconsin to the Dakotas. ELPC is also a strong advocate for protecting the Great Lakes, an international gem of incalculable ecological, cultural, and economic value. They are the largest freshwater ecosystem on earth, containing 20% of the world's freshwater supply and providing drinking water for over 40 million people. The Great Lakes support a wealth of biodiversity, including diverse and rich populations of fish, wildlife, and plants across their large geographic range. Their economic importance is also evident: commercial and recreational fishing in the Great Lakes alone inject over $5 billion into the economies of the surrounding states. Climate Change is significant threat to the Midwest and Great Lakes, endangering public health, water quality, agriculture and forests.

Every action the United States takes to reduce greenhouse gas pollution is critical to protecting the climate. This proposed rule substantially undermines fuel economy and greenhouse gas emissions standards for new vehicles posing significant risk to our climate, public health, and jobs across the Midwest.

The Environmental Protection Agency (EPA) and Department of Transportation (DOT) have provided only 60 days for the public to comment on this proposal and even less time to comment on the accompanying DEIS. This timeframe falls far short of the amount of time needed for the public to evaluate the many issues raised in the rulemaking package and to submit meaningful comments.

The proposal reflects a significant change from the Clean Car rules currently in effect, raising numerous complicated technical, policy and legal issues. It is essential that EPA and DOT allow the public more time to provide thoughtful comments and feedback. We note that the 515 page proposal is based on complex technical analyses and the docket reflects many lengthy, deeply technical documents. Thousands of additional pages of information are now in the docket and reviewing these is essential to our ability to meaningfully comment on the NPRM.

In addition, the DEIS, which details the substantial public health and climate impacts of the options for weakening standards included in the NPRM, is accompanied by lengthy appendices. ELPC submitted detailed comments on NHTSA's scoping document for the DEIS and will be commenting on the DEIS. However, providing meaningful comment on the DEIS will require more time beyond the current September 24, 2018 deadline.

Finally, we note that in addition to this NPRM, EPA is also taking comment on the replacement to the Clean Power Plan. This is another critical proposal that has significant public health and climate implications for our region. In light of the above, ELPC respectfully requests that EPA and DOT extend the comment deadline on the proposal and DEIS to allow for meaningful public comment.

Docket Number: NHTSA-2017-0069-0225
Organization: Sierra Club et al.
Commenter: Alejandra Nunez

Center for Biological Diversity, Conservation Law Foundation, Earthjustice, Environmental Defense Fund, Natural Resources Defense Council, Public Citizen, Inc., Sierra Club, and Union of Concerned Scientists ("Environmental, Advocacy, and Science Organizations") respectfully request a 60-day extension of the comment deadline—to and including December 22, 2018—on the National Highway Traffic Safety Administration's ("NHTSA") and U.S. Environmental Protection Agency's ("EPA") proposal to establish new Corporate Average Fuel Economy ("CAFE") and Greenhouse Gas Emission Standards for Model Years 2021-2026 Passenger Cars and Light Trucks ("Proposed Rule"), 83 Fed. Reg. 42,986 (Aug. 24, 2018). Environmental, Advocacy, and Science Organizations further request that NHTSA extend to the same date (December 22, 2018) the comment deadline for its Draft Environmental Impact Statement ("DEIS") for the proposed CAFE standards, 83 Fed. Reg. 39,750 (Aug. 10, 2018). We concur with California and the 177 states that the agencies must maximize the potential for public engagement on this highly significant and detrimental proposal.

As explained below, the current lengths of the periods for comment on the Proposed Rule (60 days) and DEIS (45 days) are not commensurate with the rule's enormous legal and practical importance or the complexity of the underlying technical analysis—a substantial portion of which has yet to be disclosed—that is essential to ensure adequate public participation.

Moreover, because commenting on the DEIS will raise many of the same complex issues and require the same time-intensive evaluation as commenting on the rulemaking itself, the Environmental, Advocacy, and Science Organizations request that the comment deadline for the DEIS be extended to the same date the agencies establish for the comment deadline for the Proposed Rule.

You have proposed to substantially weaken the existing EPA greenhouse gas emissions standards for passenger cars and light trucks for model years 2021-2025 and establish new standards for model year 2026. You also have proposed to substantially weaken the CAFE standard for MY2021 and establish new standards for MY2022 through 2026 that make no progress on improving fuel economy. Initial assessments indicate the proposed standards would result in over two billion tons of additional climate pollution, cost consumers hundreds of billions of dollars, and eliminate 60,000 jobs as compared to the status quo—just a few of the standards' many destructive implications. Given those far-reaching and harmful consequences, the public needs additional time to provide informed comment on this proposal.

The administrative records for both the Proposed Rule and DEIS are highly technical and voluminous, and they continue to grow, with several thousand pages of new documents added recently to these dockets. The public cannot submit informed comments without the additional time requested to evaluate this information. We also note that, in recent instances, EPA's regulatory proposals of similar importance featured significantly longer comment periods.

An extended comment period is particularly appropriate for the Proposed Rule and the DEIS, because both employ complex technical analyses and use extensive modeling to help inform the development and evaluation of the proposed alternatives. EPA has developed the Optimization Model for reducing Emissions of Greenhouse Gases from Automobiles ("OMEGA"), which evaluates the relative cost and effectiveness of available light duty vehicle technologies and applies them to a defined vehicle fleet in order to meet specified greenhouse gas emissions targets. Meanwhile, NHTSA has developed the Volpe model to estimate the effects, costs, and benefits of final CAFE standards. During the prior rulemakings addressing the same standards, EPA and NHTSA released all their respective models and underlying data to the public in advance of the proposals' publication. Here, by contrast, stakeholders have for months sought information on the agencies' models to help facilitate their analyses of these standards, with only a belated and incomplete response. More than five months ago, several signatories of this letter submitted (1) a request to EPA for the current OMEGA model, along with the relevant input files and data, and (2) a request to NHTSA for the current Volpe model and corresponding data, so as to give the signatories adequate time to familiarize themselves with the models in advance of the publication of the Proposed Rule and DEIS. As of the date of this letter, EPA has failed to respond to the request for the current OMEGA model and relevant input files and data. The agency has failed to provide the needed modeling information, even though its latest modeling and evaluation of alternatives for its own proposal is highly relevant to stakeholders' assessment of that proposal.

The proposed standards and the DEIS rely heavily on NHTSA's Volpe model. While NHTSA did provide the current Volpe model at the time the agency made available the pre-publication version of its proposed standards, the current comment period frustrates public comments by leaving too little time to understand the new model: NHTSA has incorporated entirely new modules into the model, including a novel "scrappage" module purporting to document the relationship between the price of new vehicles and the retirement of used vehicles, a dynamic apparently driving many of the dramatic changes proposed by the agencies. The current comment period is insufficient to understand the new modules in the depth necessary for thoughtful comment.

In addition, Environmental, Advocacy, and Science Organizations have identified possible inconsistencies between the Volpe model information and other critical documents in the record. Once inconsistencies are identified, commenters require time to assess and explain the implications of those inconsistencies. For example, the agencies' Proposed Regulatory Impact Analysis describes a relationship between fatalities and vehicle age with an equation and a coefficient for a model of fatalities that purportedly are embedded in the CAFE model. However, the age-dependent piece of the fatalities model is not active in the Volpe model, and model documentation shows the estimate of fatalities per mile has no dependence on vehicle age. Likewise, the Proposed Regulatory Impact Analysis shows coefficients for the sales model that are different from the values in the Volpe model and the model documentation. Given the extensive documents and technical information underlying the proposal, Environmental, Advocacy, and Science Organizations cannot discern and evaluate these types of complex technical findings and their impact on the rulemaking under a 60-day comment period.

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Environmental, Advocacy, and Science Organizations also note that the comment period for the DEIS had been running for 13 days despite the fact that the proposed CAFE standard had not yet been officially published. The CAFE proposal is closely intertwined to the DEIS; for example, the agency's proposed scrappage model and its analyses of vehicle miles traveled must be closely examined in order to assess the environmental impacts of the agency's proposal. NHTSA's failure to provide its proposed rule and supporting technical documentation during this period thus prejudices the public's ability to analyze and comment on the DEIS. In addition, while NHTSA set the deadline for comments to the DEIS on September 24, 2018 (which is the same date it has set for the hearing in Fresno, California), two of the three public hearings announced by the agencies, which also encompass oral testimony on the DEIS, will take place after this deadline—on September 25 (Dearborn, Michigan) and September 26 (Pittsburgh, Pennsylvania). In the hearing notice, the agencies indicated that they will keep the official record for each of the three dockets open for thirty days after those hearings in order to allow stakeholders to submit supplemental information. 83 Fed. Reg. 42,817, 42,818 (Aug. 24, 2018). Thus, at a minimum, the public should have until October 26, 2018 (30 days from the hearing scheduled in Pittsburgh) to submit written comments on the DEIS.

For the reasons stated above, the Environmental, Advocacy, and Science Organizations respectfully request that the agencies extend the comment deadlines for both the Proposed Rule and DEIS to allow for a meaningful public comment period. Given the far reaching and harmful implications of the Proposed Rule and the complex issues relating to the NHTSA's NEPA analysis, it is essential that the agencies allow experts, stakeholders, and the public time to provide thoughtful and substantive comments and feedback.

Docket Number: NHTSA-2017-0069-0397
Organization: Alliance of Automobile Manufacturers
Commenter: Susan Conti

The Alliance of Automobile Manufacturers ("Alliance") requests an extension of the public comment periods for The Safer Affordable Fuel Efficient (SAFE) Vehicles Proposed Rule for Model Years 2021-2026 ("NPRM") issued jointly by the U.S. Environmental Protection Agency ("EPA") and the National Highway Traffic Safety Administration ("NHTSA") ("the Agencies") as well as for NHTSA's related Draft Environmental Impact Statement ("DEIS") for this proposed rule.

The Alliance requests an extension of the NPRM comment period from the current 60 days to a total that is not less than 120 days. We also ask that NHTSA align the comment period for the Draft EIS to end on the same day as the comment period for the NRPM.

The Alliance has provided the Agencies meaningful information, data, analyses and comments on all aspects of the Midterm Evaluation process including the Draft Technical Assessment Review (Draft TAR") and Proposed Determination.

As part of its formal comments on the NPRM for this important rulemaking, the Alliance will submit several detailed technical and economic analyses and reports. Due to extensive changes to NHTSA's model, developed by the Volpe National Transportation Systems Center, and the numerous supporting documents released by the Agencies, some of the Alliance's analyses and reports cannot be completed within the current 60-day comment period.

Our request for an extended NPRM comment period both is reasonable and necessary to ensure our submissions to the dockets are timely and can become part of the formal rulemaking record. Since NHTSA's DEIS is so closely related to the NPRM, the comment periods must be carefully aligned to ensure the public has the opportunity to submit comprehensive and meaningful comments.

Docket Number: NHTSA-2017-0069-0487
Organization: California Air Resources Board
Commenter: Pippin Brehler

On August 27, 2018, the California Air Resources Board (CARB), along with the Attorneys General of the State of California and several other states, and several state agencies, requested that the United States Environmental Protection Agency (U.S. EPA) and the National Highway Traffic Safety Administration (NHTSA) extend the comment periods for the joint proposed rule referenced above, and the associated draft Environmental Impact Statement. On September 11, 2018, CARB submitted the enclosed letter to the dockets for the proposed rule to request information necessary to evaluate the proposal and its environmental impacts. We submit this request to the docket for the draft Environmental Impact Statement as well, because the information is also necessary to provide CARB and other members of the public a reasonable opportunity to evaluate the draft Environmental Impact Statement.

Docket Number: NHTSA-2017-0069-0497
Organization: South Coast Air Quality Management District
Commenter: Barbara Baird et al.

Finally, the extremely voluminous record of the rulemaking in this case makes it impossible to provide adequate comments on the DEIS within the 30-day comment period. Comments on the DEIS are integrally related to the issues discussed in the NPRM, which has already been held deserving of a 60-day comment period. At minimum, the comment period for the DEIS must match that in the NPRM. And given the voluminous record, a minimum of 120 days for comment should be provided on both documents.

* * * * *

Importantly, SCAQMD believes that comments on the Draft EIS are integrally related to comments on the rule proposal itself so that NHTSA must allow a comment period on the Draft EIS that at least matches the comment period on the proposed rule, which ends on October 24, 2018. In addition, SCAQMD, along with many others, has requested an extension of time to comment on the proposed rule and Draft EIS for a total of at least 120 days from publication in the Federal Register on August 27, 2018, which would mean a comment period ending no earlier than December 26, 2018. We strongly believe that the massive nature of the rulemaking record requires an extension of time to provide adequate comment. And this is especially true since many of the conclusions in the Draft EIS rely on analysis in the Notice of Proposed Rulemaking (NPRM) or Regulatory Impact Analysis (RIA). (See for example, Draft EIS p. 4-27, which relies on the RIA for certain aspects of benefits of reducing PM2.5.).

Given the truncated comment period provided for the Draft EIS, SCAQMD's comments focus on the alternatives analysis, which is fatally deficient. If a longer comment period were available, we would provide more detailed comments on other critical aspects of the Draft EIS, such as the errors in the air quality analysis which we address here only to a limited extent.

* * * * *

We will discuss this issue further below, but it is impossible to adequately comment on this issue in the time provided given the interrelationship between the EIS and the voluminous record published in support of the NPRM. Given the unreasonably brief comment period on the EIS, we reserve our right to provide additional comments on this issue in our comments on the NPRM. NHTSA is legally required to consider such comments in evaluating the Draft EIS.

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The opportunity for public participation in rulemaking is a fundamental tenant of the rulemaking process. We again reiterate that by granting only a 63-day comment period on a 500-page document that relies on thousands of pages of supporting materials, this process has been designed to prevent the thorough review of materials and opportunity for in-depth comment.

* * * * *

It is unreasonable to provide only a 63-day comment period for the DEIS and other rulemaking materials when these documents amount to thousands of pages.

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

On September 26, 2018, the agency granted an extension of time to file comments to October 26, 2018. 83 FR 48578. While we are grateful for the additional time, the comment period remains inadequate given the degree to which the analysis of the proposal and its alternatives, and hence the Draft EIS, depends on complex predictive models that are unfathomable to the general public and most agency commenters.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

We note that, even though NHTSA extended the comment deadline by 33 days, the time permitted under the extension is insufficient to fully analyze the DEIS. Joint Commenters and numerous other parties, *including* the auto industry, requested NHTSA to extend the DEIS comment deadline by 60 days after the deadline for comments set forth when the Proposal was published in the Federal Register. The many parties seeking an extension did so because the Proposal and the DEIS rely heavily on numerous technical changes to the Volpe model that cannot be fully understood and analyzed in the mere 63 days NHTSA has now allowed for comment. Moreover, NHTSA has yet to provide crucial evidence requested by the California Air Resources Board that is necessary to understand the agency's Proposal and its effect on the environment. NHTSA has incorporated entirely new assumptions and modules into the Volpe model, including, among other things, a novel scrappage module purporting to document the relationship between the price of new vehicles and the retirement of used vehicles, a dynamic driving many of the justifications for the dramatic decrease in vehicle fuel efficiency NHTSA proposes. NHTSA's failure to allow sufficient time for the public to analyze and comment on the DEIS and its interrelated but opaque technical changes and new assumptions has denied the public the opportunity to fully understand and meaningfully comment on the environmental impacts of the Proposal, in violation of NEPA's fundamental requirements: "Federal agencies shall to the fullest extent possible ...[e]ncourage and facilitate public involvement in decisions which affect the quality of the human environment" and "[m]ake diligent efforts to involve the public in preparing and implementing their NEPA procedures." 40 C.F.R. §§ 1500.2(d), 1506.6(a).

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

EPA and NHTSA's rulemaking process has, in multiple respects, failed to provide the public with a meaningful opportunity to access necessary information on the proposal and to allow for public comment. This failure violates the agencies' obligations under the law.

The Administrative Procedure Act, the Clean Air Act, and long-standing executive branch guidance all require that agencies share relevant rulemaking materials with the public concurrent with the release of a rulemaking proposal. However, the agencies have failed to release information critical to the proposed rule that is necessary to allow for meaningful public comment. For example, EPA has, despite numerous requests dating back to even before the release of the proposal, failed to release documents and data related to the OMEGA model, which is EPA's primary tool for evaluating and setting vehicle GHG standards. This failure is particularly problematic given ample evidence that EPA abdicated its responsibilities to NHTSA despite expressed misgivings of EPA technical staff concerning NHTSA's analysis. Information in the docket suggests EPA's modeling found costs roughly half those found be NHTSA. In addition, the agencies have failed to release, among other things, information about the models and data used to estimate battery costs, and data necessary to evaluate the proposal's projections for fleet population, size, sales, and fatalities. The failure to make these materials available renders the public comment opportunity legally inadequate and the proposal unlawful. To comply with the law, the agencies must release these materials and reopen the comment period before proceeding further.

In addition, the agencies provided a wholly inadequate public comment period, despite eighteen requests for extensions of the comment period of at least sixty days – requests signed by entities representing vast numbers of stakeholders. In announcing its denial of these requests, the agencies merely explained that "Automakers will need maximum lead time to respond to the final rule, and extending the comment period...[is] inconsistent with provision of maximum lead time." 83 FR 48578, 48579-50. This justification is arbitrary for several reasons, including that auto manufacturer representatives themselves were among those calling for a 60-day extension of the comment period. The agencies fail to explain why any interest in "maximum lead time" deserves to supersede the wide range of other concerns and interests raised by stakeholders. The agencies' arbitrary denial of the requests from a diverse chorus of stakeholders insisting that additional time was needed to review the proposal's novel and elaborate analyses, together with the agencies' refusal to make necessary information available to commenters, impeded the ability of stakeholders to meaningfully comment on the proposal.

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

By failing to provide sufficient time for members of the public to analyze and comment on the complex technical issues and extensive material reflected in the DEIS and related documents, NHTSA has denied the public an important opportunity to provide input on the environmental assessment of a significant, harmful proposal.

NHTSA released its Draft Environmental Impact Statement on August 2, 2018, and EPA published a NEPA Notice of Availability on August 10, stating that the public comment period would close on September 24, 2018. EDF and other non-governmental organizations requested that NHTSA align the DEIS comment deadline with the NPRM comment deadline, and that the agency extend the comment period to allow for a 120-day comment period on the proposed rule and DEIS. Numerous other stakeholders also requested a comparable comment extension, including 18 states, 32 U.S. Senators, the trade group representing major automakers, the City of Los Angeles, the National Coalition for Advanced Transportation, and the American Lung Association.

Just days before the DEIS comments were ostensibly due, the agencies responded by denying the extension requests. NHTSA did issue a correction, however, adding three days to the comment period and aligning the DEIS comment deadline with the NPRM deadline, so that all comments are due October 26, 2018.

This 63-day comment period is not sufficient for members of the public to review and draft informed comments on a 1,300-page DEIS with appendices, accompanied by a 1,600-page Preliminary Regulatory Impact Analysis ("PRIA")—not to mention the Notice of Proposed Rulemaking ("NPRM") itself, which is more than 500 pages long and was not published in the Federal Register until August 24, 2018. Moreover, these documents reflect a foundation of complex technical analyses and modeling that were only released (in part) on the day of the proposal, despite EDF and others' pointed requests for such information in advance, to help facilitate our ability to provide informed comments.[8] The agencies' justification for the unlawfully circumscribed comment period—the need to set standards swiftly, to provide certainty for automakers—impermissibly ignores the interests of the many other stakeholders with vital interests at stake, and furthermore cannot be reconciled with auto industry associations' *own requests* for a substantially longer comment period.

A successful NEPA process is contingent on harnessing effective public involvement. NEPA's implementing regulations provide that, "Federal agencies shall to the fullest extent possible . . . encourage and facilitate public involvement in decisions which affect the quality of the human environment" and, further, "[m]ake diligent efforts to involve the public in preparing and implementing their NEPA procedures." 40 C.F.R. §§ 1500.2(d), 1506.6(a). NHTSA's imposition of an unreasonably short comment period for this DEIS unlawfully undermines public participation in the NEPA process.

[8] EDF and allies submitted requests to EPA and NHTSA as early as March 2018, asking that the agencies release the most current versions of their modeling tools and inputs: the OMEGA and Volpe models, respectively. See Letter to William Wehrum, EPA Assistant Administrator, Office of Air & Radiation, from EDF, NRDC, Safe Climate Campaign, and Union of Concerned Scientists (Mar. 20, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-5685; Letter to Heidi King, NHTSA Deputy Administrator, from EDF, NRDC, Safe Climate Campaign, and Union of Concerned Scientists (Mar. 20, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-5685; Letter to William Wehrum, EPA Assistant Administrator, Office of Air & Radiation, from EDF, NRDC, Safe Climate Campaign, and Union of Concerned Scientists (Sept. 20, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-1057, https://www.regulations.gov/document?D=NHTSA-2018-0067-5648.

Docket Number: NHTSA-2017-0069-0563
Organization: Pennsylvania Department of Environmental Protection
Commenter: Patrick McDonnell

The 60-day comment period provided by the agencies for this Proposed Rule is inadequate for the Commonwealth and other states (especially California and the other Section 177 states) to fully evaluate the proposed changes and how they may manifest in their jurisdictions.

As stated in the Proposed Rule, the agencies consider the joint action as entirely *de novo* and as such present an "entirely new analysis" in support of their proposed action. 83 Fed. Reg. 42,987. Given the agencies' introduction of new analyses with purportedly new information resulting in a major change in the National Model framework, which the federal government, California and the states previously completed and approved as appropriate, a 60-day timeframe to review and comment is entirely inadequate. The agencies' refusal to provide additional time for states to provide meaningful analysis and comments raises the question as to whether the agencies' actions are motivated by factors other than the protection of public health, public welfare and public safety. A rulemaking on the scope of what is proposed by the agencies, in any reasonable sense, would demand no less than 120 days for states to evaluate the "new analysis" and determine not only what impact those changes might have on their citizens, but to provide significant, meaningful comment to the federal government true to the premise of the "cooperative federalism" framework that provides the basis of the CAA.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

ELPC is joining the comments filed by the Center for Biological Diversity and is filing these comments to emphasize certain issues of vital importance to people and businesses in the Midwest. ELPC submitted a letter to the docket on August 30, 2018, requesting an extension of the comment period for the DEIS and NPRM. Even with the extension of the DEIS comment period to October 26, 2018, the comment period for the DEIS is inadequate. Our comments below reflect our best effort to raise some of the key substantive and legal weaknesses with the DEIS.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The Federal Administration has declined to complete the record supporting its claims, or even to extend the comment period to allow time to properly analyze them. The process followed to develop the national program, and then to conduct the midterm evaluation, was extensive and collaborative. It honored the commitments by the federal agencies to work with CARB. The opportunities for the public to participate in the proposed rollback, and even to review the proposal to comprehend it and prepare meaningful comments, were flatly inadequate. Sixty days to consider a proposal comprising 514 pages of the Federal Register, a preliminary regulatory impact analysis (PRIA) of 1,621pages that was re-issued twice (including four days before the end of the comment period), and related models, data, and explanatory documents that had not been previously made available for peer review is unreasonable. This outcome-driven approach is contrary to Congress's expectations and dangerous to public health.

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As explained more fully in the accompanying comments on the Draft Environmental Impact Statement for the SAFE Vehicles proposal, NHTSA's NEPA review is procedurally deficient in two respects. *First*, NHTSA has provided limited time for review and public comment, about a quarter of which lapsed before NHTSA published in the Federal Register the 515-page proposed rule and released its 1,600-page preliminary regulatory impact analysis on which the DEIS relies in many respects. As explained in greater detail in the accompanying comments, additional time is warranted because many stakeholders have reasonably requested it (including the Alliance of Automobile Manufacturers). Additional time is also warranted because, as outlined in the CARB request for information dated September 11, 2018, significant technical studies and data that underlie analyses in both the DEIS and the Proposed Rollback are not available as of the date of this submission. For example, the DEIS concedes that the economic assumptions embedded in the CAFE Model "play a significant role in determining the impacts on fuel consumption, changes in emissions of criteria and toxic air pollutants and GHGs, and resulting economic costs and benefits of alternative standards." (DEIS, 2-15). Partly by necessity, but mostly due to NHTSA's design choices, the analysis presented in the DEIS is complex. It involves cross modeling of many societal, economic, safety, and scientific factors. To evaluate the validity and accuracy of NHTSA's analysis requires substantially more time than NHTSA has allowed. See also States' Letter to Heidi King, Deputy Administrator, NHTSA, dated August 27, 2018 (submitted to NHTSA's DEIS docket).

Second, and relatedly, NHTSA has not released a myriad of significant technical studies and data that underlie both the DEIS and the joint proposed rule. Either of these two deficiencies, standing alone, renders the DEIS legally inadequate.

Docket Number: NHTSA-2017-0069-0593
Organization: Center for Biological Diversity et al.
Commenter: Irene Gutierrez

In multiple respects, the agencies' rulemaking process has deprived the public of a meaningful opportunity to participate, to access necessary information on the proposal, and to provide comment on the proposed rule—violating the agencies' duties under the law. Before proceeding, the agencies must offer additional opportunity for public comment on a complete record.

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The inadequate comment period has impaired stakeholders' ability to review and provide informed comment on the proposal. In particular, the truncated comment period has shortchanged stakeholders' ability review and critique the agencies' technical analyses.

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

The time permitted for comment is wholly inadequate to fully analyze the Proposal, DEIS, and their accompanying documents. The Organizations and numerous other parties, including the regulated industry itself, requested the agencies to extend the comment deadline by 60 days from the original deadline set forth when the Proposal was published in the Federal Register. The many parties seeking an extension did so because the Proposal and DEIS rely heavily on numerous technical changes that cannot be fully understood and analyzed in the mere 63 days the agencies allowed for comment. Moreover, the agencies have yet to provide crucial information requested by the California Air Resources Board that is necessary to understand the Proposal and its effect on the environment, or have supplied it just days before the close of the comment period, too late to allow meaningful review. The Proposal incorporates entirely new assumptions and modules into its modeling, including, among other things, a novel scrappage module purporting to document the relationship between the price of new vehicles and the retirement of used vehicles, a dynamic driving many of the justifications for the dramatic decrease in vehicle fuel efficiency and increase in greenhouse gas emissions the agencies propose. The failure to allow sufficient time for the public to analyze and comment on the DEIS and its interrelated but opaque technical changes and new assumptions has denied the public the opportunity to fully understand and meaningfully comment on the environmental impacts of the Proposal, in violation of basic principles of administrative law.

Docket Number: NHTSA-2017-0069-0621
Organization: Natural Resources Defense Council et al.
Commenter: Pete Huffman

EPA and NHTSA's rulemaking process has, in multiple respects, failed to provide the public with a meaningful opportunity to access necessary information on the proposal and to allow for public comment. This failure violates the agencies' obligations under the law.

The Administrative Procedure Act, the Clean Air Act, and long-standing executive branch guidance all require that agencies share relevant rulemaking materials with the public concurrent with the release of a rulemaking proposal. However, the agencies have failed to release information critical to the proposed rule that is necessary to allow for meaningful public comment. For example, EPA has, despite numerous requests dating back to even before the release of the proposal, failed to release documents and data related to the OMEGA model, which is EPA's primary tool for evaluating and setting vehicle GHG standards. This failure is particularly problematic given ample evidence that EPA abdicated its responsibilities to NHTSA despite expressed misgivings of EPA technical staff concerning NHTSA's analysis. Information in the docket suggests EPA's modeling found costs roughly half those found be NHTSA. In addition, the agencies have failed to release, among other things, information about the models and data used to estimate battery costs, and data necessary to evaluate the proposal's projections for fleet population, size, sales, and fatalities. The failure to make these materials available renders the public comment opportunity legally inadequate and the proposal unlawful. To comply with the law, the agencies must release these materials and reopen the comment period before proceeding further.

In addition, the agencies provided a wholly inadequate public comment period, despite eighteen requests for extensions of the comment period of at least sixty days - requests signed by entities representing vast numbers of stakeholders. In announcing its denial of these requests, the agencies merely explained that "Automakers will need maximum lead time to respond to the final rule, and extending the comment period...[is] inconsistent with provision of maximum lead time." 83 FR 48578, 48579-50. This justification is arbitrary for several reasons, including that auto manufacturer representatives themselves were among those calling for a 60-day extension of the comment period. The agencies fail to explain why any interest in "maximum lead time" deserves to supersede the wide range of other concerns and interests raised by stakeholders. The agencies' arbitrary denial of the requests from a diverse chorus of stakeholders insisting that additional time was needed to review the proposal's novel and elaborate analyses, together with the agencies' refusal to make necessary information available to commenters, impeded the ability of stakeholders to meaningfully comment on the proposal.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

As a threshold matter, the DEIS is procedurally deficient under the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4347 in two respects. *First*, even with a thirty-day extension of the comment period, NHTSA has not provided sufficient time for review of and public comment on the DEIS, which expressly relies upon and incorporates by reference the 515-page text of the Proposed Rollback in the *Federal Register* and its 1,600-page preliminary regulatory impact analysis. For example, the DEIS concedes that the economic assumptions embedded in the Corporate Average Fuel Economy (CAFE) model "play a significant role in determining the impacts on fuel consumption, changes in emissions of criteria and toxic air pollutants and GHGs, and resulting economic costs and benefits of alternative standards." Partly by necessity, but mostly due to NHTSA's design choices, the analysis presented in the DEIS is complex. It involves cross modeling of many societal, economic, safety, and scientific factors. To evaluate the validity and accuracy of NHTSA's analysis requires substantially more time than NHTSA has allowed. Second, and relatedly, NHTSA has waited until three days before the close of the comment period to release some, but not all, of the missing technical studies and data requested by CARB. Either of these two deficiencies renders the DEIS legally inadequate. See States and Cities' Detailed NEPA Comment, Section I.

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On August 27, 2018, eighteen States sent a letter to NHTSA explaining that, given the breadth, complexity and novelty of the issues raised in the Proposed Rollback, the voluminous but nonetheless incomplete materials accompanying it, and the profound effects the rule would have on the public health and the environment, the States were requesting that NHTSA extend the comment period on the DEIS to align with the requested 120-day comment period for the Proposed Rollback. Such an extension would be consistent with NHTSA's past practice when dealing with comparative rulemakings.

NHTSA received seventeen other requests for an extension of the public comment period from a variety of agencies, municipalities (including the City of Los Angeles), government organizations, environmental groups, industry groups (including the Alliance of Automobile Manufacturers) and 32 United States Senators. On September 21, 2018, NHTSA issued a notice extending the public comment period for the DEIS by 33 days and for the Proposed Rollback by 3 days. The Agencies justified their refusal to grant a longer extension on their assertion that the vehicle manufacturers "will need maximum lead time to respond to the final rule." However, this claim is firmly rebutted by the fact that automakers themselves—through the Alliance of Automobile Manufacturers—requested a 60-day extension of the public comment period for many of the same reasons listed in the States' August 27, 2018 letter. Thus, NHTSA's refusal to allow a meaningful extension of the public comment period was unjustified and erroneous.

Additional time is further warranted because, as outlined in the CARB letter dated September 11, 2018 (CARB letter), significant technical studies and data of central relevance to the analyses in both the DEIS and the Proposed Rollback are not available as of the date of this submission. NHTSA's last-minute forwarding of some data to CARB does not remedy this defect. NHTSA's failure to provide adequately detailed information necessary for the public to fully comment on the DEIS runs afoul of NEPA and the Administrative Procedure Act, 5 U.S.C. §§ 551-559. *See Connecticut Light & Power Co. v. Nuclear Regulatory Comm'n*, 673 F.2d 525, 530-31 (D.C. Cir. 1982) ("An agency commits serious procedural error when it fails to reveal portions of the technical basis for a proposed rule in time to allow for meaningful commentary."); *see also Trout Unlimited v. Morton*, 509 F.2d 1276, 1282 (9th Cir. 1974) (finding that an EIS should "provide the public with information on the environmental impact of a proposed project as well as encourage public participation in the development of that information.").

For these reasons, the States and Cities respectfully reiterate their request that: (1) NHTSA and EPA make all requested information available immediately; and (2) NHTSA extend the comment period of the DEIS and the Proposed Rollback for an additional 60 days after such disclosure to afford the States and Cities and the public a reasonable opportunity to review and comment on the DEIS.

Docket Number: NHTSA-2018-0067-12305
Organization: Environmental Defense Fund
Commenter: Erin Murphy

This rulemaking also fails to provide adequate opportunity for public input. EDF, along with 18 other groups, requested a 60-day extension of the comment period and the administration denied these requests.

The wholly inadequate time period for stakeholders to develop comments on this complex, technical proposal limits informed public input.

Additionally, NHTSA and EPA announced that they would hold a Hearing in Washington D.C. on the proposal but they reneged on that commitment, denying over 6 million D.C. metro area residents an opportunity to testify, many of whom do not have the time or resources to travel elsewhere to attend a Hearing.

The cancellation of the D.C. Hearing is particularly egregious because D.C. and Maryland have adopted California's vehicle emission standards, so those residents have a clear stake in EPA's proposal to deny underlying state authority to adopt these standards.

More Hearings and more public participation are better than less, and in closing, I ask that NHTSA and EPA listen to the public, consider the harmful effects of your proposed actions, and withdraw this damaging and indefensible proposal.

Docket Number: NHTSA-2018-0067-12305
Organization: New York State Attorney General Barbara Underwood
Commenter: Austin Thompson

Last, in violation of the National Environmental Policy Act (NEPA), NHTSA has failed to provide enough information regarding the environmental impacts of the proposed rule. NEPA requires NHTSA to provide an environmental impact statement that takes a "hard and honest look" at the environmental impacts of the proposed rollback, other reasonable alternatives, including taking no further action or increasing the stringency of the rules, and any potential mitigation measures that would prevent environmental damage. And it requires that statement to be published in time for other parties-like New York-to meaningfully evaluate the environmental impacts of the action imposed.[9]

NHTSA's draft statement fails on both of these requirements. NHTSA originally provided only the statutory minimum of 45 days for review and public comment on its draft statement. Almost a third of this time had already passed before NHTSA published the actual rule it is proposing—or the 1,600-page preliminary regulatory impact analysis on which the draft statement relies.

While EPA and NHTSA have now—almost on the eve of the deadline—extended it by 32 days, that is not enough time for meaningful review of a substantial rulemaking like this one, with so many interlocking components and enormous environmental impacts. It also comes with thousands of pages of documents, as EPA and NHTSA know all too well, because they published them. These include:

- A 515-page Notice of Proposed Rulemaking;
- A 1,600-page Preliminary Regulatory Impact Analysis
- A 500-page draft environmental impact statement; and
- 819 pages of draft environmental impact statement appendices, about 575 pages of which are important regional air quality and toxics modeling results by nonattainment/maintenance area.

The 77-day period allotted is insufficient to perform the kind of analysis such a momentous rule deserves. We need more time-and the public needs more time-to consider the implications of this substantial policy change.

The task has been made even harder by the incomplete draft statement and underlying analysis that NHTSA and EPA have provided. They have declined to provide significant technical studies and data that underlie analyses in both the draft statement and proposed rollback that are not available as of the date of this submission. The proposed rollback's impacts are, like any regulation that affects consumer behavior, difficult to calculate, and doing so requires complex economic, technical, and scientific modeling.

But NHTSA has declined to show its work and provide that modeling, as it is required to under NEPA. For instance, NHTSA claims that it has a new model describing when a car will be scrapped as useless (and thus will no longer contribute to emissions), but fails to provide necessary information about that model—despite requests. That model should be interlinked with NHTSA's sales model—today's new vehicle sales become tomorrow's used car supply, and used vehicle supply, vehicle mileage, and new vehicle prices all influence used vehicle prices—but NHTSA has failed to link the models in any way.

NHTSA's estimates regarding US energy consumption are similarly flawed: while NHTSA claims that the need for energy conservation "may no longer function as assumed in previous considerations of what

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[9] NEPA's implementing regulations require that environmental information be disseminated "early enough so that it can serve practically as an important contribution to the decisionmaking and will not be used to rationalize or justify decisions already made." 40 C.F.R. § 1502.5; *see also Trout Unlimited v. Morton*, 509 F.2d 1276, 1283 (9th Cir. 1974) (an EIS does not satisfy NEPA unless "it (1) provide[s] decision-makers with an environmental disclosure sufficiently detailed to aid in the substantive decision whether to proceed with the project in light of its environmental consequences, and (2) make[s] available to the public, information of the proposed project's environmental impacts and encourage participation in the development of that information"; *see also Connecticut Light & Power Co. v. Nuclear Regulatory Com.*, 673 F.2d 525, 530-531 (D.C. Cir. 1982) ("In order to allow for useful criticism, it is especially important for the agency to identify and make available technical studies and data that it has employed in reaching the decisions to propose particular rules.").

CAFE standards would be," it still relies on the same models that were based on the decreases in energy consumption from the original standards. Other examples of these sloppy modeling failures abound—for instance, its assumptions regarding the costs for implementing efficiency improvements rely on older data that do not reflect current technology.

Response

On August 2, 2018, NHTSA published a suite of rulemaking documents, including the Draft EIS, on its website and solicited public comments. Subsequently, the Notice of Availability for the Draft EIS was published in the *Federal Register* on August 10, 2018, and included a Draft EIS comment period end date of September 24, 2018.[10] The *Federal Register* published the NPRM on August 24, 2018, which began the NPRM's 60-day public comment period.[11]

After considering several comments requesting an extension of the comment period for both the rule and the Draft EIS, including those received and summarized above, the agencies extended the comment period for the rule until October 26, 2018.[12] In addition, NHTSA extended the public comment period for the Draft EIS to October 26, 2018 as well, aligning the comment periods for all the documents related to the rulemaking. The agencies explained that they were denying requests for an extension of the NPRM comment period by at least 60 days, explaining that "[a]utomakers will need maximum lead time to respond to the final rule[.]"[13] The extension of the public comment period for the Draft EIS was extended to "provide additional flexibility to commenters," and the agencies concluded that "this amount of time should be adequate for commenters to comment meaningfully on the proposal and on NHTSA's DEIS."[14]

Although the comment period ultimately closed on October 26, 2018, the agencies' dockets remained open, and the agencies continued to accept and consider comments, to the extent practicable, for more than 1 year after the comment period began.[15]

As discussed further in Section VIII.B.2.a of the preamble to the final rule, NHTSA does not believe that any further extension of the comment period was warranted under the circumstances, as the 63-day comment period was consistent with what the law requires. Specifically, the Administrative Procedure Act does not specify a minimum number of days for a comment period, and Executive Order 13563, reaffirming Executive Order 12866, broadly states that "to the extent feasible and permitted by law" the comment period should generally be at least 60 days. Notwithstanding the sufficiency of the agencies' 63-day comment period, NHTSA also published the NPRM and Draft EIS on the website on August 2, 2018, which provided the public with additional time to review both the NPRM and Draft EIS prior to the beginning of each comment period. In addition, as discussed above, the agencies' public dockets also remained open for more than 1 year after the start of the comment period, and the agencies considered late comments received, to the extent practicable. NHTSA incorporates by reference the aforementioned discussion in the preamble to the final rule, as it applies equally to the comment period for the Draft EIS.

[10] 83 FR 39750 (Aug. 10, 2018)

[11] 83 FR 42986 (Aug. 24, 2018).

[12] 83 FR 48578 (Sept. 26, 2018).

[13] *Id*. at 48581.

[14] *Id.*

[15] The agencies notified the public of this possibility in the NPRM, stating that: "To the extent practicable, we will also consider comments received after" the close of the comment period. 83 FR 42986, 43471 (Aug. 24, 2018).

While NHTSA understands and agrees with commenters about the importance and complexity of the issues here, the public docket demonstrates that the public had a meaningful opportunity to comment on the proposed rule. The agencies received more than 750,000 public comments, many of which commented on detailed, technical portions of the proposed rule. The public had not only the opportunity to review and comment on the proposal, but did so with an extraordinary level of detail.

In addition, the California Air Resources Board (CARB) and other commenters invoked requests to NHTSA under the Freedom of Information Act (FOIA) regarding material sought in connection with the rulemaking, including technical studies and data that followed the comments above. As discussed in Section VIII and elsewhere in the preamble to the final rule, NHTSA responded to the requestors by producing relevant records and believes it is important to note that many of the requested items had already been published on NHTSA's website for the rulemaking or in the rulemaking docket.

NHTSA also believes the three hearings provided substantial additional opportunity for public participation. As discussed further in Section VIII.B.2.b of the preamble to the final rule, while neither the Administrative Procedure Act nor EPCA/EISA require NHTSA to hold public hearings, the Clean Air Act does require EPA to "give interested persons an opportunity for the oral presentation of data, views, or arguments, in addition to an opportunity to make written submissions . . . ."[16] As commenters noted, as of the date that the public hearings were announced, the Draft EIS public comment period was scheduled to close prior to two of those three public hearings. However, as discussed above, NHTSA extended the Draft EIS comment period to October 26, 2018, 30 days after the last public hearing.

Comment

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

NHTSA and EPA have also flatly ignored Minnesota's request for a workshop or webinar that provides detailed explanations of the proposed rule requirements, modeling platforms and results, and underlying data and assumptions. In previous rulemakings of similar complexity, EPA has proposed a rule only after significant periods of public engagement and discussion, including posting and taking comment on intermediate analyses and modeling. EPA has also in the past provided workshops to help states understand and comment on modeling and analyses relied on for proposed rules. These activities help states wade through complex material and provide meaningful comment. Especially without this type of assistance, the 63-day comment period is simply not adequate to fulfil the agencies' statuory obligations.

Response

While NHTSA did not conduct a live workshop or webinar regarding the proposal, extensive information was made publicly available beyond the contents of the NPRM. As discussed further in Section VIII.B.2.b of the preamble to the final rule, to assist the public, NHTSA hosted a dedicated webpage with information on the modeling.[17] The webpage included a video introduction to the CAFE model. The webpage enabled members of the public to download the model software, its system documentation,

[16] 42 U.S.C. 7607(d)(5)(ii).
[17] https://www.nhtsa.gov/corporate-average-fuel-economy/compliance-and-effects-modeling-system.

source code, and input files. As a result, many commenters commented in detail on the modeling and analyses.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The DEIS and the accompanying Preliminary Regulatory Impact Analysis comprise thousands of pages containing numerous errors and shortcomings. Yet, in the NPRM, NHTSA states that "comments must not be more than 15 pages long." The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42,986, 43,470 (Aug. 24, 2018). In support of this statement, NHTSA cites 49 C.F.R § 553.21 (which also states that attachments may be appended to comments without regard to the 15-page limit). We note, however, that no page limitation applies to the "[e]xternal review of draft environmental impact statements" according to 49 C.F.R § 520.25. Thus, to the extent that NHTSA seeks to apply a 15-page limit to the DEIS comments, such limit would be unlawful on its face and as applied to this case as inconsistent with NEPA itself and basic principles of administrative law. However, in an abundance of caution, we are structuring our detailed comments as an attachment. All references cited therein will be uploaded to EPA's and NHTSA's dockets on the Proposal and the DEIS (Docket ID Nos. EPA-HQ-OAR-2018-0283, NHTSA-2018-0067, The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks; Proposed Rule).

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

Because NHTSA's regulations for "external review of draft environmental impact statements" do not mention any page limitation on public comments, and because the DEIS's own description of the "public comment period" also does not mention a page limitation, we presume that the notice of proposed rule's reference to a 15-page limit on comments submitted under 49 C.F.R. § 553.21 (a regulation focused on the adoption of rules) does not apply to comments on the DEIS. In the event NHTSA does interpret the 15-page limit to apply, please consider all the content following this first page to be an attachment, as permitted by the submission instructions.

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

As the Organizations state in comments to be submitted to the Proposal's dockets, NHTSA-2018-0067; EPA-HG-OAR-2018-0283, the Proposal, the accompanying Draft Environmental Impact Statement, Preliminary Regulatory Impact Analysis and the accompanying attachments, collectively spanning thousands of pages, contain numerous errors and shortcomings. Yet, in the Proposal, the agencies state that "comments must not be more than 15 pages long." In support of this statement, they cite 49 C.F.R § 553.21 (which also provides that attachments may be appended to comments without regard to the 15-

page limit). Accordingly, we are attaching our detailed comments regarding climate change as an attachment.

We note, however, that limiting comments to a mere 15 pages for a very large and complex technical record underlying a highly significant rulemaking with vast impacts for climate change—made even more onerous by a truncated comment period—demonstrates a callous disregard for the public's right to meaningful comment and review.

Response

NHTSA's regulations at 49 CFR § 553.21 state that "Unless otherwise specified in a notice requesting comments, comments may not exceed 15 pages in length, but necessary attachments may be appended to the submission without regard to the 15-page limit." As discussed further in Section VIII.B.2.b of the preamble to the final rule, the page limit on primary comments did not prevent commenters from presenting any information they deemed relevant to the agencies. Both primary comments and their attachments are available in the agencies' public dockets and were considered by the agencies in this rulemaking, as demonstrated by the responses to comments discussed throughout the preamble to the final rule and in this chapter.

NHTSA's 15-page limit simply prescribed the form that comments should take: a concise summary comment of up to 15 pages, with optional attachments with no page limit. Many commenters submitted extensive attachments to their comments, including commenters that objected to the 15-page limit for primary comments. The 15-page limit had the effect of causing commenters to create executive summaries of otherwise voluminous comments, which increased efficiency during the rulemaking process, consistent with NHTSA's stated purpose for the 15-page limit. No commenter was prevented from submitting information to the agencies based on NHTSA's page limitation for primary comments.

Comment

Docket Number: NHTSA-2017-0069-0578
Commenter: Monica Koziol

It is unconscionable that the Public was not offered information on this proposed change affecting our environment and our lives.

Response

The purpose of this EIS is to analyze, disclose, and compare the potential environmental impacts of the Proposed Action and a reasonable range of alternatives.

Comment

Docket Number: NHTSA-2017-0069-0588
Organization: Alliance of Automobile Manufacturers
Commenter: John T. Whatley

The Alliance appreciates the opportunity to provide comments on the DEIS. The Alliance will comment further on the issues addressed here in its comments in the regulatory docket, and also requests an opportunity to respond to comments on the DEIS from other stakeholders that are made on or before

October 26, 2018, the current deadline for DEIS comments. The Alliance requests that all such comments be placed in the NHTSA Docket 2017-0069 as soon as possible.

Response

Comments received by NHTSA on the Draft EIS were posted to its docket (Docket No. NHTSA-2017-0069) as soon as reasonably possible for public review.

10.1.5 Document Structure and Readability

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

An EIS "must be organized and written so as to be readily understandable by governmental decisionmakers and by interested non-professional laypersons likely to be affected by actions taken under the EIS." *Or. Envtl. Council v. Kunzman*, 817 F.2d 484, 494 (9th Cir. 1987). The DEIS fails that standard because its two fundamental premises are nonsensical and not based on fact.

As discussed above, the DEIS' conclusion that weakening the CAFE standards will increase safety is based on the arguments that fewer miles will be driven (the rebound effect and the scrappage effect), and that those miles will be driven by safer, newer, and less polluting vehicles. As senior EPA staff has pointed out in a submission to the docket, neither of those arguments makes sense in the context of this EIS.

The Rebound Effect. As stated above, the rebound effect is the assertion that, as vehicle efficiency improves, vehicle miles traveled (VMT) will increase. The per-mile costs associated with that increased VMT are presented as offsetting some of the benefits of increased efficiency.[18] In the 2012 standard, the agencies used a 10% rebound effect value, noting that the available literature supported that figure.

The DEIS revises this figure, and instead assumes a 20% rebound effect. To arrive at this new figure, the agencies contort findings from studies undertaken post-2012, ignore other studies and meta-analyses undertaken post-2012, and erroneously suggest that recent literature undermines the conclusion that the rebound effect decreases as income increases. Arbitrarily utilizing a 20% rate distorts the emission results: without it, the differential in GHG and criteria pollutant emissions (and the purported safety impacts) between the alternatives would be substantially lower.

The Scrappage Effect. The scrappage analysis projects that fewer overall cars (thus less overall VMT) will be driven under the rollback. This is because the DEIS and NPRM claim that new car prices will be lower under the Proposed Vehicle Rollback, and that, because used car values are purportedly influenced by new car prices, used car values will also decrease. The agencies then assert that, as used car prices decrease, consumers will discard their old cars rather than continuing to drive them. But the agencies

[18] Some scholars do not think that the rebound effect exists; see, e.g., David B. Goldstein & Ralph Cavanagh, Energy Efficiency and the "Rebound Effect," Natural Resources Defense Council (Feb. 17, 2011), https://www.nrdc.org/experts/david-b-goldstein/energy-efficiency-and-rebound-effect.

also take pains to describe that those consumers will not replace their old cars, nor will they replace the miles they used to drive them. Instead, they will throw away the old car and simultaneously choose to drive less overall, simply because the agencies assume that new car prices will be lower than they would be if cars were more efficient. Therefore, the analysis proposes, as new car prices decrease, consumers as a whole will drive fewer miles, and will be subject to less safety risk. Both this improbable result and the erroneous assumptions underlying it are fatally flawed.

The DEIS ignored this obvious contradiction and did its best to make the augural standards show far more VMT than can be justified by assumed higher auto prices and associated lower scrappage. The professional staff at EPA recognized this in a highly critical technical analysis of the NHTSA auto mileage modeling, cited above. On page 1 of the Overview section of that analysis, EPA writes: "the[NHTSA] scrappage model produces vastly unrealistic growth in the overall fleet size[between the augural standards and the rollback], which in turn causes an unrealistic over-inflation of the fatalities estimated for the Augural standards."

In other words, the DEIS modeling shows VMTs under the 2017-2025 standards finalized in 2012 as too high, and VMTs under the NPRM standards as too low. EPA explains:

> The As-Received [NHTSA] model estimates that the Augural standards will reduce the year-over-year annual increase sales of new vehicles by approximately 8,000 vehicles on average between CY2021 and CY2032. However, during the same period, the As-Received model estimates that the used fleet will grow by an average of 512,000 vehicles per year, far exceeding the decrease in new vehicle sales. It's hard to imagine any real-world scenario under which over 60 additional used vehicles are retained for each new vehicle that the sales model predicts will be unsold as a result of the higher new vehicle prices.

When the EPA officials corrected NHTSA's scrappage model and some additional errors, they concluded that NHTSA's figure for auto accident fatalities under the rule finalized in 2012 were much too high, making the "savings" under the proposed new rule illusory. They summarized:

> Compared to the results from the As-Received [NHTSA] version, our EPA-Revised version provides technology costs that are nearly $500 lower and safety outcomes that show the proposed standards are detrimental to safety, rather than beneficial as suggested by the As-Received version. In other words, results with our code revisions indicate that the Proposed standards would result in an increase in the fatality rate of 7 deaths per trillion miles driven, and an average increase of 17 fatalities per year in CYs 2036-2045 relative to the Augural standards.

Misuse of the scrappage factor also misstates vehicle emissions. The PRIA shows that turning off the scrappage price effect under the proposed standards should increase emissions because more people will keep their older cars and therefore consume more fuel (with concomitant upstream and tailpipe emissions). But the DEIS shows reduced tailpipe emissions for most criteria pollutants under various scenarios.

As EPA pointed out, the newly proposed standards will lead to more auto accident deaths, not fewer, and more tailpipe emissions, not less. There is no comprehensible response to EPA's critique in the DEIS – the DEIS modeling just makes no sense.

As the *Kunzman* court pointed out:

> The district court stated that an EIS "must translate technical data into terms that render it an effective disclosure of the environmental impacts of a proposed project to all of its intended readership." The scant

> case law indicates that an EIS must translate technical data into terms that effectively disclose environmental impacts to its "intended readership," including "interested members of the public," that an EIS should be written "in clear, concise, easily readable form so as to provide a reasonably intelligent non-professional an understanding of the environmental impact," and that an EIS must be "organized and written in language understandable to the general public and at the same time contain sufficient technical and scientific data to alert specialists to particular problems within their expertise."

Or. Envtl. Council v. Kunzman, 817 F.2d at 493-94 (internal citations omitted); *see also California ex rel. Lockyer v. U.S. Forest Serv.*, 465 F. Supp. 2d 942, 950 (N.D. Cal. 2006) (finding Forest Service DEIS "incomprehensible" and so in violation of NEPA). As the comments from William Charmley and common sense show, the current DEIS does not meet minimum standards of intelligibility, should not have been published, and is unlawful.

Response

The CEQ regulations state: "Environmental impact statements shall be written in plain language and may use appropriate graphics so that decisionmakers and the public can readily understand them. Agencies should employ writers of clear prose or editors to write, review, or edit statements, which will be based upon the analysis and supporting data from the natural and social sciences and the environmental design arts." 40 CFR § 1502.8.

The commenters disagree with the inputs and assumptions underlying the CAFE model and the analysis supporting the NPRM and Draft EIS. Specifically, the commenters focus on the rebound effect and the scrappage model. NHTSA received numerous comments on these topics and addressed those comments in Section VI.D of the preamble to the final rule. However, NHTSA disagrees with the commenters' assertion that this relates to the readability of the Draft EIS. In fact, these commenters clearly understood the issues outlined in the Draft EIS; they provided succinct restatements of each effect in addition to a regulatory history of the agencies' consideration of each. The commenters do not claim that any of the language in the EIS is unclear or unreadable, but rather that they simply disagree with the results of NHTSA's analysis. Therefore, NHTSA believes that the case law cited by the commenters is inapposite.

Comment

Docket Number: NHTSA-2018-0067-7361
Commenter: Cor van de Water

It appears that there are numerous serious errors in the data in the DEIS, so how can there be a good opinion about the proposed rule? The Draft Environmental Impact Study report needs to be updated before a decision can be taken about this proposed rule, so the proposed rule needs to be delayed pending update of the DEIS.

For example, the preferred solution (no action) is shown in the first table S1 as if it will increase the fleet MPG to 46.8 while the text is in contradiction to this and states that MPG will not change from 2020 through 2026.

Several other serious errors and omissions in the DEIS make it likely to confuse or lead to wrong opinion on the proposed rule.

This must be corrected before the process can continue.

Response

NHTSA has reviewed hundreds of thousands of public comments, as well as studies and reports that have been published since the release of the Draft EIS, which informed the analysis supporting the final rule and, accordingly, the Final EIS.

NHTSA believes this commenter may have misinterpreted Draft EIS Table S-1 in the example provided. In that table, the No Action Alternative (Alternative 0) assumed that NHTSA would not amend the CAFE standards for MY 2021 passenger cars and light trucks and that NHTSA would finalize the MY 2022–2025 augural CAFE standards that were described in the 2012 joint final rule. Additionally, the No Action Alternative also assumed that the MY 2025 augural CAFE standards would continue indefinitely. As a result, it anticipated increases in projected required fuel economy over MYs 2021—2026. By contrast, the agency’s Preferred Alternative in the Draft EIS was Alternative 1, which would require a 0.0 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MYs 2021–2026. The alternatives were described on pages S-2 and S-3 of the Draft EIS Summary.

10.2 Proposed Action and Alternatives

10.2.1 Proposed Action

Comment

Docket Number: NHTSA-2017-0069-0511
Commenter: Harold Draper

The EIS also does not contain the section required in Section 1502.2(d) of the NEPA Implementing Regulations, which requires that environmental impact statements shall state how alternatives considered in it and decisions based on it will or will not achieve the requirements of sections 101 and 102(1) of the Act and other environmental laws and policies. In Section 101, there are six policies listed. The comments below refer to these six policies:

It is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may

With the selection of Alternative 1, the agencies are ignoring the mandates in Section 101 of NEPA.

1. NHTSA, EPA, and DOE are shifting the burden of air pollution mitigation and climate change to future generations and are failing to fulfill their responsibilities as a trustee of the environment
2. NHTSA, EPA, and DOE, in promoting additional auto pollution, are ignoring this mandate
3. The existing CAFE standards are consistent with this policy, promoting the shift to more fuel-efficient technologies; NHTSA, EPA, and DOE are ignoring this mandate
4. The adverse effects of increased air pollutant emissions and increased GHG emissions will harm our national heritage, especially those parks and historic sites that are inundated by sea level rise and

the ecosystems that are shifted or altered by climate change; NHTSA, EPA, and DOE are ignoring this mandate
5. The existing CAFE standards seek to balance the need to avoid too-stringent auto fuel efficiency standards with the ability of automakers to increase and improve fuel efficient technological standards, as well as the adverse effects of climate change; the repeal of the CAFE standards will lead to dirtier air, a lower standard of living as other countries make the renewable energy transition and we are stuck in the 20th century; NHTSA, EPA, and DOE are ignoring this mandate
6. By promoting oil refining rather than use of alternative technologies such as natural gas, electric cars, and renewables, NHTSA, EPA, and DOE are failing to enhance renewable resources and promoting the depletion of fossil fuels; NHTSA, EPA, and DOE are ignoring this mandate

Response

NHTSA's EIS provides a systematic "hard look" at the potential environmental impacts of the Proposed Action and a reasonable range of alternatives. In the preamble to the final rule, FRIA, and Final EIS, NHTSA addresses these impacts and other essential considerations of national policy. For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020 and holding those standards flat through MY 2026—does not represent the maximum feasible standards. NHTSA determined that the maximum feasible standards for MYs 2021–2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. NHTSA believes that its Preferred Alternative in this Final EIS addresses many of the issues raised by the commenter by requiring year-over-year improvements in average fuel economy.

Comments

Docket Number: NHTSA-2017-0069-0504
Organization: Maryland Department of Planning
Commenter: Myra Barnes

The proposed freezing of CAFE standards described in the EIS undermines much of the work Maryland has accomplished in improving energy efficiency, reducing greenhouse gas emission reductions and building climate resilience and adaptation. Rather than freezing, DNR considers gradual ramping up of CAFE standards to be beneficial to Maryland and the U.S. for the following reasons: it provides regulatory certainty for U.S. automakers, reduces gas costs for consumers and businesses, helps shrink the carbon footprint of the transportation sector, improves air quality and protects human health in urban centers like Baltimore, reduces airborne pollution entering the Chesapeake Bay watershed, and helps reduce Maryland's vulnerability to climate-related risks such as sea level rise, stronger, more intense storms, and agricultural crop damage from too little or too much precipitation.

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

The proposed rule will contribute to climate change by increasing GHG emissions from the United States transportation sector. The agencies estimate that their rule will increase total vehicle emissions by 10%. This will not adequately address climate change and fails to protect future generations. Climate change impacts are felt across the United States and are already dramatically altering our environment, causing more frequent and intense heat waves, more intense precipitation events, and more prolonged drought.

Docket Number: NHTSA-2017-0069-0527
Commenter: Lynn Carroll

While these standards are important for our health, they play a big part in our welfare as well. I refer to the many ways in which climate change has increasingly affected people's lives. It's certain that greenhouse gases cause the warming that drives climate change and that reducing emissions of these is urgently necessary. Otherwise the costs of more destructive storms and rising sea level are going to wipe out any benefit of a strong economy, as infrastructure and homes must repeatedly be rebuilt, strengthened, or moved. Therefore, improvement in vehicle air conditioning as well as gas mileage must be pursued in order to reduce release of potent greenhouse gases into the air.

Docket Number: NHTSA-2017-0069-0540
Commenter: Christopher Lish

I urge you not to gut vehicle fuel-efficiency and tailpipe-pollution standards for the following reasons:

1) Climate change is the single greatest threat we've ever faced—not only to public health but to the future of our planet's ecosystems. Fossil-fuel vehicles are our nation's largest source of greenhouse gases, and clean car standards (the CAFE and greenhouse gas emissions standards) are currently our most effective tool to fight climate change. Strong clean car standards have already reduced millions of tons of carbon pollution from our environment. If kept intact, these standards would further cut carbon pollution nationwide by 6 billion metric tons, protecting the environment and public health. No plan to stop climate change can succeed without significantly curbing auto emissions. Maintaining these common-sense standards is one of the most crucial things we can do to fight climate change and protect clean air. Flatlining or reducing the improvements from these rules will make climate change worse.

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

Under governing law, record evidence dictates, at a minimum, that NHTSA set standards consistent with its augural standards and that EPA maintain existing standards. Given the new evidence added to the record up through the comment period, the agencies should also evaluate further strengthening standards.

In the face of dire climate change realities, the agencies' proposal to gut existing standards with no serious consideration of alternative protective measures is irrational and capricious.

*   *   *   *   *

All of these unlawful actions are taken in arbitrary haste, with the agencies proposing to finalize far-reaching standards without affording the public a meaningful opportunity to review and comment.

*   *   *   *   *

The scientific consensus that climate change is real, man-made, and dangerous is overwhelming. EPA has repeatedly affirmed the severity of the threat and the urgency of the need to address it. Nonetheless, in their proposal, EPA and NHTSA utterly fail to evaluate the health and environmental risks posed by continued emissions of greenhouse gases. Even worse, the agencies make no attempt to relate their proposal – which would significantly increase greenhouse gas emissions – to the known facts about climate change and its threats, including the urgency of reducing emissions now to reduce the risk of horrific harms from a destabilized climate. This willful disregard of the recognized scientific facts would render adoption of the proposed standards unlawful. Both EPA and NHTSA are required by statute to protect the public: CAA Section 202 requires EPA to prescribe standards to limit vehicular emissions that cause or contribute to air pollution that endangers public health and welfare. 42 U.S.C. § 7521(a)(1). NHTSA's mandate to adopt "maximum feasible" fuel economy standards reflecting "the need of the United States to conserve energy" requires factoring in the climate-altering impacts of consuming oil. 49 U.S.C. § 32902(a), (f). The agencies' proposal to set standards that achieve no additional emissions reductions fails completely to further their statutory mandate to protect the public and is proposed without any attempt to reconcile their proposal with facts about relevant health and environmental risks – which, in this case, must include climate change. Moreover, in the face of a threat as severe and urgent as climate change, their proposal to strip away existing protections with no serious consideration of alternative protective measures is arbitrary and unlawful.

Docket Number: NHTSA-2017-0069-0564
Commenter: John Shaw

I urge the agencies to keep the current fuel efficiency (CAFE) standards that are now in place and to not allow any reduction in the efficiency (*i.e.* increase in the allowed mpg rating) for the following reasons:

CLIMATE CHANGE

Climate change (sometimes known as global warming) is real. It is, of course, a global problem and no one country is going to correct it. However, if the United States does not do all that it can do the US cannot expect other countries to take bold action on their own. We should be the leader and do everything we can do to curb climate change by reducing our output of CO_2. Only then we can ask that other countries follow our lead.

The recent report from the Intergovernmental Panel on Climate Change makes it clear that the production of greenhouse gasses must be decreased immediately to avoid serious climate damage.

Transportation is now the largest generator of greenhouse gas in the US. The amount of CO_2 released to the atmosphere is proportional to the fuel economy of the vehicle and can be reduced by increasing the fuel economy (mileage or miles per gallon).

POLLUTION

In addition to the green house gas released, the burning of petroleum releases other pollutants. Release of most of the "criteria pollutants" will increase if the proposed changes are adopted.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

These comments are submitted with IPCC special report on the impacts of global warming of 1.5° C above pre-industrial levels front and center. This report is a clarion call for urgent action. The EPA's endangerment finding under the Clean Air Act requires EPA to act to reduce dangerous climate pollution. NHTSA is required to set maximum feasible fuel economy standards that balance factors including the need of the nation to conserve oil. ELPC strongly supported the fuel economy and greenhouse gas standards that NHTSA and EPA jointly issued in 2012. EPA's pollution standards for MY2017-2025, and NHTSA's final standards for MY2017-2021 and augural CAFE standards for MY2022-2025 were supported by the auto industry, labor and public health groups. With California's agreement, this constituted a single national program for vehicle standards. They reflected the spirit of creativity, innovation and proactivity that should characterize the American auto industry for the decades to come and make it a global leader. That cooperative spirit should inform NHTSA's current process; unfortunately the public hearings, the record, and news reports reveal broad opposition to this proposal as well as the flawed process that yielded it.

If fully implemented, the 2012 EPA and DOT standards would keep 6 billion metric tons of dangerous carbon pollution out of the atmosphere, as well as reduce other harmful air pollutants. Further, they would save families up to $122 billion at the pump, decreasing oil consumption by more than 12 billion barrels. This proposal undermines those benefits, driving up oil consumption, pollution and consumer costs at the pumps—all while reducing jobs and investments in innovation and technology that will drive the competitiveness of the auto industry in the future. The DEIS fails to fully and accurately account for the environmental impacts of the proposed revised CAFE standards.

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NHTSA's proposal will substantially increase carbon emissions. Despite its internal inconsistency, the DEIS leaves no doubt that the agency's Preferred Alternative would result in far greater CO_2 emissions than the No Action Alternative. EPA has calculated that the average coal-fired power plant produces 4.038 MMT per year. The difference between the Preferred Alternative and the No Action Alternative (7,400 MMT of CO_2) is therefore equivalent to the greenhouse gas emissions produced by running 1,832 coal-fired power plants for a full year. EPA has calculated that, on average, meeting the electricity demand of one U.S. home for one year produces 6.672 metric tons of CO_2. The difference between the Preferred Alternative and the No Action Alternative is therefore equivalent to the greenhouse gas emissions produced by providing electricity to over 1.1 billion homes for one year.

Although the DEIS fails to provide adequate projections of greenhouse gas emissions for the Preferred Alternative in years before 2100, it is clear that NHTSA's proposal would begin accelerating CO_2 emissions very quickly. According to one recent study, between 2022 and 2035 alone, NHTSA's Preferred Alternative would increase CO_2 emissions by between 321 and 931 MMT, depending on oil prices. To put these projections into perspective, running 79 average coal-fired power plants for a full year would produce 321 MMT of CO_2. Alternatively, providing electricity to 48 million U.S. homes for one year would also produce approximately 321 MMT CO_2. These are very real consequences in terms of emissions from NHTSA's preferred action. NHTSA says these are minimal differences, but that is not accurate and fails to inform the reader or decision maker of the nearer term consequences of NHTSA's preferred option.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The future envisioned by the rollback rule, on the federal agencies' own admission, is one in which greenhouse gases nearly double from today, further exacerbating climate change. In that future, according to the world's leading scientists, hundreds of millions of people would be displaced, millions would die, and trillions of dollars of harm would come to what remains of the global economy. These tragedies are coming to pass now. The Intergovernmental Panel on Climate Change has estimated that human-caused emissions have already increased global average temperatures approximately 1 degree Celsius. Hurricanes, rampant wildfire, drought, heat waves, and other extreme weather events are becoming more common and severe. Moreover, worsening smog and soot pollution caused by vehicle emissions will be exacerbated by the rollback, rendering it difficult or impossible for the states readily to meet core state and federal public health standards. Yet, the federal agencies propose to actually make the situation worse, while attacking the states' sovereign authority to protect their own citizens.

* * * * *

The Agencies' proposal offends the science, the law, and the evidence. It disrupts a major industry, puts the public at risk, and reverses critical action needed to protect air quality and reduce climate change impacts. It also marks a stark departure from basic principles of governance, as the executive agencies ignore state sovereignty, Congressional direction, their own statutes, and their own experts to serve the whims of the President. The proposal fundamentally fails basic responsibilities of government.

Docket Number: NHTSA-2017-0069-0593
Organization: Center for Biological Diversity et al.
Commenter: Irene Gutierrez

Despite acknowledging that "[t]he overarching purpose of EPCA is energy conservation," NHTSA does not adequately consider the environmental and climate considerations that are part of evaluating this factor. *Cf.* 83 Fed. Reg. at 43213. In so doing, NHTSA fails to consider an important aspect of the statutory analysis and fails to explain its departure from its own past practices. *State Farm*, 463 U.S. at 43, *Encino Motorcars*, 136 S. Ct. at 2127.

As part of moving the U.S. to "greater energy independence and security," lawmakers intended NHTSA to set maximum feasible fuel economy standards, which conserve energy and account for the environmental and climate benefits that accompany reduced petroleum consumption. In the past, NHTSA itself has acknowledged that in setting fuel economy standards, consideration of the environmental implications of those standards must include "reductions in emissions of carbon dioxide and criteria pollutants and air toxics." 77 Fed. Reg. at 62669; *see also*, 75 Fed. Reg. 25324, 25556 (2010); 71 Fed. Reg. 17566, 17644 (2006).

Yet now, NHTSA ignores not just the energy conservation that will result from more stringent standards, but also the environmental and climate costs that will result from less stringent fuel economy standards. Under this proposal half a million more barrels of oil will be consumed per day, compared to NHTSA's augural standards. 83 Fed. Reg. at 42995. Extracting, processing and consuming oil has numerous adverse health effects, largely levied on low-income communities and communities of color. Many of these fence-line communities are composed of people of color, and/or low-income individuals. Some 17.6 million people in the United States live within a mile of an active oil or gas well. Such proximity leads to increased exposure to criteria air pollutants and airborne toxics, as well as contaminated soil and water. These exposures contribute to a host of adverse health outcomes, including: increased incidence of respiratory and cardiac conditions, adverse birth outcomes for developing fetuses, and increased cancer risk. Likewise, communities living near refineries and roadways also bear increased pollution burdens, and suffer from greater rates of respiratory and cardiac ailments, and increased cancer risks. Without considering this spike in oil extraction, transportation, refinement and consumption and related pollution, NHTSA has not given full consideration to the energy-conservation factor in 49 U.S.C. 39202(f), and its selection of a preferred alternative without accurate consideration of this factor violates NHTSA's mandate. See *State Farm*, 463 U.S. at 43; *CBD v. NHTSA*, 538 F.3d at 1198.

NHTSA also ignores the climate implications of its proposal. NHTSA argues that its current proposal would only increase global temperatures by 0.003° by 2100 (compared to the augural standards), and there is no need to place "an outsized emphasis" on environmental and climate considerations. 83 Fed. Reg. at 43216. Yet, as pointed out in coalition comments on the DEIS, and in the recent Intergovernmental Panel on Climate Change Report, not only is NHTSA's figure wrong, a rise in temperature would have severe consequences. The Rhodium Group calculated that additional carbon emissions resulting from NHTSA's proposal would be larger than the total current national annual emissions of 82% of the countries on Earth. Continuing increases in carbon emissions have dire consequences for a world already teetering on the brink of irreversible consequences from climate change NHTSA's failure to consider these impacts is contrary to NHTSA's own warnings in the 2012 EIS and the 2016 TAR, which cautioned against actions that would contribute to global temperature increases. It is also contrary to NHTSA's past practices of considering the climate impacts of fuel economy standards, and NHTSA fails to explain why it has departed from its past practice. *Encino Motorcars*, 136 S. Ct. at 2127; 77 Fed. Reg. at 62669. Further, because the impact of fuel economy standards on climate change must be considered in evaluating the nation's need to conserve energy, NHTSA's decision to give less weight to this factor despite imminent climate hazards is indefensible.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

The GHG standards proposed by EPA and NHTSA will have adverse environmental impacts for criteria and toxic pollutants, in addition to a dramatic increase in GHG emissions. The agencies state that the proposed standards will result in an additional 872 million metric tons of CO_2 emitted along with imprecise increases or decreases in criteria and toxic emissions. The agencies cannot provide an accurate estimate for these increases because they failed to take the requisite hard look as required under NEPA.

Docket Number: NHTSA-2017-0069-0610
Commenter: Alexandra Richter

However, other reasons are the impacts on our environment pertaining to global climate changes. Our global climate temperature increases on a yearly basis, and we have so far done very little to try and slow this rate down. The U.S alone is responsible for a vast amount of this climate change, and it is our duty to protect this planet from further damage. If not for future generations, but for our own personal continued growth on this earth. It was found that all proposals except for the 'no alternative' proposal would increase the impacts of climate change. Based on these facts I cannot support the alternatives proposed other than the 'no alternative'.

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

I. INTRODUCTION

These comments discuss the voluminous scientific evidence published in recent years to demonstrate the urgent threat to human health and welfare posed by climate change. This evidence further reinforces EPA's already compelling finding that greenhouse gases ("GHG") endanger public health and welfare by driving increasingly dangerous climate change, as well as NHTSA's long-standing recognition of the threat posed by climate change, as the agencies concluded in their 2012 greenhouse gas and fuel economy standards for light-duty vehicles as well as in EPA's mid-term evaluation of the greenhouse gas standards. In particular, we discuss the post-2015 evidence demonstrating the following climate change-driven harms, most of which are now upon us:

- An unrelenting rise in surface temperatures, rendering increasingly large geographic areas less habitable;
- The increasing frequency and severity of extreme weather events, and the scientific advances attributing shifts in extreme weather to anthropogenic GHG emissions;
- Steadily rising ocean temperatures, sea level rise and the dire effects of ocean acidification;
- Increasing harm to human health and welfare, including current and future severe illness and mortality that disproportionately affect the elderly, children and disadvantaged communities;
- Harm to biodiversity, ecosystem services, and public lands;
- Severe harm to the U.S. economy with damages exceeding hundreds of billions of dollars every year, a number that will continue to rise over time;
- The clear and present danger of climate change to our national security;
- The immense difference in climate-change related damage created by overshooting a temperature rise beyond 1.5° C by just one-half of a degree, and the critical importance of action to reduce carbon emissions *within the next decade* to avoid those damages; and
- The United States' inability to remain within its shrinking carbon budget absent immediate action to greatly reduce vehicular GHG emissions.

Climate change and the overwhelming evidence of the devastation it causes underscore that EPA must fulfill its legal mandate to address vehicular CO_2 emissions, and that any rollback of the existing vehicle greenhouse gas standards is an unlawful abrogation of EPA's obligation under the Clean Air Act. Similarly, this evidence demonstrates that NHTSA has improperly shortchanged environmental considerations in setting its fuel efficiency standards, in violation of the agency's responsibilities under the Energy Policy and Conservation Act. NHTSA has further failed to meet its obligations under the National Environmental Policy Act by failing to take a hard look at these impacts in its Draft EIS.

At the outset, it is important to emphasize that the agencies' egregious failure to address the critical threat of climate change in the Proposal reflects not merely bad public policy, but would, if the proposal were adopted, be *unlawful*. Under the Administrative Procedure Act, courts must set aside agency actions that are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." The Supreme Court has explained that agency actions are arbitrary and capricious "if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise."

This principle holds true whenever an agency seeks to change or reverse a previous policy. The agency must "show that there are good reasons for the new policy" and provide "a reasoned explanation . . . for disregarding facts and circumstances that underlay or were engendered by the prior policy." Where an agency action rests on factual findings (or, as here, factual assumptions and conclusory assertions) that contradict its earlier findings, the agency must provide "a more detailed justification than would suffice for a new policy." A failure to do so renders the action arbitrary and capricious. "An agency cannot simply disregard contrary or inconvenient factual determinations that it made in the past."

The Proposal runs directly afoul of these bedrock administrative law principles. In 2009, EPA found—based on an "ocean of evidence"—that anthropogenic GHGs are driving climate change that endangers public health and welfare; the D.C. Circuit upheld that finding in its entirety against industry challenges; and the Supreme Court refused to review the holding. In their 2012 joint rulemaking setting forth standards for MY 2017-2025, EPA and NHTSA underscored that their final rules were in response to "the country's critical need to address global climate change and reduce oil consumption." As we discuss below, since 2009, the peer- reviewed scientific literature on climate change and evidence of both future and current climate impacts has become even more clear, specific and undeniable, further buttressing the rigor of the endangerment finding and the urgency of the Clean Air Act's legal mandate that EPA address CO_2 emissions from vehicles and NHTSA's obligation to consider such impacts as part of its standard setting.

Remarkably, despite the overwhelming record evidence demonstrating that climate disruption is becoming ever more severe in the United States and globally, the Proposal all but ignores the subject of climate change. It does not even attempt to explain how rolling back the existing standards could be squared with the existing record and the additional evidence discussed herein. The Proposal also ignores scores of studies and reports published since the 2009 endangerment finding and the existing standards' promulgation. This fundamental, appalling failure renders the Proposal unlawful, arbitrary and capricious.

The Proposal's plan to entirely forgo any fuel efficiency improvements and greenhouse gas reductions for the light duty vehicle fleet from 2021 through 2026, a span of six years, is particularly egregious in light of a special report issued by the Intergovernmental Panel on Climate Change in October 2018. That report issues a stark warning that global greenhouse gas emissions must be drastically reduced *within the next decade* to avoid what will be massive and irreversible additional damages arising from overshooting a 1.5° C temperature increase by just one-half of a degree. The Proposal instead would utterly squander six of those critical ten remaining years by rolling back regulations the agencies reviewed and found eminently feasible and cost-effective just two years ago. The Proposal simply cannot be squared with the overwhelming scientific evidence mandating immediate and deep emission cuts.

These comments provide an overview of peer-reviewed, climate change-specific scientific studies released since 2015. The depth and breadth of their findings emphasize the legal deficiency of the Proposal's failure to grapple with climate change and the ever increasing havoc it wreaks.

II. RECENT SCIENTIFIC AND ECONOMIC STUDIES MAGNIFY THE IMPORTANCE OF EPA'S LEGAL OBLIGATION TO LIMIT CO_2 POLLUTION FROM VEHICLES AND NHTSA'S OBLIGATION TO CONSIDER SUCH EMISSIONS IN SETTING FUEL EFFICIENCY STANDARDS

The 2012 Final Rule and the 2016 mid-term evaluation stand in stark contrast to the Proposal's flimsy-to- non-existent record on climate change. The 2012 rulemaking is based on a comprehensive record of peer-reviewed evidence demonstrating the causes and effects of climate change and the need to promptly reduce GHGs released by cars and light duty trucks.

The 2012 Final Rule reaffirmed EPA's 2009 endangerment finding that anthropogenic GHGs emissions jeopardize public health and public welfare. That rulemaking discussed the key findings of major peer-reviewed studies of climate change issued after 2009 by the National Research Council ("NRC"). The 2012 Final Rule found that "these recent NRC assessments represent another independent and critical inquiry of the state of climate change science" and they "have reached similar conclusions to those of the assessments upon which the [EPA] Administrator relied."

The 2016 Draft Technical Assessment Report ("Draft TAR"), developed jointly by EPA, NHTSA, and the California Air Resources Board as part of the mid-term evaluation, included additional discussion of more recent climate science findings, concluding that these studies "confirm and strengthen the science that supported the 2009 Endangerment Finding." The Draft TAR discussed the key findings of major peer-reviewed studies of climate change issued after 2009 by the U.S. Global Change Research Program ("USGCRP"),[19] the Intergovernmental Panel on Climate Change ("IPCC"), and the NRC. The Draft TAR explained, for example, that since the 2009 Endangerment Finding, the USGCRP Third National Climate Assessment and multiple NRC assessments have projected future rates of sea level rise that are "40 percent larger than, and in some cases more than twice as large as, the projected rise" estimate referred to in the Endangerment Finding. It noted a recent NRC assessment that had concluded that "[i]n the Northern Hemisphere, the last 30 years were likely the warmest 30 year period of the last 1400 years."

In contrast to the 2012 Final Rule and Draft TAR, the Proposal's preamble does not mention any of the evidence supporting either the 2009 endangerment finding or the subsequent determinations on climate harm, and includes virtually *no* discussion of climate change at all apart from briefly acknowledging that climate benefits would be sacrificed by rolling back the existing standards. The accompanying Preliminary Regulatory Impact Analysis ("PRIA") omits nearly any discussion of climate impacts, and the accompanying Draft EIS's discussion is fatally flawed. Worse still, as discussed in other comments to the docket, the proposal's regulatory impact analysis has deeply discounted these forgone public health and environmental benefits by using faulty economics and science. The Proposal's failure fully to account for and properly measure the ever increasing harm necessarily resulting from increased GHG emissions is unlawful, arbitrary, and capricious.

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[19] See, e.g., USGCRP, Climate Change Impacts in the United States: The Third National Climate Assessment, Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe (eds.) (2014), http://nca2014.globalchange.gov/. Congress created the USGCRP in 1990 to serve as "a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change," Global Change Research Act of 1990, Pub. L. No. 101-606, 15 U.S.C. § 2931(b), and urged EPA and other policymakers to use its work to formulate "a coordinated national policy on global climate change," id. § 2938(b)(1)- (2). See also 15 U.S.C. § 2934(d)(3) (directing the USGCRP to "combine and interpret data from various sources to produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change").

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v. Climate change threatens national security.

Military and intelligence leaders have long recognized the national security threats of climate change. As the Department of Defense concluded in a 2015 report to Congress, "[g]lobal climate change will have wide-ranging implications for U.S. national security interests over the foreseeable future because it will aggravate existing problems—such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions—that threaten domestic stability in a number of countries."

In fact, the Department of Defense "sees climate change as a present security threat, not strictly a long-term risk. [The Department is] already observing the impacts of climate change in shocks and stressors to vulnerable nations and communities, including in the United States, and in the Arctic, Middle East, Africa, Asia, and South America." For instance, the number of dangerously hot days – known as "black flag days" – has increased at a Department facility in the Middle East, requiring the suspension of "non-mission essential physical training and strenuous exercise." Flooding associated with high tides has also damaged national security infrastructure at multiple locations, including antenna facilities at a missile testing range in the Pacific.

Extreme heat, storms and floods, sea level rise, and loss of natural resources will damage military installations, disrupt supply chains, imperil the safety of personnel, hamper training and readiness, increase the need for deployments in high risk areas of the world, and dramatically increase operating costs—exposing America's service personnel and citizens at home and abroad to needless risks and preventable harms.

In sum, the record at the time the 2012 Final Rule was promulgated and studies and reports issued thereafter present overwhelming evidence that climate change is already wreaking havoc on public health and the environment, that the American economy is suffering damages measured in hundreds of billions of dollars annually, and that these trends are accelerating and could lead to catastrophic effects unless action is taken *now* to reverse course. EPA's and NHTSA's failure to engage with these facts in the Proposal is arbitrary and capricious. The agencies must withdraw that document and implement and strengthen the existing standards.

Docket Number: NHTSA-2017-0069-0621
Organization: Natural Resources Defense Council et al.
Commenter: Pete Huffman

The scientific consensus that climate change is real, man-made, and dangerous is overwhelming. EPA has repeatedly affirmed the severity of the threat and the urgency of the need to address it. Nonetheless, in their proposal, EPA and NHTSA utterly fail to evaluate the health and environmental risks posed by continued emissions of greenhouse gases. Even worse, the agencies make no attempt to relate their proposal - which would significantly increase greenhouse gas emissions - to the known facts about climate change and its threats, including the urgency of reducing emissions now to reduce the risk of horrific harms from a destabilized climate. This willful disregard of the recognized scientific facts would render adoption of the proposed standards unlawful. Both EPA and NHTSA are required by statute to protect the public: CAA Section 202 requires EPA to prescribe standards to limit vehicular emissions that cause or contribute to air pollution that endangers public health and welfare. 42 U.S.C. § 7521(a)(1). NHTSA's mandate to adopt "maximum feasible" fuel economy standards reflecting "the need of the United States to conserve energy" requires factoring in the climate-altering impacts of consuming oil. 49 U.S.C. § 32902(a), (f). The agencies' proposal to set standards that achieve no additional emissions reductions fails completely to further their statutory mandate to protect the public and is proposed without any attempt to reconcile their proposal with facts about relevant health and environmental risks - which, in this case, must include climate change. Moreover, in the face of a threat as severe and urgent as climate change, their proposal to strip away existing protections with no serious consideration of alternative protective measures is arbitrary and unlawful.

Docket Number: NHTSA-2017-0069-0689
Commenter: Reinmar Seidler

This document is truly shocking. As a teacher of environmental science and sustainability at the University of Massachusetts Boston, I had to show my students this document as a shameful example of statistical sleight-of-hand and manipulation. It is not even subtle -- it is an obvious, bare-faced and embarrassingly simplistic effort to mislead the public. Comparing the possible positive impacts of staying with current CAFE standards (Alternative 0) to the *global-scale* GHG emissions problem, and then declaring all action to be useless because it does not solve the problem all by itself, is a truly cowardly way to avoid addressing this urgent, universal problem. Shame on you for trying to pass this transparently manipulative charade past an unsuspecting public!

Docket Number: NHTSA-2017-0069-0693
Commenter: Rafael Pagán and Madeleine Green

An important aspect to consider is the social cost of carbon which for the United States is predicted in, "Country-Level social cost of carbon" to be at \$48/tCO_2 by the year 2020. At a global scale, research indicates that the entire world will experience a cost of \$417/tCO_2 by the year 2020 significantly impacting agriculture, energy, and health. The most recent IPCC report, which is an inter-agency document, suggests that the economy in the United States will be more negatively impacted by climate change than previously suggested. The impacts of greenhouse gas emissions are proving to be more harmful for the nation than previously concluded to be. With this information, we believe that the NHTSA would not be able to fully defend a decision to implement Alternative 1.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

There is a profound disconnect between the severe harms cataloged in the DEIS and the regulatory rollback contemplated in the Proposal. The DEIS assumes little abatement of GHG emissions through the 21st century.[20] It thus concludes that by 2100, the Earth will experience over 4°C of warming, nearly 1 meter of sea level rise, and atmospheric concentrations of CO_2 of approaching 800 parts per million (“ppm”). The last time the Earth’s CO_2 levels exceeded 750 ppm may well have been 35 million years ago, during the Eocene Epoch, before the major ice sheets had formed. Human civilization has never experienced changes of this magnitude in the climate system. Stalling emissions reductions efforts, considering the harms predicted by the DEIS, is irrational and arbitrary.

[20] The DEIS does not explain why it has chosen such a pessimistic projection. See DEIS at 5-25, 8-20.

Response

NHTSA received numerous comments that generally expressed opposition to the agency's Preferred Alternative (as identified in the Draft EIS), usually because of the impacts related to greenhouse gas (GHG) emissions and climate change. Chapter 5, *Greenhouse Gas Emissions and Climate Change*, discusses the direct and indirect impacts of the Proposed Action and alternatives on GHG emissions and climate change. Section 8.6, *Greenhouse Gas Emissions and Climate Change*, discusses the cumulative impacts of the Proposed Action and alternatives on GHG emissions and climate change. It also discusses the health, societal, and environmental impacts of climate change. Some commenters note other environmental impacts as reasons for expressing their opposition to NHTSA's action, and these impacts are also discussed in the Final EIS. Other issues conveyed by the commenters that relate primarily to the agency's balancing of the statutory factors, economic analysis, or other aspects of the rulemaking not related to the environmental analysis are addressed in the preamble to the final rule and FRIA.

Contrary to the assertions of some commenters, NHTSA explicitly discussed various environmental impacts, including climate change, at length in the NPRM. NHTSA considered the environmental impacts of this rulemaking, including the contents of this Final EIS, as it developed its final rule. For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards. NHTSA determined that the maximum feasible standards for MYs 2021–2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. While CO_2 emissions (and other environmental impacts) will be higher under this final rule than if NHTSA had determined that the augural standards were maximum feasible, they will be lower than they would have been under the proposal. The preamble to the final rule (like the NPRM before it) includes lengthy discussions of how environmental impacts, including climate change, factored into the agency's balancing of the EPCA statutory factors and why that balancing may differ from its approach in previous rulemakings.

Comment

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

EPA and NHTSA fail to take the requisite "hard look" at the adverse environmental impacts of their proposed GHG standards as required by NEPA. In the NPRM, as well as the PRIA and DEIS, the agencies only considered the "no action" or baseline alternative (i.e., the current standards) and 8 alternatives, all of which were less stringent than the no action alternative. There was no consideration given to alternatives that were more stringent than the existing baseline standards. There is no discussion of what the agencies learned from the DEIS, nor how it informed their decisions regarding the roll back of existing GHG standards in the NPRM and PRIA. Clearly, the agencies began with a predetermined conclusion to weaken existing standards and the entire rulemaking process is merely window dressing used to justify their arbitrary pre-judgement.

All the non-preferred alternatives (i.e., alternatives 2-8) would severely weaken the existing GHG and augural CAFE standards for model years 2022-2025. Alternatives 2, 4-6, and 8 offer minimal percentage increases in stringency per year far below the existing standards, but eliminate provisions for air conditioning efficiency and off-cycle emissions. Alternatives 3 and 7 offer the same minimal increases in stringency as alternatives 2, 4-6, and 8, while phasing out air conditioning efficiency and off-cycle provisions. Again, not a single alternative scenario considered by the agencies evaluated the effect of standards more stringent than the baseline scenario.

Further evidence that EPA and NHTSA did not take the requisite hard look at environmental impacts of the proposed standards is shown in NHTSA's discussion of the impacts on conformity rules in the DEIS. NHTSA essentially states that the proposed standards will have no effect on conformity; and even if there were to be an adverse impact, NHTSA is in no way responsible for this obviously foreseeable and entirely preventable outcome.

Response

As discussed in Draft EIS Chapter 1, *Purpose and Need for the Proposed Action*, several commenters responding to NHTSA's Notice of Intent, stated that the agency should consider alternatives more stringent than the augural standards. In response, NHTSA stated,

> The No Action Alternative, described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, is the most stringent alternative under consideration. Although several commenters expressed a desire for NHTSA to analyze alternatives that are more stringent than the augural standards, the agency ultimately concluded that such alternatives are beyond maximum feasible and are not reasonable for consideration here.

Based on the information available to the agency as described in the preamble to the final rule, NHTSA continues to believe that the range of alternatives considered in this Final EIS encompasses a reasonable range of alternatives for where maximum feasible standards would fall.

In response to comments such as this, as discussed in Section V of the preamble to the final rule, the agencies used the CAFE model to examine a progression of stringencies extending outside the range presented in the proposal and Draft EIS, and as a point of reference, using a case that reverts to MY 2018 standards starting in MY 2021. Scenarios included in this initial screening exercise ranged as high as increasing stringency annually at 9.5 percent during MYs 2021–2026, reaching average CAFE and CO_2 requirements of 66 miles per gallon (mpg) and 120 grams per mile (g/mi), respectively. Among other conclusions discussed further in Section V of the preamble to the final rule, NHTSA determined that increases in stringency beyond the baseline augural standards show costs continuing to accrue much more rapidly than fuel economy and CO_2 improvements. With that information in mind, as discussed further in the preamble, even the No Action Alternative is already well beyond levels that can be supported under EPCA. If further stringency increases appeared likely to yield more significant additional energy and environmental benefits, it is conceivable that these could outweigh the significant additional cost increases. However, the screening analysis showed no dramatic acceleration of energy and environmental benefits. Therefore, NHTSA did not analyze in detail alternatives that were more stringent than the No Action Alternative.

NHTSA has carefully considered all the alternatives presented in this Final EIS and explains its final decision on CAFE standards for MYs 2021–2026 in the preamble to the final rule. Additionally, NHTSA addresses its obligations related to the General Conformity Rule under the Clean Air Act in Final EIS Section 4.1.1.4, *Conformity Regulations*, and in Section X.E.2 of the preamble to the final rule.

10.2.2 No Action and Action Alternatives

Comment

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 1. The alternatives considered only specify the annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MYs 2021-2026. It needs to clearly specify what would happen in subsequent years and what that projection is based on.

The impacts of increased CO_2 emissions are computed out to 2100 yet the alternatives do not specify what happens after 2026 (pages S-3 and 2-1). There is nothing in the proposed policy change that would require increases in the fuel economy after 2026. **Alternative 1 should assume the same policy persists so that the required fuel economy increases should remain at zero through 2100.**

Response

As explained in Section 2.2.1, *Alternative 0: No Action Alternative*, the No Action Alternative assumes that NHTSA would finalize the MY 2022–2025 augural CAFE standards that were described in the 2012 joint final rule, and that the MY 2025 CAFE standards would continue indefinitely. Furthermore, as explained in Section 2.2.2, *Action Alternatives*, NHTSA assumed, for purposes of its analysis, that the MY 2026 CAFE standards for each alternative would continue indefinitely.

NHTSA's analysis of CO_2 emissions impacts are computed out to 2100. NHTSA's methodology is described in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions.* In short, the CAFE model simulates technology application through MY 2050, after which NHTSA applies the projected rate of change in U.S. transportation fuel consumption from Global Climate Change Assessment Model (GCAM).

10.2.2.1 No Action Alternative/Baseline (Alternative 0)

Comments

Docket Number: NHTSA-2017-0069-0526
Organization: Oregon Department of Environmental Quality
Commenter: Richard Whitman

To meet our climate goals, we need GHG reductions resulting from low and zero emission vehicles, components of the existing EPA/NHTSA regulations through 2035. The existing regulations would also continue to provide improved fuel economy and overall cost savings to Oregon consumers.

While the existing standards reduce GHG emissions, they also decrease emissions of criteria pollutants and air toxics. This decrease comes as a result of vehicle efficiency and reduced fuel demand. Oregon currently depends on these co-benefits for a number of plans developed throughout the state. Most notably, EPA has approved the use of our Section 177 motor vehicle emission standards as a control strategy in our current State Implementation Plan to meet the National Ambient Air Quality Standards for criteria air pollutants.

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

Federal and state vehicle emissions, efficiency and technology standards adopted in 2012 were carefully researched and negotiated between U.S. EPA, NHTSA and California with significant public and stakeholder input. These standards are providing meaningful pollution reductions and fuel savings and are being achieved ahead of schedule in a cost-effective manner. The transportation sector has become the leading source of harmful carbon pollution in the United States, demanding the robust policy response to reduce carbon pollution reflected in the existing standards.

Docket Number: NHTSA-2017-0069-0563
Organization: Pennsylvania Department of Environmental Protection
Commenter: Patrick McDonnell

PADEP supports the no-action alternative in the Proposed Rule, which maintains the existing and augural CAFE and GHG standards for MYs 2021-2025 and setting MY 2026 to MY 2025 standards and is based on EPA's previous analysis in the 2012 final rule and January 12, 2017, Mid-Term Evaluation.

Response

The commenters generally identified the No Action Alternative as maximum feasible, encouraging NHTSA to finalize those standards on the basis of a variety of stated benefits. As discussed in Section VIII of the preamble to the final rule, based on a careful balancing of the statutory factors and consideration of the administrative record, NHTSA has concluded that the augural standards are beyond maximum feasible. Because the final rule will result in annual increases in CAFE standards, NHTSA believes that many of the environmental benefits cited by the commenters for the augural standards will still occur, though to a lesser degree.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NEPA regulations require agencies to include a ''no-action'' alternative in their environmental impact statements, and to compare the environmental impacts of not taking action with a reasonable range of action alternatives so that each alternative's environmental impacts becomes clear. 40 C.F.R. § 1502.14(d). In the Scoping Notice, NHTSA indicated that it was considering a "baseline" that assumed that the agency "would issue a rule that would continue the current CAFE standards for MY2021 indefinitely." 82 Fed. Reg. at 34,742.

NHTSA's decision to abandon the baseline suggested in the scoping notice and to adopt the augural standards for MY2022-2025 as the No Action Alternative for this analysis is appropriate. The current approach reflects both NHTSA's decision, in the augural standards, about where to set CAFE standards for MY2022-2025, and its most recent final EIS for the CAFE standards that also presented and analyzed the augural standards. It also reflects the conclusions of the 2016 Draft Technical Assessment Report ("TAR"). The status quo for MY2022-2025 today is not the MY2021 CAFE standard, but EPA's greenhouse gas standards for MY2022-2025 for light-duty vehicles and California's Advanced Clean Cars Program regulations, which have been adopted in 12 other states and are consistent with the augural standards. Ignoring existing, enforceable law to set a phantom baseline in 2021 would have been clear legal error.

We note, however, that although NHTSA vaguely mentions that it "may still select the No Action Alternative" (which is the only alternative that would not increase environmental harm as compared to the augural standards, and EPA's and California's currently effective vehicle greenhouse gas regulations for MY2017-2025), NHTSA has selected the most environmentally damaging alternative (Alternative 1) as its preferred course of action. NHTSA never discusses actually adopting the No Action Alternative, never discloses or explains the reasons for proposing the most harmful alternative as its Preferred Alternative, and refuses to even consider adopting any alternative other than the one it prefers as a mitigating step. (See discussion in section VII, "Mitigation," below). The NPRM itself nowhere contemplates the No Action Alternative as a regulatory option. The failure to analyze and consider the adoption of the "No Action" alternative is unreasonable and capricious.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

NEPA regulations require agencies to include a ''no-action'' alternative in their environmental impact statements, and to compare the environmental impacts of not taking action with a reasonable range of action alternatives so that each alternative's environmental impacts becomes clear. 40 C.F.R. § 1502.14(d). Although NHTSA vaguely mentions that it "may still select the no action alternative" (which is the only alternative that would not increase environmental harm), NHTSA has selected the most environmentally damaging alternative (Alternative 1) as its preferred course of action. NHTSA never discusses actually adopting the no action alternative and the Proposed Rollback does not contemplate the no action alternative as a regulatory option. The failure to analyze and consider the adoption of the "no action" alternative is unreasonable and capricious.

Response

In general, an agency's No Action Alternative represents expectations regarding the world in the absence of a proposal, accounting for applicable laws already in place. NHTSA agrees with the commenters that using the augural standards to inform the baseline is appropriate, and the agency has maintained the No Action Alternative from the Draft EIS in the Final EIS. However, NHTSA does not agree that California's Advanced Clean Cars Program is an appropriate basis for informing its choice of baselines. EPA and NHTSA issued a separate action in September 2019 withdrawing California's Clean Air Act waiver under Section 209 and promulgating regulations stating that state or local laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy are expressly and impliedly preempted under 49 U.S.C. § 32919.[21]

NHTSA also disagrees with the commenters that it failed to consider the No Action Alternative or disclose its reason for proposing Alternative 1 as its Preferred Alternative in the Draft EIS. NHTSA's consideration of the alternatives involves balancing the EPCA statutory factors and considering the

[21] EPA and NHTSA, *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program*, 84 FR 51310 (Sep. 27, 2019).

entirety of the administrative record; that occurs in the preamble to the NPRM and the final rule. In the EIS, NHTSA frequently refers the reader to those preambles for that discussion, thereby incorporating it by reference to eliminate duplication and reduce bulk. NHTSA discussed the augural standards extensively in the NPRM and does so again in the preamble to the final rule, explaining why it no longer believes that they are the maximum feasible standards. NHTSA has, therefore, considered the No Action Alternative as part of its decision-making process.

Comment

Docket Number: NHTSA-2018-0067-12078
Organization: American Fuel & Petrochemical Manufacturers
Commenter: James Wedeking

Although the Draft EIS does not provide specific estimates, it assumes that refinery emissions will increase under the Proposed Rule's alternatives when compared to the No Action Alternative. This should not be assumed for two reasons. First, as NHTSA acknowledges, subsequent to the 2012 Rule, EPA promulgated new Petroleum Refinery MACT 1 and MACT 2 standards, estimated to result in a 59% reduction in air toxics emissions. Thus, refinery air toxics emissions will decrease under all alternatives, not solely the No Action Alternative.[22] Second, NHTSA should not assume that refinery emissions would decline under the No Action Alternative due to decreasing *domestic* demand for gasoline. The U.S. refining sector is exceedingly competitive in the global marketplace and is well positioned to excel in markets outside of the United States. As the EIA noted, U.S. exports of gasoline more than doubled between 2010 and 2016, from 335,000 barrels per day to 761,000 barrels per day. There is no reason to assume that U.S. refineries will sit idle instead of simply diverting gasoline to other markets.

Response

As U.S. refiners participate in a global market for petroleum products, NHTSA and EPA believe uncertainty remains regarding how changes in U.S. demand for petroleum products to fuel passenger cars and light trucks will ultimately affect levels of activity at U.S. refineries. The reference case analyses presented in the Final EIS and Final Regulatory Impact Analysis (FRIA), like those in the Draft EIS and Preliminary Regulatory Impact Analysis (PRIA) (and in the agencies' analyses supporting previous rules), assume that for each additional gallon of gasoline consumption, output by U.S. refineries will increase by half a gallon, resulting in corresponding increases in emissions from U.S. refineries. However, the FRIA includes a sensitivity analysis that includes two alternative cases—one that assumes refinery output will increase on a gallon-for-gallon basis, and another that assumes refinery output will remain unchanged; together, these cases bound span the complete range of possible outcomes for refinery activity and emissions. See the FRIA for additional information.

[22] EPA proposed minor revisions to these standards but, if finalized, they are not expected to have any appreciable impact on the emissions reductions required of the 2015 rulemaking. 83 Fed. Reg. 15,473.

10.2.2.2 Reasonable Range of Alternatives

Comment

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The DEIS fails to include and analyze a reasonable range of alternatives. The stated goal of the Energy Policy and Conservation Act (EPCA) is to conserve energy supplies including through improved fuel efficiency of vehicles. The National Environmental Policy Act requires NHTSA to rigorously explore all reasonable alternatives within the scope of the proposal. The DEIS must therefore include all reasonable alternatives, including those that are more stringent than the augural standards. The 2016 Draft Technical Assessment Report (TAR) found that the augural standards are achievable and at lower cost than previously predicted. NHTSA has failed to demonstrate that the data and assessment published in the 2016 TAR is inaccurate or out of date and therefore must consider alternatives that reflect these findings. More stringent standards are consistent with EPCA's purpose of energy conservation, are technologically and economically feasible, and would reduce the significant impacts of NHTSA's proposed action.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Under NEPA, agencies must consider "alternatives to the proposed action." 42 U.S.C. § 4332(2)(C)(iii). The analysis of alternatives is "the heart of the environmental impact statement." 40 C.F.R. § 1502.14. In considering alternatives, NHTSA shall "[r]igorously explore and objectively evaluate *all* reasonable alternatives." *Id.* at § 1502.14(a) (emphasis added). An agency must follow the "rule of reason" when preparing an EIS, and "this rule of reason governs 'both *which* alternatives the agency must discuss, and the *extent* to which it must discuss them.'" *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d at 195 (citation omitted).

> Agencies "should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public," including a "no-action" alternative ... Agencies must "rigorously explore and objectively evaluate" these alternatives "so that reviewers may evaluate their comparative merits." ... "Without substantive, comparative environmental impact information regarding other possible courses of action, the ability of an EIS to inform agency deliberation and facilitate public involvement would be greatly degraded."

Wildearth Guardians v. BLM, 870 F.3d at 1226-27 (internal citations omitted).

In its scoping notice, NHTSA initially indicated that it would consider four alternative CAFE standards for passenger cars and four alternatives for light trucks: a no action alternative, action alternatives representing the lower bound and upper bound of the range of reasonable fuel economy standards, and a preferred alternative reflecting its proposed determination of the maximum feasible fuel economy standards. In the DEIS, NHTSA included a No Action Alternative, a Preferred Alternative, and seven additional alternatives "to cover the range of complexity of this action."

The DEIS presents eight alternatives which the agency has concluded are consistent with the stated purpose and need of the action it is considering, and which it claims represent permissible ways of balancing the statutory factors under EPCA. As we explain below, these alternatives do not express a reasonable range.

- Alternative 1, the Preferred Alternative, would require a 0.0 percent average annual fleet- wide increase in fuel economy for MY2021–2026; in other words, it would "freeze" the standards after year 2020. This alternative would change the MY2021 standards to weaken them to the MY2020 levels and maintain the MY2020 standard through MY2026.
- Alternative 2 would require a 0.5 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MY2021–2026.
- Alternative 3 would require a 0.5 percent average annual fleet-wide increase in fuel economy for both passenger cars and light trucks for MY2021–2026, and would also phase out AC and off-cycle credits beginning in MY2022 and fully eliminate them in MY2026.
- Alternative 4 would require a 1.0 percent annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent increase for light trucks for MY2021-2026.
- Alternative 5 would require a 1.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 2.0 percent increase for light trucks for MY2022-2026, without changing the current MY2021 standard.
- Alternative 6 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent average annual increase for light trucks for MY2021-2026.
- Alternative 7 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent increase for light trucks for MY2021-2026, and would also phase out AC and off-cycle credits beginning in MY2022 and fully eliminate them in MY2026.
- Alternative 8 would require a 2.0 percent average annual fleet-wide increase in fuel economy for passenger cars and a 3.0 percent increase for light trucks for MY2022-2026, without changing the current MY2021 standard.

We note that most of the stated alternatives would set fuel efficiency standards for six years, from 2021 through 2026, even though EPCA restricts NHTSA to setting standards for no more than five model years. 49 U.S.C. § 32902(b)(3)(B). We comment on this illegal overreach in our comments to the NPRM.

These alternatives (combined for passenger cars and trucks) are presented in tabular form below. All alternatives under consideration would decrease fuel economy requirements when compared to the No Action Alternative. Under the proposed alternatives, the combined fleet-average fuel economy standard ranges from 36.9 to 39.0 mpg in MY2021 and 37.0 to 44.3 mpg in MY2026. Each would represent a vast step backward when compared to the estimated fleet-average fuel economy levels of 39.0 mpg in MY2021 and 46.8 mpg[23] in MY2025 under the No Action Alternative (the augural standards).

[23] We note that 46.8 miles per gallon that NHTSA projects for MY2025 under the Augural Standards departs widely from the 49.7 NHTSA projected for that year in its 2012 FEIS. NHTSA, Corporate Average Fuel Economy Standards Passenger Cars and Light Trucks Model Years 2017-2025, Final Environmental Impact Statement (July 2012) ("2012 Final EIS"), at S-7, 2-12. The fact that the 2012 estimate has been missed constitutes an additional reason why the standards must be strengthened. We reserve the right to comment on the divergence between the 2012 and 2018 estimates in supplemental comments.

> [See original comment for table titled Projected Average Required Fleet-Wide Fuel Economy (mpg) for Combined U.S. Passenger Cars and Light Trucks by Model Year and Alternative.]

As we point out in our comments to the NPRM, a voluminous evidentiary record demonstrates that standards more stringent than the No Action Alternative are feasible and cost-effective. In light of that record, the alternatives examined in the DEIS do not represent a range of *reasonable* alternatives that would meet the agency's stated purpose and need, consistent with EPCA, EISA, and NEPA requirements. None of these alternatives increases fuel economy in comparison with the No Action Alternative, none conserves energy, and none represents maximum feasible CAFE standards.

*   *   *   *   *

Based on the robust record and findings resulting from the mid-term review of the standards, more stringent alternatives are reasonable and "technically and economically practical or feasible and meet the purpose and need of the proposed action." *Union Neighbors United, Inc. v. Jewell*, 831 F.3d 564 (D.C. Cir. 2016) (citing 43 C.F.R. § 46.420(b)). They also fall well within the range of what is the maximum feasible under EPCA. NHTSA must present them in any new DEIS once the current version has been withdrawn.

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

EPCA mandates that NHTSA achieve the "maximum feasible" standards. A range of analysis and evidence demonstrates that it is possible to improve fuel economy beyond the existing standards; given its clear statutory directive to maximize fuel savings, NHTSA should have considered a range of alternatives that would be more protective than the existing standards. NHTSA's failure to consider such options in the DEIS is unlawful.

EPA's January 2017 Final Determination provided a robust demonstration that the existing standards are achievable and indeed, that more stringent MY2022-2025 standards are feasible. The Technical Assessment Report (TAR) for EPA's Mid-Term Evaluation of light-duty vehicle standards confirms "[a] wider range of technologies exist for manufacturers to use to meet the MY2022-2025 standards, and at costs that are similar or lower, than those projected in the 2012 rule."

New technologies continue to enter the market at an accelerating pace, and there is strong evidence that costs will be lower than those projected in the TAR. For example, a study by the International Council on Clean Transportation (ICCT) found that improvements in current technologies, together with emerging technologies, means 8% - 10% greater efficiency improvements are available compared to the 2012 assessment by EPA and NHTSA. Similarly, ICCT found that, based on new engineering studies and supplier technology developments, key technology costs will be reduced by hundreds of dollars. ICCT's update of the assessment with this new information shows that the costs to meet the 2025 standards will be 34%-40% less than EPA and NHTSA estimated in the TAR, providing a compelling reason to increase the standards through 2025. These reductions in technology costs far outweigh the effects of lower gas prices. NHTSA should incorporate these updates to technology costs as well as other updated evidence as part of their analysis.

Even more recent information strongly supports the achievability of more ambitious standards. These materials are discussed in detail in EDF's NPRM Comment at Part IV.

Docket Number: NHTSA-2017-0069-0597
Organization: National Coalition for Advanced Transportation
Commenter: Devin OConnor

A. NEPA Requirements

Under NEPA, NHTSA is required to consider the environmental impacts of its proposed CAFE standards as well as the impacts of alternative actions. See 42 U.S.C. § 4332(2)(C). The agency's NEPA analysis must be detailed, *id.*, and provide a comprehensive "hard look" at the potential environmental impacts, *see, e.g., League of Wilderness Defenders-Blue Mountains Biodiversity Project v. U.S. Forest Serv.*, 689 F.3d 1060, 1075 (9th Cir. 2012) ("Taking a 'hard look' includes 'considering all foreseeable direct and indirect impacts. Furthermore, a 'hard look' should involve a discussion of adverse impacts that does not improperly minimize negative side effects.'" *Id.* (citation omitted)).

When determining the "purpose and need" of the action for NEPA analysis, NHTSA must frame the need, and corresponding alternatives, by reference to EPCA's statutory purpose and requirements. The agency "must look hard at the factors relevant to the definition of purpose" and should consider the views of Congress in the agency's statutory authorization, as well as in other congressional directives. *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991). The agency must define its objectives broadly enough to avoid unreasonably narrowing the scope of the action and alternatives for consideration. *See, e.g., League of Wilderness Defenders-Blue Mountains Biodiversity Project*, 689 F.3d at 1069; *Nat'l Parks & Conservation Ass'n v. BLM*, 606 F.3d 1058, 1072 (9th Cir. 2010) (holding that "[a]s a result of this unreasonably narrow purpose and need statement, the BLM necessarily considered an unreasonably narrow range of alternatives") (internal citations omitted).

As described in the NEPA regulations, the section analyzing alternatives relative to the proposed action is "the heart of the environmental impact statement." 40 C.F.R. § 1502.14. NHTSA must "[r]igorously explore and objectively evaluate all reasonable alternatives." *See id.* § 1502.14(a). The NEPA regulations provide that the alternatives analysis shall "include the alternative of no action," 40 C.F.R. § 1502.4(d), which provides a baseline for the agency to analyze impacts of the proposed action.

B. The Range of Alternatives Analyzed in the DEIS is Insufficient

In the DEIS, NHTSA evaluated alternatives that only range in stringency from the existing MY 2021 and MY 2022-2025 augural standards (most stringent alternative) to freezing the standards at MY 2020 levels into the future (least stringent alternative). DEIS at S-2–S-4. As a result of the factual record before the agency, in defining "reasonable alternatives" for analysis NHTSA instead should identify and analyze technology-forcing alternatives that exceed the stringency of the existing/augural standards. As explained in NCAT's EIS Scoping Comments, in the 2012 rulemaking, NHTSA analyzed options including a 7 percent annual increase in fuel economy—though it ultimately settled on augural standards reflecting (on average) an average annual increase of 4.7 to 4.9 percent for MY 2022-2025. As explained above, advanced vehicle and other fuel efficiency technologies have improved and costs have declined considerably since the augural standards were announced in 2012. In the six years since the announcement of the augural standards, there has been a dramatic shift in investment, consumer support, and infrastructure development in favor of EVs and other advanced technology vehicles. Given that NHTSA identified a 7 percent annual increase in stringency as a reasonable upper bound for analysis of "maximum feasible" standards in 2012, changes since that time support analysis of alternatives at least this stringent in the pending rulemaking. At the very least, NHTSA should have evaluated an alternative that is more stringent than the existing/augural standards. In addition, NHTSA must also consider an alternative that keeps the California waiver in effect. While EPA has proposed to rescind the waiver, it remains currently in effect and should have been considered among the alternatives evaluated in the DEIS. These deficiencies in the DEIS's alternatives analysis render NHTSA's NEPA analysis inadequate.

C. The DEIS Is Premised on Flawed Modeling and Analysis and Fails to Address Important Impacts

NHTSA must take a "hard look" at adverse impacts of any decision to weaken standards, as well as beneficial impacts of any decision to strengthen standards. The fundamental and pervasive flaws in the modeling and analysis underpinning the standards (discussed in Sections III and IV) carry over to the DEIS and substantially affect NHTSA's review of the projected impacts of its proposal. As noted above, these flaws affect estimates of fatalities and non-fatal injuries, fuel consumption, GHG and non-GHG air pollutant emissions, and traffic congestion and noise, among other impacts. If these defects are not corrected, this would render NHTSA's environmental review noncompliant with NEPA and otherwise arbitrary and capricious.

Docket Number: NHTSA-2018-0067-11910
Organization: United States Senate
Commenter: Tom Carper

NHTSA failed to include a reasonable range of regulatory alternatives as mandated by the National Environmental Policy Act: The range of alternative standards that were analyzed in NHTSA's Draft Environmental Impact Statement depart from past practice, because they do not appear to include a reasonable range of alternative rulemaking options. In fact, none of the alternatives analyzed are more stringent than the current (augural) standards. This also poses a legal vulnerability. In 1981, the Council on Environmental Quality published in a memorandum to agencies that addressed how alternatives should be selected, saying that the range examined should include "the full spectrum of alternatives". It uses as an example a proposal to designate wilderness areas within a National Forest from 0 to 100 percent of the forest and states that "An appropriate series of alternatives might include dedicating 1, 10, 30, 50, 70, 90 or 100 percent." The document goes on to explain that reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant. Several court decisions have opined on this 'reasonableness' test and required a broader range of alternatives to be required for consideration by agencies that were found to have unlawfully constrained them.

Docket Number: NHTSA-2018-0067-12025
Organization: North Carolina Department of Environmental Quality
Commenter: Sheila Holman

Under NEPA, as noted in the proposed rulemaking, the purpose of an EIS is to "provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." NEPA requires that agencies develop alternatives to a proposed action based on the action's purpose and need. In accordance with EPCA/EISA, the purpose of the rulemaking as stated in the DEIS is to revise/establish the CAFE standards for model years 2021–2026, passenger cars and light trucks at "the maximum feasible average fuel economy level that the Secretary of Transportation decides the manufacturers can achieve in that model year." EPCA requires that NHTSA consider the four statutory factors of "technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy" when determining the maximum feasible levels that manufacturers can achieve in each model year. In addition, the agency has the authority to consider other relevant factors, such as the effect of the CAFE standards on motor vehicle safety.

The DEIS for the rulemaking does not fully satisfy the requirements of NEPA in the following ways.

- First, NHTSA has not analyzed a reasonable range of alternatives. NHTSA has only analyzed a range of alternatives with fuel economy stringencies that are less than the current standards. In doing so NHTSA improperly narrowed the range of alternatives by not considering standards that are more stringent than the baseline Alternative (0) standards. Alternatives that exceed the stringency of the current standards are consistent with EPCA's purpose "to conserve energy supplies through energy conservation programs, and, where necessary, the regulation of certain energy uses and to improve the fuel economy of motor vehicles." NHTSA recognizes that more stringent alternatives are possible but justifies not analyzing more stringent CAFE standards on its balancing of EPCA's four supplementary statutory factors. Without elaborating on how that balancing prevents the selection and analysis of alternatives that are more stringent than the current standards, NHTSA only states "that such an alternative would, after careful balancing of EPCA's four statutory factors, fall well outside the range of the maximum feasible level."
- Second, NHTSA appears to have narrowed the range of alternatives by its inputs to the CAFE model to justify a predetermined result of fuel economy standards that are less stringent than the current standards. The model assumptions appear to result in an overestimation of the VMT and resultant tailpipe emissions resulting from the current standards, and underestimate the impacts of climate change by use of only the domestic social cost of carbon. NHTSA should have begun the NEPA analysis with a range of reasonable alternatives, including more stringent standards, and then evaluated the complete environmental, economic, and social costs and benefits of each alternative.

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Because of these omissions, the proposed rulemaking and DEIS does not fully address the requirements of NEPA in a transparent manner that provides appropriate context for decision makers.

Docket Number: NHTSA-2018-0067-12305
Organization: New York State Attorney General Barbara Underwood
Commenter: Austin Thompson

Finally, the draft statement fails to sufficiently evaluate all the reasonable alternatives to NHTSA and EPA's drastic decision. As NHTSA itself recognizes, "[t]he purpose of an EIS is to 'provide full and fair discussion of significant environmental impacts and [to] inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. "

But NHTSA analyzes a much more restricted range of alternatives: it only considers the original standards and loosening these standards—i.e., replacing them with standards that are less restrictive. Given that New York and other states are already suffering the effects of climate change, a decision to intentionally ignore the rational step of imposing stronger standards flouts common sense. It makes even less sense in the context of EPA's previous conclusion that "the current record, including the current state of technology and the pace of technology development and implementation, could support a proposal, and potentially an ultimate decision, to adopt more stringent standards for MY 2022-2025." A more thorough analysis that considered all the reasonable alternatives—as is required under NEPA—might come to a much different conclusion. We ask NHTSA to conduct such an analysis: New York, its residents, and the rest of the United States deserve a fair opportunity to evaluate the impact of the proposed rollbacks and to consider the proposal in a more accurate context.

Response

As discussed in Chapter 1 of the Draft EIS, several commenters responding to NHTSA's Notice of Intent, stated that the agency should consider alternatives more stringent than the augural standards. In response, NHTSA stated that

> The No Action Alternative, described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, is the most stringent alternative under consideration. Although several commenters expressed a desire for NHTSA to analyze alternatives that are more stringent than the augural standards, the agency ultimately concluded that such alternatives are beyond maximum feasible and are not reasonable for consideration here.

Based on the information available to the agency as described in the preamble to the final rule, NHTSA continues to believe that the range of alternatives considered in this Final EIS encompasses a reasonable range of alternatives for where maximum feasible standards would fall.

In response to comments such as these, as discussed in Section V of the preamble to the final rule, the agencies used the CAFE model to examine a progression of stringencies extending outside the range presented in the proposal and Draft EIS, and as a point of reference, using a case that reverts to MY 2018 standards starting in MY 2021. Scenarios included in this initial screening exercise ranged as high as increasing stringency annually at 9.5 percent during MYs 2021–2026, reaching average CAFE and CO_2 requirements of 66 mpg and 120 g/mi, respectively. Among other conclusions discussed further in Section V of the preamble to the final rule, NHTSA determined that increases in stringency beyond the baseline augural standards show costs continuing to accrue much more rapidly than fuel economy and CO_2 improvements. With that information in mind, as discussed further in the preamble, even the No Action Alternative is already well beyond levels that can be supported under EPCA. If further stringency increases appeared likely to yield more significant additional energy and environmental benefits, it is conceivable that these could outweigh the significant additional cost increases. However, the screening analysis showed no dramatic acceleration of energy and environmental benefits.

NHTSA recognizes the additional environmental benefits that may result from an alternative that is more stringent than the augural standards. However, NHTSA must consider *all* the statutory factors when considering which standards are maximum feasible. Based on those factors, as described in the preamble to the final rule and this analysis, NHTSA has concluded that it is not appropriate to analyze in detail alternatives that were more stringent than the No Action Alternative.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Regarding calculation and significance of the proposed policy action loosening the present CAFE standards: The draft EIS considers 8 alternative policy actions and finds that the proposed relaxation of the CAFE standards would add only relatively small increments to the projected changes in climate calculated for the No Policy Actions baseline scenario. While we defer to the views of other experts on the calculation of the changes in emissions resulting from the proposed policy changes, we would note that were the international community of nations to do as the US is proposing (and the baseline scenario assumes all nations are taking the same approach, namely no policy actions to limit climate change), the impacts would be considerably larger given that the US is presently responsible for of order only one-sixth of global emissions. In addition, as we explain in the specific comments below, the calculation of the effect of these policy steps on sea level rise in 2100 due just to U.S. adoption of these policies represents only roughly 1% of the projected long-term equilibrium effect on sea level. **Most importantly, that the U.S. would be proposing to take actions that would add to global emissions and further increase climate change in any way when projecting that taking no actions would cause a 4°C (~7°F) global warming by 2100, with consequent impacts much, much more severe than those already affecting the U.S. and the world with only ~1°C (1.8°F) warming would be in direct conflict with the objective of the United Nations Framework Convention on Climate Change (UNFCCC)**. The UNFCCC was negotiated by the Administration of President George H. W. Bush and ratified by the U.S. Senate on October 15, 1992; under Article Six of the Constitution, it is the supreme law of the land. The Convention sets as its objective "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." **The 3°C (~5.5°F) warming during the 21st century that is the baseline, no-policy-action scenario of human-induced global warming presented in this draft EIS as "how the Proposed Action and alternatives potentially would affect the pace and extent of future changes in global climate" would be so rapid that ecosystems would be unable to adapt, that food production would be severely threatened, and that very high costs and impacts would be imposed on the economy and natural resource base which society depends due to the disruption of the weather and sea level rise that would result. Already, extremely warm summers that in the mid-20th century had a likelihood of 1 in a thousand are occurring with a likelihood of about 140 in a thousand, and occurrences of other extreme conditions are similarly increasing. In our view, the analysis provides no basis for considering any of the proposed alternative actions as acceptable, including Alternative 0 (zero) that proposes no action at all.**

Response

NHTSA recognizes that under any of the action alternatives considered in this EIS, emissions of GHGs would be anticipated to increase compared to the No Action Alternative, thereby exacerbating the impacts of climate change. However, under all of the action alternatives, the overall fuel economy of the light-duty vehicle fleet is anticipated to improve over time as older, less fuel-efficient cars and light trucks are replaced with newer, more fuel-efficient ones. In addition, under Alternatives 2 through 7, annual CAFE standards would increase in stringency on an annual basis, resulting in additional improvements in vehicle fuel economy. These improvements are consistent with NHTSA's statutory responsibilities and would result in incremental reductions to the anticipated impacts associated with climate change.

Comment

Docket Number: NHTSA-2017-0069-0497
Organization: South Coast Air Quality Management District
Commenter: Barbara Baird et al.

The South Coast Air Basin includes Los Angeles and surrounding areas, and is home to over 16 million people. Its residents breathe the worst air in the nation for ozone and the second worst for PM2.5. Zero-emission light-duty vehicles are essential for their emission reductions and as a bridge to zero-emission heavy-duty and off-road vehicles, all of which are essential if SCAQMD is to attain federal clean air standards.

In the attached comments, SCAQMD shows that the analysis in the Draft EIS is fatally defective because it fails to analyze an alternative that would keep the California waiver in place, even while amending the rules for the rest of the nation. This alternative must be analyzed because the existence of reasonable but unexamined alternatives render the EIS inadequate. *Friends of Southeast's Future v. Morrison*, 153 F.3d 1059, 1065 (9th Cir. 1998). Since NHTSA and EPA have no legal authority to withdraw the California waiver, as explained in our comments, NHTSA must consider an alternative that keeps the waiver in place and the DEIS must be recirculated after its defects have been corrected.

* * * * *

The alternatives analysis is the "heart of the environmental impact statement." 40 C.F.R. § 1502.14. The EIS must "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." 40 C.F.R. §1502.14(a). The Draft EIS is glaringly deficient because it fails to analyze any alternative which would keep the California waiver in place for the existing standards, and thus allow Section 177 States to also enforce the California standards. Nor does the analysis even explain why this alternative was rejected.

The "agency must look at every reasonable alternative within the range dictated by the nature and scope of the proposal. *See Idaho Conservation League*, 956 F.2d at 1508. The existence of reasonable but unexamined alternatives renders an EIS inadequate. *See Alaska Wilderness Recreation and Tourism Ass'n.*, 67 F.3d at 729." *Friends of Southeast's Future v. Morrison*, 153 F.3d 1059, 1065 (9th Cir. 1998).

As we will explain more fully in our comments on the NPRM, SCAQMD submits that NHTSA/EPA have no legal authority to withdraw the California waiver for the Advanced Clean Cars program and the Zero-Emission Vehicles requirements. Therefore, the EIS must include an alternative which keeps the California waiver in place. Even if there were legal authority to withdraw the waiver, EPA and NHTSA seek comment on whether to withdraw the waiver. The agency must not be hamstrung by its NEPA analysis and prevented from adopting an alternative which preserves the waiver. The agency must analyze an alternative which preserves the waiver because it is a reasonable one within the range of action contemplated by the proposal. *Friends of Southeast's Future*, *supra*, 153 F.3d at 1065. Moreover, NHTSA may not foreclose consideration of an alternative which preserves the waiver by saying that this is not one of the alternatives it wishes to pursue. "An agency will not be permitted to narrow the objectives of an action artificially and thereby circumvent the requirement that relevant alternatives be considered." *City of New York v. U.S. Dept. of Transportation*, 715 F.2d 732, 743 (2d Cir. 1983). NHTSA's failure to analyze an alternative that preserves the waiver renders the EIS fatally defective because it does not analyze a reasonable alternative within the range contemplated by the proposal.

* * * * *

SCAQMD staff submits that the EIS must take into consideration California-specific data in evaluating the impacts of an alternative that would preserve the California waiver. California is far ahead of the rest of the nation in acceptance of electric vehicles. It accounts for half of all electric vehicle sales, while only accounting for 12% of national light duty vehicle sales. With annual electric vehicle sales jumping 29% between 2016 and 2017, it is fair to say the market is taking off. Almost a third of light-duty vehicle sales were electric vehicles in the city of Palo Alto. Several automakers have already transitioned their fleets to a greater electric vehicle share than would be required to meet California's 2025 requirements. This indicates that manufacturers are rising to the challenge of electrifying transportation. There is no basis for the speculation that manufacturers "may not be willing" to supply vehicles to a more limited California waiver market.

Rapidly-growing electric vehicles sales belie any assertion that the California waiver standards are "technologically infeasible." Therefore, the Draft EIS must consider an alternative which preserves the California waiver.

Given the growing demand for electric vehicles and the availability of incentives, the assumption that manufacturers will "subsidize" ZEV production with their other vehicles is unsupported.

And California is well on its way to meeting its goal of at least 1.5 million electric vehicles on the road by 2025. NHTSA fails to explain how it considered these facts in considering the impact of its suggested alternatives, let alone an alternative that preserved the California waiver. There is no basis to conclude that the ZEV standard is "technologically infeasible," even considering costs, in California.[24]

NHTSA's conclusion is premised on flawed assumptions that do not support withdrawal of the California waiver, even if they could support changing the national fuel economy standards. Therefore, NHTSA is obligated to evaluate an alternative that includes preserving the California waiver.

* * * * *

NHTSA claims that the range of alternatives which it did consider allows decision-makers to make a reasoned judgement about the environmental impacts of other possible alternatives, because such impacts would be likely to fall somewhere within the range of impacts of the alternatives that are analyzed. But this conclusion is not supported by the facts in the Draft EIS, because none of those facts examine the effects of an alternative that would preserve the California waiver, even while implementing NHTSA's preferred alternative in the rest of the country. As discussed above, NHTSA fails to rebut evidence of substantial and growing demand for electric vehicles in California.

* * * * *

Courts are required to invalidate an EIS and set aside the associated project approval (here, the revisions to fuel economy regulations and withdrawal of California waiver) if the EIS omits an alternative that is necessary to making a "reasoned choice." *State of California v. Block*, 690 F.2d 753, 767 (9th Cir. 1982).

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[24] Moreover, other states such as Colorado, are projected to have significant demand for ZEVs. The National Renewable Energy Laboratory (NREL) prepared a technical report entitled "Electric Vehicles in Colorado: Anticipating Consumer Demand for Direct Current Fast Charging." NREL concluded that by 2030, using its "medium" growth scenario, electric vehicles would account for 5% of all light-duty vehicles on the road in Colorado, for a total of over 300,000 vehicles. (p. 5.) https://www.nrel.gov/docs/fy17osti/68447.pdf.

In that case, the Court of Appeals affirmed the District Court's decision that the agency must consider two specific alternatives before approving the project. In particular, the Court concluded that it was unreasonable to "overlook the obvious alternative" of allocating more than a third of the acreage to wilderness use. *Id.*. p.769. The Court found it "troubling" that the agency "saw fit to consider from the outset only those alternatives leading to [its desired] end result." *Id.*, p.768. Similarly here, NHTSA has deliberately chosen only those alternatives that include its desired end result of withdrawing the California waiver. By doing so, it has failed to consider an alternative that is necessary to make a reasoned choice. The EIS is further defective because the air quality analysis is unrealistic, and because it fails to include photochemical air quality modeling. Accordingly, the Draft EIS must be revised to correct all defects and be recirculated for further comments or the project approval will be in jeopardy.

Docket Number: NHTSA-2017-0069-0508
Commenter: Blanca Luevanos

The EIS must rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated. 40 C.F.R. 1502.14(a). But it fails to analyze any alternative which could keep the California waiver in place for the existing standard, or give valid reason to why alternative was rejected.

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

We contended that the Draft EIS is inadequate because it failed to consider the reasonable alternative of preserving the California waiver.

*   *   *   *   *

To the extent NHTSA's assumption that consumers will not purchase ZEVs and PHEVs is invalid, it means (1) NHTSA has violated NEPA by failing to consider a reasonable alternative of keeping the California waiver in place, (which would allow other states to take advantage of it) and (2) the analysis of criteria pollutant impacts fails to consider realistically the benefits of increased sales of these vehicles that exceeds even what was projected in the original rulemaking.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA has also failed to include and analyze action alternatives that retain California's GHG standards and its ZEV mandate. As the Joint Commenters note in comments to the NPRM, the Proposal would unlawfully promulgate regulations declaring that California's waiver under section 209 of the Clean Air Act for its GHG and ZEV Programs is preempted by EPCA. In addition, EPA has proposed to revoke California's waiver under Section 209 of the Clean Air Act. As the Joint Commenters fully explain there, EPCA unambiguously does not preempt California's waiver, and EPA lacks authority to revoke California's lawfully-issued waiver. The proposed action alternatives, however, appear to assume that these regulations, currently in effect in California, the District of Columbia, and the 12 states that have adopted California's regulations pursuant to Section 177 of the Clean Air Act, will not exist while the proposed standards are in effect. But NHTSA cannot simply assume that these regulations will cease to exist, which would improperly assume the outcome of a proposal that is currently open for comment. Among the set of more stringent alternatives that NEPA requires the agency to consider, NHTSA must include action alternatives that retain the standards California and other states have lawfully adopted.

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

EPCA requires NHTSA to account for "the effect of other motor vehicle standards of the Government on fuel economy." 49 U.S.C. § 32902(f). NHTSA's analysis of this factor fails to account for the effect of California's emission standards. Because NHTSA relies on that analysis, its proposed standards are not in accordance with law.

The agencies' arbitrary decision to ignore California standards is unprecedented. NHTSA concedes that EPA's emission standards "obviously" must be considered,[25] but then refuses to consider California's emission standards on the basis that those standards are legally preempted by EPCA itself. Courts have upheld California standards against EPCA preemption challenges and Congress has amended EPCA without altering that framework. NHTSA's decision to perform its own statutory interpretation "afresh," NPRM at 43209, is arbitrary given past judicial and legislative action. Further, the agencies' assertion that fuel economy standards and emission standards are interchangeable is unsound. To fulfill its statutory duty under EPCA, NHTSA must at a minimum evaluate the effect of existing and potential California emission standards on maximum feasible fuel economy levels.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The Agencies have not acknowledged the effect on states, citizens, and the various sectors of the industry from disrupting the consistent national program that provided regulatory certainty for many years. California has designed its motor vehicle emissions control program to align with the harmonized national program and has been granted a waiver for those standards. As discussed in greater detail below, California, and the section 177 states that have elected to adopt those standards as their own have incurred reliance interests ultimately flowing from those standards. For instance, California has incurred reliance interests because it is mandated to achieve an aggressive GHG emissions reduction target for 2030. California law requires a multipronged approach demanding GHG emissions reductions from various sectors, including the transportation sector, which is the largest contributor to California's GHG emissions. California's Advanced Clean Cars program, including the State's GHG and ZEV standards, is a crucial part of this multi-pronged approach, and California has made, and is continuing to make, decisions about other regulatory actions in reliance on the emissions reductions the Advanced Clean Cars program will produce. Consequently, the Agencies' proposal to reduce the stringency of their respective standards would, in the absence of affirmative CARB action, undermine the basis of California's planning for its emission reduction goals, infringing on the State's core police power and ability to protect its citizens. The agency proposal therefore contravenes Congress' intent in enacting the Clean Air Act that expressly preserves States' reliance interests. "Where coordinate state and federal

[25] NHTSA's consideration of the effect of EPA's standards is flawed. The Volpe CO_2 program models a compliance pathway that allows manufacturers to pay fines, despite the Clean Air Act prohibiting such a path.

efforts exist within a complementary administrative framework, and in the pursuit of common purposes, the case for federal pre-emption becomes a less persuasive one."

The Agencies have offered explanations for their proposal that run counter to the evidence. The Agencies assert that fuel efficiency and emissions controls have sacrificed other attributes that are in greater demand, despite the evidence of increasing sales over the same model years that standards have been increasing, with growing options and features in the market.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

In determining what constitutes a reasonable range of alternatives, NEPA requires that agencies "take into proper account all possible approaches to a particular project." *Alaska Wilderness Recreation & Tourism Ass'n v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995). "An EIS aids the agency's own decisionmaking process by ensuring that the agency has before it all possible approaches to a particular project ... which would alter the environmental impact and the cost-benefit balance." *Northwest Coalition for Alternatives to Pesticides (NCAP) v. Lyng*, 844 F.2d 588, 591-92 (9th Cir. 1988) (internal quotations and citations omitted). Moreover, "when the proposed action ... is an integral part of a coordinated plan to deal with a broad problem, the range of alternatives that must be evaluated is broadened." *'Ilio'Ulaokalani Coalition*, 464 F.3d at 1098.

Here, the DEIS analyzes action alternatives premised on the legally baseless assumption that EPA and California's vehicle emission standards do not exist. The DEIS leaves the public guessing as to NHTSA's reason for this assumption.[26] EPCA expressly requires NHTSA to consider "the effect of other motor vehicle standards of the Government on fuel economy." 49 U.S.C. § 32902(f). Although NHTSA contends otherwise, NHTSA must consider both EPA vehicle emission standards under the Clean Air Act (including GHG standards currently in effect) and California's vehicle emissions standards, "which are currently enforceable there and in other states that have adopted those standards." Although EPA has proposed to relax its motor vehicle GHG emissions standards, those emissions standards are currently in effect. Likewise, EPA's final action granting California's waiver currently remains in effect.

Therefore, in order for the public to make a reasoned decision, NHTSA must analyze "all possible approaches" to the proposed action, which includes an analysis of all action alternatives under two scenarios: (1) a scenario in which EPA and California's vehicle emission standards are not in effect; and (2) a scenario in which EPA and California's vehicle emissions standards remain in effect. The DEIS appears to present only the first scenario, but NHTSA must analyze the impact of EPA and California's standards as they currently exist, and the environmental benefits they are expected to provide. Failing to do so obscures the degree of environmental harm of the Proposed Rollback by not informing the public of the emission reductions that would otherwise occur if EPA and California's vehicle emission standards remain in effect.

[26] DEIS at 1-15. The States vigorously disagree with NHTSA's preemption assertions and its claimed authority to declare California GHG and ZEV standards void (DEIS at 8-22, fn. 10) and incorporate by reference the States and Cities' Proposed Rollback Comments and CARB Proposed Rollback Comments on this issue.

Docket Number: NHTSA-2018-0067-12025
Organization: North Carolina Department of Environmental Quality
Commenter: Sheila Holman

Third, the DEIS also omits consideration that California currently has in place LDV GHG emissions standards in-place which have also been adopted by several other states. The DEIS does not account for the possibility that the waiver of preemption for the California standards is not withdrawn and that these standards remain in-place. The potential for the current California program to remain in-place, and the potential for it to remain in place, should be included in the analysis.

Because of these omissions, the proposed rulemaking and DEIS does not fully address the requirements of NEPA in a transparent manner that provides appropriate context for decision makers.

Response

The issues of Clean Air Act waivers of preemption under Section 209 and EPCA/EISA preemption under 49 U.S.C. § 32919 are not addressed in this Final EIS, as they were the subject of a separate final action and rulemaking by EPA and NHTSA in September 2019. The joint action is available at 84 FR 51310, and comments on these issues have been addressed and responded to in that action and rulemaking process. In that action, EPA withdrew aspects of a Clean Air Act preemption waiver previously granted to California, and NHTSA concluded that EPCA expressly and impliedly preempted state laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy. Therefore, NHTSA concludes it is not appropriate to consider alternatives keeping California's waiver in place in this Final EIS.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The range of alternatives proposed also fails the essential purposes of a DEIS by flouting NHTSA's obligation to "inform decisionmakers and the public of the reasonable alternatives *which would avoid or minimize adverse impacts or enhance the quality of the human environment."* 40 C.F.R. § 1502.1 (emphasis added). All that NHTSA does here is to propose alternatives that worsen the light duty fleet's adverse environmental and health impacts. We again note that (as will be explained in greater detail below) the data NHTSA presents in fact vastly underestimates the alternatives' harmful environmental effects, as they are derived from faulty modeling and unsupported assumptions. But even a review of what NHTSA does present demonstrates the drastic environmental damage all of the action alternatives would inflict.

NHTSA admits that all criteria pollutants and some toxics would increase when compared to the No Action Alternative. The DEIS also concludes that the action alternatives would result in increased incidence of adverse health impacts due to particulate matter (PM2.5) pollution, including premature mortality, acute bronchitis, respiratory emergency room visits, and work-loss days, with the Preferred Alternative being the worst option of all. (As we explain below, these effects are largely underestimated). As for climate pollutants, all of the alternatives would result in large increases in CO_2

emissions when compared to the No Action Alternative, with – according to NHTSA itself – total emissions increases ranging from 1,800 $MMTCO_2$ (Alternative 7) to 7,400 $MMTCO_2$ (Alternative 1) by 2100, resulting in increases in atmospheric CO_2 concentrations, temperatures, precipitation, and sea-level rise.

Because it lacks a reasonable range of alternatives that avoids or minimizes these impacts, the DEIS, if finalized as proposed, would violate NEPA. NHTSA must withdraw this document and analyze in detail a set of alternatives that strengthen rather than weaken fuel economy, prepare a new DEIS, and submit it for public comment.

Response

The range of alternatives considered in an EIS is dictated by the purpose and need for the agency's action. As described in Chapter 1, *Purpose and Need for the Action*, NHTSA must consider the requirements of EPCA, which sets forth the four factors the agency must balance when determining "maximum feasible" standards. NHTSA's explanation for how it arrived at the range of alternatives under consideration is in Section V of the preamble to the final rule and incorporated by reference in the EIS. As described in the preamble to the final rule (and in response to comments above), NHTSA believes the range of alternatives under consideration is reasonable, in light of the factors it must balance.

NHTSA also believes the commenters' application of 40 CFR § 1502.1 is too narrow. In fact, six of the seven action alternatives would establish CAFE standards that increase in stringency annually for MYs 2021–2026, and the seventh would still result in fleetwide fuel efficiency improvements as older, less fuel-efficient vehicles are replaced with newer, more fuel-efficient ones. As a result, all of the action alternatives would result in enhancing the quality of the human environment compared to the current light-duty fleet. NHTSA's authority allows it to reconsider the standards it announced in 2012 that have not yet taken effect (or, in the case of augural standards, will not take effect).

Comment

Docket Number: NHTSA-2017-0069-0588
Organization: Alliance of Automobile Manufacturers
Commenter: John T. Whatley

The Alliance first addresses an issue related to process and to the definition of alternatives. In comments on the DEIS that it filed last month, the South Coast Air Quality Management District ("SCAQMD") asserts the DEIS is "fatally defective" because it does not analyze an alternative "that would keep the California waiver in place, even while amending the rules for the rest of the nation." The Alliance understands and supports the efforts of SCAQMD to meet its goals for the reduction of criteria and precursor pollutants. In our view, the cases cited in SCAQMD's comments, *Friends of the Southeast's Future v. Morrison*, 153 F.3d 1059 (9th Cir. 1998), *California v. Block*, 690 F.2d 753 (9th Cir. 1982), and *City of New York v. US. Dep't of Transp.*, 715 F.2d 732, 743 (2d Cir. 1982), do not cast doubt on NHTSA's handling of alternatives analyzed in the DEIS. In the regulatory proceeding commenced in August, NHTSA seeks comment on its position that state GHG standards and ZEV mandates are preempted by the Energy Policy & Conservation Act ("EPCA").[27] *Friends of the Southeast's Future and California v. Block* faulted federal agencies for denying the public an opportunity to comment on proposed actions. If NHTSA were to adopt its current proposal, there is no reason under NEPA for NHTSA to consider a scenario that it believes federal law does not permit.[28]

Response

NHTSA agrees with the commenter, as it has explained in responses to previous comments.

10.2.2.2.1 Suggestion for More Stringent Alternatives

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-28, Section 5.4, Environmental Consequences: Given the seriousness of the climate change issue described in this EIS, it seems irresponsible in the extreme that there are not alternatives being proposed that would address the underlying issue raised by the No Action Alternative and that all of the proposed alternatives would increase the warming, sea level rise and ocean acidification, even if by small amounts. We strongly recommend that the NHTSA and EPA go back to the drawing board and come up with additional policy options to consider that would address the underlying climate change being caused by human activities.

Docket Number: NHTSA-2017-0069-0498
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto et al.

The DEIS is fatally flawed (and must be replaced with a new draft EIS) because it does not consider any alternatives that improve vehicle gas mileage more than the present set of standards. Instead, the DEIS only considers the "no project option" and seven alternatives that ratchet up the production of climate changing gases. The attached July 2012 final EIS for the current system expressly considered a reasonable pro-climate option. See page 2-14. In view of last year's hurricanes Harvey and Maria and today's Florence, both the NEPA and common sense require NHTSA to fully and publicly consider a few options that require at least a seven annual percent improvement in vehicle fleet mileage.

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[27] *See* DEIS at 8-22 n.10 (noting that NHTSA seeks comment on its proposed preemption determination). As the Alliance explains in its comments in the regulatory docket, federal and state agencies should work together to achieve a consensus on a new unified regulatory framework. NHTSA's position on the scope of EPCA preemption of state ZEV mandates and state GHG standards is longstanding. See 83 Fed. Reg. 42,986, 43,232 (Aug. 24, 2016) (noting that the government's position on EPCA preemption of ZEV mandates dates back to 2002); 71 Fed. Reg. 17,654-70 (Apr. 6, 2006). As early as 1992, the Chief Counsel had opined that a state statute that provided for different titling taxes for new vehicles based on their fuel efficiency was preempted by EPCA. Letter from Paul Jackson Rice, NHTSA, to the Hon. Joseph T. Curran, Jr., Att'y Gen. of Maryland, June 8, 1992 (Attachment A).

[28] NHTSA explains in the August 24 notice of proposed rulemaking that if state regulations are preempted by EPCA, EPA cannot permit enforcement of such regulations under the limited waiver provision in section 209 of the Clean Air Act. *See* 83 Fed. Reg. at 43,235-36.

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The DEIS fails to include and analyze a reasonable range of alternatives. The stated goal of the Energy Policy and Conservation Act (EPCA) is to conserve energy supplies including through improved fuel efficiency of vehicles. The National Environmental Policy Act requires NHTSA to rigorously explore all reasonable alternatives within the scope of the proposal. The DEIS must therefore include all reasonable alternatives, including those that are more stringent than the augural standards. The 2016 Draft Technical Assessment Report (TAR) found that the augural standards are achievable and at lower cost than previously predicted. NHTSA has failed to demonstrate that the data and assessment published in the 2016 TAR is inaccurate or out of date and therefore must consider alternatives that reflect these findings. More stringent standards are consistent with EPCA's purpose of energy conservation, are technologically and economically feasible, and would reduce the significant impacts of NHTSA's proposed action.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Under the "rule of reason" governing NEPA's preparation of an EIS, an agency "may not define the objectives of its action in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action." *Citizens Against Burlington*, 938 F.2d at 196 (citing *City of New York v. Dep't of Transp.*, 715 F.2d 732, 743 (2d. Cir. 1983); *Friends of Se.'s Future v. Morrison*, 153 F.3d 1059, 1066 (9th Cir. 1998). Even under the faulty assumptions permeating the NPRM and DEIS (which systematically understate their environmental harm), none of the proposed action alternatives NHTSA has examined could conceivably be described as environmentally "benign." Instead, by proposing only those alternatives that reduce fuel efficiency compared to the No Action Alternative, NHTSA has unlawfully defined the range of alternatives so narrowly that all of them would accomplish NHTSA's predetermined goal of nullifying Congress' intent to conserve the nation's energy.

NHTSA's consideration only of this cramped range of alternatives is fundamentally at odds with any reasonable notion of the meaning of maximum feasible standards that manufacturers can achieve in a given model year. 49 U.S.C. § 32902(a). Proposing as the Preferred Alternative the least fuel-efficient of all is most contrary to this statutory requirement—especially given the agency's projection that market forces alone will drive fuel economy increases beyond those required by the Proposal. Most importantly, presenting only action alternatives that decrease fuel efficiency is directly contrary to EPCA and EISA's core focus on conserving energy. *Ctr. for Auto Safety v. Thomas*, 847 F.2d at 845; *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d at 1219 ("[s]ince EPCA's overarching goal is energy conservation, consideration of more stringent fuel economy standards that would *conserve more energy* is clearly reasonably related to the purpose of the CAFE standards") (emphasis in original).

NHTSA states that it has not analyzed more stringent alternatives "because the agency believes that such ... alternative[s] would, after careful balancing of EPCA's four statutory factors, fall well outside the range of the maximum feasible level." This cursory pronouncement is directly contradicted by NHTSA's own analysis, which predicts that fuel economy will continue to increase due to market forces by themselves, and thus does not meet the rule of reason. It is also contrary to NHTSA's own conclusions, and those of EPA and California, in 2012 and 2016, and NHTSA's complete failure to explain its changed policy (including its abandonment of prior factual findings) renders the statement arbitrary and capricious. *FCC v. Fox Television Stations, Inc.*, 556 U.S. 502, 515-16 (2009). But NHTSA's discretion in balancing the statutory factors for its own policy reasons is limited: it may do so only to the degree that it does not prioritize them over the core focus of EPCA—energy conservation. *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1194, 1197-98 (9th Cir. 2008).

NHTSA's decision not to include any alternatives that are more stringent than the current MY2017-2025 greenhouse gas standards is also contrary to its own 2012 Final EIS for those standards, which did consider more stringent alternatives than those the agency adopted. In the 2012 Final EIS, NHTSA analyzed a range of action alternatives with fuel economy stringencies that increased on average 2 to 7 percent annually from the MY2016 standards for passenger cars and light trucks. In its 2017 Mid-Term Evaluation of its greenhouse gas standards for MY2022-2025, which is based on a robust technical record that includes the Draft TAR co-authored by NHTSA, EPA concluded that more stringent standards than those in effect for MY2017-2025 are in fact feasible and less costly than initially estimated:[29]

> The EPA found in 2012 that the projected standards were feasible at reasonable cost, and the current record shows that the standards are feasible at even less cost and that there are more available technologies (particularly advanced gasoline technologies) than projected in 2012, and that the benefits outweigh the costs by nearly $100 billion. These factors could be the basis for a proposal to amend the standards to increase the standards' stringency. Moreover, one could point to the overall need to significantly reduce greenhouse gases in the transportation sector even further, especially given expected growth in vehicle travel.

Other than to cursorily announce that more stringent alternatives are not within a reasonable range, NHTSA never explains in the DEIS why more stringent alternatives are now not presented, nor why the alternatives it previously presented can no longer be considered within that range. NHTSA's refusal to consider any alternative that increases fuel efficiency standards beyond the No Action Alternative falls short of NEPA's mandate to "[r]igorously explore and objectively evaluate all reasonable alternatives." *New Mexico ex rel. Richardson v. BLM*, 565 F.3d 683, 708 (10th Cir. 2009) (quoting 40 C.F.R. § 1502.14(a)). Courts have frequently invalidated agency NEPA reviews that fail to consider alternatives providing sufficiently varying degrees of environmental protection. *Id.* at 711 (BLM violated NEPA by refusing to consider an alternative closing planning area to future oil and gas leasing); *Nat. Res. Def. Council v. U.S. Forest Serv*, 421 F.3d 797, 814 (9th Cir. 2005) (agency violated NEPA by refusing to consider alternatives that allocated less than 50 percent of roadless areas for development). In addition, NHTSA's failure to discuss the reasons why it eliminated more stringent alternatives from the DEIS even though it analyzed them in the 2012 Final EIS violates NEPA's regulations requiring an explanation for eliminating alternatives from that detailed study. 40 C.F.R. § 1502.14(a).

* * * * *

[29] Ultimately, EPA decided not to commence a rulemaking to strengthen the standards based on concern about industry certainty, but not because stronger standards were not feasible or cost-effective. EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (Jan. 2017), at 8.

The disclosure and discussion of more stringent alternatives is necessary to effectuate NHTSA's statutory mandate and to comply with NEPA, "our national charter for protection of the environment." *Wildearth Guardians v. BLM*, 870 F.3d at 1226 (quoting 40 C.F.R. § 1500.1(a)). While NEPA does not require agencies to analyze alternatives that have "in good faith [been] rejected as too remote, speculative, or impractical or ineffective," it does require enough information to allow a "reasoned choice of alternatives as far as environmental aspects are concerned." *New Mexico ex rel Richardson v. BLM*, 565 F.3d 683, 708 (10th Cir. 2009) (citation omitted). *See also* 40 C.F.R. § 1502.1 (an environmental impact statement "shall inform decision makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.")

More stringent alternatives than those that NHTSA has proposed (including alternatives more stringent than the augural standards, which NHTSA is not considering as a true alternative) serve the DEIS' purpose and need. They would meet EPCA's mandate to promote energy conservation as well as NEPA's requirement that agencies avoid or minimize impacts and enhance the quality of the human environment.

In the 2012 Final EIS, NHTSA analyzed a range of alternatives with an upper bound of 7 percent annual increase in fuel economy. At a minimum, NHTSA must analyze that 7 percent alternative now as well. Given that the most recent record resulting from the mid-term review shows that the CAFE standards are feasible at lower cost than estimated in 2012, and that there is a wider range of technologies available for compliance, NHTSA must also analyze more stringent alternatives than the augural standards. In our comments to NHTSA's Scoping Notice, several of the undersigned groups requested that NHTSA use an upper bound of 8 percent annual increase in fuel economy, based on an analysis from the American Council for an Energy-Efficient Economy (ACEEE) prepared as part of its comments to the Draft TAR. That analysis presents the results of employing the Volpe model as used by NHTSA in 2012 and 2016 to run fuel economy stringencies higher than the augural standards based on real world settings.

As ACEEE explained in those comments, employing the Volpe model as NHTSA did for the 2016 TAR shows that the augural standards fall well below the rate of increase that leads to the largest net benefits. While the augural standards deliver net benefits of $85 billion, higher annual increases would create even larger net benefits. NHTSA's most stringent alternative must be set at no lower than a 9 percent improvement per year.

> [see original comment for table titled Net Benefits of MY 2022-2025 Standards over Lifetime of MY 2016-2028 Vehicles]

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

NEPA requires that an agency assess all reasonable alternatives to the proposed action in its EIS, 42 U.S.C. § 4332(C)(iii); 40 C.F.R. § 1502.1, and this alternatives analysis is "the heart of the environmental impact statement." 40 C.F.R. § 1502.14. The alternatives assessed in the NEPA analysis must encompass the full range of alternatives that the agency is required to consider. *Id*. § 1505.1(e).

EPCA requires that NHTSA set fuel economy standards at the "maximum feasible average fuel economy level" that manufacturers can achieve for gas- and diesel-powered vehicles—and in order to do that, the agency would have to consider the upper bound of what fuel economy level is feasible. 49 U.S.C. §

32902(a). The purpose of EPCA is to conserve energy through a comprehensive program to improve vehicle fuel economy. And although EPCA instructs the agency to consider four factors when setting standards—technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy—no factor may overtake the fundamental goal of energy conservation. *See Ctr. for Biological Diversity v. NHTSA*, 583 F.3d 1172, 1194 (9th Cir. 2008).

A wealth of technical data and analysis contained in the 2012 rulemaking record, the Mid-Term Evaluation record, and more recent findings demonstrates that more protective standards than the current Clean Car Standards are achievable. Yet of the eight alternatives considered by NHTSA in the DEIS, *none* provide for improved fuel economy beyond the existing requirements that have been set through MY 2025. By only considering alternatives that would weaken the existing Model Year 2021-2025 standards, NHTSA shirks its duty under both NEPA and EPCA.[30] A strengthening of the existing standards is both "reasonable" and "feasible." NHTSA improperly failed to consider such alternatives.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

Under the National Environmental Policy Act (NEPA), NHTSA must evaluate alternatives, including a no-action alternative. NHTSA's consideration of a full range of standards, including those stronger than the augural standards, is critical given that the transportation sector has now overtaken the power sector as the United States' largest source of greenhouse gas pollution and remains dependent on oil. It would also be an essential element of a *de novo* rulemaking process.

In our comments on the NOI we urged the agency to consider a robust set of alternatives, including the augural standards but also standards that provide even greater fuel efficiency. We noted that the Technical Assessment Report (TAR) issued by NHTSA, EPA, and the California Air Resources Board (CARB) in 2016 confirmed "[a] wider range of technologies exist for manufacturers to use to meet the MY2022-2025 standards, and at costs that are similar or lower, than those projected in the 2012 rule." Thus the MY2022-2025 EPA and NHTSA's augural standards no longer represent the upper range of what should be considered by NHTSA in its determination of "maximum feasible" standards.

While NHTSA appropriately considers the augural standards as the No Action Alternative, it fails to include consideration of more stringent standards. NHTSA states that it is considering a wide range of alternative approaches in the EIS to cover the complexity of this action. However, all of the alternatives are weaker than the augural standards. Without adequate explanation, NHTSA states that "The No Action Alternative . . . is the most stringent alternative under consideration… the agency ultimately concluded that such [more stringent] alternatives are beyond maximum feasible and are not reasonable for consideration here."

The lack of any rationale to support the conclusion that the augural standards are the most stringent possible is especially galling in light of the government's assertion in seeking to dismiss a challenge to the Mid-Term Evaluation as premature, arguing that EPA "retains discretion under section 7521(a) [of

[30] A federal agency preparing an EIS must "specify the underlying purpose and need to which the agency is responding" in its proposed action and alternatives. 40 C.F.R. § 1502.13. When determining the purpose of its action, "an agency should always consider the views of Congress, expressed, to the extent that the agency can determine them, in the agency's statutory authorization to act." *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991).

the Clean Air Act] to decide in a final rulemaking notice, after receiving public comments on proposed revised standards and based on the administrative record before EPA at that time, that the existing standards established in 2012 should be retained, *be made more stringent*, or be made less stringent." Case Nos. 18-1114 *et al.*, *California v. EPA*, Respondents' Motion to Dismiss Petitions for Lack of Jurisdiction at 16 (D.C. Cir. July 10, 2018) (emphasis added). If this was not in fact a misrepresentation to the court as to the potential outcomes of this rulemaking, NHTSA has an obligation to explain why it did not even consider any approaches more stringent than the current standards.

In preparing the EIS for prior CAFE standards dating back to 2008, NHTSA has included scenarios that reflect a greater range of technology forcing standards (even considering technology exhaustion standards) even if these standards are "beyond its authority." Rather than taking this approach, which would demonstrate to the reader and decision makers the benefits, costs, and impacts of stronger standards, NHTSA rules this out by simply saying it "believes" more stringent standards are beyond maximum feasible.

NHTSA's assessment of scenarios is also confusing to the reader as it varies how it refers to the augural standards; in some contexts they are within the range of considered options and in others they are identified beyond maximum feasible standards. NHTSA has an insufficient basis for not including a more stringent option (or options) than Option 0, implementing the augural standards. This failure and confusion over the possible range of standards under consideration renders the DEIS invalid and fails to satisfy the requirements of NEPA.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Just as fundamentally, the DEIS fails to include and analyze a reasonable range of alternatives, including alternatives that are more stringent than the augural standards. "The agency must look at every reasonable alternative within the range dictated by the nature and scope of the proposal. The existence of reasonable but unexamined alternatives renders an EIS inadequate." *'Ilio'Ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083, 1095 (9th Cir. 2006). Here, NHTSA has narrowly interpreted "maximum feasible" in a manner that contravenes EPCA such that only one set of alternatives – the less stringent alternatives – would achieve the goals. But, more stringent standards are consistent with NHTSA's statutory charge of energy conservation, are technologically feasible and economically practicable, and would reduce the significant impacts of the Proposed Rollback. NHTSA must also analyze "all possible approaches" to the proposed action, which includes an analysis of all action alternatives under a scenario in which EPA and California's vehicle emissions standards remain in effect. Failing to do so obscures the degree of environmental harm of the Proposed Rollback by not informing the public of the emission reductions that would otherwise occur if EPA and California's vehicle emission standards remain in effect. The alternatives section "is the heart of the environmental impact statement," 40 C.F.R. § 1502.14(a), and yet, NHTSA's analysis falls far short. See States and Cities' Detailed NEPA Comments, Section II.C.

* * * * *

As NHTSA recognizes, "[t]he purpose of an EIS is to 'provide full and fair discussion of significant environmental impacts and [to] inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.'" 83

Fed. Reg. at 43,213 (citing 40 C.F.R. § 1502.1). Indeed, the alternatives section "is the heart of the environmental impact statement." 40 C.F.R. § 1502.14. In order to fulfill its intended role of "sharply defining the issue and providing a clear basis for choice among options by the decisionmaker and the public," the environmental impact statement must "[r]igorously explore and objectively evaluate all reasonable alternatives." *Id.* § 1502.14(a). "The agency must look at every reasonable alternative within the range dictated by the nature and scope of the proposal. The existence of reasonable but unexamined alternatives renders an EIS inadequate." *'Ilio'Ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083, 1095 (9th Cir. 2006); see also *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 812-13 (9th Cir. 1999).

As further detailed below, the alternatives presented by the DEIS are wholly insufficient, thereby rendering the DEIS inadequate. NHTSA has chosen to analyze a narrow range of action alternatives "with fuel economy stringencies that increase annually, on average, 0.0 to 3.0 percent from the model year 2020 or model year 2021 standards for passenger cars and for light trucks (depending on alternative)." A threshold question when evaluating the adequacy of an environmental impact statement is "whether the selection and discussion of alternatives fosters informed decision-making and informed public participation." *California v. Block*, 690 F.2d 753 (9th Cir. 1982.) By failing to analyze alternatives that exceed the stringency of the augural standards and an alternative that retains the California program, the answer to the threshold question posed above is, quite clearly, "no."

*   *   *   *   *

NHTSA has taken the position that it needs to analyze only a range of alternatives with fuel economy stringencies that are less than the augural standards. That is, NHTSA appears to believe that the augural standards represent the upper bound of the analysis, with the preferred alternative of rolling back the standards to model year 2020 levels as the lower bound of the analysis. These alternatives (combined for passenger cars and trucks) are presented in tabular form below. All alternatives under consideration would decrease fuel economy requirements when compared to the augural standards.

> [See original comment for figure titled Projected Average Required Fleet-Wide Fuel Economy (mpg) for Combined U.S. Passenger Cars and Light Trucks by Model Year and Alternative.]

NHTSA concedes that more stringent alternatives are possible, but ascribes its failure to analyze more stringent CAFE standards to its balancing of EPCA's four statutory factors. The DEIS does not elaborate on how that balancing precludes the selection and analysis of alternatives that are more stringent than the augural standards. NHTSA merely states "that such an alternative would, after careful balancing of EPCA's four statutory factors, fall well outside the range of the maximum feasible level."

As stated, NHTSA's interpretation of "maximum feasible" contravenes EPCA (*supra*, Section II.A.) NHTSA has narrowly defined the project such that only one set of alternatives – the less stringent alternatives – would achieve the goals. An agency preparing an environmental impact statement may not define objectives of its action such that only one alternative would accomplish the goals of the agency action. *See Idaho ex rel. Kempthorne v. U.S. Forest Service*, 142 F. Supp. 2d 1248 (D. Idaho 2001). "If the purpose is defined too narrowly, only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action, and the environmental impact statement (EIS) would become a foreordained formality." *North Carolina Alliance for Transp. Reform, Inc. v. U.S. Dept. of Transp.*, 151 F. Supp. 2d 661, 686 (M.D.N.C. 2001). By advancing a preferred alternative that freezes CAFE standards for at least six years and increases the nation's consumption of petroleum by approximately 500,000 barrels per day, NHTSA has effectively decided that the nation no longer needs to conserve energy and has defined "maximum feasible" in a manner that contravenes its congressional mandate under EPCA. Indeed, in 2012, NHTSA rejected less stringent alternatives because they would not have represented "the appropriate balancing of the relevant factors, because they would have left technology, fuel savings, and emissions reductions on the table unnecessarily, and not contributed as much as possible to reducing our nation's energy security and climate change concerns." With the Proposed Rollback, NHTSA has radically changed positions—assuming energy conservation provides little, if any, benefits, for example—without explaining or even acknowledging this complete reversal of course. *See Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2126 (2016) ("explanation fell short of the agency's duty to explain why it deemed it necessary to overrule its previous position").

Further, "[s]ince EPCA's overarching goal is energy conservation, consideration of more stringent fuel economy standards that would *conserve more energy* is clearly reasonably related to the purpose of the CAFE standards." *CBD v. NHTSA*, 538 F.3d at 1219 (emphasis in original). As NHTSA recognizes in the DEIS, the transportation sector is, and will continue to be, the largest consumer of U.S. petroleum and second-largest consumer of total U.S. energy. As a result, by increasing fuel economy of passenger cars and light trucks, the United States has the potential to achieve significant reductions in fuel consumption. In the July 2016 Draft Technical Assessment Report jointly conducted by NHTSA, EPA, and CARB, the agencies found that:

> on balance, each gallon of fuel saved as a consequence of the [Light-Duty Vehicle] GHG/fuel economy standards is anticipated to reduce total U.S. imports of petroleum by 0.9 gallons.

Given the extensive record evidencing that NHTSA's MY 2021 standards and MY 2022- 2025 augural standards are both technologically and economically feasible—including, but not limited to, the 2016 Draft TAR, EPA's Technical Support Document and Proposed Determination (Nov. 2016) and Final Determination (January 2017), and CARB's Advanced Clean Cars Midterm Review—NHTSA cannot justify its selection of action alternatives that exclusively are less stringent than the augural standards. Informed analyses post-dating NHTSA's 2012 final EIS for the augural standards have concluded that the augural standards will be even less costly to achieve and that both the augural standards and more stringent standards are technologically and economically feasible. NHTSA concedes as much, at least as to the technology; as discussed above, its assumptions about costs and other factors are unsupported and, in some cases, demonstrably false. Thus, inclusion of more stringent alternatives in the DEIS is reasonable and NHTSA must analyze multiple alternatives that exceed the stringency of the augural standards. For instance, in the final EIS accompanying its 2012 fuel efficiency standards, NHTSA analyzed an alternative with a 7-percent annual increase in fuel economy. At a minimum, NHTSA should analyze an upper bound alternative at least as stringent here.

* * * * *

In addition, the DEIS fails to satisfy NEPA because NHTSA has designed its CAFE model to rationalize a preconceived result: the selection of action alternatives that are less stringent than the augural standards. NHTSA's refusal to consider more stringent alternatives stems not from any actual inconsistency with EPCA, but from the decision to rollback the existing standards before performing any analysis, which necessitated misconstruing the statute and the technical analysis (*supra*, Section II.A. and B.).

In March 2017, the President announced he was "cancelling" U.S. EPA's Final Determination that the current light-duty vehicle greenhouse gas emissions standards are appropriate, that his administration would "work on the CAFE standards" and eliminate "industry-killing regulations." Shortly thereafter, EPA announced that it intended to reconsider the Final Determination, and NHTSA announced it would initiate a rulemaking to set CAFE standards for model years 2022 to 2025. Specifically, in following this direction to relax the CAFE standards, NHTSA has embedded the CAFE model with assumptions that result in an inaccurate estimate of safety impacts of the augural standards, an overestimation of the vehicle miles driven and thus tailpipe emissions (criteria pollutants and GHGs) as a result of the augural standards, and an underestimation of the impacts of climate change by using a domestic social cost of carbon. See *supra*, Section II.D.

The results from this complex, confusing, and weighted modeling process are an extremely narrow universe of potential regulatory options that are all less stringent than the augural standards. While NHTSA leans on various baseless reasons to justify its narrow range of alternatives, it has also—via unsound modeling—built the emissions conclusions in a way that forecloses consideration of more stringent and environmentally beneficial alternatives. By creating a narrative that mischaracterizes the environmental impacts of the proposed action and alternatives, NHTSA has deliberately deprived the public of information "essential to a reasoned decision between the alternatives." 40 C.F.R. § 1502.22(a).

NHTSA should have begun the NEPA analysis with a range of reasonable alternatives (including more stringent standards), and then evaluated the environmental, economic, and social costs and benefits of each alternative using a model with scientifically and technically sound inputs that produce rational results. See 40 C.F.R. § 1500.1. Instead, NHTSA ran the NEPA process in reverse by preordaining a narrow range of action alternatives and weighting the CAFE model to justify the less stringent standards. In effect, the DEIS is nothing more than a post hoc paper exercise to justify a choice that NHTSA had already made. "Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made." *Id*. § 1502.2. NEPA review must be conducted "not as an exercise in form over substance, and not as a subterfuge designed to rationalize a decision already made [or] .... to file detailed impact studies which will fill governmental archives." *Metcalf v. Daley*, 214 F.3d 1135, 1142 (9th Cir. 2000) (internal citation and quotation marks omitted). Accordingly, NHTSA must consider a full range of alternatives that are feasible and that are not artificially limited by a predetermined end-result.

Docket Number: NHTSA-2017-0069-0693
Commenter: Rafael Pagán and Madeleine Green

The Draft Environmental Impact Statement (DEIS) is insufficient under Council of Environmental Quality (CEQ) regulations. CEQ regulations define the purpose of environmental impact statements and mandates that the EIS "shall inform decision makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." CEQ § 1502.1. By not informing the public of the impacts of *more* stringent standards, the agency is failing to comply with this requirement. The DEIS only provides the information on the No-Action alternative, which would keep existing standards, and, on standards that are less stringent. There is no analysis regarding the impacts associated with more stringent standards. Because of this, the agency must at a minimum "discuss the reasons for [the alternative of more stringent standards] having been eliminated," pursuant to CEQ § 1502.14(a). By failing to asses more stringent standards the DEIS is insufficient under CEQ regulations.

Response

As discussed in Draft EIS Chapter 1, *Purpose and Need for the Proposed Action*, several commenters responding to NHTSA's Notice of Intent stated that the agency should consider alternatives more stringent than the augural standards. In response, NHTSA stated that

> The No Action Alternative, described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, is the most stringent alternative under consideration. Although several commenters expressed a desire for NHTSA to analyze alternatives that are more stringent than the augural standards, the agency ultimately concluded that such alternatives are beyond maximum feasible and are not reasonable for consideration here.

Based on the information available to the agency as described in the preamble to the final rule, NHTSA continues to believe that the range of alternatives considered in this Final EIS encompasses a reasonable range of alternatives for where maximum feasible standards would fall.

In response to comments such as these, as discussed in Section V of the preamble to the final rule, the agencies used the CAFE model to examine a progression of stringencies extending outside the range presented in the proposal and Draft EIS, and as a point of reference, using a case that reverts to MY 2018 standards starting in MY 2021. Scenarios included in this initial screening exercise ranged as high as increasing stringency annually at 9.5 percent during MYs 2021–2026, reaching average CAFE and CO_2 requirements of 66 miles per gallon (mpg) and 120 gallons per mile (g/mi), respectively. Among other conclusions discussed further in Section V of the preamble to the final rule, NHTSA determined that increases in stringency beyond the baseline augural standards show costs continuing to accrue much more rapidly than CAFE and CO_2 improvements. With that information in mind, as discussed further in the preamble, even the No Action Alternative is already well beyond levels that can be supported under EPCA. If further stringency increases appeared likely to yield more significant additional energy and environmental benefits, it is conceivable that these could outweigh the significant additional cost increases. However, the screening analysis showed no dramatic acceleration of energy and environmental benefits.

NHTSA recognizes the additional environmental benefits that may result from an alternative that is more stringent than the augural standards. However, the range of alternatives considered in an EIS is dictated by the purpose and need for the agency's action. As described in Chapter 1, *Purpose and Need for the Action*, NHTSA must consider the requirements of EPCA, which sets forth the four factors the agency must balance when determining "maximum feasible" standards. NHTSA's explanation for how it arrived at the range of alternatives under consideration is in Section V of the preamble to the final rule and incorporated by reference in the EIS. NHTSA must consider *all* the statutory factors when considering which standards are maximum feasible. Based on those factors, as described in the preamble to the final rule, and this analysis, NHTSA believes the range of alternatives under consideration is reasonable, in light of the factors it must balance.

NHTSA does not agree with some commenters that it is obligated to consider the same range of alternatives it considered in its 2012 Final EIS. NHTSA is aware of new facts since 2012 (which are described extensively in the preamble to the final rule and FRIA) and may screen its alternatives accordingly. NHTSA also denies that its decision was somehow "preordained" and that its analysis was adjusted to reach that result. In fact, NHTSA assessed the entirety of the record to develop the alternatives and balance the EPCA statutory factors. In response to claims that NHTSA has failed to discuss the issues raised by commenters in the Draft EIS, NHTSA refers the commenters to the preamble to the final rule and FRIA and incorporates those extensive discussions of these issues by reference. NHTSA need not duplicate those discussions in the EIS if they result in needless bulk without providing additional information to the decision-maker and public. As those documents are publicly available with this EIS, NHTSA believes this approach is reasonable.

Comment

Docket Number: NHTSA-2017-0069-0490
Commenter: Francis Jackson

Purpose and need section page S-2: "the maximum feasible average fuel efficiency…. can be achieved in that model year". Why don't you do it considering all possible options including the below defined option!

Below defined option LD fleet non hybrid 80 mpg and 100 for non plug-in hybrids; 80 mpg vs. your preferred option at 39 mpg (see below table): 63% less oil; 62% less CO_2, 79% less NO_X and 18% less cost to Nation to own and fuel a LD vehicle!! Hybrid even better: 71% less oil, 70% CO_2, 83% NO_X and 17% less cost vs. your preferred option! Include this option in your considerations, How to do it explained below!!!

*   *   *   *   *

Comment: The way to lower pollutions is to do what I believe we can and should do: have 100+ mpg (no faulty math) low polluting Light Duty vehicles. Let's make it happen!

Lower NO_X/mile: improve efficiency and minimize compression of hot combusted products and pre heat exhaust & catalyst for sooner effective catalyst operation.

Lower fuel demand and lower pollutions by increasing engine efficiency substantially.

"….reduce emissions from cars…..face significant challenges, experts say" to me the issue is not are challenges significant, which I do not believe they are, but can they accomplish significant improvement and are they worth pursuing. My answer is yes, but pursue the best for Nation approach not the approaches I see currently discussed by Govt & Industry!

But 1st let's look at some of the "faulty analyses and reporting" that need to be corrected: NO_X is a local & world problem. Just examining the tailpipe exhaust, while a necessary component, is inadequate, we need to compute reality at the local & National level NO_X/mile. We also need to compute at National level: purchase plus fuel plus subsidies cents/mile, NO_X/mile etc. Example: for 2025 38.4 mpg vehicle using E10 fuel I calculate 208 gCO_2/mile. For a ZEV I calculate 650 and the Govt allows zero to be used because it only counts tailpipe exhaust for a significant number of ZEVs! Even when generation CO_2 is included, most data I've seen in print uses average CO_2 per Kwhr I believe not true: it is a marginal problem and therefore requires marginal analyses, i.e.; what power source is used for the extra demand, using average (often half marginal value} is I believe incorrect. Further, using Cents/Kwhr as billed does not include road taxes (a subsidy). ZEVs should have to pay for the roads like other vehicles do! About 2 cents/mile per current LD fleet EIO fueled vehicles. And we need to compare options, not against the current inefficient high polluting vehicles, but against the Best for the Nation possible future options.

Summary: I believe neither Govts nor Industry show any indication they are looking outside their self-imposed “box” to find the best solution for Nation & Citizens, i.e., technologies are available that I believe could provide higher fuel efficiencies, lower pollution, lower weight, lower cost and lower engine displacement vehicles; and are applicable Sis and CIs. Need to look beyond what! believe is Govts & lndustry “faulty &promotional analyses & reporting”, It is not only what they are doing (faulty analyses & reporting), but what it appears they are not doing: Best for Nation highest mpg least polluting lowest total lifetime cost to consumers & taxpayers!!!.

Example of additional technologies to put on the table: 1st, Larger diameter to stroke ratios IC engines with a more rapid combustion process. One way of achieving a more rapid combustion is by using multiple spark plugs (or Diesel fuel injectors) per cylinder(cy) to shorten the combustion process by firing all together or better yet a firing pattern that allows increased CRs, delayed combustion start and fires each individual plug (or injector; note: it is also possible with Diesel injectors to fire all at once but better yet control the flow rates to program as a function of crank angle desired fuel injection rates) to maximize efficiency & minimize pollution at each load & rpm, e.g., Four plugs/injectors can make significant gains, while 7 per cylinder (1 in the center and 6 optimally spaced on a circle at about 0.8 radius) with one firing 1st near (or after) TDC offers more; and as the chamber expands firing more to increase the combustion rate allowing some burn ate control as a function of crank angle; this allows increased compression/expansion ratios and with further delayed initial ignition at high loads the compression/expansion ratio can be further increased. In addition to, or instead of, multiple plugs/injectors other design decisions can also help obtain the desired combustion rate: combustible mixture (fuel, air/fuel ratio, egr %, energy density of charge, temperature of charge at ignition), turbulence, turbocharging (tc), compression ratio (er), stroke, flame plugs, Atkinson & other cycle variations, etc.

2nd, friction losses should be reduced substantially; some examples I would put on the table are:

1. A substantial mechanical advantage rocker arm with an efficient rocker. bearing that reduces the fore on the Main & Crank bearings and additionally greatly reduces piston side load (requires redesigned piston to minimize piston viscous friction) - see abandoned US patent 5,398,652.
2. Variable oil temperature to journal bearings, e.g., split the oil flow into paths and one path is at today temperature and others that are heated at various higher temperatures (lower viscosity) and modulate (or a “bang bang” - simpler but not as effective) the flow from each to achieve the desired temperature, hence viscosity, oil to the bearings to minimize viscous friction losses as a function of rpm & load. Would also benefit both cold weather and startup efficiency (as would 3 below).
3. Segmented journals: at low rpm (including lower Idle fpm/rpms) high force, oil to all segments; at higher rpms and/or low force, oil to some segments and air (or neither air or oil) to others. E.G, visualize a 1 inch journal hub be replaced by a 1.125 inch hub with one 1/8th inch slit that in effect becomes two (1/3rd & 2/3rd) of an inch bearings that are all feed oil at low rpm high load and only one at high rpms and/or low loads.
4. Lower max pressure at high loads: 1. spring overload store and return energy to limit peak pressure, 2. with turbocharger less or no turbocharging at low t/c as rpms and gradually increase t/c as rpms increase and journal carrying capacity increases, 3. lower low rpm charge energy at high loads and restore as rpms increase (lean mixture, reduced pressure charge, increased egr, delayed ignition).
5. Use roller bearings whose friction varies little as rpms increase in place of journals where friction loss increases almost directly with rpm.
6. Lower ring friction with more balanced pressure (abandoned patent 5,271,315) and different materials & surfaces, e.g., BMW Nano Slide, to reduce friction, vary the ring forces acting on it as a

function of expected chamber pressure; even consider a slight chamber wall taper to reduce ring tension as piston withdraws or relieving ring compression pressure at various cycle times or less compression force and more cylinder pressure force. Lower friction surfaces can also be used other places in the engine and in the accessories. Larger piston dia also lowers ring friction %.

3rd, A multi piston expansion design, i.e., early combustion chamber exhaust valve opening (I generally model at 130 degrees after TDC) bottoming cycle described in abandoned US patent 4,860,701 except I believe the valving described in the patent is complex and I would design it with more conventional poppet valving, i.e., visualize 4 in-line cylinders: cylinder 1 is a 2 stroke compressor, cylinders 2 & 4 are 4 stroke combustion chambers and cylinder 3 is a 2 stroke bottoming expander; chambers 1 & 3 alternate in charging and accepting high pressure exhaust from cylinders 2 & 4.

4th, Modify the piston drive to move the piston faster away from TDC and/or a different profile than current drives; e.g., a cam drive, complete cam drive or a current technology drive with a cam to create a bump or modified profile that speeds up or modifies profile withdrawing piston from around, or after top dead center. Another design would be to move the main crank centerline off the piston centerline.

My recommended plan would be to develop the more efficient and least polluting engines with in addition EPA-420-D-11-004 November 2011 tables 1.2-15, -16, -18, -19 with some weight reduction technologies, no plug ln hybrids & EVs, no ethanol for fuel purposes, very efficient cabin climate control, improved traffic controls. And develop and refine/optimize all technologies including polished chamber surfaces, faster expansion after combustion with cam operation and others for later incorporation (longer development time and higher risk, but need to be pursued to eventually maximize performance).

A few examples of gasoline engines (modification to for 4 cylinder (cy) Camry 3.2 inch diam. by 3.4 inch stroke cr10) are: 4 cylinder 3.2 in. diameter by 3.4 inch stroke, 16 compression ratio, four plug equispaced at about 0.707 radius fired individually about or later than TDC for which I calc a 50 % mpg increase, NO_X down 50%. Then a new engine: Max friction reduction 1cy 6psi turbocharged, 4.2x2.55, cr 24, 4 plugs, Atkinson (AT235) cycle (inlet valve closing at 235 and later degrees crank angle, later and programmed ignitions, and I calc 130 % mpg improvement, NO_X down 70 %. Include the EPA increases plus non-plugin hybrid and I compute 258 % more mpg and 84 % less NO_X).

Then a multi piston expansion Spark ignition engine: all pistons 2.25 in stroke, 2 combustion cy 2.75 inch diam, 2.75 inch diam charging and expansion bottoming pistons,11 psi turbocharger, cr 25, later ignition at high loads, ignition earlier as load decreases until at low loads it is about or before TDC (degrees before TDC determined, and firing of additional plugs for each load & rpm condition to maximize efficiency at each load & rpm), variable bottoming chamber exhaust valve opening, again serious engine friction reductions, increased egrs, inlet valve closes at 235 degrees (Atkinson cycle) at max load and later at off loads, for this package I calc 190 % mpg improvement and 75 % less NO_X. And for this configuration (with cited EPA upgrades and no “faulty” analyses as can be found in some of the promotional data available in print) I calc 317 % mpg improvement and 83% less NO_X.

And if given high priority I believe many of these technologies could be in production by 2021! And monies can be made available by recouping National monies saved by eliminating boondoggles, e.gs, Ethanol, plug in EVs plus monies saved by lower cost to own and drive a vehicle!

Note: Above examples not fully optimized.

And if automobile companies do not want to do the best for the nation then authorize the military to take charge and get it done as they have done developing the best tanks and airplanes, etc.

End of opinion.

Also, see table with my calculated values of a number of possibilities!

[See original comment for table with values mentioned directly above.]

Response

NHTSA does not mandate the use of any particular technology by manufacturers in meeting the standards. However, NHTSA considered nearly 50 individual vehicle technologies (encompassing the range of technologies mentioned by the commenter) in the analysis used to inform the agency about what level of standards would be maximum feasible. These technologies are discussed in detail in Section VI.C of the preamble to the final rule. As discussed further in Section VIII of the preamble to the final rule, NHTSA continues to believe that technological feasibility is not inherently limiting in the timeframe covered by this rulemaking, and that all technologies reasonably applicable during the rulemaking timeframe have been considered as part of the analysis. However, the per-vehicle cost increase as stringency increases is relevant to NHTSA's consideration of economic practicability, and that is factored into the agency's decision to set fuel economy standards at the levels discussed in the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

As discussed above, the record does not provide a rational basis to conclude that NHTSA's proposed standards are the "maximum feasible" standards as required by law. The record does provide a rational basis to conclude that the augural standards are feasible, and NHTSA should, at a minimum, finalize the augural standards. The additional new evidence available to NHTSA since 2012 strongly suggests that the augural standards are now less than the feasible maximum, and NHTSA should evaluate further increasing fuel economy standards. Additionally, given the agencies' conclusion that "consumer preferences have shifted markedly" toward larger vehicles, NPRM at 42993, NHTSA should evaluate whether additional fuel economy standard increases for larger vehicles are feasible and would advance EPCA's purpose of energy conservation.

Response

Several alternatives considered in both the Draft and Final EIS considered a larger average rate of improvement for light trucks than passenger cars. As discussed in Section V of the preamble to the final rule, the agencies added an alternative in which stringency for both passenger cars and light trucks increases by 1.5 percent each year from MYs 2021–2026, consistent with comments received requesting that both fleets' standards increase in stringency by the same amount.

10.2.2.3 Suggestions for Other Alternatives

Comment

Docket Number: NHTSA-2017-0069-0498
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto et al.

The DEIS is fatally flawed (and must be replaced with a new draft EIS) because it does not consider any market-based alternatives (*e.g., a "cap and trade"* type option). *See* Wikipedia https://en.wikipedia.org/wiki/Emissions_trading (discussing "cap and trade" systems).

Response

EPCA contains a number of requirements governing the scope and nature of NHTSA's authority to set CAFE standards. As discussed in Section V of the preamble to the final rule, while EPCA/EISA does include very specific provisions regarding trading of CAFE compliance credits, the statute provides no authority for a broad-based cap-and-trade program involving other sectors.

Comment

Docket Number: NHTSA-2017-0069-0597
Organization: National Coalition for Advanced Transportation
Commenter: Devin OConnor

Before turning to NCAT's concerns with the proposed federal standards (discussed in Sections III-VI and IX and X), this Section outlines NCAT's recommended approach to achieve a win-win outcome in the final standards. On May 2, 2018, NCAT submitted a letter to the agencies requesting that they propose an "Advanced Technologies Compliance Flexibility Option," which would maintain the top-line targets in the current model year (MY) 2022-2025 GHG standards but provide manufacturers with certain additional compliance flexibilities. Under this approach, CAFE standards would be calibrated accordingly to maintain comparably robust targets and incorporate similar flexibilities.

The flexibilities NCAT has supported, summarized below, would include a combination of the following elements:

1. continuing to attribute zero GHG emissions to EVs, plug-in hybrid electric vehicles (PHEVs) when operating on electricity, and hydrogen fuel cell vehicles (FCVs);
2. extending and potentially restructuring credit multipliers for EVs, PHEVs, and FCVs;
3. reforming the current off-cycle credit recognition process while strengthening the integrity of the program; and
4. maintaining existing credits for reduced air conditioning refrigerant leakage.

This package of reforms would provide more near-term flexibility in complying with the current GHG and CAFE targets and lower compliance costs. At the same time, it would continue appropriate incentives to further advance and deploy technologies needed to reduce GHG emissions and increase fuel economy. This approach would also strengthen the domestic manufacturing base and promote the infrastructure investment necessary to support continued emission reductions and increased fuel efficiency in the years to come.

Several other stakeholder groups made similar proposals. On May 17, 2018, several trade associations representing automotive suppliers (Motor & Equipment Manufacturers Association, Manufacturers of Emission Controls Association, Advanced Engine Systems Institute, and Emissions Control Technology Association) submitted a letter requesting that the agencies consider a similar option. On May 22, 2018, the Alliance of Automobile Manufacturers, the Association of Global Automakers, the Edison Electric Institute, the American Public Power Association, and the National Rural Electric Cooperatives Association joined together in submitting a similar proposal (Auto-Utility Proposal). The Auto-Utility Proposal called for "increases in the stringency of fuel economy and GHG standards year-over- year that also incorporate policies from California and other ZEV states to ensure that 'One National Program' is maintained"—along with "extend[ing] and improv[ing] the current regulatory mechanisms that provide critical support for EVs and advanced vehicles."

The agencies did not formally propose such an option and did not provide detailed analysis of the potential impacts of this approach. However, the NPRM includes discussion of most of the requisite elements of NCAT's proposed approach. It discusses and analyzes a range of overall stringencies, including maintaining stringency at the level of the current GHG standards and the augural CAFE standards for MY 2022-2025. Further, the NPRM requests comment on technology-based credits, including EV and off-cycle credits, and analyzes the potential impacts of extending and expanding such credits on overall program performance. Accordingly, NCAT's proposed Advanced Technologies Compliance Flexibilities Option remains within the scope of the proposal, and the agencies could finalize this Option based on the proposal.[31] NCAT requests that the agencies further consider, analyze, and finalize this Option—as refined in our comments below.

A. Baseline Program—Maintain State Authority and Top-Line Targets for GHG Standards

In reiterating and refining our request that the agencies adopt an Advanced Technologies Compliance Flexibilities Option, NCAT underscores that maintenance of state authority and rigorous top-line GHG targets are critical "baseline" elements of this Option. Because of the tradeoffs between flexibilities and overall stringency, expansion of compliance flexibilities in the absence of any requirement to improve GHG reductions or fuel economy (as under the agencies' preferred option) could result in an effective deterioration of existing GHG and fuel economy performance, as well as little or no effective support for advanced vehicle technology development or deployment.

B. Extend Attribution of Zero Emissions to Electric Vehicles

Under the current MY 2017-2025 standards, EPA established a two-phase mechanism for addressing whether and how to attribute upstream emissions to EVs, PHEVs and FCVs for purposes of determining compliance with the GHG standards. For the first phase (MY 2017-2021), EPA set the value at 0 g/mile for EVs, PHEVs (for the electricity usage portion) and FCVs, with no limit on the number of vehicles that could be counted as 0 g/mile for tailpipe emissions accounting purposes.

For the second phase (MY 2022-2025), EPA set a per-company cumulative sales cap on the number of EV/PHEV/FCVs that could be counted as 0 g/mile for tailpipe CO_2 emissions compliance. Manufacturers that sell 300,000 or more EV/PHEV/FCVs combined in MY 2019- 2021 can count up to 600,000

[31] In Sections III, IV and V, we argue that the agencies should correct certain fundamental errors in their analysis and provide an additional opportunity for comment on supplemental proposal or notice of data availability. Even if the agencies decline to do so, however, the option NCAT supports is within the scope of the proposal.

EV/PHEV/FCVs combined as 0 g/mile for the MY 2022-2025 standards. Manufacturers that sell fewer than 300,000 EV/PHEV/FCVs combined in MY 2019- 2021 can only count up to 200,000 EV/PHEV/FCVs combined as 0 g/mile for the MY 2022- 2025 standards. Beginning in MY 2022, the compliance values for EVs, FCVs, and the electric portion of PHEVs above the individual automaker cumulative production caps must be based on net upstream accounting of GHG emissions for fuel production and distribution. EPA adopted a specific methodology to calculate the net upstream GHG emissions compliance value for EVs (and the electric portion of PHEVs), based in part on projected national average GHG emissions for electricity generation.

Provided EPA maintains the top-line GHG targets at their current levels, EPA should amend the MY 2022-2025 standards to extend treatment of EVs, PHEVs (for the electricity usage portion), and FCVs as having 0 g/mi emissions for purposes of the GHG program, without any per manufacturer production cap or other limitation. This option should continue to vary the electric proportion of PHEVs' expected usage based on the all-electric range of the relevant vehicle model.

C. Extend and Reform Advanced Vehicle Technology Credits

In addition, provided EPA maintains the top-line GHG targets, the agency should extend and reform the credit multipliers available for EVs, PHEVs, and FCVs available under the existing GHG regulations for MY 2017-2021.

Under the current regulations, each EV/PHEV/FCV sold in MY 2017-2021 is counted as more than one vehicle for purposes of determining credits for compliance with the GHG standards. EPA adopted the following multipliers, set forth at 40 C.F.R. § 86.1866–12:

[See original comment for vehicle types table]

EPA justified this approach as necessary to promote commercialization of these advanced technologies and emphasized that advanced technologies would be necessary to meet future GHG standards as stringency increased.

NCAT supports extension of the credit multipliers at 2021 levels, or possibly higher, through MY 2025. Some portion of the additional credits could be subject to eligibility criteria such as those discussed below, the agencies should consider delayed phase down of the credits during the MY 2022-2025 period, and appropriate multiplier levels should be determined based on further analysis of the impacts of any eligibility criteria and phase down. If appropriately designed, extension and enhancement of the credit multipliers would reward manufacturers who invest in zero emissions technologies now, thus both ensuring lower emissions in future model years (by accelerating the introduction of advanced technologies at scale) and lowering manufacturer compliance burdens.

1. Enhanced Credit for Vehicles Beyond State ZEV Compliance

Manufacturers should receive enhanced credit to the extent their sales of qualifying vehicles exceed ZEV program requirements in California and other Section 177 states. These ZEV programs require manufacturers to submit credits demonstrating achievement of a certain level of sales of qualifying vehicles in the ZEV states. For purposes of the federal GHG program, EPA should provide enhanced credit for EV, PHEV and FCV sales that go above and beyond what is already required for compliance with the California and other states' ZEV mandates. This would have the effect of making the federal program incentive “additional” to that provided by the state program—providing greater and more targeted support for advanced technology deployment, both in the ZEV states and beyond them.

2. Enhanced Crediting Based on All-Electric Range

In addition, EPA should provide larger credits for EVs, PHEVs, and FCVs that demonstrate longer all-electric range and/or greater energy efficiency based on EPA range per kWh or BTU. This approach incentivizes more rapid nationwide deployment of longer-range zero and near-zero emission vehicles, and would provide support for a broader market transition to such vehicles.

3. Enhanced Crediting for High-Mileage, Clean On-Demand and Fleet Vehicles

In addition, upon manufacturer election for qualifying vehicle fleets, EPA could provide enhanced credit multipliers for EV, PHEV and FCV sales of demonstrated high-mileage vehicles used in ride-hailing, ride-sharing or other “on-demand” transportation applications, and/or for use in government or corporate fleets. Such vehicles are likely to displace use of other vehicles at the margins; to the extent they use zero-emission advanced technologies, they would achieve disproportionate reduction in system-wide emissions. In addition, incentivizing use of advanced technology vehicles for fleets, ride-sharing and on-demand transportation could provide a bridge for broader commercial deployment of such technologies. Implementation of enhanced credits for such vehicles would, of course, require a rigorous system of verification and enforcement.

D. Off-Cycle Credits

Several manufacturers have expressed concern with challenges and transaction costs associated with the existing processes for issuing off-cycle credits. In the NPRM, EPA requests comment on a number of potential reforms. NCAT is supportive of appropriate reforms if adopted as part of the overall Advanced Technologies Compliance Flexibility approached proposed here, including maintaining the top-line GHG targets, and if they are adopted and implemented in a manner that does not compromise the GHG benefits of the program.

If those conditions can be met, the agencies should adopt a streamlined process for adding new technologies to the menu of pre-approved technologies for off-cycle credits, such as EPA’s proposal in the NPRM to add technologies to the menu without having to go through notice and comment based on one or more manufacturer applications to approve a technology. In addition, the manufacturer testing processes required to demonstrate greater credit than available from the pre-approved list should be reviewed to shorten the time, effort and cost required to establish defensible credits. The program should maintain the principle that the amount of credit available should reflect the degree of certainty provided by the available data. In addition, increases to the cap on off-cycle credit, such as those proposed by EPA, may be appropriate.

Further, consistent with such program enhancements, the agencies should improve the transparency and integrity of this mechanism. Such changes could include providing transparent reporting of off-cycle credits approved by vehicle make and model; providing further clarification of principles and data requirements governing EPA’s evaluation of off-cycle credit petitions; and establishing transparent mechanisms for ex-post evaluation of emissions and fuel economy benefits of off-cycle credits, and mechanisms to correct any over- or underestimation of credits, to help ensure the long-term integrity of this mechanism and the overall program (i.e., to ensure that the emission reduction and fuel efficiency benefits that are the basis for off-cycle credits are real and verifiable).

E. Air Conditioning Refrigerant Leakage Credits

The agencies have proposed to discontinue credits for reduced air conditioning refrigerants leakage under the existing regulations and to reduce the stringency of the standards accordingly. NCAT supports extending the existing credits within the context of the overall Advanced Technologies Compliance Flexibility Option.

F. Consistent and Equally Rigorous CAFE Standards

Several of the compliance flexibility mechanisms discussed above are primarily relevant to EPA's GHG standards. The potential changes to the off-cycle credit mechanism are applicable to both programs. Attribution of emissions to EVs, PHEVs, and FCVs applies only to the GHG standards. With regard to credit multipliers, NHTSA has previously taken the position that it lacks authority to apply multipliers for EVs or other advanced technologies because EPCA separately specifies how such vehicles are to be counted for purposes of fuel economy. One approach to address this issue would be to calibrate CAFE targets for MY 2022-2025 to be equally stringent overall, such that they are achievable by the same manufacturer fleets that could meet the GHG standards under the Advanced Technologies Compliance Flexibilities Option described above. A further alternative would be to differentiate the CAFE and EPA GHG standards such that the GHG standards provide the greater stringency while offering the additional flexibility noted here.

Response

As discussed in Section V of the preamble to the final rule, the agencies carefully considered this comment and determined that the current suite of "flexibilities" generally provide ample incentive for more rapid development and application of advanced technologies and technologies that produce fuel savings and/or CO_2 reductions that would otherwise not count toward compliance. The agencies share some stakeholders' concern that expanding flexibilities could increase the risk of "gaming" that would make compliance less transparent and would unduly compromise energy and environmental benefits. Nevertheless, as discussed in Section IX of the preamble to the final rule, EPA is finalizing some changes to procedures for evaluating applications for off-cycle credits and expects these changes to make this process more rigorous (i.e., less susceptible to potential "gaming") and more efficient. Also, recognizing that while manufacturers have introduced many battery-electric vehicle offerings for the United States, market demand and adoption has thus far been lackluster, EPA is issuing regulations that delay the inclusion of emissions from electricity generation until MY 2027. As discussed below, even with this change, and even accounting for continued increases in fuel prices and reductions in battery prices, battery-electric vehicles are likely to continue to account for less than 5 percent of new light vehicle sales in the United States through MY 2026. This means that although the 0 g/mi treatment of electricity causes EPA's program to over-represent the ultimate environmental performance of its CO_2 standards, this aspect of such over-representation is likely to remain small.

Comment

Docket Number: NHTSA-2017-0069-0544
Commenter: David Bella

This EIS claims that raising the mileage requirements for cars (and light trucks) would make little difference. But, a mileage requirement may not address a more fundamental problem where positive leadership could be made to make much needed differences. This problem involves the continuing expansion of car-dependent infrastructure so that people become dependent upon their cars to go nearly everywhere in their day to day lives.

OBSERVATIONS

The EIS presents evidence that: (1) transportation is a significant contributor to CO_2 emissions and (2) continuing CO_2 emissions increase the risks of serious and potentially disastrous climate change, but, (3) lower emissions for vehicles will make such an insignificant difference that they can be set aside.

As CO_2 emissions continue, the probabilities of sudden, unforeseen, irreversible, and catastrophic possibilities increase.

Large sums of money (1) are now needed for deferred maintenance, (2) will be needed for future maintenance, and (3) are continuing to be spent on the construction of car-dependent infrastructure.

This infrastructure has and will continue to **lock in** future carbon emissions.

Car-dependent infrastructure continues to expand, setting bad (higher **locked in** CO_2 emissions) examples for other parts of the world.

COMMENTS AND QUESTIONS

By showing that lower mileage requirements would only produce very small differences in climate change impacts, the EIS makes a strong case that alternatives to expanding car-dependent infrastructure should be taken very seriously.

Such alternatives would set good (lower **locked in** CO_2 emissions) examples for other parts of the world.

This EIS has not considered or even mentioned real alternatives to the continuing expansion of car-dependent infrastructure. WHY?

When considering such alternatives, it is essential to address a fundamental concept: **lock in**.

Response

NHTSA recognizes that other policy options, such as alternative transportation infrastructure, could mitigate the impacts of climate change. NHTSA discusses some of these options in Chapter 9, *Mitigation*. Ultimately, however, these options are beyond the scope of this rulemaking and NHTSA's analysis.

10.2.2.4 Comparison of Alternatives

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

In connection with a major action affecting the quality of the human environment such as this one, NHTSA is required to prepare a "detailed statement" discussing and disclosing the environmental impacts of that action. 42 U.S.C. § 4332(2)(C).

To perform this task, NHTSA must "take a 'hard look' at the environmental consequences of its actions, including alternatives to its proposed course." *Sierra Club v. FERC*, 867 F.3d 1357, 1367 (D.C. Cir. 2017) (quoting *Balt. Gas & Elec. Co. v. Nat. Res. Def. Council*, 462 U.S. 87, 97 (1983)); *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989). When undertaking its analysis, NHTSA must also "insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements." 40 C.F.R. § 1502.24.

Here, NHTSA not only fails to take the requisite "hard look" at the effects of its proposed action and its action alternatives, but frequently mischaracterizes very large increases in fuel combusted and greenhouse gases emitted as decreases by deploying a false comparison. While it does sometimes measure its action alternatives against the No Action Alternative, it also compares them to what it calls "current levels" of fuel efficiency and emissions. For example, NHTSA claims that "[u]nder the alternatives analyzed in this EIS, fuel economy is expected to *improve* compared to current levels under each alternative."[32] Plainly, however, all alternatives NHTSA proposes do the opposite when correctly compared to the No Action Alternative. Moreover, "current levels" are undefined; even if they were intended to mean MY2021 levels (the last year before the augural standards), NHTSA's assertion is erroneous as to its Preferred Alternative, which would freeze the standards as of MY2020, and as to the other alternatives (2 to 7) that would reduce efficiency for MY2021 vehicles below the existing standard. In addition, as discussed below, NHTSA has strayed far from ensuring the professional or scientific integrity of the data upon which it relies, and the manner in which it presents them, by devising erroneous assumptions of "scrappage" and the rebound effect, among others, that make gallons of fuel consumed and millions of tons of pollution emitted vanish into thin air.

Response

The commenter correctly states that the EIS measures impacts under the action alternatives compared to the No Action Alternative. But in some cases, NHTSA compares future conditions to current conditions, and the agency is usually referring to the time around when the Final EIS was drafted. For example, as a result of anticipated reductions in criteria air pollutant emissions due to EPA standards,

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[32] DEIS, at 2-24 (emphasis added). Additional examples are at 4-47 ("Under any alternative, total emissions from passenger cars and light trucks are expected to decrease over time compared to existing conditions."); at 4-47 ("[U]nder any alternative the total health effects of emissions from passenger cars and light trucks are expected to decrease over time compared to existing conditions."); and at 5-28 ("[A]ll of the action alternatives would result, to a greater or lesser extent depending on the alternative, in reductions in GHG emissions on a per-vehicle basis compared with current conditions.").

many air pollutant emissions in 2025 are expected to be lower than air pollutant emissions in 2020 regardless of the alternative selected. NHTSA believes that sort of context is important for the decision-maker and the public, and it is reasonable to include that context in the EIS.

10.2.3 Analysis Methods

Comment

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The 2016 Draft Technical Assessment Report showed that the augural standards were achievable and at lower cost than previously predicted. Before rejecting this conclusion and the possibility of more stringent standards, NHTSA must conduct a thorough and transparent review of the data. Such a study should be reflected in the DEIS.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NEPA requires that environmental review documents contain "high quality" information and "[a]ccurate scientific analysis" sufficient to "help public officials make decisions that are based on understanding environmental consequences." 40 C.F.R. §§ 1500.1(b), (c). To fulfill this requirement, agencies have a duty to "insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements." 40 C.F.R. § 1502.24. NHTSA's analysis misses this mark in numerous ways.

First, as discussed above, NHTSA's analysis of its preferred action and other alternatives is deeply distorted because of the flaws in, among other things, its scrappage model, its pricing assumptions, the way it factors an unsupported value of 20 percent for the rebound effect into its calculations, the phantom fatalities it ascribes to the No Action alternative, and the other ways described here and in Joint Commenters' comments on the NPRM. These errors are caused by the use of data that lacks scientific or professional integrity and render NHTSA's Proposal untenable.

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

The proposed rules are unlawful and should not be finalized.

The National Highway Traffic Safety Administration (NHTSA) has a legal duty to set maximum feasible fuel economy standards for new motor vehicles. NHTSA previously determined that it was feasible for vehicle manufacturers to meet steadily-increasing average fuel economy standards. The Environmental Protection Agency (EPA) has a legal duty to set emission standards that mitigate dangerous air pollution from new motor vehicles. EPA previously determined that steadily-improving greenhouse gas emission standards were feasible and necessary to protect the public health and welfare. A vast amount of evidence supported those reasoned determinations.

The proposed SAFE Vehicles Rule, 83 Fed. Reg. 42986 ("NPRM"), radically departs from the agencies' prior determinations. Directly contrary to its prior analysis, NHTSA now asserts that it is not feasible for manufacturers to make *any* improvement in average fuel economy for any of six future model years (MY2021-MY2026). EPA now asserts that full consideration of the public health and welfare warrants rolling back emission standards for each of those years.

The agencies suggest this about-face is compelled by "new information" and "new analysis." NPRM at 42990. Relevant, high-quality new data should inform rulemaking. But an agency's ultimate duty is to base decisions on the best information available. The agencies fail to do so. The agencies' technical analysis is also not "new" in the sense of being "updated," but is rather "novel and untested." As explained below, this novel technical analysis is fundamentally flawed and its results conflict with the best available evidence. Because the agencies explicitly base the proposed rule on this flawed analysis, the rule is arbitrary. The agencies also fail to provide a plausible reasoned justification for reversing their own prior determinations.

Perhaps cognizant of the overwhelming evidentiary basis supporting the augural and existing standards, the agencies market the rollback as necessary to save lives: They brand it the "SAFE" rule and assert that it will prevent thousands of fatalities. This is nonsense. The projected fatalities are artifacts of the agencies' flawed technical analysis. The current standards do not make real-world vehicles less safe or real-world driving more dangerous.

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

NEPA requires that an agency's environmental impact statement contain "high quality" information and "[a]ccurate scientific analysis" sufficient to "help public officials make decisions that are based on understanding environmental consequences." 40 C.F.R. § 1500.1(b), (c). To fulfill this requirement, the agency has a duty to "insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements." 40 C.F.R. § 1502.24. NHTSA failed to meet this standard in the DEIS, in part due to its failure to properly consider the preexisting administrative record or new studies and data showing the eminent feasibility of ambitious standards—all of which are crucial to informing an accurate analysis of the maximum feasible fuel economy standards.

i. NHTSA Disregarded the Existing Record

NHTSA's starting point for its DEIS and rule development should have been the extensive record that has been developed over the last six years, including its own feasibility analysis included in the MY2017-2025 final rule. This includes, but is not limited to, NHTSA's final rule analysis of its "augural" fuel economy standards, the Draft Technical Assessment Report (TAR) jointly prepared by EPA, NHTSA, and CARB (issued July 2016), EPA's Proposed Determination (issued November 2016), EPA's original Final Determination (issued January 2017) and CARB's Advanced Clean Cars Midterm Review (issued January 18, 2017). The Agencies solicited and received hundreds of thousands of public comments on the TAR, the Proposed Determination, and CARB's Midterm Review. NHTSA, EPA and CARB held hundreds of meetings, and received numerous independent studies and analyses confirming the feasibility and appropriateness of the MY 2022-2025 fuel economy and GHG standards. This body of work comprises the most extensive record ever developed to support EPA's light-duty greenhouse gas emission and NHTSA's CAFE standard setting efforts. NHTSA should have fully considered this existing record in its DEIS.

The Draft TAR, which was prepared jointly by NHTSA, EPA, and CARB, examined a wide range of factors, including technology advancements, the penetration of more fuel-efficient technologies in the marketplace, consumer acceptance of these technologies, trends in fuel prices and the vehicle fleet, employment impacts, and others. Even though EPA and NHTSA performed independent analyses in the Draft TAR, both agencies reached the same conclusions:

- "A wider range of technologies exist for manufacturers to use to meet the MY2022- 2025 standards, and at costs that are similar or lower, than those projected in the 2012 rule";
- "Advanced gasoline vehicle technologies will continue to be the predominant technologies, with modest levels of strong hybridization and very low levels of full electrification (plug-in vehicles) needed to meet the standards."

Based on NHTSA and EPA's analyses, there is no question that the auto industry is bringing new technologies to the market at a quicker pace and at lower cost than the agencies projected in the 2012 rulemaking for MY2017-2025: "manufacturers are adopting fuel economy technologies at unprecedented rates. Car makers and suppliers have developed far more innovative technologies to improve fuel economy and reduce GHG emissions than anticipated just a few years ago." This occurred while the industry has experienced an unprecedented period of growth – 2016 marked the seventh year in a row that car sales in the US set an all-time sales record.

Both analyses indicate that the costs for complying with the existing MY2022-2025 standards are lower than the agencies' estimates in the 2012 rulemaking. EPA's primary analysis shows MY2025 compliance costs (incremental to MY2021) significantly lower than those projected in the final rule ($252 lower for cars and $197 lower for trucks). NHTSA's analysis shows similar downward trends in compliance costs.

The agencies also concluded in the TAR that the cost, effectiveness, and feasibility of the individual technologies needed to comply with the future standards are "generally consistent" with those projected in the 2012 final rulemaking. The agencies did, however, find that several new technologies and developments in the TAR were neither foreseen nor included in the analysis supporting the 2012 rulemaking for MY2017-2025. Examples of these technologies include the application of direct injection Atkinson Cycle engines to non-hybrids, greater penetration of continuously variable transmissions (CVT), and greater use of diesel engines. The agencies concluded that these additional technologies contribute to lower cost compliance pathways.

Not only are manufacturers adding innovative fuel economy technologies at unprecedented rates, but these improvements have come while other metrics of vehicle performance have continued to improve, including acceleration times and durability. At the end of 2016, there were already over 100 car, SUV, and pickup versions on the market that already meet 2020 or later standards. The 2016 analysis found that new technologies were already being utilized that allowed a number of individual vehicle models to meet standards all the way out to 2025—an extraordinary nine model years in advance. In EPA's 2016 Fuel Economy Trends Report, it estimated that "17% of projected MY2016 vehicle production already meets or exceeds the MY2020 CO_2 emissions targets."

On January 12, 2017, former EPA Administrator Gina McCarthy signed her determination to maintain the current GHG emissions standards for MY2022-2025 vehicles. This Final Determination found that automakers are well positioned to meet the standards at lower costs than previously estimated. And the Administrator chose to "retain the current standards to provide regulatory certainty for the auto industry despite a technical record that suggests the standards could be made more stringent." EPA's Final Determination provided further robust demonstration that the existing standards are achievable and indeed, that more stringent MY2022-2025 standards are feasible and should be considered.

Over the last year and a half, EPA moved in a different direction, as Administrator Scott Pruitt announced the agency's intent to reconsider the 2017 Final Determination and took public comment. In April 2018, Administrator Pruitt withdrew the original determination and issued a Revised Final Determination, concluding that the existing standards are "not appropriate" and must be revised. This determination cannot contribute to NHTSA's DEIS analysis, because EPA did not develop a technical record to support its decision, and did not provide an adequate justification for the reversal from its prior positions. EDF and a group of allied organizations have petitioned for review of the unsupported and unlawful Revised Final Determination in the U.S. Circuit Court of Appeals for the D.C. Circuit, and that action is ongoing. In light of the procedural and substantive deficiencies with EPA's effort to revise the Final Determination, this determination does not provide NHTSA with any meaningful record information or analysis to consider in its DEIS analysis.

We maintain that the extensive record summarized above conflicts with the DEIS's preferred alternative to relax the augural standards established in the 2012 final rule. The existing record fundamentally defines the starting point for NHTSA's 2012 draft EIS and standard-setting effort and underscores that any weakening of the CAFE standards relative to the augural standards would be arbitrary and capricious and unsupported by the existing record and that, if anything, the standards should be strengthened. The DEIS is flawed because it fails to take into account the strength of this record in evaluating and selecting its alternative scenarios.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

When preparing an EIS, federal agencies are required to use high-quality information and accurate scientific analysis, and to ensure the professional and scientific integrity of the discussions and analyses therein. 40 C.F.R. §§ 1500.1(b), 1502.24; see also *Custer Cty. Action Ass'n v. Garvey*, 256 F.3d 1024, 1034 (10th Cir. 2001) (NEPA requires agencies to use "the best available scientific information."). Here, NHTSA's modeling decisions lie at the core of the DEIS:

> Using NHTSA-selected inputs, the agency projects a set of technologies each manufacturer could apply to each of its vehicle models to comply with various levels of CAFE standards to be examined for each fleet, for each model year. The model then estimates the costs associated with this additional technology utilization and accompanying changes in travel demand, fuel consumption, fuel outlays, emissions, an economic externalities related to petroleum consumption and other factors.

The economic assumptions embedded in the CAFE model "play a significant role in determining the impacts on fuel consumption, changes in emissions of criteria and toxic air pollutants and GHGs, and resulting economic costs and benefits of alternative standards." However, NHTSA's dramatically revised CAFE model is a radical departure from past analyses and modeling of the light-duty vehicle sector. Further, the assumptions and other model inputs on which NHTSA relies, introduce profound errors into the analyses and conclusions regarding safety, vehicle sales and costs, and profoundly distort the environmental impacts of the Proposed Rollback.

Response

As discussed in Section VIII of the preamble to the final rule, every analysis of CAFE and CO_2 standards relies on hundreds of assumptions, and estimates of costs and benefits developed as part of those analyses, by their very nature, depend on those assumptions. The NPRM and final rule analyses were entirely *de novo*, reflecting the best and most up-to-date information available to the agencies. Some of the best and most up-to-date information included some inputs and assumptions used in the 2016 Draft TAR (such as some technology cost estimates, as discussed in Section VI.C of the preamble to the final rule), and the agencies discuss in the preamble where those assumptions were carried through. On the other hand, the final rule identified a number of critical assumptions in earlier analyses that were problematic (for example, the projected fuel prices in that analysis inflated the value of fuel savings relative to what has actually occurred). Both the NPRM and preamble to the final rule engaged extensively with the record and examined these inputs and assumptions in detail, providing a thorough and transparent review of the data before the agencies in prior analyses and the data before the agencies today.

As described in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, NHTSA relies on the CAFE model for its estimates of the various environmental impacts reported in this EIS. Chapter 2 frequently cross-references the preamble to the final rule, thereby incorporating by reference the extensive discussions regarding the agency's assumptions and its engagement with the record. NHTSA does not believe it is necessary to repeat this discussion in the EIS, as it would be unnecessarily duplicative of another federal record prepared by the agency and available to the decision-maker and the public.

10.3 Energy

Comment

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

The DEIS fails to fully and accurately address the impacts of increased oil consumption. If fully implemented, the standards NHTSA set in 2012, including the augural standards through MY2025, would save 12 billion barrels of oil. NHTSA's preferred option will increase oil consumption by as much as 500,000 barrels of oil per day (as noted in the CBD joint comments NHTSA's model could be vastly undercounting the increases in oil consumption). NHTSA's decision to select this option, or any of the weaker standards analyzed in the DEIS are in direct conflict with the congressional mandate in EPCA and reasserted in EISA that NHTSA's standards address the need of the U.S. to conserve oil.

NHTSA's DEIS does not adequately consider the full impacts of increased need for oil drilling, including fracking, and the greenhouse gas and other pollutants emitted as a result of increased oil drilling, refining, and transport of fuels. In fact, as noted above, EPA and now BLM rollbacks of standards to reduce methane emissions from the oil and gas industry will both increase emissions associated with greater demand for oil. They must be fully and clearly accounted for in the DEIS.

The DEIS fails to address the threat to public lands and wildlife from increased need to drill for oil and of increased climate change. As NHTSA turns congressional intent on conserving oil on its head, it must account for the consequences of driving up pressure to lease public lands and waters for oil (and gas drilling) and the resulting impacts on land, water and air quality as well as wildlife. NHTSA references that it is incorporating conclusions reached on these issues from its FEIS for the 2017-2025 standards, but this is inappropriate given that those standards reduced oil consumption while NHTSA's current preferred option and other scenarios (expect for the No Action option) drive up oil consumption.

NHTSA says that the increase in demand for oil is small and happens over a long period of time– but 500,000 million barrels of oil per day is significant and can have very real impacts in terms of increased demand for drilling. Given these failures, NHTSA should withdraw the DEIS.

The above analysis and concerns are made based upon the information provided in the DEIS. As noted in our joint DEIS comments (filed with the CBD) the models and analysis NHTSA employs to assess freezing standards have many flaws which fatally taint the environmental impact analysis including the climate, oil consumption, and air quality impacts.

Response

In this Final EIS, NHTSA presents a reasonable range of alternatives that would meet the purpose and need of the action. As presented in Chapter 3, *Energy*, each of the alternatives would result in improved fleetwide fuel economy over time, consistent with the congressional mandate in the EPCA and EISA. NHTSA addresses its choice among alternatives in the preamble to the final rule.

NHTSA incorporates upstream air quality and greenhouse gas emissions as part of its analysis in Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*. Actions undertaken by the U.S. Environmental Protection Agency and the U.S. Department of the Interior Bureau of Land Management are independent, and impacts associated with those activities are addressed as part of the analyses conducted by those agencies. However, NHTSA provides a qualitative discussion of the cumulative impacts associated with those activities in Chapter 8, *Cumulative Impacts*.

NHTSA conducted a review of the research literature on related life cycle analyses (Chapter 6, *Life-Cycle Assessments of Vehicle Energy, Material, and Technology Impacts*) and discusses potential land-use impacts in Chapter 7, *Other Impacts*. To the degree to which NHTSA has incorporated by reference its discussions from its MY 2017–2025 Final EIS, the agency is referring to general qualitative discussions of potential impacts associated with changes in fuel economy standards, rather than particular impacts associated with an alternative. Incorporation by reference of this matter is appropriate, as the agency cannot quantify differences among alternatives as it pertains to those impacts.

10.4 Air Quality

Comment

Docket Number: NHTSA-2017-0069-0497
Organization: South Coast Air Quality Management District
Commenter: Barbara Baird et al.

NHTSA also fails to look realistically at the adverse environmental impacts of keeping the waiver in place. For example, NHTSA attributes adverse criteria pollutant impacts to increased generation of electricity for electric vehicles. But it assumes a nationwide electricity grid, heavily impacted by coal-fired power plants. If the electric vehicles were primarily utilized in California, as if the waiver were preserved, a California-specific electricity grid should be used. According to the California Energy Commission, of the electric power consumed in California in 2017 (not just that produced in California), only 4% is coal-fired, with natural gas accounting for 34%, renewables 29%, hydro 15%, and nuclear 9%. This mix of power sources would have far different criteria pollutant and GHG impacts than the electricity grid used in the Draft EIS. And as discussed immediately below, the Draft EIS fails to examine the air quality benefits of keeping the California waiver in place. The evidence we present below belies NHTSA's conclusion that the environmental effects of all reasonable alternatives, including preserving the California waiver, are captured by the analysis of existing alternatives. At minimum, it casts sufficient doubt on NHTSA's conclusion to require a separate analysis of an alternative that would preserve the waiver.

*   *   *   *   *

Nor does the Draft EIS adequately consider the air quality benefits of the current rules it proposes to revoke, or the California waiver. As a result the air quality analysis is not realistic or complete. The analysis fails to adequately analyze the potential <u>adverse</u> air quality impacts of selecting the NHTSA preferred alternative. The 2016 South Coast Air Quality Management Plan (AQMP) contains attainment demonstrations for both the 2023 deadline 80 ppb standard and the 2031 deadline 75 ppb standard. Light duty vehicles will still be the fourth-largest source of NO_X emissions in the South Coast Air Basin in 2023, our attainment date for the 80 ppb ozone standard. The 2016 AQMP relies on emission reductions from the existing Advanced Clean Cars program, which NHTSA and EPA seemingly propose to dismember, as well as the California Air Resources Board's (CARB) future rulemakings for even more advanced clean light duty technology.[33] In the South Coast Air Basin, attaining the future ozone standards depends on very large reductions of NO_X to meet the ozone standards.[34]

The following is an estimate of the emission reduction benefits from the Advanced Clean Cars program in the South Coast Air Basin. It is important to understand these benefits in order to evaluate the adverse impacts of the alternatives analyzed, especially the NHTSA preferred alternative. In proposing the existing Advanced Clean Cars program, CARB estimated that it would provide statewide emission reductions of NO_X in 2023 of 14.7 tons per day, in 2025 of 21.3 tons per day, and in 2035 of 48.9 tons per day. The South Coast Air Basin should see about 40% of that benefit, since the Basin has about 40% of California's population.[35] This amounts to nearly six tons per day in 2023 (5.88) and possibly up to 16 tons per day in 2031 (using linear interpolation and the same 40% share of total reductions). The NPRM states that it is withdrawing the waiver for the Advanced Clean Cars program. This statement is unclear as to whether it includes withdrawing the waiver to the extent it applies to criteria pollutants as well as GHGs. If it includes withdrawing the waiver for criteria pollutant requirements, the Draft EIS must consider the adverse impacts of losing these substantial and critical NO_X reductions.

The Draft EIS admits that NHTSA's preferred alternative results in just under 1 ton per day of NO_X emissions increases in the South Coast Air Basin, compared to the existing rule, in 2025. Even this

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[33] CARB predicts a need to obtain at least 7 tons per day of NOx from the 2023 baseline from light duty vehicles beyond the reductions expected from Advanced Clean Cars 2. 2016 AQMP p. 4-35, Table 4-5.

[34] CARB predicts a need for 90 tons per day of NOx emission reductions from mobile sources by 2023. Id.

[35] 16 million is about 40% of California's population in 2018, which is 39.78 million. Worldpopulationreview.com/states/california-population/.

increase cannot be tolerated in the SCAQMD where mobile sources must reduce NO_X emissions by 90 tpd in 2023. Moreover, the Draft EIS fails to explain why the 2025 increase is less than 1 ton per day, while the loss of the Advanced Clean Cars program could be nearly 6 tons per day, as described above.

NHTSA explains that reducing fuel economy standards will increase emissions a relatively small amount because of two phenomena. First, NHTSA concludes that the “rebound effect” will be 20%, which is twice the assumption of 10% used in the analysis for the original rule. The “rebound effect” is an increase in vehicle miles traveled resulting from consumers driving more in response to lower fuel costs due to their newer cars having higher fuel efficiency. We question the 20% function as it seems to assume that miles driven will continue to increase, regardless of need, just because gasoline is cheaper.

At the same time, NHTSA explains the projected increase in certain criteria pollutants under the no action alternative (keeping the existing and augural rules) by making the exact opposite assumption: NHTSA assumes that vehicles meeting the existing and augural standards will be more expensive than today’s vehicles, so people will continue to drive older vehicles for much longer. And since the older vehicles have higher emissions, at least some criteria pollutants will increase if standards become more stringent. But this assumption negates the “rebound effect”: if people do not buy the newer cars because they are more expensive, they will not get the improved fuel economy that will cause more driving and higher emissions. We find it very convenient that NHTSA managed to predict the exact mix of these two phenomena that would purportedly result in some future criteria pollutant emissions actually being reduced on a nationwide basis, by NHTSA’s preferred alternative, rather than worsened by the rollback of existing standards.

NHTSA and EPA’s embracing of two contradictory theories mirrors the agencies’ approach to vehicle safety. On the one hand the proposal assumes that vehicles meeting improved fuel efficiency standards will be newer and safer than older vehicles. But NHTSA posits that because these vehicles will also be more expensive, people will not buy them, and will continue to drive older less-safe cars. At the same time, the proposal assumes that vehicles meeting the improved fuel efficiency standards will be lighter than older ones, and thus less safe. But this theory contradicts the previous one both in (1) whether vehicles meeting improved fuel efficiency standards are more or less safe than vehicles that do not meet them, and (2) in whether or not people will buy the new vehicles that meet improved fuel standards. (If people will not buy cars meeting the fuel economy standards, as the first theory presumes, they will not be driving lighter less-safe cars, as the second theory presumes.) Remarkably, the proposal assumes just the “right” combination of these two factors to “prove” that implementing improved fuel economy and emission standards will result in less-safe vehicles.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

Preemption of California's ZEV mandate is an integral part of this proposal. This aspect of the proposed action receives no consideration beyond a statement that tailpipe criteria pollutant emissions will not be affected because (presumably) California's LEV 3 tailpipe standards would remain unchanged. NHTSA and EPA must consider and discuss the local impacts that preempting the ZEV mandate would have on localities where ZEV sales are currently concentrated, and localities where they will likely concentrate as the program matures. Specifically, these include the major metropolitan areas of California, and the other States that have adopted the ZEV mandate pursuant to section 177 of the Act. In these areas, it can reasonably be foreseen that under the agencies' proposal some amount of VMT that would have been electrified will instead be fueled by internal combustion engines. This will lead to increases in criteria pollutant and toxics emissions in these major metropolitan areas, even if statewide criteria pollutant emissions levels are unchanged.

NHTSA also assumes that plug-in electric vehicles (PEVs) are charged using a national average electricity generating fuel mix. This is certainly not the case today. The electrical grid in states with high concentrations of PEVs is cleaner than the national average, and this disparity will only grow in future years. The use of an outdated average overestimates the upstream emissions from PEVs under the baseline no action alternative.

Response

As NHTSA's action is to set nationwide fuel economy standards, this EIS provides results on a national average basis, which is a reasonable analytical approach for such a nationwide rulemaking. Conducting impact analyses for all possible combinations of energy sources (e.g., grid mixes) and vehicle fuel use (e.g., EV share of vehicle miles traveled [VMT]) on a state-by-state basis is not feasible. In addition, because of the primarily local nature of air pollution impacts, it is not clear that a statewide analysis would be more reliable for purposes of this rulemaking. Still, NHTSA does consider localized impacts in this EIS that reflect the various grid mixes across the United States. Chapter 6, *Lifecycle Assessment of Vehicle Energy, Material, and Technology Impacts*, discusses how emissions from the electricity grid vary with different grid mixes and how emissions decrease with cleaner grid mixes. Appendix A, *Air Quality Nonattainment Area Results*, provides estimates of potential air quality impacts in various nonattainment areas for each of the criteria air pollutants analyzed in the EIS. Finally, Appendix E, *Air Quality Modeling and Health Impacts Assessment*, presents the results of NHTSA's photochemical analysis. Specifically, the appendix summarizes the application of air quality modeling tools using a 36-kilometer grid to assess the impacts on air quality and the related health effects of the alternatives.

Regarding California's waiver, the issues of Clean Air Act waivers of preemption under Section 209 and the EPCA/EISA preemption under 49 U.S.C. § 32919 are not addressed in this Final EIS, as they were the subject of a separate final action and rulemaking by EPA and NHTSA in September 2019. The joint action is available at 84 FR 51310, and comments on these issues have been addressed and responded to in that action and rulemaking process. In that action, EPA withdrew aspects of a Clean Air Act Preemption waiver previously granted to California, and NHTSA concluded that EPCA expressly and impliedly preempted state laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy. Therefore, NHTSA concludes it is not appropriate to consider alternatives keeping California's waiver in place.

NHTSA has not undertaken an analysis of and comparison with the CARB estimate of statewide nitrogen oxides (NO_X) reductions resulting from its Advanced Clean Cars program. However, it is reasonable to assume that methodological differences in the respective analyses of the programs make it inappropriate to compare the results from supporting documentation.

NHTSA addresses issues such as the rebound effect, scrappage, and safety in its discussion of modeling assumptions in Section VI of the preamble to the final rule and the FRIA.

Comment

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

Docket Number: NHTSA-2017-0069-0616
Organization: National Tribal Air Association
Commenter: Wilfred J. Nabahe

Docket Number: NHTSA-2017-0069-0595
Organization: 1854 Treaty Authority
Commenter: Tyler Kaspar

Cars and trucks are among the largest sources of GHG and air pollutant emissions in our nation, emitting approximately 1,556 million metric tons in 2016. Light-Duty Vehicles emit 60% of GHG emissions in the U.S. transportation sector, according to EPA data. The GHGs from transportation sources include CO_2, CH_4, and N_2O. Additionally, light-duty vehicles emit toxic air pollutants such as volatile organic compounds and certain common air pollutants referred to as “criteria pollutants” under the Clean Air Act (CAA) which are regulated under the National Ambient Air Quality Standards. The criteria pollutants emitted by motor vehicles during fuel combustion include carbon monoxide (CO), nitrous dioxide (NO_2), particulate matter equal to or less than 2.5 microns (PM2.5), and sulfur dioxide (SO_2). A small amount of hydrofluorocarbons (HFCs) are also emitted due to leaks and end-of-life disposal from air conditioners. These pollutants contribute to environmental degradation through climate changes, acid deposition, ozone formation, reduced visibility, damaging sensitive ecosystems, and harming wildlife through habitat degradation.

The impact to human health from air pollution is outlined in NHTSA’s draft environmental impact statement: “Criteria pollutants have been shown to cause the following adverse health impacts at various concentrations and exposures: damage to lung tissue, reduced lung function, exacerbation of existing respiratory and cardiovascular diseases, difficulty breathing, irritation of the upper respiratory tract, bronchitis and pneumonia, reduced resistance to respiratory infections, alterations to the body’s defense systems against foreign materials, reduced delivery of oxygen to the body’s organs and tissues, impairment of the brain’s ability to function properly, cancer, and premature death.” This anticipated damage to the public health is corroborated by a 2013 study conducted at the Massachusetts Institute of Technology. Researchers there found that roughly 200,000 early deaths in the United States each year are attributable to combustion emissions.

[*Sac and Fox Nation/National Tribal Air Association:*] NHTSA predicts increases in criteria pollutant emissions from the SAFE Vehicles Rule, including increases under the Preferred Alternative from 1% for PM2.5 to 9% for SO_2. Thus, we expect greater adverse impacts to both human health and the environment from the agencies’ proposed relaxation of the 2012 standards. We call on the agencies to maintain the status quo and continue progress towards cleaning our air, sparing communities across the country from adverse impacts.

[*1854 Treaty Authority:*] NHTSA predicts increases in criteria pollutant emissions from the SAFE Vehicles Rule, including increases under the Preferred Alternative from 1% for PM2.5 to 9% for SO_2. The 1854 Treaty Authority is concerned this will lead to greater impacts to human health, the environment and treaty rights in the 1854 Ceded Territory from the agencies' proposed relaxation of the 2012 standards.

We recommend that the agencies maintain the 2012 standards and continue progress towards improving air quality by reducing combustion emissions of criteria pollutants.

Docket Number: NHTSA-2017-0069-0508
Commenter: Blanca Luevanos

Fossil fuel when burned is known to emit horrible toxins and global warming emissions. Even the waste products are hazardous to public health and the environment, more demand and use of fossil fuel will increase pollution of greenhouse emissions.

Response

NHTSA recognizes that criteria pollutants and GHGs contribute to human health effects, climate change, and effects on ecosystems, wildlife, and other resources. Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, discuss these effects and the impacts of the alternatives under consideration. The preamble to the final rule addresses NHTSA's consideration of these potential air quality impacts in its decision-making process.

Comment

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

Theoretically, NHTSA's claimed increase in driving due to higher fuel economy (and thus increases in emissions) should be offset by the fact that higher fuel-economy vehicles emit less criteria pollutants. NHTSA fails to explain why this is not the case and thus its analysis is arbitrary and capricious.

Response

The overall change in tailpipe emissions due to an increase in fuel economy is the net of two opposing effects: the increase in driving (the "rebound effect") and the decrease in emissions rates per VMT (from the use of fuel economy technologies). The overall change in upstream emissions due to an increase in fuel economy also is the net of two opposing effects: the increase in driving (VMT rebound increases fuel usage) and the decrease in fuel usage rates per VMT (due to greater fuel economy). Depending on the size of the VMT rebound, the effectiveness of fuel economy technologies in reducing emissions rates, and the required levels of fuel economy, if all else is equal, the combined effect on emissions can be either an increase or a decrease. Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and Chapter 4, *Air Quality*, of the Final EIS provide further discussion of these effects. In addition, NHTSA discusses this effect further in Section VII.A.4.c.1 of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

The proposal concludes that any impacts of the rule rollback and withdrawal of the California waiver on criteria pollutants would be "far too small to observe." 83 FR 43327. But these conclusions are contradicted by other information in the record. The Draft EIS presents conclusions about the increases and decreases in criteria pollutant emissions on page S-8. We assume these conclusions are based on the detailed data in Appendix A, although the tables in Appendix A do not present any national totals so it is not easy to verify this assumption. Appendix A presents a multitude of pages purporting to show the expected emission reduction benefits from each alternative for each criteria pollutant in each nonattainment area in the nation over the years 2025, 2035, and 2050. However, nowhere is an analysis presented of how these numbers are calculated. We therefore assume that they are based on the Preliminary Regulatory Impact Analysis (PRIA), including the outputs from the NHTSA CAFE Model. But NHTSA may not lawfully base any conclusions on the air pollutant emissions information in the Draft EIS, because it is contradicted by the evidence in the PRIA.

In the Draft EIS, p. S-8, the agency states that NO_X emissions decrease in 2025 and 2035 under the preferred alternative as compared to the “no action” alternative. But this statement is contradicted by the information in Table 1-73 (page 85) of the PRIA (cost-benefit analysis), which states that NO_X damage benefits from implementing the proposal (preferred alternative) become negative in 2024 and remain negative through the end of the analysis period in 2029.[36] “Negative” benefits, of course, means adverse impacts. Thus, NO_X emissions must be higher under the preferred alternative than under the no project alternative in 2025—or there would not be “NO_X damage reduction benefit” from the preferred alternative.[37]

These contradictory data make it impossible for the public to provide informed comment on the actual air quality impacts and impossible for NHTSA to rely on either the Draft EIS or the PRIA conclusions.

Response

The *Summary* summarizes the air quality analysis results presented in Chapter 4, *Air Quality*. Section 4.2, *Environmental Consequences*, presents the nationwide air quality results. Section 4.1.2.2, *Regional Analysis*, explains how the emissions changes in nonattainment areas were calculated. NHTSA conducted its analysis based on the outputs of the NHTSA CAFE model. However, NHTSA’s results for nonattainment areas in the EIS are not comparable to the information in its Regulatory Impact Analysis (RIA) for several reasons. First, the RIA reports only nationwide results and does not include an analysis of nonattainment areas. Second, the RIA presents aggregated results in terms of the lifetime of affected vehicles, rather than in terms of a particular analysis year (as done in the EIS). Third, as discussed in Section 2.3.2, *Constrained versus Unconstrained CAFE Model Analysis*, NHTSA prepares two analysis runs of the CAFE model: one for the preamble and RIA (“constrained”) and another for the EIS (”unconstrained”). NHTSA provides a fuller explanation for how to understand its presentation of environmental impacts in Section VII.A.4.c.1 of the preamble to the final rule.

[36] As indicated on page 14 of the PRA (updated 8/23/18, 10/16/2018): “…negative signs are used for changes in costs or benefits that decrease from those that would have resulted from the augural standards for MY 2022–2026 or the existing standard for MY 2021.”

[37] The proposal states at p. 43330 that it uses different values for “upstream” air pollution (refining and marketing) than for “downstream” pollution (tailpipe emissions) but does not assert or explain why this difference, whatever it may be, could cause these anomalous results.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

At a minimum, NHTSA's new assumptions are inconsistent with those contained in the Final EIS it prepared in 2012 for the MY 2017-2025 standards. In the 2012 Final EIS, NHTSA analyzed the criteria pollution effects of the MY 2022-2025 standards (including both upstream and downstream emissions), without a scrappage model, and found that emissions of some conventional and toxic air pollutants (CO and PM2.5) would increase under the augural standards due to higher VMT, while emissions from other pollutants (VOC, SO_2, and NO_X) would decrease due to more stringent regulation of EPA tailpipe emissions and reductions from fuel production. The 2012 EIS concluded that, even with these constraints, overall the augural standards would result in decreases of VOC, PM2.5, SO_2, and NO_X over time, primarily due to decreases in fuel production and distribution. This result is unsurprising, given the reductions in fuel consumption expected from the current standards.

On the other hand, NHTSA's DEIS, which *reverses* the fuel savings of the augural standards by freezing the MY 2020 standard, concludes that under the Preferred Alternative, emissions of some pollutants (CO and NO_X) actually decrease in 2025 and 2035 as compared to the much more fuel efficient No Action Alternative. The analysis also shows that VOCs decrease in 2025 even though the Proposal would entail no fuel economy improvements. With these notable exceptions, NHTSA admits that (except for CO emissions), all conventional and toxic air pollutants analyzed (NO_X, PM2.5, SO_2, and VOCs) would increase by 2050 under the Preferred Alternative. Specifically for the various action alternatives, NHTSA's air quality analysis identifies the following impacts below on criteria pollutants, including CO, NO_X, PM2.5, SO_2, and VOCs:

- For CO, NO_X (in 2025 and 2035), and VOCs (in 2025), emissions would generally decrease across action alternatives (compared to the No Action Alternative), with the largest decreases occurring under Alternative 1 and emissions decreases getting smaller from Alternatives 1 through Alternative 8. Exceptions to this trend are for CO in 2035 and 2050, which shows the smallest emissions decrease in Alternative 7, and for NO_X in 2035, which shows a small increase under Alternative 8.
- For NO_X (in 2050), PM2.5, SO_2, and VOCs (in 2035 and 2050), emissions would generally increase across action alternatives (compared to the No Action Alternative), with the largest increases occurring under Alternative 1 and emissions increases getting smaller from Alternative 1 through Alternative 7. Exceptions to this trend are for PM2.5 and SO_2 in 2025, which show the smallest emissions increase under Alternative 8.
- Emissions increases would be largest under Alternative 1 for all criteria pollutants (except CO). By 2050, these increases would range from less than 1 percent for PM2.5 to 9 percent for SO_2. Emissions of CO would decrease across all alternatives and analysis years; the decreases would be greatest under Alternative 1 and the maximum decrease would be 5 percent.
- Under Alternative 1, emissions of all criteria pollutants in 2050 would increase except for CO, compared to emissions under the No Action Alternative. By 2050, these increases would range from 2.1 percent for NO_X to 9.1 percent for SO_2. By 2050, CO emissions would decrease by 3.4 percent.

This is a logical implication of freezing the standards but, as we explain below, corrected modeling analysis shows that NHTSA greatly underestimates those increases.

NHTSA has also failed to consider the results of the updated air quality assessment performed for the Draft TAR, prepared jointly with EPA and California's Air Resources Board in 2016 as part of EPA's mid-term evaluation of the standards. In the TAR, EPA's OMEGA model assumed that downstream emissions are affected by the rebound effect (at a more reasonable and commonly accepted level, as explained above). Even with these constraints (which results in CO increases due to driving behavior), EPA's modeling also shows that the MY2022-2025 standards will decrease VOC, NO_X, PM2.5, and SO_X emissions over time.

In sum, NHTSA must analyze and present the environmental, health, and other relevant impacts of its action alternatives without the new, uncorroborated and inadequately explained modeling assumptions addressed here, and instead use the same assumptions it used in the 2012 DEIS and the 2016 TAR to enable the reader to meaningfully compare the current Proposal with the No Action Alternative. To do otherwise falls far short of the "hard look" NEPA requires and prevents an informed understanding by readers and decision makers.

Docket Number: NHTSA-2017-0069-0625**Organization:** California Office of the Attorney General et al.
Commenter: Kavita Lesser

As described above, the modeling used to arrive at the calculations in the DEIS suffers from many deficiencies and as a result, the DEIS overstates the emissions benefits from the Proposed Rollback. In order to evaluate how these flaws may impact the analysis, CARB ran the CAFE model with a few corrected assumptions. Figure 1 below demonstrates the significant difference in emission estimates by only partially correcting the inputs and assumptions in the CAFE model. Notably, the slight CO decrease shown in Figure 1 in the "CARB CAFE Run" bar graph is not accurate, as it reflects the fact that NHTSA's flawed inputs and assumptions have only been partially corrected in the modeling shown below. In reality, the Proposed Rollback would not result in any decreases of any criteria pollutant. Nevertheless, this figure demonstrates the profound effect on emissions quantification that results from correcting even some of the inputs and assumptions in NHTSA's CAFE modeling.

> [See original comment for Figure 1, titled "Total Additional Lifetime Criteria Pollutant Emissions Under Proposed Rollback"]

As detailed in CARB's Comments, by partially correcting assumptions and turning the dynamic scrappage model off, the CAFE model demonstrates that the Proposed Rollback will substantially increase cumulative emissions of the pollutants CO, VOC, NO_X, and PM when compared to existing standards. This difference in emission estimates is mostly a result of the agencies assertion that the Proposed Rollback will significantly decrease VMT and thus decrease downstream emissions from vehicle tailpipes. But, in actuality, the Proposed Rollback will not decrease VMT and instead, the Proposed Rollback will increase fuel consumption and thus increase "upstream" emissions associated with extracting, refining, and delivering fuel. Thus, contrary to the agencies assertions, the Proposed Rollback will – quite "noticeably" – increase net emissions of criteria pollutants.

Docket Number: NHTSA-2018-0067-12123
Organization: Center for Biological Diversity et al.
Commenter: Alejandra Núñez et al.

As also explained more fully in comments submitted in this docket by the state of California et al., when realistic and scientifically-defensible air impacts modeling and proper assumptions are used, it is likely that none of the nonattainment or maintenance areas in the U.S. would in fact see any of the emissions decreases described immediately above from the Preferred Alternative or any other alternatives relative to the No Action Alternative. That conclusion, emerged from analysis by the California Air Resources Board ("CARB"), which attempted to perform side-by-side comparisons between the DEIS' California-related emissions calculations and similar calculations using EMFAC2014, a computer model that estimates emission rates for hydrocarbons, CO, NO_X, PM10, PM2.5, lead, CO_2, and SO_X for on-road mobile sources for calendar years 2000 to 2050 operating in California. When approving a 2014 update to the state's EMFAC model, the EPA found that the model was the most current, accurate and applicable model for the state.

As the California DEIS Comment Letter explains, the side-by-side comparisons were an extremely difficult undertaking because the DEIS failed to describe many of the necessary assumptions and bounds the agency used in its emissions calculations, and failed to explain how NHTSA arrived at one of its most inexplicable results: that, in certain years under the proposed action, criteria pollutant emissions were estimated to decrease in areas where refinery operations would likely increase operations, and thus increase production-related emissions, to meet increased fuel demand. California's DEIS Comment Letter offers the San Francisco Bay Area as an example; the DEIS illogically concludes that this nonattainment area would see some criteria emissions benefits (*i.e.*, reductions) despite the fact that, as California et al. points out, the Bay Area is one of two primary fuels-refining regions in California, with five refineries in that air basin alone.

The DEIS's illogical conclusion extends to other nonattainment areas which have refineries within their boundaries across the nation. See the table below for additional examples. As discussed in Section XI below, many of these refineries are located in communities in the U.S. with the highest percentiles of people of color and low-income populations, who already are adversely affected by the refineries' operations.

> [See original comment for table titled Nonattainment Areas with Refineries and Criteria Pollutant Emission "Benefits"]

Response

NHTSA recognizes that an analysis based on the assumptions used for the analyses in the 2012 Final EIS and the 2016 Draft Technical Assessment Report would yield results different from those in this EIS. However, NHTSA has thoroughly addressed the methodology and assumptions for its analysis in the preamble to the NPRM and the PRIA, including how and why they differed from prior analyses. NHTSA received a significant number of public comments on issues related to its analysis methodology, and those comments are addressed in the preamble to the final rule. The Draft and Final EIS are based on the modeling described in those documents and in associated CAFE model documentation in the docket, and the analysis performed is consistent with NHTSA's approach in prior rulemakings. Chapter 4, *Air Quality*, presents the agency's air quality analysis based on revisions made to the CAFE model in response to public comments.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The DEIS also departs from the 2012 Final EIS by including, but failing to explain, a change in the air quality impacts analysis periods. To evaluate impacts to air quality, NHTSA previously selected calendar years that were meaningful in light of its action alternatives' likely effects: 2021 (the endpoint of the regulations then being finalized), 2025 (the endpoint of the augural standards), 2040 (a midterm forecast year with "a large proportion" of passenger car and light truck VMTs accounted for by vehicles meeting Proposed Action economy standards), and 2060 (almost all passenger cars and light trucks in operation meeting Proposed Action fuel economy standards, and impacts of standards determined primarily by VMT growth). In the DEIS, however, NHTSA selected only three calendar years – 2025 (an early forecast year with about one-fourth passenger car and light truck VMTs accounted for by vehicles meeting Proposed Action economy standards), 2035 (a midterm forecast year with about three-fourths passenger car and light truck VMTs accounted for by vehicles meeting Proposed Action economy standards), and 2050 (almost all passenger cars and light trucks in operation meeting Proposed Action fuel economy standards, and changes in year-over-year impacts determined primarily by VMT growth) – and shortened the time span covered by the analysis by a decade. NHTSA offers no explanation for either change.

Response

The analysis years selected in this EIS are based on the model years affected by the rule, the available data, and usefulness of the predicted results to the decision-maker. NHTSA makes this selection independently for each of its EISs, and there is no requirement that the analysis years used in one EIS match those used in a prior EIS. NHTSA's selection of analysis years in this EIS, as in previous EISs, follows the "early"/"mid-term"/"late" concept for forecast years. In the EIS, Section 4.1.2.3, *Analysis Periods,* defines the analysis years used to assess impacts on air quality. For this EIS, NHTSA selected 2050 as the "late" forecast year, as almost all passenger cars and light trucks in operation would meet fuel economy standards as set forth under the Proposed Action. This selection aligns with the forecast period for the Annual Energy Outlook (AEO) (which forecasts energy markets through 2050) and is the last year for which the CAFE model defined inputs for model CAFE compliance pathways. Later analysis years would be increasingly uncertain, especially as they would rely on assumptions based on fuel economy trends rather than compliance modeling. Therefore, use of 2050 as the final analysis year is appropriate, and no changes to the Final EIS are required.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Additional criteria pollutants emitted by less fuel-efficient vehicles will trigger or worsen NAAQS violations, as demonstrated by data in the DEIS showing numerous areas in the country that are already in nonattainment for ozone and PM2.5. (See also the General Conformity discussion below.) It is remarkable for federal agencies to advocate rolling back regulations even though their admitted effect—which the agencies refuse to mitigate, see below—is to exacerbate the pollution exceedances in nonattainment areas. It is equally noteworthy that all nine areas NHTSA identifies as suffering from "serious" or "extreme" nonattainment conditions for ozone and PM2.5 are located in California, even though the agencies unlawfully propose to revoke (or declare preempted) the state's Clean Air Act waiver for GHG emissions and the state's ZEV mandate that currently allows California to set more stringent vehicle pollution standards to combat these deadly conditions.

In an effort to gloss over the impact on the health of those forced to breathe the additional criteria pollutants emitted under NHTSA's proposed action, the agency states that it "assumed that little to no extraction of crude oil occurs in nonattainment areas." This is untrue, as considerable (and not "little to no") amounts of oil extraction occurs both in Kern and Los Angeles County nonattainment areas.[38] The same is true of NHTSA's assertion that "probably" only a "very small proportion" of criteria pollution emitted in the transportation of crude oil occurs in nonattainment areas. To the contrary, the oil extracted in Kern and Los Angeles County must inevitably travel through these nonattainment areas to reach refineries. NHTSA's nonchalant dismissal of exacerbated non-attainment area pollution caused by its Proposal certainly fails the "hard look" test.

Response

NHTSA's methodology for addressing crude oil extraction and transportation in the Draft EIS mirrored the approach the agency took in prior EISs for CAFE rulemakings. However, NHTSA recognizes that crude oil extraction and transportation contribute to upstream emissions. In response to this comment, NHTSA has revised the analysis of upstream emissions to include the effects of crude oil extraction and transportation. Chapter 4, *Air Quality*, discusses how NHTSA accounted for these activities, and Appendix A, *Air Quality Nonattainment Area Results*, provides the revised results by nonattainment area.

[38] California Council on Science and Technology and Lawrence Berkeley National Labs, An Independent Scientific Assessment of Well Stimulation in California, Volume 2, Potential Environmental Impacts of Hydraulic Fracturing and Acid Stimulations (July 2015), at 237–239 ("The two air basins (San Joaquin Valley and South Coast) most strongly impacted by oil and gas production also coincide with the worst air quality in California. Both air basins are currently out of compliance with both national ozone and PM2.5 standards.").

Comments

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Under the Clean Air Act's General Conformity Rule, "a conformity determination is required where a federal action would result in total direct and indirect emissions of a criteria pollutant or precursor originating in nonattainment or maintenance areas equaling or exceeding the rates specified in 40 C.F.R. § 93.153(b)(1) and (2)." Essentially, federal actions must not interfere with a state's ability to implement its SIP or meet the NAAQS. 42 U.S.C. § 7506(c)(1)- (2); see also 40 C.F.R. Part 51, Subpart W, and Part 93, Subpart B. To the extent that a federal action will increase emissions of a criteria pollutant and precursors, the attainment and maintenance of the NAAQS standards becomes more difficult. The added pollution is especially problematic in states such as California, that have significant areas now in nonattainment, or in areas that are newly-designated as attainment and are at risk of backsliding into nonattainment due to such added pollution.

The DEIS states that the General Conformity Rule does not apply because the Proposed Rollback will not directly or indirectly affect air quality. There are three fundamental issues with NHTSA's conclusion. First, NHTSA uses inappropriate modeling to determine that the General Conformity Rule does not apply. Second, NHTSA argues that any emissions flowing from its actions are neither "direct" nor "indirect" under the meaning of general conformity because NHTSA cannot control the technologies that automobile manufacturers would use, or consumer behavior (including purchasing). Yet this contradicts NHTSA's assertion that the costs of the augural standards purportedly are causing new vehicles to become too expensive, and are thereby negatively impacting consumer purchasing behavior. NHTSA then attempts to justify this course of action by predicting, using new, unsupported modelling inputs of its own design, the emissions levels that would flow from its action. In other words, the rulemaking is premised on understanding consumer purchasing and the emissions implications of such purchasing, while NHTSA claims on the other hand that it cannot make assumptions about these very things when it comes to satisfying its obligations under the General Conformity Rule. NHTSA cannot have it both ways. Indeed, the Ninth Circuit Court of Appeals has previously recognized that "[b]y allowing particular fuel economy levels, which NHTSA argues translate directly into particular tailpipe emissions, NHTSA's regulations are the proximate cause of those emissions just as EPA Clean Air Act rules permitting particular smokestack emissions are the proximate cause of those air pollutants…." *CBD v. NHTSA*, 538 F.3d at 1217. Finally, in the context of this joint rulemaking between NHTSA and EPA, it is inappropriate that NHTSA's determination regarding its own conformity obligations, regardless of its independent merit or lack thereof, does not address any conformity-related obligations EPA may have that flow from the joint rulemaking.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The Clean Air Act's general conformity requirement is that federal actions must not interfere with a state's ability to implement its State Implementation Plan and meet the National Ambient Air Quality Standards (NAAQS). 42 U.S.C. § 7506(c)(1)-(2); see also 40 C.F.R. Part 51, Subpart W, and Part 93, Subpart B. To the extent that a federal action will increase emissions of criteria pollutants, the attainment of the NAAQS standards becomes more difficult. The added pollution is especially problematic in states, like California, that have significant areas now in nonattainment. Because the DEIS' criteria pollutant emission estimates are permeated by fundamental errors that understate the emissions impacts of NHTSA's Proposal, it is highly unlikely that the Proposal would not violate general conformity; at a minimum, NHTSA must take another look at its assumptions and must compare its current conclusion to one not based on its erroneous and unsupported scrappage and rebound models.

As the DEIS states: "Under the General Conformity Rule, a conformity determination is required where a federal action would result in total direct and indirect emissions of a criteria pollutant or precursor originating in nonattainment or maintenance areas equaling or exceeding the rates specified in 40 CFR § 93.153(b)(1) and (2)."

NHTSA's argument that the general conformity rule does not apply because the proposed rules will not directly or indirectly affect air quality is not credible on its face. Perhaps recognizing this, the DEIS purports to analyze whether the regulatory thresholds for invoking the conformity rule apply. The threshold depends on the attainment status of the area, and becomes lower as nonattainment worsens. Where nonattainment is extreme, such as in California's South Coast Basin, excess emissions of NO_X or VOCs triggering the need for a conformity analysis can be as little as 10 tons/year. Although Appendix A to the DEIS purports to show that the conformity minimum standards in 40 C.F.R. § 93.153(b)(2) have been met, the figures in Appendix A are based on the analysis badly skewed by the unsupported and result-oriented assumptions as to scrappage, sales, pricing, and the rebound effect discussed above, among others. In light of these errors, the required hard look has not been taken as to whether the Clean Air Act general conformity requirement applies here.

Response

NHTSA recognizes that the Proposed Action and alternatives could affect air quality. However, as discussed in Section 4.1.1.4, *Conformity Regulations*, and Section X.E.2 of the preamble to the final rule, NHTSA concludes that its action results in neither direct nor indirect emissions as those terms are defined in 40 CFR § 93.152. Therefore, a general conformity determination is not required.

Both commenters assert that NHTSA's modeling is flawed and, therefore, the agency cannot conclude that the General Conformity Rule does not apply. On the contrary, NHTSA's conclusion is based on the federal regulations and applicable case law, not on the results of its modeling. One comment asserts that NHTSA "cannot have it both ways" by alleging that it cannot control the technologies that automobile manufacturers would use or consumer purchasing behavior, yet justifies its rulemakings based on consumer purchasing and emissions implications. The rulemaking analysis presents a feasible pathway for manufacturers to comply with the rules, based on a series of assumptions about consumer behavior; it is not sufficiently foreseeable to trigger application of the General Conformity Rule. Furthermore, NHTSA cannot directly control these behaviors, and the chain of causation is too attenuated to be responsible for the resulting emissions. Finally, regarding the other comment, we note that Appendix A, *Air Quality Nonattainment Area Results*, is expressly provided for informational purposes only, as no conformity determination is required, and NHTSA is not obligated to compare potential emissions to regulatory thresholds for this rulemaking.

Comment

Docket Number: NHTSA-2017-0069-0563
Organization: Pennsylvania Department of Environmental Protection
Commenter: Patrick McDonnell

On the issue of air quality effects and fuel consumption, the analysis dismisses the additional emissions from not only the fuel consumption (downstream), but the additional emissions associated with the acquisition, refining, distribution and other life cycle elements of the petroleum fuel (upstream). This concept is particularly important to Pennsylvania as two major petroleum refineries (including the largest refinery on the east coast) are situated in a multi-state ozone nonattainment area and PM2.5 maintenance areas.

Furthermore, western Pennsylvania is a large producer of natural gas and natural gas liquids from the Marcellus Shale. As suitable gasoline blending components are fractionated from these liquids, the location and the potential increase in these activities may be significant. The increasing role of natural gas-powered vehicles and, perhaps more significantly, company vehicle fleets in Pennsylvania and nationally, for meeting the current and augural standards has not been fully considered by the agencies.

With the upstream emissions, the new analysis appears to arbitrarily assume that ninety percent of the incremental supply of crude oil needed to meet the increased demand will be imported and that half of all additional refining will be domestic. While this may reflect a national trend, state level and regional effects of this rebound may be significant considering Pennsylvania's regional role in natural gas and petroleum processing and refining. The agencies' new analysis in this Proposed Rule appears to be "diluting" emissions impacts across the nation, and thus reducing potentially significant local, state and regional level air quality impacts.

For example, in addressing downstream emissions of the rebound effect, the agencies state:

> The analysis does not estimate evaporative emissions from light-duty vehicles. Other factors which may impact downstream non-GHG emissions, but are not estimated in this analysis, include the potential for decreased criteria pollutant emissions because of increased air conditioner efficiency; reduced refueling emissions because of less frequent refueling events and reduced annual refueling volumes resulting from the CO_2 standards; and increased hot soak evaporative emissions because of the likely increase in number of trips associated with VMT rebound modeled in this proposal. In all, these additional analyses would likely result in small changes relative to the national inventory. (83 Fed. Reg. 43,335)

Pennsylvania disagrees with the agencies' dismissal of these potential changes in downstream emissions. While these emissions when compared to a national emissions inventory may not be relevant in the eyes of the agencies, they are relevant at a regional, state or nonattainment/ maintenance area level where emissions from mobile sources account for significant portions of the regional, state or area-specific inventories.

Moreover, Pennsylvania does not support the agencies' use of modeling with a rebound value of 20 percent. Instead, Pennsylvania believes that the 10 percent rate used for the current existing and augural standards modeling, given that value's sensitivity in the model, would yield a more realistic approximation of the future regarding that effect. This 10 percent value was originally used for the analysis supporting both the current and augural standards. Therefore, PADEP believes that the agencies' new analysis of the rebound effect in this Proposed Rule is inadequate because the agencies used modeling with an unrealistic assumption of the rebound effect.

Response

As discussed in Section 4.1.2, *Methods*, the estimated emissions in nonattainment areas, including Pennsylvania, were not based on a simple application of national averages but were developed using county-level VMT from the Federal Highway Administration and EPA, facility-level refinery data from EPA, and county-level data for other upstream emissions sources prepared by EPA.

As the commenter notes, NHTSA's analysis does not estimate evaporative emissions from light-duty vehicles. Gasoline vapor emissions from vehicle fuel systems occur when a vehicle is in operation, when it is parked, and when it is being refueled. These evaporative emissions, which occur on a daily basis from gasoline-powered vehicles, are primarily functions of temperature, fuel vapor pressure, and activity. NHTSA recognizes that overall evaporative emissions are relevant at a regional, state, or nonattainment/maintenance area level. EPA regulates evaporative emissions as part of its Tier 3 Motor Vehicle Emission and Fuel Standards. For purposes of this rule, changes to evaporative emissions would be driven largely by changes in EV use and the number of refueling events. Impacts on evaporative emissions from this rule are anticipated to be in proportion to tailpipe emissions changes and are likely to be small.

All other issues raised by the commenter pertain to NHTSA's CAFE model assumptions, methodologies, and inputs. These issues are addressed in Section VI of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0499
Organization: Boulder County Public Health
Commenter: Jeffrey Zayach

This rollback will lead to poor air quality, subsequently causing increased illness and premature death due to cardiovascular and respiratory disease. The DEIS states that, "Adverse health impacts would increase nationwide under each of the Action Alternatives compared to the No Action Alternative". Table 4.2.3-1 shows that all of the Alternatives would result in increased premature mortality, increased acute bronchitis, increased "work-loss days," and increased respiratory-related emergency room visits, **but NHTSA's Preferred Alternative would result in the highest increases in these negative health impacts.** In contrast, The No Action Alternative's increasingly stringent emission standards requirement would minimize adverse health effects.

The adverse effects of vehicle pollution on everyone who breathes - especially on the old, the young, and those disadvantaged by health or socioeconomic conditions - is well-documented. Near-roadway air pollution disproportionately impacts low-income communities and communities of color, children, older adults, people with preexisting cardiopulmonary disease, and children whose homes or schools are located near highways. The EPA states that, "People who live, work, or attend school near major roads appear to have an increased incidence and severity of health problems associated with air pollution exposures related to roadway traffic." Weakening of federal clean car standards would exacerbate these adverse effects.

Research by the Health Effects Institute concluded there is sufficient evidence pointing to the relationship between exposure to traffic-related air pollution and the exacerbation of asthma. This research also found, "…suggestive evidence of a causal relationship with onset of childhood asthma, nonasthma respiratory symptoms, impaired lung function, total and cardiovascular mortality, and cardiovascular morbidity..."

In addition to near-roadway air pollution, there are impacts from the fuel production process, also called "upstream" emissions. This emission category includes the extraction, refining, and transport of fossil fuels for traditional vehicles. The upstream vehicle-related emissions category also contributes to air quality impacts on public health in Colorado.

Response

NHTSA recognizes the health risks of exposure to emissions related to motor vehicles, including near-roadway exposure to emissions and exposure to upstream emissions. Section 4.1, *Affected Environment*, and Section 7.5, *Environmental Justice*, discuss near-road exposure. Section 4.2.1, *Criteria Pollutants*, and Section 4.2.2, *Toxic Air Pollutants*, discuss the estimated upstream emissions. NHTSA considered these impacts as part of its decision-making process.

Comment

Docket Number: NHTSA-2017-0069-0597
Organization: National Coalition for Advanced Transportation
Commenter: Devin OConnor

Table 4.2.3-1 of the DEIS reflects that the proposed rollback of the standards will result in as many as 299 premature deaths and 16,819 lost days of work by 2050 as a result of increased emissions of non-GHG air pollutants. These additional deaths and other adverse health impacts do not appear to be factored into the agencies' analysis of total fatalities or other costs of the proposal. Further, as noted above, the agencies' erroneously inflated estimates of the VMT impacts of the proposal result in a significant underestimate of the GHG and non-GHG emissions impacts of the proposal—suggesting that they also significantly underestimate air quality-related fatalities and other adverse health impacts.

In addition, by increasing transportation sector emissions of non-GHG air pollutants, the proposal has the effect of shifting regulatory burdens to other sectors, including electric utilities. In many areas of the country, transportation accounts for a substantial proportion of criteria pollutant emissions. EVs and other clean vehicle technologies provide a critical and cost-effective means of achieving compliance with NAAQS and related regulatory requirements. By increasing air pollution emissions and undermining state regulatory authority to drive the deployment of ZEVs and clean vehicles, the agencies' proposal has the effect of shifting burdens to meet air quality requirements from the transportation sector to other sectors. The agencies fail to acknowledge or analyze this dynamic in the NPRM or PRIA, and should do so.

Response

Chapter 4, *Air Quality,* includes the analysis of changes in criteria pollutant emissions and health impacts resulting from the considered alternatives. NHTSA's cost-benefit analysis, as presented in the preamble to the final rule and the FRIA, displays the net impacts as monetized costs and benefits and number of fatalities. NHTSA considered the health impacts reported in the Final EIS as part of its decision-making process.

With respect to the relative burdens to meet air quality requirements across sectors, in response to this comment, NHTSA has added discussion of this issue to Final EIS Chapter 4, *Air Quality*. NHTSA's responsibilities are defined by the EPCA statutory factors, and the agency explains its balancing of these factors in Section VIII.B.4 of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

Additionally, NHTSA concluded that the proposed standards will result in nearly universal reductions of toxic air emissions for years 2025, 2030, and 2050, with the sole exception of diesel exhaust particulate matter in 2050. There is no discussion of how NHTSA arrived at this conclusion, nor the data used to support this conclusion. NHTSA further fails to explain how toxic emissions are lower under the proposed standards than the augural standards, despite the fact that upstream emissions will increase due to a significant increase in refining to meet the increased fuel consumption resulting from the proposed standards.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

NHTSA also calculates, at a nonattainment and maintenance area scale, anticipated toxic air emissions changes for the years 2025, 2030, and 2050. This analysis concludes that, compared to the augural standards, the Proposed Rollback would result in nearly across-the- board reductions in toxic air emissions other than diesel particulate. NHTSA does not explain how it arrived at this conclusion, nor does it provide sufficient information in the DEIS to analyze NHTSA's results. The DEIS states cryptically that under the Proposed Rollback "[e]missions decline from 2025 to 2050 due to increasingly stringent EPA regulations…and from reductions in upstream emissions from fuel production, despite a growth in total [vehicle miles traveled] from 2025 to 2050." This fails to explain why toxic emissions under the Proposed Rollback would be lower than under the augural standards, as that same rationale would presumably apply under the augural standards. Moreover, the Proposed Rollback assumes that it will lead to a greater use of gasoline, and in turn a greater volume of oil refining, which, all else being equal, would increase upstream emissions of toxic pollutants as compared to the augural standards.

In short, the DEIS fails both to provide the public with sufficient information to evaluate NHTSA's assertions about impacts on toxics emissions and to take the requisite "hard look" at the Proposed Rollback's impacts on toxics emissions. It lacks the evidence, data, analysis, and explanation sufficient to inform the decisionmakers or the public of the bases for its counterintuitive claim that the preferred alternative would reduce toxic air emissions.

Response

Section 4.2.2.1, *Emission Levels*, explains that toxic air pollutant emissions decline over time (i.e., from 2025 to 2035 to 2050) due to increasingly stringent EPA regulations. (EPA does not primarily regulate air toxics directly via motor vehicle emission standards, but indirectly through fuel standards.) This time trend would occur under any alternative and is distinct from the effects of the action alternatives, which vary by alternative.

The predicted changes in emissions under the action alternatives, compared to the No Action Alternative, in the Final EIS are different from those reported in the Draft EIS. Tailpipe emissions predominate and upstream emissions are relatively small for all air toxics except diesel particulate matter (DPM), for which upstream emissions predominate. As described in Section 4.2.2.1, in 2025 under each action alternative (Alternatives 1 through 8) compared to the No Action Alternative (Alternative 0), decreases in emissions would occur for all toxic air pollutants except for diesel particulate matter (DPM). These decreases in emissions would occur because VMT would decrease, which would result in decreased tailpipe emissions. The decreases in tailpipe emissions due to lower VMT would be greater than the increases in upstream emissions due to increased fuel production, resulting in net decreases in total emissions in 2025 compared to the No Action Alternative. DPM is an exception because upstream emissions predominate and tailpipe emissions are relatively small. For DPM, the decreases in tailpipe emissions would be less than the increases in upstream emissions due to increased fuel production, resulting in net increases in total DPM emissions in 2025 compared to the No Action Alternative.

In 2035 and 2050, under each action alternative compared to the No Action Alternative, increases in emissions would occur for all toxic air pollutants. Increases in tailpipe emissions (except for DPM) in 2035 and 2050 would occur because the proposed standards would result in lower VMT than the augural standards, but would increase emissions rates (on a per-VMT basis). The percentage decreases in VMT would be slightly smaller than the percentage increases in emissions rates, leading to net increases in tailpipe emissions. The increases in tailpipe emissions would add to the increases in upstream emissions due to increased fuel production, resulting in net increases in total emissions in 2035 and 2050 compared to the No Action Alternative. Tailpipe emissions of DPM are an exception because the proposed standards would result in lower VMT than the augural standards and would decrease DPM emissions rates (on a per-VMT basis), leading to net decreases in tailpipe emissions. However, the decreases in tailpipe emissions would be less than the increases in upstream emissions due to increased fuel production, resulting in net increases in total DPM emissions in 2035 and 2050 compared to the No Action Alternative.

Comment

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

It is also unclear what threshold NHTSA is using for analyzing the significance of air emissions increases.[39] But, NEPA requires agencies to determine whether their actions would significantly affect the quality of the environment. 42 U.S.C. § 4332(C). To do so, agencies must consider both the context and the intensity of the impacts. 40 C.F.R. § 1508.27. NEPA also requires consideration of "[w]hether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the

[39] NHTSA includes general conformity thresholds, but it states those thresholds are "provided for information only; a determination under the General Conformity Rule is not required for the Proposed Action." Draft EIS Appendix A, *Air Quality Nonattainment Area Results,* p. A-19.

environment," among many other factors. 40 C.F.R. § 1508.27(b). Yet the DEIS does not clearly indicate what significance metric it is using to evaluate the air quality impacts, so the degree of significance remains undisclosed. NHTSA must correct this by providing appropriate context for the air emissions from the Proposed Rollback.

Response

Under CEQ's implementing regulations, agencies are required to consider whether their actions would significantly affect the quality of the human environment to determine the level of NEPA review that is appropriate (e.g., whether to prepare an EIS). NHTSA has prepared an EIS for this action. This treatment of significance under NEPA is different from that under the California Environmental Quality Act (CEQA), which requires specific findings of significance relative to specified thresholds. This EIS discusses pollutants and health effects in Chapter 4, *Air Quality*, and Appendix E*, Air Quality Modeling and Health Impacts Assessment.* NHTSA addresses how it considered environmental impacts as part of its decision-making process in Section VIII of the preamble to the final rule.

10.4.1 Local Air Quality Impacts

Comment

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

States rely on the Corporate Average Fuel Economy (CAFE) standards to achieve greenhouse gas (GHG), criteria pollutant, and toxic air pollutant emissions reductions. These standards are necessary for states to achieve their GHG reduction goals as well as attain and maintain the National Ambient Air Quality Standards.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

There are several areas in New York either categorized as non-attainment or maintenance areas under National Ambient Air Quality Standards (NAAQS). The proposed standards will result in significant increases in emissions of volatile organic compounds (VOC), sulfur dioxide (SO_2), NO_X, fine particulate matter (PM2.5) among others. This will make it difficult, if not impossible, for New York to achieve and maintain its air quality goals as required by the NAAQS and its State Implementation Plan (SIP) commitments.

Docket Number: NHTSA-2017-0069-0522
Organization: Mid-America Regional Council, Air Quality Forum
Commenter: Scott Burnett

The Kansas City region has struggled to meet the National Ambient Air Quality Standards (NAAQS) for ozone pollution for many years. While the region is currently designated as attainment for the 2015 standard, monitored values indicate we are barely attaining this standard and must continue to work to reduce ozone precursor emissions from all sources to remain in compliance.

National regulations such as fuel economy standards help the Kansas City region remain in compliance with the ozone NAAQS and reduce regulatory burden on all types of sources in the region as a result. With the anticipation of additional vehicles on the road and increased fuel consumption as outlined in this proposed rule, it would be more difficult for the Kansas City region to continue to meet the ozone NAAQS in the future.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

Further, while recognizing the harm to public health and air quality that result from its preferred option, NHTSA asserts states will still be complying with NAAQS and other standards that will mitigate the impact of increased pollution. However, NHTSA does not account for the other actions the administration is taking that will undermine air quality (as noted above) and therefore cannot back up its claims regarding state actions. States have relied on the augural standards and factor those into their compliance plans. The administration is serially taking these tools out of state's clean air toolboxes. This DEIS fails to address the very real concern for how this and other steps the administration is taking concurrently will impair air quality and the ability of states to mitigate those increases.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Further, these increases in emissions will undermine state implementation plans (SIPs). A SIP is a federally enforceable plan that identifies how a state will attain and maintain NAAQS. SIPs must identify both the magnitude of reductions needed and the actions necessary to achieve those reductions in order to meet NAAQS. SIPs also include a demonstration that: the area will make reasonable further progress toward attainment, is implementing reasonably available control technology on all major sources, has a program in place to address emissions from new stationary sources, and meets transportation conformity requirements. An increase in upstream emissions from fuel consumption will have dire implications for states that need to comply with SIPs. For example, in areas such as the South Coast air basin in California, CARB has estimated that the Proposed Rollback would create an additional 1.24 tons per day of NO_X emissions. Because of SIP commitments for federal ozone standards, that increase would have to be offset by reducing emissions from mobile sources, which would require working into the region's fleet 1.3 million more fuel-efficient vehicles, or 1 million more zero emission vehicles. And yet, via the Proposed Rollback, the agencies seek to yank away tools that states, including California, need to get those additional fuel-efficient and zero-emission vehicles on the road.

The DEIS arrives at numerous inexplicable results, including projected criteria pollutant decreases from the preferred alternative for certain years in areas where refinery operations would likely experience increased operations due to increased fuel demand. As an example, for the San Francisco Bay Area in California, the DEIS concludes that this nonattainment area would experience certain criteria emissions benefits under NHTSA's preferred alternative, including reductions of NO_X in 2025 and VOCs and CO in 2025 and 2035. This is despite the facts that the Proposed Rollback would increase consumption of refined fuels and that the Bay Area is one of two primary fuels-refining regions in California, with five refineries in that air basin. As stated, with increased fuel consumption comes increased fuel production-related emissions.

NHTSA also calculates, at a nonattainment or maintenance area level, anticipated emissions changes for the years 2025, 2030, and 2050.[40] Because all nine areas that NHTSA identifies as suffering from "serious" or "extreme" non-attainment conditions for ozone and PM2.5 are located in California, these comments focus on the air quality impacts in California from the Proposed Rollback. However, our analysis suggests that the same fundamental flaws in the DEIS as it pertains to California also apply to the DEIS's analysis for the rest of the country. By necessity, CARB's analysis is very preliminary, because not enough time has been provided to confirm many of NHTSA's calculations. This deprives both the decisionmakers and the public of essential information. See 40 C.F.R. § 1502.22(a). Figure 2, below, shows CARB's preliminary assessment of the differences between NHTSA/EPA's analysis and CARB's analysis using proper assumptions:

> [See original comment for figure 2 titled NO_X Emissions Changes from the NPRM Preferred Alternative in 2035 as Compared to the Augural Standards]

Given California's extraordinary challenges in attaining both federally and state prescribed ambient air quality standards (AAQS), its SIP is designed with very tight margins for error. The South Coast and San Joaquin Valley air basins, in particular, are faced with extremely challenging ozone attainment deadlines (75 ppb 8-hour standard) in 2031. Even marginal increases in NO_X emissions in those areas can impede attainment of the AAQS. By CARB's current estimates, NHTSA's action alternatives would only magnify the difficulty of meeting ozone attainment deadlines in multiple California air basins. Furthermore, increased temperatures due to climate change have been shown to exacerbate ozone conditions by increasing ozone-forming reactions in the atmosphere. Because NHTSA's Proposed Rollback would further exacerbate climate change, it would also exacerbate ozone levels.

Docket Number: NHTSA-2017-0069-0532
Organization: South Coast Air Quality Management District
Commenter: Wayne Nastri

The SCAQMD is the largest local air authority in the nation, responsible for protecting the air in the greater Los Angeles area. Over 17 million people reside in the South Coast Air Basin, breathing the most polluted air in the nation for ozone, and the second most polluted air for fine particulate matter (PM2.5). This pollution exposure can cause or contribute to respiratory disease, lung damage, cancer, and premature death.

NO_X is the primary pollutant that must be controlled to meet the federal standards for both ozone and PM2.5 in the South Coast Air Basin. Mobile sources constitute over 80% of the NO_X emissions in our basin. Due to the dominance of NO_X emissions from mobile sources, even if we were to completely eliminate NO_X emissions from all industrial sources, we would still fail to attain the national standards. As a regional air quality district, we have limited authority to control emissions from mobile sources, and rely on the Federal government to take action.

We are deeply concerned about the damaging air quality impacts of the SAFE Vehicles Rule if finalized, as well as the potential revocation of the California waiver for light duty vehicles.

In the proposal, NHTSA and EPA contend that the air quality impacts associated with rolling back the standard will be negligible, and even make the implausible argument that relaxing the standards may

[40] Confusingly, the emissions reductions in these tables are shown as positive values, and the increases are shown as negative values.

reduce overall emissions. This is simply not the case. In 2023 – the year in which we face a hard deadline to attain the Federal ozone standards – we must reduce NO_X emissions by 45% beyond existing requirements. In that year, light duty vehicles are estimated to contribute 11% of our basin's VOC and PM2.5 emissions, and 9% of our NO_X emissions. This estimate presumes that the current standard is in place. We must also reduce NO_X emissions by 55% by 2031 to meet the ozone standards. Achieving this magnitude of emission reductions over a relatively short period of time is an immense undertaking, and we need to achieve emission reductions across all sectors. Any relaxation of the vehicle standards will increase these contributions, further impacting the health of the 17 million people who call our area home and jeopardizing our attempts to attain the federal standards.

The proposed rule would also impact air quality in areas beyond southern California. With the implementation of the 2015 ozone standards, about 160 million people – approximately half the population of the U.S. - will be living in nonattainment areas. Many of these states are facing the prospect of ozone nonattainment for the first time, and are also impacted by NO_X emissions from mobile sources. Increasing emissions from mobile sources will force these states to seek additional emission reductions from industry, and will further hamper their ability to attain the standard.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

CARB staff have estimated that the Agencies' proposal to rollback fuel economy and GHG standards can significantly impact California's criteria and GHG emissions in future years.

Passenger cars and light trucks are a major contributor to NO_X emissions in California. The State's 39 million residents collectively own about 24 million passenger vehicles and drive more than most other Americans. Over ten million of these vehicles are in South Coast. The vast majority of these vehicles have internal combustion engines and use gasoline. The light-duty vehicle sector is projected to grow to approximately 30 million vehicles statewide by 2031. CARB's 2016 State Strategy for the SIP calls for reducing NO_X emissions by approximately six tons per day from the light duty sector in order for South Coast air basin to attain the 75 ppb ozone standard. According to the State Strategy, a fraction of these emissions reductions (about 0.6 tons per day) will be achieved through a combination of aggressive light-duty vehicle strategies such as higher zero emission vehicle (ZEV) sales requirement, and more stringent tailpipe standards. The remaining NO_X emission reductions (about 5 tons per day) need to be achieved through incentive programs by accelerating the turnover of the oldest, highest emitting vehicles. This would mean removing older, dirtier vehicles from the road, either by replacing 1.1 million old vehicles with the cleanest conventional vehicle in 2031 or 700,000 zero emission vehicles.

Passenger cars and light trucks are a major contributor to NO_X emissions in California. The State's 39 million residents collectively own about 24 million passenger vehicles and drive more than most other Americans. Over ten million of these vehicles are in South Coast. The vast majority of these vehicles have internal combustion engines and use gasoline. The light-duty vehicle sector is projected to grow to approximately 30 million vehicles statewide by 2031.

As a result of the Agencies proposal, CARB staff has estimated that regional criteria and local toxic emissions would further increase in California non-attainment regions such as South Coast, primarily from increased fuel production activity at refineries and fuel distribution systems. More gasoline consumption means more diesel tanker truck trips to community gasoline stations, and therefore higher diesel PM emissions and refueling evaporative emissions.

According to staff analysis, the proposed rollback creates an additional 1.24 tons per day of NO_X emissions in the South Coast air basin, 90 percent of which is from upstream fuel activity increases. Because of the SIP commitments for federal ozone standards, these increased refinery emissions would have to be offset elsewhere. This means that even more vehicles would need to be removed to compensate for the NPRM increased NO_X emissions of 1.24 tons per day. Because the dirtiest vehicles would already be removed to achieve the targets set by South Coast, comparatively newer and cleaner vehicles would need to be removed--either an additional 1.3 million clean conventional vehicles or 1 million zero emission vehicles. This will almost double the number of vehicles that were originally supposed to be replaced to meet the region's air quality commitments.

Docket Number: NHTSA-2017-0069-0499
Organization: Boulder County Public Health
Commenter: Jeffrey Zayach

The increased emissions in Colorado that would result from the proposed Preferred Alternative are significant. The increases in carbon dioxide equivalent (CO_2e) would be nearly 2.6 million tons per year by 2030 and over 4.5 million tons per year by 2040. To provide a sense of the scale of these impacts, the biggest current effort to reduce emissions in Colorado is Xcel Energy's plan to shut down more coal-fired power plants and replace them with wind and solar. Xcel's plan will increase its share of renewable generation from 29% to 55% of its total energy mix by 2026, a shift that would reduce emissions by 4.1 million tons per year. Rolling back the clean car standards would reverse these advances, increasing ozone-forming pollutants, such as VOCs and NO_X, as well as fine particulates (PM2.5), and sulfur oxides (SO_X).

High ozone levels in the Denver Metro/North-Front Range (DMNFR) ozone nonattainment area have been a problem for many years. Subverting modern clean car standards would further exacerbate the problem. In the DMNFR 31% of NO_X and 16% of VOC emissions are due to on-road vehicle pollution. Vehicle emissions are one of the two largest contributors to ozone formation (as shown by air quality modeling).

In 2017, 10 Colorado counties (Adams, Arapahoe, Boulder, Clear Creek, Douglas, El Paso, Jefferson, Larimer, Rio Blanco, and Weld) received an "F" grade, and two counties (Denver and La Plata) received "D" grades for high ozone days in the American Lung Association's (ALA) State of the Air report. And the ALA rated Denver as the 11th most polluted city in the nation for ozone levels in 2017. After repeatedly exceeding both the 2008 and the 2015 ozone standards this summer at multiple monitors, the DMNFR continues to violate the standards and is faced with a reclassification to serious nonattainment after 2019 (the highest allowable 4th maximum 8-hour average value for 2019 is as low as 55 parts per billion [ppb] at the highest recording monitor in the area).

Because the federal vehicle emission standards are incorporated in the ozone State Implementation Plan (SIP) for the DMNFR, a rollback of these standards would result in further increased emissions in this nonattainment area. If the federal rollback is finalized, the ozone SIP would need to be revised to reflect higher vehicle emissions in the future from those already included in the SIP's emissions projections. This action would be absurd for an area that should be classified as serious nonattainment and is not achieving pollution reduction goals. If California's waiver is revoked as a result of this proposed action, Colorado's hands will be tied - it will not be able to address pollution issues through adoption of California's or its own standards.

Response

NHTSA recognizes the challenges that nonattainment and attainment areas face in reducing ozone precursor (NO_X and volatile organic compounds [VOCs]) and particulate matter 2.5 microns or less in diameter (PM2.5) emissions to achieve attainment or assure continued attainment. However, this alone is not determinative of NHTSA's final decision, as it must balance the four EPCA statutory factors and other relevant considerations in setting CAFE standards. Although the CAFE standards are not, by statute, an emissions reduction program, NHTSA recognizes that states design State Implementation Plans and other emissions reduction programs under the assumption that federal regulation of vehicle emissions will continue. Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, discuss the emissions impacts of the alternatives under consideration, and Appendix A, *Air Quality Nonattainment Area Results*, provides estimated emissions changes by nonattainment area. The photochemical modeling analysis in Final EIS Appendix E, *Air Quality Modeling and Health Impacts Assessment*, shows the estimated changes in air pollutant concentrations by alternative. Over time, NHTSA continues to anticipate reductions in tailpipe criteria pollutant emissions compared to current levels due to fleet turnover and increasingly stringent EPA criteria pollutant emissions requirements for motor vehicles. Changes in emissions that may result from revisions to the CAFE standards could lead to states reviewing their own emissions reduction programs to meet their self-imposed statewide emissions targets. Ultimately, states may need to work with EPA regarding any changes in emissions that may result from this action and their State Implementation Plans.

Comment

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

Overestimating EV Emissions: The DEIS may be overestimating upstream emissions from electric vehicle use, and so underestimating the net greenhouse gas increases of the proposed action to roll back CAFE standards. After acknowledging that upstream emissions would vary "across the country," the DEIS instead "assumes that the future EV fleet would charge from a grid whose mix is uniform across the country." This assumption ignores the fact that EV usage may be clustered in states with cleaner electricity fuel mixes. Notably, about half of EV sales in 2016 and 2017 occurred in California, and California has a significantly cleaner current and planned electricity system than the national average.

Response

The EIS uses the CAFE model upstream and downstream national-scale outputs to estimate changes in air pollutant emissions. The CAFE model does not attempt to estimate which types of vehicles will be operated in which regions of the country. Especially for projections extending decades into the future, uncertainties regarding, for example, the region-by-region prevalence of full-size pickup trucks, or luxury brands, or EVs, etc., are so uncertain that regional-scale analysis would not only be unduly resource-intensive, it would also falsely imply precision in results. Emissions factors for electricity upstream emissions used in the NPRM CAFE model were based on Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) 2017. For the final rule and Final EIS, NHTSA has updated the CAFE model to use GREET 2018. In both cases, NHTSA used GREET to estimate national average upstream emissions factors, including for electricity. For additional detail of CAFE model assumptions used in the calculations of upstream emissions, see the air quality impacts methodology discussed in Section VI.D.3.c in the preamble to the final rule. NHTSA provides a qualitative discussion of the impact of charging location on greenhouse gas (GHG) emissions in Section 6.2.3.1, *Charging Location*.

Comment

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Finally, the DEIS does not analyze impacts at a geographic scale that is any smaller than nonattainment and maintenance areas. To the degree the Proposed Rollback may present any more geographically-specific challenges, NHTSA should consider this in its analysis. Given the magnitude of the changes the Proposed Rollback would cause, and the sensitivity of many freeway-adjacent communities to vehicle emissions, the DEIS should consider impacts to specific areas such as major freeway corridors that would foreseeably be impacted by the proposal.

Response

As NHTSA's action is to set nationwide fuel economy standards, this EIS provides results on a national basis, which is a reasonable analytical approach for such a rulemaking. It is not practical to provide a corridor-by-corridor air quality analysis for the entire United States, as such location-specific impacts are less certain. Still, NHTSA recognizes the health risks of near-roadway exposure to emissions. Section 4.1, *Affected Environment*, and Section 7.5, *Environmental Justice*, discuss near-road exposure. Appendix E, *Air Quality Modeling and Health Impacts Assessment*, provides the results of NHTSA's photochemical air quality modeling to assess emissions and health-related impacts.

10.4.2 Health Effects

Comment

Docket Number: NHTSA-2017-0069-0188
Commenter: Ryan Scott

Figures S-1 and S-2 of the EIS summary illustrates changes but the figure does not indicate this on the y axis of the figure (it purports to illustrate total emissions). This is deceptive and should be fixed in the draft.

Response

In Figures S-1 and S-2 of the Draft EIS, the y-axis shows total emissions not emissions changes. Figures S-1 and S-2 are consistent with the emissions totals given in Draft EIS Tables 4.2.1-1 and 4.2.2-1.

Comment

Docket Number: NHTSA-2017-0069-0522
Organization: Mid-America Regional Council, Air Quality Forum
Commenter: Scott Burnett

Additionally, the primary NAAQS are set at a particular level to protect public health. If the Kansas City region is unable to maintain compliance with the ozone NAAQS, it may also have a detrimental impact on public health in the region, particularly for vulnerable populations such as children, the elderly and those with existing respiratory conditions. For these reasons we oppose the relaxation of the fuel economy standards after model year 2021 as proposed.

Response

NHTSA recognizes that changes in ozone precursor (NO_X and VOC) emissions could affect a region's ability to maintain compliance with the ozone National Ambient Air Quality Standards (NAAQS) and may contribute to human health effects. Chapter 4, *Air Quality*, discusses these effects and Section 4.2.3, *Health Impacts*, discusses the emissions-related health impacts of the considered alternatives.

Comment

Docket Number: NHTSA-2017-0069-0527
Commenter: Lynn Carroll

I live in the Wasatch Front of Utah, where air pollution is bad in the summer and worse in the winter. There has been progress in reducing the pollution from vehicles, but increasing population and high use of trucks and SUVs have kept our air unhealthy on many days. It's important to continue to pressure auto manufacturers to produce less polluting vehicles.

Response

Chapter 4, *Air Quality*, and Appendix A, *Air Quality Nonattainment Area Results*, discuss regional emissions impacts of the alternatives. NHTSA considered all appropriate factors in setting the final CAFE standards, including the emissions and health impacts disclosed in the EIS.

Comments

Docket Number: NHTSA-2017-0069-0540
Commenter: Christopher Lish

2) The pollution from cars and trucks can have other frightening impacts on our environment—such as acid rain and smog, among other problems—and our health. Fossil-fuel vehicles emit pollutants that cause smog and ground-level ozone, which, in turn, lead to increased rates of pollution-caused death, asthma, allergies, and other serious health problems. Undermining these achievable, successful, and commonsense standards will allow automakers to manufacture dirtier vehicles that pollute the air and harm our health. Freezing car emissions standards at 2020 levels for the next six years will allow billions of tons of dangerous pollution to continue to enter our atmosphere. More than 25 million Americans already suffer from asthma. You shouldn't be rolling back safeguards that protect them.

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

No rational basis exists for curtailing advancement of vehicle technologies that reduce harmful levels of emissions, fuel consumption and consumer costs. The proposed standards will lead to the consumption of an additional half million barrels of oil a day, raising direct health impacts associated with criteria air pollutants and carcinogenic toxic emissions for communities already most impacted by the “upstream” pollution associated with the extraction, transportation and refining of petroleum products, and creating an overall increase in particle pollution as compared to the existing standards in 2025 and beyond.

By contrast, the existing standards remain an appropriate reflection of the urgent action needed to protect public health against climate change health impacts and an ongoing over-dependence on fossil fuels. The health consequences of climate change have never been clearer; worsened wildfires, storms, and heatwaves are just some of the climate-related impacts harming health today. It is simply the wrong approach to roll back these critical health-protective standards and leave states unable to offer their citizens necessary levels of protection against harmful emissions that contribute to climate change. We urge the Administration to reject this proposal and focus on implementation of the existing standards.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

In our comments on the NOI, ELPC noted that air pollution is a threat to public health across the US. Several Midwest states suffer significant impacts from harmful air pollutants and the transportation sector is a key contributor to those effects. In the American Lung Association’s most recent State of the Air report, areas such as Milwaukee and Kenosha County, WI; Cleveland, Columbus, and Cincinnati, OH; Indianapolis, IN; Macomb County, MI and myriad other cities and counties in the Midwest all received failing air quality grades due to ozone or particulate matter pollution. As NHTSA recognized in its original final rule for MY 2017-2025 light-duty vehicles, robust fuel efficiency standards can provide substantial benefits in reducing these pollutants and the public health problems they cause.

Failing to enforce the final FY2021 standard and freezing standards at 2020 levels will do real harm to Midwesterners’ health in the form of more asthma attacks, aggravation of chronic lung disease, and earlier deaths. And, as noted above, these impacts will only be exacerbated by increased carbon emissions and warmer temperatures.

Despite the very real health impacts of dirtier air, NHTSA identifies a Proposed Action and alternatives that will only make these impacts worse: “As demonstrated in Chapter 3, *Energy*, and Chapter 4, *Air Quality*, the Proposed Action and alternatives are projected to result in an increase in energy consumption, an increase in most criteria pollutant emissions, and a reduction in most hazardous air pollutant emissions, compared to the No Action Alternative.”

NHTSA finds: Increases in some pollutant emissions could also have additional adverse impacts on human health; thus, overall U.S. health impacts associated with air quality (mortality, asthma, bronchitis, emergency room visits, and work-loss days) are anticipated to increase across the Proposed Action and alternatives as compared to the No Action Alternative. In fact, NHTSA concludes that its preferred option would result in 86,194 cases of premature mortality and 10,892 lost days of work as compared to retaining the augural standards. Even this scenario may be overly optimistic in light of a recently released draft EPA Integrated Science Assessment finding that PM2.5 levels as low as 5 micrograms/cubic meter, well below the current NAAQS of 12 micrograms per cubic meter, have "a linear relationship" with adverse health impacts, including "strong evidence of impaired lung function growth" in particularly vulnerable populations such as children. As noted in the joint CBD comments, NHTSA's model and inputs raise significant questions regarding the validity of the air quality impacts.

Since NHTSA fails to consider standards more stringent than the augural standards, there is no data or analysis of the air quality and health benefits such a scenario could provide.

Response

NHTSA recognizes that alternatives other than the No Action Alternative could lead to an increase in health effects, as discussed in Section 4.2.3, *Health Impacts*. NHTSA considered these comments and the information contained in Chapter 4, *Air Quality*, in setting the final CAFE standards.

Comment

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

Millions of Americans suffer greater vulnerability to these threats. Many people face greater risk or exposure, as documented in the USGCRP's recent health assessment. Children court special risks because their bodies are growing and because they are so active. Risks are also greater for pregnant women and their pregnancies. Older adults are more likely to die during high heat events. People with chronic respiratory diseases like asthma and chronic obstructive pulmonary disease, people with cardiovascular diseases and people with diabetes also risk greater harm from increased pollution.

*   *   *   *   *

The Proposed Standards Would Increase Health Risks

Current vehicle standards benefit Americans with fewer harmful emissions and associated impacts to our air and climate. In addition to worsening climate change, ozone, and particulate matter, rolling back these standards would increase the risk to health from direct emissions from these vehicles.

Today, nearly 40 percent of Americans – more than 124 million – live in communities in nonattainment for ozone and particulate matter, with many residents impacted more severely by local pollution sources, including near-road pollution.

Near-road pollution has been found to increase asthma attacks in children, cardiovascular health impacts, impaired lung function and premature death. For example, several Volatile Organic Compounds (VOCs) from gasoline emissions are recognized carcinogens, including benzene, 1,3- butadiene and formaldehyde. Reducing VOC emissions will help reduce the burden of these carcinogens on many communities, especially those living or working near these roadways.

Instead, the proposed standards would lead to the consumption of an additional half million barrels of oil a day, raising direct health impacts associated with criteria air pollutants and carcinogenic toxic emissions for communities already most impacted by the "upstream" pollution associated with the extraction, transportation and refining of petroleum products, and creating an overall increase in particle pollution and sulfur dioxide emissions as compared to the existing standards in 2025 and beyond. Fine particulate matter causes cardiovascular and respiratory harm, including lung cancer, and causes premature death. Sulfur dioxide causes difficulty breathing and asthma attacks and has been linked to premature death.

In contrast to the carefully designed existing standards, the proposal to roll back the rate of vehicle emissions improvements in 2020 through 2026 would lock out emissions reductions needed to protect public health, and lock in less protective standards for a longer timeframe.

The Existing Standards are the Best Way to Protect Health

The existing standards remain an appropriate reflection of the urgent action needed to protect public health against climate change health impacts. As discussed above, the health consequences of climate change have never been clearer; in recent years, rising temperatures, extreme heatwaves, droughts and catastrophic wildfires linked to climate change have ravaged American communities. These events ratchet up the formation of ground-level ozone, create stagnant conditions for trapping unhealthy air and affect vast regions of the country – far from the flames – with wildfire smoke. Rolling back these critical health-protective standards and leaving states unable to offer their citizens necessary levels of protection against emissions that contribute to climate change is the wrong approach. Recognizing the threats posed by transportation pollution, Americans overwhelmingly support maintaining the existing vehicle standards.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

This proposal will lead to increased cardiovascular and respiratory related illness, hospitalization, and deaths. Indeed, EPA and NHTSA concede that the proposed standards will cause the premature deaths of up to 300 people per year due to entirely preventable, and foreseeable, increased criteria and toxic pollutant emissions

Docket Number: NHTSA-2017-0069-0610
Commenter: Alexandra Richter

My main concern is the air pollution that is being caused by the emissions. Air quality is important for all of us and exposing future generations to more emissions is a direct threat to public health. Some of the causes of car emissions stated were respiratory, cardiovascular, and cancer causing agents. This alone should be a deterrent for the latter proposals.

Response

NHTSA recognizes that air pollutants contribute to human health effects. Chapter 4, *Air Quality*, discusses these effects and Section 4.2.3, *Health Impacts*, discusses the impacts of the Proposed Action and alternatives. Section 4.1, *Affected Environment*, and Section 7.5, *Environmental Justice*, discuss near-road exposure.

Comments

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

One of the most notable departures from the more comprehensive analysis of air quality impacts presented in the 2012 Final EIS appears in the DEIS's discussion of adverse health effects of conventional and toxic air pollutants. For example, in the 2012 Final EIS, NHTSA both quantified and monetized the increase in health benefits from reductions in adverse health effects, such as mortality, chronic bronchitis, emergency room visits for asthma, and work-loss days, generally resulting from all of the action alternatives. For instance, for criteria pollutants, the 2012 Final EIS included a lengthy discussion of monetized health benefits, including descriptions of monetized health impacts for each alternative and crucial data tables that allowed decision makers and the public to compare monetized health benefits between alternatives at a glance. Neither the DEIS nor the accompanying PRIA include similarly robust discussions.

Additionally, the 2012 Final EIS acknowledged that the information necessary to monetize all potential health and environmental benefits was not available, and thus the 2012 FEIS "likely underestimated the total benefits of reducing criteria pollutants." No such disclosure appears in the DEIS.

Response

As NHTSA specifically stated in its scoping notice, "In order to streamline its documentation and eliminate redundancy, NHTSA plans not to include [analysis] of . . . monetized health benefits in its air quality analysis . . . in the EIS" as it would be included in its RIA.[41] Consistent with this statement, NHTSA monetizes the potential costs and benefits of the Proposed Action and alternatives in the RIA. The RIA was subject to public notice and comment concurrently with the EIS; therefore, the public had an opportunity to review and provide comment on those impacts concurrent with the NEPA process. The CEQ implementing regulations specifically allow for NHTSA to combine environmental documentation with any other agency document to reduce duplication and paperwork[42] and to incorporate by reference material when it would cut down on bulk.[43]

[41] NHTSA, *Notice of Intent to Prepare an Environmental Impact Statement for Model Year 20222025 Corporate Average Fuel Economy Standards*, 82 FR 34740, 34744 (Jul. 26, 2017).

[42] 40 CFR § 1506.4.

[43] 40 CFR § 1502.21.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA gives equally short shrift to the health impacts of its alternatives, providing summaries of criteria and toxic pollutant increases on health only through 2035, and quantifying only premature deaths and work days lost. While it concludes that in 2035, the Preferred Alternative will cause between 86 and 194 more premature deaths and 10,982 extra work days lost, the faulty scrappage model and flawed rebound effect assumptions, among other things, seriously underestimate the total additional amount of criteria pollutants and toxics emitted, as described above. The true health impacts would clearly be far worse than NHTSA describes.

Docket Number: NHTSA-2017-0069-0499
Organization: Boulder County Public Health
Commenter: Jeffrey Zayach

Despite Alternative 1 being described by NHTSA as, "the least stringent and highest fuel use action alternative," it is the chosen Alternative. The modeling results for the proposal call the analysis into question because of the predicted decreases in some pollutants, compared to the No Action Alternative, even with decreased fuel economy. NHTSA explains that these decreases are due to the rebound effect, where improved fuel economy would reduce the cost of driving, and therefore lead to additional driving. The DEIS shows modeling results for the years 2025, 2035, and 2050. Decreases are projected for carbon monoxide (CO), nitrogen oxides (NO_X) (for 2025 and 2035, but increases are projected by 2050), and volatile organic compounds (VOCs) for 2025 (while increases are projected for 2035 and 2050). EPA commented on the drafts of both the Regulatory Impact Analysis (RIA) and the preamble to the proposed rule that NHTSA was using a higher than appropriate percentage for the rebound effect. Therefore, the amount of decrease in emissions reflected in the DEIS is likely over-predicted.

Increased emissions are predicted for NO_X under Alternatives 1 through 8, with the highest emissions under NHTSA's Preferred Alternative. Increased emissions in 2050 would be 7,911 tons per year. Increases in particulate matter (PM2.5) emissions are predicted for 2025, 2035, and 2050 (506 tons per year by 2050), increased sulfur dioxide (SO_2) emissions are predicted for 2025, 2035, and 2050 (10,863 tons per year by 2050), and increased VOC emissions are predicted for 2035 and 2050 (23,442 tons per year by 2050).

CO_2 emissions would also increase under Alternatives 1 through 8, with the highest emissions from the Preferred Alternative. In the US, the transportation sector accounts for 34% of CO_2 emissions; of that portion, 59% of the emissions come from passenger cars and light trucks. Under the Preferred Alternative, CO_2 emissions would increase by 9% through 2100. Any action, other than the No Action Alternative would cause an increase in both criteria pollutant and CO_2 emissions and would harm the health of people and the environment.

Response

Draft EIS Table 4.2.3-1 and the corresponding table in the Final EIS provide the estimated health impacts through 2050. NHTSA recognizes that the results are affected by the assumptions made for the scrappage model and the VMT rebound effect. NHTSA's modeling assumptions are discussed in Section VI of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0557-53
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

Despite their professed concern with safety, the agencies fail to accurately assess the obvious risk of rolling back standards: increased emissions. The proposed rollback of standards would lead to additional fatalities due to the negative health effects from increased vehicle emissions. When the worst of the agencies' modeling errors are corrected, and when emissions are accounted for, the evidence shows that the augural and existing standards *reduce fatalities*.[44]

Response

Section 4.2.3, *Health Impacts*, discusses health impacts resulting from the alternatives considered. NHTSA considered these impacts and the other impacts described in the Final EIS in its decision-making.

Comment

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

2. Criteria Pollutant Emissions Will be Significantly Higher if NHTSA Rolls Back the Clean Car Standards

Across the board, NHTSA misrepresents the extent to which harmful criteria pollutant emissions will increase if the Clean Car Standards are rolled back. The agency concedes in the DEIS that emissions of multiple criteria pollutants from the light-duty vehicle sector will increase under any of the action alternatives considered, and that harmful emissions would generally increase the most under the agency's preferred alternative.

NHTSA acknowledges that, "[a]ll action alternatives would result in increased adverse health impacts (mortality, acute bronchitis, respiratory emergency room visits, and work-loss days) nationwide compared to the No Action Alternative"—the existing Clean Car Standards—"as a result of increases in emissions of PM2.5,[diesel particulate matter] and SO_X." NHTSA specifically notes that "the action alternatives would result in increased incidence of PM2.5- related adverse health impacts due to the emissions increases."

However, NHTSA underestimates the extent of the increase. The agency's use of the scrappage model unjustifiably predicts that Americans will drive substantially fewer vehicle miles, and the model wrongly

[44] See Comment by CBD on Draft Environmental Impact Statement; Comment by EDF.

assumes that fuel will not primarily be processed in domestic oil refineries. Because of these errors, the agency underestimates the scope of the increase in annual criteria pollutant emissions under each of the alternatives.

The presentation of criteria pollutant emission impacts in the DEIS is incorrect and misleading, as demonstrated by the significant gaps between NHTSA's results and the analysis conducted by EDF using a corrected version of the Volpe model. NHTSA's preferred alternative will cause SO_X, NO_X, PM, and VOC emissions to increase significantly from the levels anticipated under the existing standards.

Oxides of Nitrogen (NO_X). Figure B shows how much higher annual NO_X emissions will be in 2025, 2035, and 2050 under the agency's preferred alternative compared to the existing Clean Car Standards. For example, light-duty vehicle NO_X emissions will be 63,902 tons/year higher in 2050 if the standards are flatlined than if the Clean Car Standards remained in effect. NO_X is a precursor to the formation of ozone, and such additional air pollution will harm the health of all Americans, particularly those with asthma or other respiratory conditions, and those who live, work, or play in close proximity to roadways.

NHTSA downplays this emissions increase. The DEIS analysis drastically underestimates the annual increases in NO_X emissions that will result from a rollback of the Clean Car Standards, and in fact the DEIS asserts that NO_X emissions would be lower without the standards in 2025 and 2035. But as EDF's analysis shows, this calculation is incorrect and the resulting DEIS presentation is deeply misleading. NHTSA's analysis predicts that NO_X emissions in 2035 would decrease by 682 tons per year under a complete rollback of the Clean Car Standards, while the EDF analysis concludes that annual NO_X emissions would actually be 53,183 tons higher with a rollback. Figure B shows the extent to which NHTSA is miscalculating NO_X emissions increases.

[See Original Comment for Figure B: Change in Annual NO_X Emissions Resulting from Rollback]

Sulfur Oxide (SO_X). NHTSA's emission impacts analysis in the DEIS underestimates the extent to which SO_X emissions will increase as a result of rolling back the Clean Car Standards. As demonstrated in our analysis, compiled by running a corrected version of the Volpe model, SO_X emissions will continue to rise at higher levels through 2025, 2035, and 2050 if the existing standards are flatlined.

[See Original Comment for Figure C: Additional Annual Sox Emissions Resulting from Rollback]

Particulate Matter (PM2.5). NHTSA also grossly underestimates the annual increases in emissions of particulate matter that would result from adopting the agency's preferred alternative instead of keeping the existing Clean Car Standards in place. Figure D below demonstrates the emissions increases documented in the DEIS compared with the results of EDF's own corrective analysis. PM2.5 can increase the risk of heart disease, lung cancer, and asthma attacks; and particles are easily trapped in the lungs because of their small size.

The contrast between the DEIS and EDF's analysis is particularly striking regarding PM2.5 emissions. NHTSA concluded that particulate matter emissions would be 126 tons higher per year in 2025 if the Clean Car Standards are rolled back, but EDF concluded that emissions of this harmful pollutant would actually be more than 1,600 tons per year higher under a rollback—an increase thirteen times larger than what NHTSA stated in the DEIS. This disparity continues in 2035 and 2050.

[See Original Comment for Figure D: Additional Annual PM2.5 Emissions Resulting from Full Rollback]

Volatile Organic Compound (VOCs). In the DEIS, NHTSA does not accurately present the changes in VOC emissions that would result from rolling back the Clean Car Standards. NHTSA incorrectly concludes that VOC emissions would be lower in 2025 with a rollback than they would be if the standards remained in effect; and NHTSA undercounts the extent to which VOC emissions would increase in 2035 and 2050. Our analysis shows the true, harmful effect of a total rollback of the Clean Car Standards: VOC emissions would increase significantly through 2050, as demonstrated below in Figure E. VOCs are another precursor that contribute to the formation of ozone, which poses a variety of risks to public health including chest pain, asthma attacks, and reduced lung function.

[See Original Comment for Figure E. Additional Annual VOC Emissions Resulting from Rollback]

3. Toxics Emissions Will be Significantly Higher if NHTSA Rolls Back the Clean Car Standards

As with greenhouse gases and criteria pollutants, NHTSA's emissions analysis in the DEIS significantly miscalculates the increase in toxic chemical emissions that will result from a rollback of the standards to MY2020 levels through MY2026. The resulting DEIS presentation misleads the public and the agency, unlawfully failing to meet NEPA's requirements.

Diesel particulate matter, or diesel PM, typically comprised of carbon particles (soot) and cancer-causing toxic chemicals, and is classified as a probable or likely human carcinogen by the U.S. Environmental Protection Agency, the National Institute for Occupational Safety and Health, the International Agency for Research on Cancer, Health Effects Institute, and the U.S. Department of Health and Human Services National Toxicology Program. The World Health Organization and the California EPA classify diesel exhaust as a known human carcinogen. As indicated in Figure F, NHTSA misstates the extent to which diesel PM emissions would increase with a rollback. Our analysis concluded that in 2025, 2035, and 2050, if the Clean Car Standards are rolled back, the increases in annual diesel PM emissions be at least four times greater than what NHTSA calculated.

[See original comment for Figure F: Change in Annual Diesel Particulate Emissions with Rollback of Clean Car Standards]

Benzene, which is also a component of diesel PM, is a well-characterized human carcinogen, associated with increased risk of leukemia and lymphoma. NHTSA concluded, according to its erroneous Volpe model, that emissions of this toxic chemical would be significantly lower if the Clean Car Standards were weakened. But this conclusion is not only counterintuitive; it is incorrect and misleading. EDF's analysis shows the extent to which benzene emissions will increase with a full rollback of the Clean Car Standards.

[See original comment for Figure G: Change in Annual Benzene Emissions with Rollback of Clean Car Standards]

EDF's analysis shows that there will be severe consequences for air quality and public health for decades to come if NHTSA rolls back the Clean Car Standards to MY2020 levels. Moreover, it demonstrates that the information considered and disclosed in NHTSA's DEIS is incorrect. Given the severe deficiencies with the emissions analysis in the DEIS, the agency cannot have properly considered these harmful consequences in crafting its proposed standards, nor can the public properly review and comment on the proposal. Given these violations of NHTSA's duty under NEPA, the agency must develop new alternatives, new analysis, and issue a new DEIS.

Response

NHTSA recognizes that EDF's analysis, being based on different assumptions, yields results different from those in the Draft EIS. NHTSA has made changes to the CAFE model based on comments it received during the public comment period, as described in the preamble to the final rule. Chapter 4, *Air Quality*, in the Final EIS presents the air quality analysis based on the updated CAFE model and compares those results to the Draft EIS. As discussed in Chapter 4 and in Section 2.5.3, *Comparison to the Draft EIS*, NHTSA concludes that the changes are not substantial and a supplement to the Draft EIS is not required.

Comment

Docket Number: NHTSA-2017-0069-0575-112
Organization: California Air Resources Board
Commenter: Richard Corey

Near-source exposure from vehicle emissions poses a significant health risk for those living within 300 to 500 meters of a major roadway. As noted in analysis underlying the proposed rollback, locations near to major roadways have elevated concentrations of many air pollutants emitted from vehicles, making these "microclimates" or "hot spots" of harmful pollution.

Traffic on major roadways is the largest source of near-source pollution due in part to the combustion of gasoline. Traffic pollution is a complex mixture of gaseous and particulate pollutants, including particulate matter, NO_X, and benzene. The extent of exposure to these components depends on a number of factors, including upwind/downwind location, meteorological conditions, time of day, and season. For instance, high volumes of vehicles on a roadway during early morning commute hours can increase traffic delay and thus concentrations of near-roadway emissions. Differences in meteorology can contribute to pollutants from roadways traveling farther into nearby areas at night and during early morning hours than during the day. Also, NO_2 concentrations have been shown to increase with rush hour traffic and areas of traffic delay. At trafficked intersections, levels of PM can be elevated by as much as 40 percent for larger PM (PM 10) and by 16 percent to 17 percent for fine PM (PM 2.5). These pollutants can enter vehicles, further exposing those driving on major roadways. For instance, significantly high levels of PM have been measured inside of Los Angeles-area buses. The vehicle pollutants can also enter homes through open windows and vents in the early morning due to air patterns. Exposure to vehicle pollution by those living within 300 to 500 meters of a major roadway has been shown to contribute to and exacerbate asthma, impair lung function, and increase cardiovascular mortality. Additionally, there is evidence linking near- roadway pollution exposures to higher rates of heart attacks, strokes, lung cancer, pre- term births, childhood obesity, autism, and dementia. Epidemiological studies have shown that even levels below the PM2.5 NAAQS can increase the risk of health impacts. These studies estimate that "[f]or every increase of 10 micrograms per cubic meter of PM 2.5, mortality increased by 13.6 percent."

California studies have indicated that some groups are more sensitive to traffic-related pollutants than the general population including children, the unborn, the elderly, and those with preexisting conditions. One study found that the total number of deaths from cardiovascular disease associated with near-roadway pollution will increase by 2035 due to an increased number of the elderly in the population at risk, even though the exposures and the risk to individuals will be reduced. Traffic exposure can be linked to an increased prevalence of childhood asthma and bronchitis symptoms. The Children's Health Study, conducted in California, demonstrated that particulate pollution may significantly reduce lung development in children, and that these effects are likely permanent. The investigators found associations between children exposed to heavy traffic and slower lung development, as well as significant increases in asthma prevalence, asthma medication use, and wheezing. Living near heavy traffic could also be associated with increased rates of new cases of asthma. Ongoing studies examining long-term health trends in the Children's Health Study participants have found that the recent reductions of air pollution in South Coast are associated with significantly reduced bronchitic symptoms and clinically significant positive effects on lung development in these children. Both regional particulate matter pollution and local near-roadway exposures affect children's health independently, resulting in reduced lung function. Other investigators have found adverse birth outcomes, such as low birth weight seen in infants whose mothers are exposed to traffic pollution. Short-term exposure to PM2.5 causes premature mortality, and long-term exposure additionally may cause reproductive harm, developmental problems in children, and cancer.

The specific component or components of traffic pollution responsible for the health impacts observed are not known and the mechanisms of toxicity are an active area of research. Epidemiological studies worldwide, as well as California-specific studies, however, have clearly shown that adverse health effects are associated with vehicle emissions and are concentrated within a few hundred meters of heavily traveled freeways and major roadways. A comprehensive review of traffic impacts by the Health Effects Institute (HEI) concluded that there is evidence to indicate that traffic-related pollution is a public health concern.

Docket Number: EPA-HQ-OAR-2018-0283-5471
Organization: Community Action to Promote Healthy Environments

3. <u>The transport sector's emissions affect large numbers of individuals who live close to major roads and who are disproportionately exposed to traffic related air pollutants</u>. This means that for conventional and toxic pollutants, emissions from the transportation sector have a larger impact than emissions from other sectors on a ton-for-ton basis. This results since in most other sectors, emissions occur from tall stacks or occur in more remote or less populated areas. The DEIS and others estimate that roughly 20% of the nation's population or about 60 million individuals live within 500 m or major roads, a zone in which numerous adverse health effects associated with traffic-related air pollutants have been documented.

4. <u>The NHTSA assessment is flawed as it does not recognize that individuals living in transportation corridors and adjacent areas are more vulnerable to adverse health effects and will suffer adverse health effects</u>. The assessment does not account for the increased susceptibility of this population. A growing body of peer-reviewed scientific literature documents the increased susceptibility of this population. In Detroit alone, we estimate the air pollution health burden that is attributable to ambient PM2.5, O3, SO2 and NO_X is responsible for 560 death annually, 13,000 disability-adjusted life years (DALYs), with a financial valuation of $5.5 billion annually; much of this is due to vehicular sources. As noted above, approximately 60 million individuals live near major roads, many of whom will have enhanced susceptibility to traffic-related air pollutants. The approach used in the NHTSA analysis severely underestimates health impacts associated with traffic-related pollutants.[45]

[45] For example, 4-28 of the DEIS states that: The EPA incidence-per-ton estimates shown in Table 4.1.2-3 are national averages and account for effects of upstream and downstream emissions separately. However, they do not reflect localized variations in emissions, population characteristics, or exposure to pollutants. Most upstream emissions are released from elevated points

*   *   *   *   *

In summary, as the preceding comments demonstrate, the NHTSA analysis of health impacts in the DEIS and the Proposed Rule Docket is outdated, incomplete, flawed, and arbitrary. The noted omissions, simplifications, and other issues lead to a misleading assessment. Contrary to the discussion in the Docket, the uncertainty is not plus or minus, but is biased downwards to disregard known impacts. The selection of the least stringent alternative (the preferred alternative) for the Proposed Rule, and the flawed analyses, lead to a Proposed Rule that is not protective of public health.

Response

NHTSA recognizes and discusses the health risks of near-roadway exposure to emissions. Section 4.1, *Affected Environment*, and Section 7.5, *Environmental Justice*, discuss near-road exposure. As indicated by one of the commenters, in Section 4.1.2.7, *Health Impacts*, NHTSA acknowledges that populations located near roadways could experience relatively greater pollutant levels because the short distance from the roadway allows less pollutant dispersion to occur. Appendix E, *Air Quality Modeling and Health Impacts Assessment*, provides the results of NHTSA's photochemical air quality modeling to assess emissions and health-related impacts, which better accounts for these spatial variations.

Comment

Docket Number: NHTSA-2017-0069-0580
Organization: South Dakota Corn Growers Association
Commenter: Troy Knecht

Bringing a 98 RON fuel to market in the form of midlevel ethanol blends will be less capital-intensive for refiners than attempting to increase blendstock octane with hydrocarbon components. It will also be incredibly cleaner. The avoided cost to refiners and offset emissions lower end-costs to consumers—reducing both economic costs at the pump and social costs related to health and environment.

Increased volumes of ethanol displace the most harmful compounds from gasoline. These aromatic hydrocarbon additives (i.e. benzene, toluene, ethylbenzene, xylene – or BTEX) have high cancer-causing potential. Increasing the ethanol volume in fuel to a midlevel blend has a positive impact on tailpipe emissions of toxins, including significant reductions in particulates and carbon monoxide.

The petroleum-based aerosol particles released when gasoline is combusted represent a significant source of pollution, especially in population-dense urban areas. These secondary organic aerosols

(for example, tall stacks at refineries and power plants) and disperse widely before reaching ground level. The population in a large geographic region could be affected, but pollutant concentrations generally would be relatively low at any one location. On the other hand, concentrations very near an upstream source that releases emissions at a relatively low elevation could be greater. The actual health impacts from human exposure at any particular location would vary with emissions, local meteorology and topography, and population characteristics. Unlike most upstream emissions, downstream emissions occur across the roadway system and are released at or near ground level. Populations located near roadways could experience relatively greater pollutant levels because the short distance from the roadway allows less pollutant dispersion to occur. Populations located at greater distances from roadways would be larger than the populations near the roadways but would experience much lower pollutant levels. As with upstream emissions, the actual health effects from human exposure at any particular location would vary with emissions, local meteorology and topography, and population characteristics. Because of these variations, the actual change in health impacts per ton of emissions change could be larger or smaller at any particular location than the values in Table 4.1.2-3.

(SOAs) fall into the class of pollutants called Particulate Matter (PM). Health issues related to PM and other emission-based pollutants can be reduced by lowering the volume of petroleum in the domestic gasoline pool.

PM from air pollution affects regional visibility and public health, as it can penetrate deeply into the lungs and cause respiratory issues. A 2013 study released by the Harvard Center for Risk Analysis focused on premature mortalities associated with SOAs. The use of hydrocarbon aromatics, based on a 2005 baseline, resulted in national mortality rates that "correspond with approximately $13.6 billion to $34.9 billion in total social costs," and these costs rise to nearly $50 billion annually when assuming higher levels SOAs are attributable to vehicle costs in urban areas.

Adopting a high-octane, midlevel ethanol blend would substantially offset a sizeable amount of the volume of BTEX and other hydrocarbon particles in the gasoline pool. The increased octane level from ethanol would limit the need for added hydrocarbon aromatics and lower the overall volume of petroleum-based fuel needed in the gasoline pool. NCGA agrees with the agencies' decision to consider the larger, more complete body of research demonstrating the significant health effects and social costs related to overdependence on petroleum during this rulemaking process.

Docket Number: NHTSA-2017-0069-0626
Organization: Urban Air Initiative
Commenter: James Conde

As the DEIS notes, motor vehicle emissions from conventional gasoline-fueled vehicles have significant adverse impacts on the environment and on human health. See, e.g., DEIS at S-6 - S-9 (summarizing impacts of mobile source criteria pollutants and toxic air pollutants); *id.* at 4-3 - 4-5. Ethanol can be used to displace gasoline components that contribute to these impacts. In other words, replacing today's E10 gasoline with a mid-level ethanol-gasoline blend would not only increase gasoline octane, but reduce tailpipe and evaporative emissions of harmful air pollutants. Many studies have established that mid-level ethanol blends would reduce – to an even greater extent than E10 – emissions and ambient levels of particulate matter (PM); the aromatic hydrocarbons benzene, toluene, ethylbenzene, and xylene (collectively known as BTEX); non-methane organic gases (NMOG); NO_X; and other pollutants, including secondary organic aerosols (SOA), polycyclic aromatic hydrocarbons (PAH), and other mobile source air toxics (MSATs). Additionally, blending a higher volume of ethanol into gasoline would reduce the Reid Vapor Pressure (RVP) of the resulting fuel mixture, which would reduce evaporative emissions associated with E10. By contrast, if aromatics (a component of conventional gasoline) instead of ethanol were used to further increase gasoline octane levels, the result would be to increase harmful air pollutant emissions.

Response

NHTSA recognizes that air pollutants contribute to human health effects. Chapter 4, *Air Quality*, discusses these effects and Section 4.2.3, *Health Impacts*, discusses the impacts of the Proposed Action and alternatives. Section 6.2.4.2, *Ethanol*, discusses the use of ethanol as a vehicle fuel.

Comment

Docket Number: NHTSA-2017-0069-0589
Organization: Environmental Defense Fund
Commenter: Alice Henderson

While the agencies elevate the purported (and entirely fabricated) safety impacts attributable to the Proposed Rollback, they completely ignore the very real, adverse emissions and health impacts that will result from the proposal. Indeed, the agencies remarkably claim that rolling back protective greenhouse gas and fuel economy standards for the nation's largest source of climate pollution will nonetheless have negligible emissions impacts.

This conclusion is based on a series of new, deeply flawed, and unsupported assumptions, which center on four key areas: 1) NHTSA's assumption that the proposed rollback will cause Americans to drive used vehicles nearly a trillion miles less (an assumption without any scientific, economic, or logical basis); 2) NHTSA's assumption that 95% of the additional gasoline needed to power the Proposed Rollback's less efficient vehicles will be produced from imported crude and 50% refined outside the United States (and so will dramatically reduce pollution impacts domestically);[46] 3) NHTSA's unprecedented assumption that automakers will voluntarily over-comply with "maximum feasible" standards under the Proposed Rollback; and 4) NHTSA's inflated estimate of the "rebound effect."

When we correct these errors, we find that, when compared to the original MY 2021-25 standards, the Proposed Rollback will have dramatic and harmful emissions and health impacts, including:

- Approximately 200 million tons of additional, annual CO_2 emissions in 2050 (nearly double what NHTSA's analysis estimates) and approximately 4.5 billion tons of additional cumulative CO_2 emissions between 2017-2050.
- Substantial NO_X, VOC, PM, and SO_2 emissions, which NHTSA's analysis underestimates by orders of magnitude. Compared to the recent light-duty Tier 3 rule, the emission increases attributable to the rollback in the 2030 calendar year will offset 24% of the VOC reductions expected from Tier 3, offset 13% of the NO_X reductions that are expected from Tier 3, and offset 38% of the PM2.5 reductions that are expected from Tier 3.
- In addition to analyzing the health impacts for calendar year 2030, EDF also calculated the cumulative PM-related health impacts from 2017 to 2050. Table 1, below, shows the Proposed Rollback will result in 14,501-32,362 premature mortality incidences, translating into dollar damages of $89 to $197 billion. The agencies entirely ignore these substantial impacts, which far outweigh NHTSA's flawed, safety-related benefits.

  [See original comment for Table 1: Cumulative Effect of the Proposal on PM2.5-Related Health impacts from 2017-2050]]

Response

NHTSA recognizes that the analysis results are affected by the various assumptions underlying the CAFE model inputs. These assumptions are discussed in Section VI of the preamble to the final rule. EDF's

[46] NHTSA makes these analytical assumptions despite attempting to justify its Proposed Rollback on the flawed assertion that fuel economy improvements are no longer needed because of increased domestic energy production.

analysis, being based on different assumptions, yields results different from those in the EIS. Final EIS Chapter 4, *Air Quality*, presents the updated air quality analysis based on the revised CAFE model. NHTSA considered these impacts in its decision-making process.

Comment

Docket Number: NHTSA-2017-0069-0589
Organization: Environmental Defense Fund
Commenter: Alice Henderson

Health Impacts

Table 31 presents the application of these health impact factors to the effect of the proposal on NO_X, SO_X, and PM emissions in 2030 shown in Table 29.

> [See original comment for table 31 titled Effect of the Proposal on PM-Related Health Impacts in 2030: EPA Regulatory Analysis Tool]

As can be seen, just the effect of the proposal on NO_X, SO2 and PM emissions produces $20-50 billion of health impacts in 2030. The vast majority of this monetized health impact is due to premature deaths. As shown, the proposal would cause 502-1,413 more premature deaths in 2030. These premature deaths due to PM emissions and precursors are an order of magnitude greater than the traffic deaths saved by the proposal in 2030, even including 20% rebound. NHTSA must consider these PM-related deaths when they consider relaxing CAFE and CO_2 standards in the future.

We extended this analysis to the public health impacts associated with the total emission impacts over the entire 2017-2050 CY period in Table 32. It should be noted that we are applying damage functions estimated for CY 2030 to emission impacts which run from essentially 2021-2050, though the bulk of the emission impacts occur in 2030 and beyond (70-75%). CY 2030 was the last year for which EPA estimated damage functions. These functions steadily increased between 2016 and 2030, even in constant dollars. Thus, applying the damage functions for 2030 to emission impacts predominantly occurring later is conservative. We only present the health impacts and not their monetary benefits. Monetary benefits over such a long period would require discounting in order to be summed and this is done in the next section.

> [See original comment for table 32 titled Effect of the Proposal on PM-Related Health Impacts from 2017-2050: EPA Regulatory Analysis Tool]

As can be seen, the proposal's increase in health-related premature mortality is far greater than the safety-related benefits claimed by NHTSA in their proposal even with all of the unreasonable assumptions and projections described above. These figures argue very strongly for an extensive and thorough analysis of the proposal on refining emissions in particular and their impact on public health. As we have said before, the proposal is so completely deficient in identifying its likely impact on public health that it needs to be rescinded. Any re-proposal needs to consider impacts like those shown in Table 32.

Response

Both the EIS and the RIA disclose emissions and health impacts to the decision-maker. In setting the final CAFE standards at the maximum feasible level, NHTSA considered all appropriate factors, including the emissions (Section 4.2), health (Section 4.2.3), and climate (Section 5.4) impacts disclosed in this Final EIS, and the monetized impacts discussed in the FRIA. NHTSA recognizes that the analysis results are affected by the various assumptions underlying the CAFE model inputs. These assumptions are discussed in Section VI the preamble to the final rule. The commenter's analysis, being based on different assumptions, yields results different from those in the EIS.

Comment

Docket Number: EPA-HQ-OAR-2018-0283-5471
Organization: Community Action to Promote Healthy Environments

5. The analysis of health effects is based on obsolete information and does not utilize the current understanding of the adverse effects of air pollutants on health. The supporting information pertaining to the public health impacts draws mostly on a 2013 document (Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors, U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, January 2013), which itself largely draws on 2009 work and older literature, including older Integrated Science Assessment (ISA) documents produced by EPA that describes the health effects of the criteria air pollutants. Most of the documents cited in the DEIS and the NHTSA analysis are 10 to 20 years old, and they do not adequately reflect current knowledge regarding adverse health impacts of pollutants. The Proposed Rule and supporting documents do not appear to have been developed with significant input and review from US EPA, contrary to the intention of the EIS and rulemaking processes.

6. The analysis of health effects is incomplete and has numerous significant exclusions. Even the obsolete 2013 document cited above acknowledges the following health effects that have been associated with exposure to air pollutants which are excluded from the NHTSA analysis: chronic bronchitis; emergency room visits for cardiovascular effects (all ages); strokes and cerebrovascular disease (age 50-79); other cardiovascular effects (e.g., other ages); other respiratory effects (e.g., pulmonary function, non-asthma ER visits, non-bronchitis chronic diseases, other ages and populations); reproductive and developmental effects (e.g., low birth weight, pre-term births); and cancer, mutagenicity, and genotoxicity effects.

7. The NHTSA assessment understates the cumulative health impact. The DEIS states that the preferred alternative in the Proposed Rule would increase PM2.5-related adverse health impacts by an estimated 135 to 299 deaths per year by 2035 due to premature mortality, acute bronchitis, and respiratory emergency room visits. Accounting for these deaths over the lifetime of the Proposed Rule, using simple straight line interpolations, gives between 2323 and 6685 preventable deaths. This figure is not presented in the NHTSA docket.

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9. The NHTSA analysis is incomplete as it does not evaluate impacts due to secondary particulate matter (PM), another significant omission. In many portions of the country, secondary PM (measured as PM2.5) are approaching or exceeding the levels of primary PM. The NHTSA analysis relies on modeled estimates

of PM emissions, derived from the US EPA model MOVES, which does not quantify secondary PM. This is of great importance since most health effects from criteria air pollutants are generally associated with PM exposure. A doubling of PM2.5 due to secondary PM formation would essentially double the health impacts associated with the Proposed Rule noted in comment 7 above.

10. The analysis is incomplete as it does not consider tropospheric ozone (O3), another significant omission. O3 concentrations are likely to increase due to emissions and climate change. Currently, approximately 40% of the nation is in non-attainment or maintenance status of the National Ambient Air Quality Standard (NAAQS) for ozone, Title I of the Clean Air Act. Exceedance of the O3 standard is associated with a number of serious health effects, also emitted in the NHTSA analysis. The DEIS notes that "At this time, NHTSA intends to conduct a photochemical modeling analysis for the Final EIS using the same methods as in the CAFE Final EISs (NHTSA 2010, 2012) and the HD Fuel Efficiency Standards Phases 1 and 2 Final EISs (NHTSA 2011, 2016c)." However, no such analysis has been attempted.

11. The NHTSA analysis does not properly account for differences in emissions, dispersion and exposure to tailpipe and upstream emissions, or the likely trends of the electricity generation sector across the lifetime of the Rule and the affected vehicles. The Proposed Rule will affect and increase emissions at multiple points across the fuel cycle, e.g., in oil extraction areas, at refineries, and on roads. The analysis improperly accounts for regional differences in emissions associated with the power grid and growth of renewables that underestimates the health impact of the preferred alternative. For example, fully electric or plug-in hybrid vehicles that draw from a cleaner electric grid will result in significantly lower emissions and health impacts. The analysis does not account for the diversity of electricity sources and the ongoing transition to low emission electricity sources. Further, the analysis does not properly weight emissions that occur in different areas. For example, upstream fuel cycle emissions occurring in rural areas or from elevated sources (even with coal-fired power plants) will have considerably lower impact than those associate with traffic emissions.[47] The BENMAP estimates used in the NHTSA modeling analysis does not appropriately reflect differences between these types of sources. This has the effect of decreasing the air pollution exposures and health impacts associated with the Proposed Rule.

12. The NHTSA analysis does not consider impacts outside the US. Conventional and toxic pollutants can affect populations in Canada and Mexico. Impacts of increased greenhouse gas emissions has a world-wide impact.

Response

Regarding the commenter's suggestions that NHTSA's health effects methodology is obsolete and incomplete (paragraphs 5 and 6), the analysis of health impacts in the Draft EIS has been updated for the Final EIS, as explained in Section 4.1.2, *Methods*, of the Final EIS. For example, the Final EIS analysis is based on the 2018 revision of the EPA *Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors* and includes additional quantified health impacts. However, as disclosed in Table 4.1.2-2, some health effects are excluded from quantification because of

[47] For example, analyses that are much more detailed than BENMAP and designed to correctly portray intra-urban pollution gradients typically shows a 10-fold difference in intake factors between traffic/urban sources and remote sources. A recent evaluation and review of the literature of spatial differences in exposure and effect estimates is provided in: Joana Bastos, Chad Milando, Stuart A. Batterman, Fausto Freire, "Intake fraction estimates for on-road fine particulate matter (PM2.5) emissions: exploring spatial variation of emissions and population distribution in Lisbon, Portugal," *Atmospheric Environment* 190, 2018, 284–293.

insufficient confidence in available data or methods, or because current evidence is only suggestive of causality or there are other significant concerns over the strength of the association.

Regarding the commenter's suggestion that NHTSA's analyses understates the cumulative health impact (paragraph 7), the Final EIS presents estimated changes in mortalities per year for 2025, 2035, and 2050 to show how impacts would change over time, rather than a single total of mortalities for an assumed span of years. Section VII.A.4.c.3.c of the final rule preamble includes tables showing the cumulative changes in adverse health impacts for the lifetime of MY 1975-2029 vehicles under the action alternatives.

Regarding the commenter's suggestions that NHTSA's analysis does not consider secondary PM or ozone (paragraphs 9 and 10), the Final EIS includes a photochemical grid modeling analysis that accounts for secondary particulate matter and ozone. Appendix E, *Air Quality Modeling and Health Impacts Assessment*, presents the results of NHTSA's photochemical analysis.

Regarding the commenter's suggestion that NHTSA's analysis does not properly account for differences in emissions, dispersion and exposure to tailpipe and upstream emissions, or the likely trends of the electricity generation sector (paragraph 11), the analysis in the Final EIS, through the CAFE model, accounts for anticipated changes in the electric grid toward a cleaner mix, as well as increasing sales of hybrid and electric vehicles. The BenMAP analysis in the Final EIS appropriately distinguishes between impacts from mobile sources and impacts from stationary sources. As NHTSA's action is to set nationwide fuel economy standards, this EIS provides results on a national average basis, which is a reasonable analytical approach for such a nationwide rulemaking. Conducting impact analyses for all possible combinations of energy sources (e.g., grid mixes) and vehicle fuel use (e.g., EV share of VMT) on a more localized basis is not feasible. Still, NHTSA does consider localized impacts in this EIS that reflect the various grid mixes across the United States. Chapter 6, *Lifecycle Assessment of Vehicle Energy, Material, and Technology Impacts*, discusses how emissions from the electricity grid vary with different grid mixes and how emissions decrease with cleaner grid mixes. Appendix A, *Air Quality Nonattainment Area Results*, provides estimates of potential air quality impacts in various nonattainment areas for each of the criteria air pollutants analyzed in the EIS. Finally, Appendix E, *Air Quality Modeling and Health Impacts Assessment*, presents the results of NHTSA's photochemical analysis. Specifically, the appendix summarizes the application of air quality modeling tools using a 36-kilometer grid to assess the impacts on air quality and the related health effects of the alternatives.

Regarding the commenter's suggestion that NHTSA's analysis does not consider impacts outside the United States (paragraph 12), NHTSA recognizes that while changes in emissions associated with the action alternatives would occur within the United States, some proportion of pollutants emitted near the northern and southern border may be transported in the atmosphere into Canada or Mexico. However, NHTSA does not believe it is feasible or appropriate to quantify these impacts.

The data necessary to conduct such an analysis is not reasonably available. NHTSA does not have sufficient data regarding the proportion of populations in Canada or Mexico that would be affected by motor vehicle emissions in the United States, nor can the agency identify with sufficient confidence where changes in VMT, fleet turnover, and fuel extraction and refining (which drive downstream and upstream emissions changes) will occur. While NHTSA has conducted a national-level analysis for the United States and some localized analyses (see, e.g., Appendix A and Appendix E), there is more uncertainty associated with an analysis of populations in Canada and Mexico, so NHTSA cannot reasonably quantify impacts on neighboring countries.

Additionally, attempting to quantify such impacts would significantly expand the scope of NHTSA's analysis. Pursuant to CEQ guidance, it is appropriate for NHTSA to set boundaries on its analysis that are appropriate to ensure a "hard look" at potential environmental impacts and to enable an informed choice among alternatives. Should NHTSA consider air quality impacts on Canadian and Mexican areas near the U.S. border, it would also need to expand the geographic scope of its other associated analyses. Similarly, many U.S. motor vehicles are driven across the borders, resulting in further air quality impacts in Canada and Mexico that are dependent on where such American-sold vehicles in fact are operated. This added complexity introduces added uncertainty and may unnecessarily complicate the analysis without providing significant new information for the decision-maker.

Ultimately, any emissions changes in Canada and Mexico would be reflected in incremental impacts in those counties compared to the No Action Alternative. Because of the transport distances required for emissions from sources in the United States to reach Canada or Mexico, any impacts in these countries are expected to be much less than impacts within the United States. NHTSA does not anticipate that reasonably foreseeable impacts outside the U.S. would be significant.

10.4.3 Photochemical Air Quality Modeling

Comment

Docket Number: NHTSA-2017-0069-0497
Organization: South Coast Air Quality Management District
Commenter: Barbara Baird et al.

NHTSA's air quality analysis is incomplete for the further reason that it has not included air quality modeling which would illustrate the actual ozone impacts of the various alternatives. NHTSA states that it will do so in the final EIS. But that comes too late for the public to be able to comment on that analysis. The agencies state in their Regulatory Impact Analysis, p. 1335, that they had insufficient time to perform such modeling. We find it ironic indeed that the agencies managed to produce an RIA consisting of over 1600 pages, and crammed with complex and difficult-to-understand purportedly scientific analyses, yet could not perform air quality modeling. The EIS must be recirculated to allow public comment after the air quality modeling is performed.

Docket Number: EPA-HQ-OAR-2018-0283-6218
Organization: U.S. House of Representatives
Commenter: Jan Scakowsky et al. (+ 35 other Members of Congress)

Rather than working to reduce U.S. fuel consumption and greenhouse gas emissions, the preferred alternative in the proposed rule would increase fuel consumption and the associated emissions significantly as compared to the augural CAFE and emissions standards. Even your own flawed Draft Environmental Impact Statement (DEIS) accompanying the agencies' proposal agrees.

While the DEIS correctly states that the proposed rule would negatively affect the environment by raising oil consumption and emissions of harmful air pollutants and contribute to increased global mean surface temperature, the DEIS is woefully incomplete. In particular, the analysis of air quality and associated adverse health effects in the DEIS is deficient. The DEIS fails to include results of air quality modeling on ozone pollution for the various alternatives proposed in the rule.

Response

NHTSA publicly stated its intent to conduct the analysis as part of the Final EIS in its scoping notice published on July 26, 2017.[48] The agency noted that this approach was consistent with past practice and resulted from the substantial time required to complete such an analysis. NHTSA also announced that, due to the substantial lead time required, the analysis would be based on the modeling of the alternatives presented in the Draft EIS, not of the alternatives as presented in the Final EIS. NHTSA received no public comments in response to the scoping notice addressing this analytical approach, and the agency proceeded accordingly. Furthermore, while photochemical modeling provides spatial and temporal detail for estimating changes in ambient levels of air pollutants and their associated impacts on human health and welfare, the analysis affirms the estimates that appear in the EIS and does not provide significant new information for the decision-maker or the public.

10.5 Greenhouse Gas Emissions and Climate Change

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-7, last paragraph of section 5.2.1.2, regarding trends in global emissions: We concur with the statement here that "the current global trajectory [of GHG emissions] is similar to the most fossil-fuel emissions scenario" considered in the most recent IPCC analysis, and that this is the case should be a matter of intense policy concern given the projected changes in climate, sea level, pH, and ecological impacts that would result.

Page 5-9, Section 5.2.2, Climate Change Trends, first paragraph: We concur that the quotation drawn from IPCC's Fifth Assessment Report is a critical finding and indeed merits presentation in this EIS. To reiterate, current global warming is both "unequivocal" and "unprecedented over decades to millennia" and would merely point out that this EIS is based on a base case assuming no policy actions that would lead to global warming that is four times the current level—and this merits emphasis.

*   *   *   *   *

Page 5-30, Section 5.4.1.1 Global Carbon Budget, last paragraph: While it is the case that truly addressing the issue of human-caused global warming and climate disruption, that is not an excuse for not undertaking measures that would have modest beneficial effects and certainly not a basis for adding emissions to a baseline scenario. For example, were one to dismiss the value of a 1% reduction in emissions (such as the policy that was undertaken to reduce emissions from existing coal-fired power plants), there are less than two-dozen countries that contribute to more than 1% of global CO_2 emissions—if a 1% action can be dismissed, and the other 200 countries choose to take no action at all to limit CO_2 emissions? There is a need to get to zero emissions to halt global warming and ocean acidification, much less pull the values back toward levels that would not cause extreme warming and very disruptive, even disastrous impacts, and so every action counts. The dismissal of this aspect of the

[48] NHTSA, "Notice of Intent to Prepare an Environmental Impact Statement for Model Year 2022–2025 Corporate Average Fuel Economy Standards," 82 FR 34740, 34743 fn. 15 (Jul. 26, 2017).

issue in this paragraph is simply very mistaken a path to progress on moderating human-induced climate change.

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Page 5-33, Section 5.4.2.1 Atmospheric Carbon Dioxide Concentrations: The first problem is that the alternatives would add to the CO_2 concentration rather than act to reduce its value to levels that would have much less disastrous impacts. The second problem is that if every nation followed the U.S. lead (and similar reasoning could be applied to the reasons being offered for the U.S. policy), the changes in the concentration would be much larger as the U.S. currently represents about a sixth of global emissions, and this fraction will be decreasing as the standard of living in other nations rises as projected.

Page 5-34, Section 5.4.2.2 Climate Change Attributes, Temperature: Every little bit counts in seeking to reduce the very large amounts of warming that would result from the No Action Alternative, which is an approximation to this Administration's policy and that it apparently is urging on the international community. These results make clear that the EIS needs to go back to the starting point and consider a much wider set of alternative policies, including ones that would lead to reductions in U.S. transport-sector emissions.

Response

This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions, including those documented in the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report*, and is not intended to minimize the impact of the current action and its contribution to climate change. As noted in this EIS, each of the alternatives represents a different level of stringency NHTSA considered in balancing policies and considerations in setting the standards. While NHTSA considers the potential environmental impacts of the rule as part of its decision-making, it must consider the four statutory factors (technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy) and other relevant considerations when setting "maximum feasible" CAFE standards. For more information regarding NHTSA's consideration of the four statutory factors, see Section VIII of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Notably, the DEIS states that NHTSA did not "draw[] its own conclusions relating to climate change," but instead relied on sources such as the Intergovernmental Panel on Climate Change. But an agency must make its own. It is, of course, acceptable for any agency to cite authoritative bodies such as the IPCC for information on climate change, but NHTSA must nonetheless make "its own case-by-case balancing judgment" about climate change and its impacts from its own proposed actions and alternatives. Indeed, by proposing to roll back the current vehicle standards, by selecting a "Preferred Alternative" freezing efforts to control emissions as of 2021, and by proffering what it claims is a reasonable range of alternatives, NHTSA *has* made its own judgment. If it nonetheless has drawn no conclusions relating to climate change—as it says it has not—then it certainly has not taken the requisite "hard look" at the environmental effects of what it proposes. At a minimum, it would have to explain how its failure to reach a conclusion could be reconciled with the overwhelming scientific consensus and its own firm conclusions concerning climate change less than two years ago, when it co-authored the 2016 TAR (as well as in 2012 and before). But if NHTSA *has* drawn a conclusion—for example a conclusion that diverges from those reached in the TAR and other previous documents—it must disclose it and offer a reasoned, corroborated explanation.

Response

The commenters appear to misunderstand NHTSA's statement at the beginning of Section 5.1, *Introduction*. For its understanding of climate science and analysis of the potential impacts of the alternatives on climate change, NHTSA relied on existing expert panel- and peer-reviewed climate change studies and reports. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and GCRP, supplemented with additional peer-reviewed literature and new information published since the Draft EIS. NHTSA relies on the conclusions about climate change presented by the authors of these reports, rather than rereviewing the underlying source data and drawing its own conclusions. NHTSA has revised Section 5.1 in an attempt to clarify this statement. Ultimately, NHTSA does factor these findings into its balancing of the statutory factors set forth by the EPCA. In fact, NHTSA explained at length in the NPRM how climate change, among other environmental impacts, factored into its proposal. NHTSA addresses these issues again in the preamble to the final rule.

Comments

Docket Number: NHTSA-2017-0069-0593
Organization: Center for Biological Diversity et al.
Commenter: Irene Gutierrez

A. The scientific record confirms that anthropogenic climate change is a grave and imminent hazard, and the latest studies – which the agencies have not even considered – reinforce that climate change is proceeding at an unprecedented pace requiring rapid and decisive action to reduce greenhouse gas emissions now.

As we explain in more detail in separate comments on climate science and on NHTSA's Draft Environmental Impact Statement (DEIS), climate change caused principally by combustion of fossil fuels poses severe hazards to human civilization and is already causing extensive damage throughout the nation and the world. In 2009, EPA found—based on an "ocean of evidence"—that anthropogenic GHGs are driving climate change that endangers public health and welfare; the D.C. Circuit upheld that finding in its entirety against industry challenges, and the Supreme Court refused to review the holding. In their 2012 joint publication setting out standards for MY 2017-2025, EPA and NHTSA underscored that their final rules were in response to "the country's critical need to address global climate change and reduce oil consumption." As is detailed in our separate Climate Change comments, since 2009, the peer-reviewed scientific literature on climate change and evidence of both future and *current* climate impacts has become even more clear, specific and undeniable, further buttressing the rigor of the endangerment finding and the urgency of the Clean Air Act's legal mandate that EPA address CO_2 emissions from vehicles and NHTSA's obligation to consider such impacts as part of its standard setting. In the U.S.

alone, climate change-related damages have already reached hundreds of billions of dollars every year, with 2017 setting an annual record of $306 billion.

As EPA put it less than just two years ago, climate change is "the United States' most important and urgent environmental challenge." Recent assessments of the best available science – an already vast and definitive body of knowledge – from the United States Government, scientific and professional bodies, and the international scientific community, have confirmed both that these climate change hazards are even more severe than previously believed and that they gravely damage us now.

As explained in a 2016 review of the scientific literature on impacts in the United States:

> Climate change is a significant threat to the health of the American people. The impacts of human-induced climate change are increasing nationwide. Rising greenhouse gas concentrations result in increases in temperature, changes in precipitation, increases in the frequency and intensity of some extreme weather events, and rising sea levels. These climate change impacts endanger our health by affecting our food and water sources, the air we breathe, the weather we experience, and our interactions with the built and natural environments. As the climate continues to change, the risks to human health continue to grow.

In surveying the climate science less than two years ago, EPA explained that:

> [T]he most recent data before the agency indicate that climate change is an urgent and worsening global environmental crisis, and it will require countries to take steps to dramatically reduce greenhouse gas emissions. Climate change is already having a harmful impact on public health and the environment in this country (as well as globally), affecting the health, economic well-being, and quality of life of Americans across the country, and especially those in the most vulnerable communities.

Other climate studies have reinforced and expanded upon these conclusions. For example, the Fourth National Climate Assessment published in November 2017 by the USGCRP – a federal program for which EPA is a constituent agency, along with NASA, NOAA, the National Science Foundation, and others – explained that "there is no convincing alternative explanation" for the observed warming of the climate over the last century other than human activities, that "[c]hoices made today will determine the magnitude of climate change risks beyond the next few decades," and that "[t]here is significant potential for humanity's effect on the planet to result in unanticipated surprises and a broad consensus that the further and faster the Earth system is pushed towards warming, the greater the risk of such surprises."

The 2016 Draft Technical Assessment Report (Draft TAR), developed jointly by EPA, NHTSA, and the California Air Resources Board as part of the mid-term evaluation, surveyed more recent climate science studies that "confirm and strengthen the science that supported the 2009 Endangerment Finding." The Draft TAR discussed the key findings of major peer-reviewed studies of climate change issued after 2009 by the U.S. Global Change Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and the NRC. EPA and NHTSA acknowledged the scientific consensus, canvassed the massive documentation of current and ongoing harms occurring in the United States and elsewhere, acknowledged the large share of overall U.S. GHG emissions that come from cars, light trucks, and medium-duty passenger vehicles, Draft TAR at 1-20 to 1-21, and noted that the evidence pointed decisively toward the need to achieve substantial reductions in emissions quickly. Draft TAR at 1-16 to 1-17.

This month, the IPCC issued a new report, synthesizing the latest peer-reviewed climate scientific research, and issuing a stark warning that the time to act on the increasingly exigent circumstances is now. Based on more than 6,000 scientific references and including contributions from thousands of expert and government reviewers worldwide, the Report considers the effects of global warming of 1.5°C above pre-industrial levels versus the previously-considered 2°C.[49] It concludes that pathways to limit warming to 1.5°C with little or no overshoot require "a rapid phase out of CO_2 emissions and deep emissions reductions in other GHGs and climate forcers." In pathways consistent with a 1.5°C temperature increase, global net anthropogenic CO_2 emissions must decline *by about 45% from 2010 levels by 2030*, reaching net zero around 2050 *(high confidence)*.

The October 2018 IPCC report explains the approximately 1°C temperature rise that has already occurred has "resulted in profound alterations to human and natural systems, bringing increases in some types of extreme weather, droughts, floods, sea level rise and biodiversity loss, and causing unprecedented risks to vulnerable persons and populations." The report elaborates on the specific nature of the threat at 1.5°C versus 2°C, indicating that the consequences of warming above 1.5°C are more devastating than previously understood, and highlighting the urgent importance of limiting warming below this threshold. The report demonstrates that a half degree Celsius of additional warming makes a vast difference in avoiding immense damage in food and water security, loss of coastal properties, extreme heat waves, droughts and flooding, migration, poverty, devastating health outcomes and lives lost. And it leaves no doubt that emission reductions *within the next decade* will make that difference.

As the agencies themselves have recognized, TAR at 1-17, a central feature of the climate change problem is that carbon dioxide, once emitted, remains in the atmosphere for decades or centuries. This means that each year of unabated emissions contributes to a growing, destabilizing stock of climate-altering gases, and that only a limited opportunity to abate emissions remains before the Earth faces long-lasting and effectively irremediable consequences. Yet in the NPRM, the agencies propose to lock in increased emissions from six model years' worth of vehicles—which will stay on the roads and combust fuel for decades more—during precisely this crucial next ten-year span of time.

The IPCC report provides overwhelming scientific evidence for the necessity of immediate, deep greenhouse gas reductions across all sectors to avoid devastating climate change-driven damages, and underscores the high costs of inaction or delays, *particularly* in the next decade. There is high confidence climate-related risks will be experienced at 1.5°C and "will increase with warming of 2°C and higher." But, limiting global warming to 1.5°C can reduce this risk by – depending on the region – limiting the risk of increases in heavy precipitation events; substantially reducing the probability of drought and risks associated with water availability; lessening risks of local species losses and, consequently, risks of extinction; lessening projected frequency and magnitude of floods and droughts; reducing risks associated with forest fires, extreme weather events, and the spread of invasive species, pests, and diseases; providing strong benefits for terrestrial and wetland ecosystems and for the preservation of their essential services to humans; and limiting an expansion of desert and arid vegetation, which could cause "changes unparalleled in the last 10,000 years."

[49] IPCC (2018) at 3-6. The IPCC Special Report on Global Warming found that many of the most disastrous outcomes of climate change would occur between 1.5°C and 2°C, rather than between 2°C and 2.6°C as considered in the IPCC's Fifth Assessment Report. See, e.g., IPCC (2018) 3-12, 3-13.

The October 2018 IPCC report stresses the speed with which climate change is occurring and the urgency of taking decisive steps to curtail the emissions that will lock in further warming causing ever more severe harms: "If the current warming rate continues, the world would reach human– induced global warming of 1.5°C around 2040," and "[l]imiting warming to 1.5°C depends on GHG emissions *over the next decade*]." Existing national emissions-reduction pledges are insufficient to limit global warming to 1.5°C, the IPCC report explains, "even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030." Thus, decisive mitigating action must occur *before* 2030. Limiting emissions to 1.5°C will require action at "a greater scale and pace of change" than ever before, including "very ambitious, internationally cooperative policy environments that transform both supply and demand." "[E]very year's delay before initiating emission reductions reduces by approximately two years the remaining time available to reduce emissions to zero."

The transport sector "accounted for 28% of global final-energy demand and 23% of global energy-related CO_2 emissions in 2014," with emissions in this sector growing faster than any other over the past half-century. To stop these devastating consequences, the IPCC Report explains that there must be "major reductions in greenhouse gas emissions in all sectors," and that such reductions "will require substantial societal and technological transformations." Relevant to the NPRM, the IPCC report specifically discusses the transportation sector, the largest U.S. source of GHG emissions: In order to keep climate warming below 1.5°C, major reductions in emissions from the transport sector are necessary.

In sum, the scientific record is now overwhelming that climate change poses grave harm to public health and welfare; that its hazards have become even more severe and urgent than previously understood; and that avoiding devastating harm requires substantial reductions in greenhouse gas emissions, including from the critically important transport sector, within the next decade.

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

According to the Fourth National Climate Assessment published in November 2017 by the USGCRP—(a federal program in which the EPA is a constituent agency, along with NASA, NOAA, the National Science Foundation, and others)—"there is no convincing alternative explanation" for the observed warming of the climate over the last century other than human activities. Global CO_2 emissions from fossil fuel use more than tripled from the 1960s to the period from 2007 to 2016, and CO_2 accounted for approximately 82 percent of the increase in radiative forcing (i.e., "heat trapping") over the past decade.

2017 was the third warmest year ever recorded for the United States, with only 2012 and 2016 warmer than last year. 2017's extreme weather and climate disasters killed hundreds of Americans and cumulatively cost $306 billion, making 2017 by far the costliest year on record in terms of climate harms. According to one recent study, "*this sequence of record-breaking temperatures had a negligible (<0.03%) likelihood of occurrence in the absence of anthropogenic warming*." Another new study found that "the 2016 record global warmth was only possible due to substantial centennial-scale anthropogenic warming."

Annual average temperatures in the United States have increased by 1.8°F (1.0°C) between 1895 and 2016, and the number of heat waves (defined as six-day periods with a maximum temperature above the 90th percentile for 1961 through 1990) has increased since the 1960s. In the last two decades, more than two daily heat records were broken in the U.S. for every daily cold record. By comparison, in a stable climate, the ratio of high- to low- temperature records would be approximately 1:1.

To put their findings in context, scientific reports often express the extent of scientific understanding of key findings by means of clearly defined metrics expressing the degree of confidence in those findings.[50] Where the following discussion uses these metrics, it presents them in italics.

The U.S. is expected with *high confidence* to warm by an additional 2.5°F, on average, over the next few decades. Daily highs are likewise projected with *very high confidence* to increase. Under business as usual, the hottest days of the year could be at least 5°F (2.8°C) warmer in most areas by mid-century and 10°F (5.5°C) by late this century. The urban heat island effect—which is expected with *high confidence* to strengthen as urban areas expand and become denser—will amplify climate-related warming even beyond those dangerous increases, which can cause heat-related illness and death, as discussed below.

Heavy precipitation has likewise become more frequent and intense in most regions of the U.S. since 1901 (*high confidence*), even as average annual precipitation has decreased in some regions (*medium confidence*). This finding is consistent with the scientific understanding that more water vapor is available to fuel extreme rain and snowstorms as the world warms (*medium confidence*). Recent studies of Hurricane Harvey and the 2016 flood in south Louisiana concluded that climate warming made the record rainfall totals of both disasters more likely and intense. Under continued high GHG emissions, most U.S. regions are projected to experience two to three times more extreme precipitation events by the end of the century than relative to the historic average. Rainfall during hurricanes making landfall in the eastern U.S. could also increase by 8 to 17 percent over the next century, compared to 1980-to-2006 levels.

Anthropogenic activities have contributed to the upward trend in North Atlantic hurricane activity since the 1970s (*medium confidence*). Climate change is projected to increase hurricane intensity, making hurricanes more destructive by fueling higher wind speeds and more rainfall. One recent study suggests the average intensity of Atlantic hurricanes will increase 1.8 to 4.2 percent by the 2080s, compared to a 2000 baseline. Adding to increases in hurricane intensity, there is *very high confidence* that sea level rise will make coastal floods more frequent and severe during storms. For example, relative sea levels in New York City increased 19.7 inches (50 centimeters) between 1800 and 2000.[51] The rise in sea levels increased the height of flooding during Hurricane Sandy from 7.5 to 9.2 feet (2.3 to 2.8 meters).

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[50] The USGCRP communicates the extent of scientific understanding of its key findings with two metrics: "confidence", and "likelihood." Confidence is defined as "the validity of a finding based on the type, amount, quality, strength, and consistency of evidence (such as mechanistic understanding, theory, data, models, and expert judgment); the skill, range, and consistency of model projections; and the degree of agreement within the body of literature." The scale is very high confidence (strong evidence and high consensus), high confidence (moderate evidence and medium consensus), medium confidence (suggestive evidence and competing schools of thought), and low confidence (inconclusive evidence and disagreement or lack of expert opinion). Likelihood is defined as the "probability of an effect or impact occurring," and is "based on measures of uncertainty expressed probabilistically … e.g., resulting from evaluating statistical analyses of observations or model results or on expert judgment." The scale is virtually certain (99 to 100 percent likelihood), extremely likely (95 to 100 percent likelihood), very likely (90 to 100 percent likelihood), likely (66 to 100 percent likelihood), about as likely as not (33 to 66 percent likelihood), unlikely (0 to 33 percent likelihood), very unlikely (0 to 10 percent likelihood), extremely unlikely (0 to 5 percent likelihood), and exceptionally unlikely (0 to 1 percent likelihood). USGCRP 2017 at 6, 7.

[51] Lin, N., et al., Hurricane Sandy's Flood Frequency Increasing from Year 1800 to 2100, 113 PNAS 12071 (2016), www.pnas.org/content/113/43/12071. We converted the return period in Lin et al. 2016 to probabilities with National Weather Service, Flood Return Period Calculator, www.weather.gov/epz/wxcalc_floodperiod (accessed Nov. 28, 2017).

Combined with sea level rise, more intense hurricanes could result in a median increase in storm surge from 25 to 47 percent along the U.S. Gulf and Florida coasts.

Global average sea level rose by seven to eight inches since 1900, and the rate of sea level rise is accelerating. Global sea level is likely to rise by 1.0 to 4.3 feet by the end of the century relative to the year 2000, with sea level rise of 8.2 feet possible. The severity of sea level rise is dependent on the actions taken to reduce greenhouse gas pollution. By the end of the century, global mean sea level is projected to increase by 0.8 to 2.6 feet under a lower emissions scenario (the "Representative Concentration Pathway 2.6" scenario), compared with 1.6 to 6 feet under a high emissions scenario (the Representative Concentration Pathway 8.5 scenario"). Sea level rise is already making flooding more likely. Sea level rise has contributed to a 5- to 10-fold increase in minor tidal floods along the U.S. coast since the 1960s (*very high confidence*). Those tidal floods are expected with *very high confidence* to become more frequent, deeper, and wider in extent as sea levels continue to rise. Sea level rise and intensifying storm surge threaten coastal ecosystems and millions of Americans living along the coast. Recent research projected that 4.2 million Americans would be at risk of flooding from 3 feet of sea level rise, while 13.1 million people would be at risk from 6 feet of sea level rise, driving mass human migration and societal disruption. Climate warming also has exacerbated recent historic droughts and western U.S. wildfires by reducing soil moisture and contributing to earlier spring melt and reduced water storage in snowpack (*high confidence*). In the continental western U.S., human-caused climate change accounted for more than half of observed increases in forest fuel aridity from 1979 to 2015. Drying of forest fuels has contributed to an increase the number of large fires (*high confidence*) and a doubling in fire area since the early 1980s. The risk of severe wildfire in Alaska has likely increased by 33 to 50 percent because of climate change. One model suggests that anthropogenic climate change may have quintupled the risk of extreme vapor pressure deficit (a measure of atmospheric moisture) in the western U.S. and Canada in 2016, increasing the risk of wildfire.

In addition to warming Earth's climate, CO_2 emissions have made the surface of global oceans about 30 percent more acidic over the last 150 years. There is *medium confidence* that the current rate of acidification is higher than at any time in at least the last 66 million years. Under continued high emissions of CO_2, surface acidity is expected with *high confidence* to increase by another 100 to 150 percent by the end of the century.

Finally, the Fourth National Climate Assessment concludes with *very high confidence* that large-scale shifts in the climate system, also known as tipping points, and the compound effects of simultaneous extreme climate events have the potential to create unanticipated, and potentially abrupt and irreversible, "surprises" that become more likely as warming increases. The disastrous effects of compound extreme events are, in fact, already occurring, such as during Hurricane Sandy when sea level rise, abnormally high ocean temperatures, and high tides combined to intensify the storm and associated storm surge, and an atmospheric pressure field over Greenland steered the hurricane inland to an "exceptionally high-exposure location." The crossing of tipping points could result in climate states wholly outside human experience and result in severe physical and socioeconomic impacts. For example, increased rainfall and meltwater from Arctic glaciers have the potential to slow a major ocean current called the Atlantic meridional overturning circulation ("AMOC"). If the AMOC slows or collapses, the northeastern U.S. will see a dramatic increase in regional sea levels of as much as 1.6 feet (0.5 meters). Another potential tipping point in the Arctic is the release of carbon (either as CO_2 or as methane) from thawing permafrost, which has the potential to "drive continued warming even if human-caused emissions stopped altogether." In 2016, record high temperatures were set at most permafrost monitoring sites in the Arctic. A recent analysis suggests that the earth is at risk of crossing a planetary threshold that could lock in a rapid pathway toward much hotter conditions—"Hothouse Earth"—propelled by self-reinforcing feedbacks, and that this risk could exist at a 2°C temperature rise and increase significantly with additional warming.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

A. Dramatic Changes to the Climate System Are Already Occurring

Significant changes in the climate system are well underway. The DEIS acknowledges "evidence of rapid climate change," DEIS at 5-10, and that the rate of this warming is accelerating, *id.* at 11. Temperatures are already about 1°C warmer than pre-industrial averages, with the last decade being "the warmest on record, and 2016 the hottest year on record in the continental United States." *Id.* at 5-10. The rate of increase in the Arctic is even higher, with "almost twice the global average rate over at least the past several decades." Associated with this warming are "more frequent weather extremes such as droughts, floods, severe storms and heat waves," 19 centimeters of sea level rise, and increasingly intense hurricanes and tropical storms in the North Atlantic. More severe "storm surges and waves," in turn, have caused substantial coastal erosion in Mississippi, Texas, and Louisiana since the 1970s.

Climate change-related impacts have been seen and felt throughout 2018. Hurricane Michael, the fourth strongest hurricane ever to hit the United States, was powered in part by "warmer than usual" waters in the Gulf of Mexico. Hurricane Florence, similarly, was fed by warmer-than-average oceans and moister air. The country also saw historic storms in 2017. Hurricane Harvey dumped record amounts of rain on Houston in August 2017 and caused widespread flooding throughout Texas. Hurricane Maria, a few weeks later, killed nearly 3,000 people in Puerto Rico and left much of that U.S. territory without electricity or clean drinking water for months. The magnitude of Hurricanes Harvey, Maria, and Irma and others from the 2017 season have all been linked to warmer-than-average ocean temperatures attributable to climate change. Meanwhile, California's wildfires have become more widespread as conditions have become hotter and drier due to climate change.

B. 4°C of Warming by 2100 Will Cause Serious Harms to Many Aspects of Human Society and the Natural World

The DEIS observes that the world is currently on a high-emissions trajectory and that only a minimal amount of mitigation is reasonably foreseeable through the 21st century. DEIS at 8-20. It thus projects the climate impacts corresponding to a high level of emissions: nearly 800 ppm of CO_2, more than 4°C of warming, and about 1 meter of sea level rise by the year 2100. DEIS at 5-31. The harms to the United States and the world at this level of warming are difficult to overstate. Such warming would cause "substantial species extinction, large risks to global and regional food security, and . . . high temperature and humidity compromising normal human activities, including growing food or working outdoors in some areas for parts of the year." These changes will last "well beyond 2100," because elevated CO_2 concentrations "will persist [in the atmosphere] for many centuries." DEIS at 5-10.

At 4°C of warming the U.S. economy is projected to suffer $698 billion in damage per year by 2100. More frequent and more intense extreme weather events, like heat waves, heavy rains, droughts, and storms, will harm the productivity of U.S. agriculture and forestry activities, making those sectors more vulnerable to climate risks. The harms to global agriculture increase with each degree-Celsius increase in warming: wheat crop yields will decrease by 6%, corn by 7.4%, rice by 3.2%, and soybean by 3.1%. U.S.

agriculture may sustain disproportionate harms, with U.S. corn yields reduced by 10.3% per degree-Celsius warming due to corn's high sensitivity to rising temperatures.

The DEIS, relying on projections reported by the IPCC, projects a range of "likely" additional sea level rise between 0.26 meter and 0.82 meter over the coming century. The projected rise in sea level would have "serious implications" for low-lying coastal areas and small islands, including parts of Florida, Louisiana, Texas, Mississippi, and the Carolinas. Notably, these projections may be low, as they do not fully account for sea level rise from the breakup and disintegration of major ice sheets, meaning "sea-level rise could be even greater." DEIS at 5-13. Specifically, GHG emissions growth over the coming decades could trigger "runaway" instability in Antarctica's ice sheets, causing "more than 15 meters [of sea level rise] by 2500."

Climate impacts on food security, sea level, and the economy will threaten the national security of the United States. By the end of the 21st century, the U.S. intelligence community predicts the United States will face "wide-ranging national security challenges" driven by climate change, including geopolitical instability, increased sectional tensions, and negative impacts on the global financial and economic system. This is because climate change is a "threat multiplier," meaning it "exacerbates existing or arising threats to stability and peace" and can "trigger armed conflict." Long-term displacement of climate refugees in particular may lead to additional conflicts in their new home countries. Such mass displacement—estimated on the order of hundreds of millions of people by 2100, DEIS at 8-44—will in turn harm U.S. military humanitarian operations and "strain [the military's] ability to respond to conflict."

Response

This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions. For its understanding of climate science and analysis of the potential impacts of the alternatives on climate change, NHTSA relied on existing expert panel- and peer-reviewed climate change studies and reports when preparing this EIS, including several of the resources cited by the commenters. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and GCRP, supplemented with additional peer-reviewed literature. These reports assess numerous individual studies to draw general conclusions about the potential impacts of climate change, thus, providing a "hard look" at the potential environmental consequences of the final rule. In response to the comments, NHTSA has reviewed the provided references and added additional information to Final EIS Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Final EIS Chapter 8, *Cumulative Impacts*. For example, in the Final EIS, NHTSA has integrated the findings of consensus reports and peer-reviewed literature that have been published since the release of the Draft EIS, including the IPCC *Special Report: Global Warming 1.5°C* and the GCRP Fourth National Climate Assessment.

Comments

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA's presentation also masks the effect of delay. Because carbon emissions are long-lived (a time measured in centuries) and their effects are cumulative and do not diminish for millennia, any quantity of carbon emitted now causes much more damage than the same quantity of carbon emitted later. Again, in stark contrast to NHTSA's current DEIS, in its 2012 Final EIS, NHTSA disclosed the consequences of delay in its discussion of delaying mitigation: "Several recent studies have shown that delaying mitigation of GHG emissions results in greater accumulation of CO_2 in the atmosphere, thereby increasing the risk of crossing tipping points and triggering abrupt changes." In 2014, the White House issued a report demonstrating that the cost of delay is not only extremely steep but also potentially irreversible, and rises exponentially as delay continues. According to the National Research Council, "[e]missions of [CO_2] from the burning of fossil fuels have ushered in a new epoch where human activities will largely determine the evolution of Earth's climate. Because [CO_2] in the atmosphere is long lived, it can effectively lock Earth and future generations into a range of impacts, some of which could become very severe. Therefore, emission reduction choices made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia." NHTSA's analysis, however, does not account for the effect of delaying climate action, leaving the reader to fail to appreciate that forgoing action now multiplies the later damage by many times. Particularly now that NHTSA has also proposed to slash the social cost of carbon to near-negligible amounts, NHTSA completely fails to account for this highly significant magnifying effect.

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

The attachment to this letter summarizes the recent scientific findings demonstrating that climate change is *already* causing vast economic damages, and that those damages are both much more severe and urgent than has previously been understood. That evidence, which constitutes the best available science, demonstrates that steep reductions in greenhouse gas emissions must occur *within the next decade.* The agencies, which propose to freeze the fuel efficiency of the light duty vehicle fleet and cause enormous additional greenhouse gas pollution during six of those crucial years, must take this evidence into account. In light of the indisputable, severe and immediate damage to human health and welfare that would be done by weakening the existing vehicle standards, we urge the agencies to withdraw their Proposal and instead set to work to strengthen the standards forthwith. All references cited herein will be uploaded to EPA's and NHTSA's dockets on the Proposal and the DEIS.

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b. To Avoid the Most Devastating Impacts of Climate Change, the United States Must Act *Now* to Reduce Greenhouse Gas Emissions from Cars and Light Duty Trucks.

The hazards posed by GHG emissions for health and welfare are inherently time-sensitive. Because CO_2 is long-lived in the atmosphere, each year's emissions add to the accumulated total of CO_2 already in the atmosphere, building year after year to ever higher concentrations.[52] The longer we wait to reduce

[52] 77 Fed. Reg. at 62,895 (citing NRC, Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia (2011) ("Emissions of carbon dioxide from the burning of fossil fuels have ushered in a new epoch where human activities will largely determine the evolution of Earth's climate. Because carbon dioxide in the atmosphere is long lived, it can effectively lock Earth and future generations into a range of impacts, some of which could become very severe. Emission reduction choices made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia.")).

emissions, the greater the risks will be, and the greater the cost of reducing those risks in the future. Action too long delayed may put a sustainable climate out of reach altogether.

In 2014, the White House issued a report demonstrating that the cost of delay is not only extremely steep but also potentially irreversible, and rises exponentially as delay continues. As the report notes, the costs of delay are “driven by fundamental elements of climate science and economics” because CO_2 remains in the atmosphere for hundreds of years after it is emitted. Any mitigation policy that is delayed must therefore “take as its starting point a higher atmospheric concentration of CO_2.” Based on conservative assumptions (omitting, for example, the effects of crucial tipping points such as methane releases from melting permafrost), the report values the cost of *delay alone*—i.e., excluding the damages that occur absent delay—at no less than $150 billion (or 0.9 percent of global output) for every year that action is delayed, if that delay causes global temperatures to overshoot a threshold increase of two degrees Celsius by just one additional degree (relative to pre-industrial levels). Every additional degree of warming thereafter will sharply raise the annual damage above this increment (for example, an *additional* 1.2 percent of global output for a rise in temperatures to the next degree Celsius). These costs are not one-time, but are incurred permanently and cumulatively, year after year. Conversely, a delayed policy to mitigate climate change, once implemented, “must be more stringent and thus more costly in subsequent years.” Summarizing numerous peer-reviewed scientific and economic studies, the report concluded that “delay substantially decreases the chances that even concerted efforts in the future will hit” aggressive climate targets.

A 2018 special report from the Intergovernmental Panel on Climate Change (“IPCC”) on *Global Warming of 1.5°C* demonstrates the need for immediate, far-reaching action to reduce greenhouse gas emissions to limit warming to 1.5°C to avoid devastating harms to people and life on earth, and emphasizes the high costs of delayed action in making emissions cuts.

The report quantifies the harms that would occur at 2°C warming compared with 1.5°C, and the differences are stark. According to the IPCC’s analysis, the damages that would occur at 2°C warming compared with 1.5°C include more deadly heat waves, drought and flooding; 10 centimeters of additional sea level rise within this century, exposing 10 million more people to flooding; a greater risk of triggering the collapse of the Greenland and Antarctic ice sheets with resulting multi-meter sea level rise; dramatically increased species extinction risk, including a doubling of the number of vertebrate and plant species losing more than half their range, and the virtual elimination of coral reefs; 1.5 to 2.5 million more square kilometers of thawing permafrost area with the associated release of methane, a potent greenhouse gas; a tenfold increase in the probability of ice-free Arctic summers; a higher risk of heat-related and ozone- related deaths and the increased spread of mosquito-borne diseases such as malaria and dengue fever; reduced yields and lower nutritional value of staple crops like corn, rice, and wheat; a doubling of the number of people exposed to climate-change induced increases in water stress; and up to several hundred million more people exposed to climate-related risks and susceptible to poverty by 2050.

The IPCC report concludes that pathways to limit warming to 1.5°C with little or no overshoot require “a rapid phase out of CO_2 emissions and deep emissions reductions in other GHGs and climate forcers.” In pathways consistent with a 1.5°C temperature increase, global net anthropogenic CO_2 emissions must decline *by about 45% from 2010 levels by 2030*, reaching net zero around 2050 (*high confidence*). For a two-thirds chance for limiting warming to 1.5°C, CO_2 emissions must reach carbon neutrality in 25 years (*high confidence*). The special report lays out in stark terms that a mere one-half of a degree Celsius of additional warming makes a vast difference in avoiding immense damage in food and water security, loss of coastal properties, extreme heat waves, droughts and flooding, migration, poverty, devastating health outcomes and lives lost. And it leaves no doubt that emission reductions within *just the next decade* will make that difference.

In regard to the transportation sector, the report finds that the needed deep emissions reductions would be achieved by technology-focused measures that include energy efficiency and fuel-switching. In 1.5°C-consistent pathways, renewables would supply 70% to 85% of power by 2050. Transport would need to shift heavily towards green electricity, which "would [have to] rise from less than 5% in 2020 to about 35-65% in 2050."

In short, the IPCC report provides overwhelming scientific evidence for the necessity of immediate, deep greenhouse gas reductions across all sectors to avoid devastating climate change-driven damages, and underscores the high costs of inaction or delays, particularly in the next crucial decade—which spans the six years of inexcusable inaction the agencies propose—in making these cuts.

The current proposal to drastically weaken existing vehicle GHG standards flouts these fundamental and well-understood principles. The mere act of delaying further reductions in vehicle GHG emissions itself exacerbates the harm they cause, an effect completely ignored in the Proposal. It is arbitrary, capricious, and unlawful for this reason alone.

Until this administration's announcement of its intention to reverse U.S. policy committing to the Paris Agreement,[53] every country in the world endorsed the effort to act now in order to keep temperature increases and their enormous costs at a minimum. As part of its efforts under the Paris Agreement to combat climate change, the United States committed to the target of holding the long-term global average temperature "to well below 2°C above pre- industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre- industrial levels." The Paris Agreement codifies the international consensus that climate change is an "urgent threat" of global concern. The Agreement also requires a "well below 2°C" climate target because 2°C of warming is no longer considered a safe guardrail for avoiding catastrophic climate impacts and runaway climate change. EPA and NHTSA considered the impact of the existing standards in the context of this international effort to combat global climate change during the course of the mid-term evaluation; the current Proposal, on the other hand, does not mention the global effects of that action, let alone explain why EPA and NHTSA's earlier conclusions were incorrect.

Instead of delay, immediate and aggressive GHG emissions reductions are necessary to keep warming well below a 2°C rise above pre-industrial levels. The U.S. is the world's second- largest emitter of CO_2 from fossil fuels, and in 2017, transportation sector emissions contributed about 37 percent of U.S. energy-related CO_2. As discussed below, aggressive climate action requires a steep reduction in emissions from the transportation sector, which recently overtook power plants as the largest U.S. source of GHG emissions. Without major reductions in U.S. transportation sector emissions, success in keeping temperatures below a 2°C rise above pre-industrial levels is extremely unlikely.

[53] On December 12, 2015, the United States and 194 other nation-states meeting in Paris at the 2015 United Nations Framework Convention on Climate Change Conference of the Parties consented to the Paris Agreement, committing its parties to take action to tackle dangerous climate change. Although the Trump administration has announced its intent to leave the Paris Agreement, the U.S. remains a party to it until it formally withdraws pursuant to Article 28 of the Paris Agreement. Paris Agreement Art. 28.

The IPCC's Fifth Assessment Report and other expert assessments have established global carbon budgets, which correspond to the total amount of CO_2 (and CO_2-equivalent emissions of other GHGs) that can be released into the atmosphere while maintaining some probability of staying below a given temperature target. According to the IPCC, the total cumulative anthropogenic emissions of CO_2 from 2011 onward must remain below about 1,000 gigatonnes ($GtCO_2$) for a 66 percent probability of limiting warming to 2°C above pre-industrial levels, and to 400 $GtCO_2$ from 2011 onward for a 66 percent probability of limiting warming to 1.5°C. 2018 IPCC special report on *Global Warming of 1.5°C* provides a revised carbon budget for a 66 percent probability of limiting warming to 1.5°C, estimated between 420 $GtCO_2$ and 570 $GtCO_2$, from January 2018 onwards. At the current emissions rate of 42 $GtCO_2$ year, this carbon budget will be spent in just the next 10 to 14 years, underscoring the urgent need for transformative global action to reduce carbon emissions to net zero within the next three decades.

Published scientific studies have estimated the United States' portion of the global carbon budget by allocating the remaining budget across countries based on equity, economics, and other factors. Estimates of the U.S. carbon budget vary depending on the temperature target used by the study (1.5°C versus 2°C), the likelihood of meeting the temperature target (50 percent versus 66 percent probability), the equity principles used to apportion the global budget among countries, and whether a cost-optimal model was employed. As detailed below, the U.S. carbon budget for limiting temperature rise to well below 2°C has been estimated at 25 $GtCO_2eq$ to 57 $GtCO_2eq$ on average, while the budget for limiting temperature rise to 2°C ranges from 34 $GtCO_2$ to 123 $GtCO_2$.

To estimate the remaining U.S. carbon budget from 2010 to 2100 for a 50 percent chance of keeping the global average temperature rise to 1.5°C by 2100, researchers used averages across IPCC-AR5 equity-based sharing principles under a cost-optimal model. Using this methodology, these researchers estimated the U.S. carbon budget at 25 $GtCO_2eq$ for six well- mixed GHGs (which corresponds to CO_2-specific emissions of ~17 $GtCO_2$) by averaging across four equity principles: capability, equal per capita emissions, greenhouse development rights, and equal cumulative per capita emissions. The study estimated the U.S. budget at 57 $GtCO_2eq$ (which corresponds to CO_2-specific emissions of ~38 $GtCO_2$) when averaging across five sharing principles by adding the constant emissions ratio to the four above-mentioned principles.[54] The U.S. carbon budget for a 66 percent probability of keeping warming below 2°C was estimated at 60 $GtCO_2eq$ based on four equity principles (capability, equal per capita, greenhouse development rights, equal cumulative per capita), and at 104 $GtCO_2eq$ for six well- mixed GHGs based on five principles (adding in the constant emissions ratio, but see footnote above). For a 66 percent probability of keeping warming below 2°C, another study estimated the U.S. carbon budget at 34 $GtCO_2$ based on an "equity approach" for allocating the global carbon budget, and 123 $GtCO_2$ under an "inertia approach." The equity approach allocates national carbon budgets based on population size and provides for equal per capita emissions across countries, whereas the inertia approach bases sharing on countries' current emissions. Also using a 66 percent probability of keeping warming below 2°C, a third study estimated the U.S. carbon budget at 78 to 97 $GtCO_2$ based on a contraction and convergence framework, in which all countries adjust their emissions over time to achieve equal per

[54] Robiou du Pont, Yann et al., Equitable Mitigation to Achieve the Paris Agreement Goals, 7 NATURE CLIMATE CHANGE 38 (2017), at Supplemental Table 1. We note, however, that the constant emissions ratio, which maintains current emissions ratios, is not considered to be an equitable sharing principle because it is a grandfathering approach that "privileges today's high-emitting countries when allocating future emission entitlements." Kartha, S. et al., Cascading Biases Against Poorer Countries, 8 NATURE CLIMATE CHANGE 348 (2018).

capita emissions.[55] Although the contraction and convergence framework corrects current emissions inequities among countries over a specified time frame, it does not account for inequities stemming from differences in historical emissions. When accounting for historical responsibility, the study estimated that the United States has an additional cumulative carbon debt of 100 $GtCO_2$ as of 2013. Using a non-precautionary 50 percent probability of limiting global warming to 2°C, an additional study estimated the U.S. carbon budget at 158 $GtCO_2$ based on a "blended" approach of sharing principles that averages the "inertia" and "equity" approaches. Of that 158 $GtCO_2$ budget, 91 $GtCO_2$ was categorized as "committed" emissions through the lifetimes of existing CO_2-emitting infrastructure (unless they are retired early).

Although the cited studies differ in terms of certain assumptions and normative emphases, they all tell the same fundamental story: under any conceivable scenario, the remaining U.S. carbon budget for limiting global average temperature rise to 1.5°C or 2°C is extremely small and is rapidly being consumed. In 2017, the U.S. transportation sector emitted 1.9 $GtCO_2$. Regardless of whether the total remaining U.S. carbon budget is 38 $GtCO_2$ (to limit temperature rise to well below 2°C) or in the range of 34 $GtCO_2$ to 158 $GtCO_2$ (to hold the rise to 2°C), the country must rapidly reduce and then eliminate its vehicular emissions. By delaying critical emission reductions from cars and trucks, the Proposal could seriously imperil the United States' ability to avoid the most harmful impacts of climate change. Yet it has given no consideration to this key consequence of its proposed action.

c. The Transportation Sector Has Become the Largest Source of Climate-Destabilizing Emissions; No Strategy for Curbing Climate Change Can Succeed Without Substantial and Rapid Reductions of Emissions from this Sector.

In 2016, the U.S. transportation sector surpassed the electric sector for the first time as the nation's largest emitter of GHGs. In 2017, the transportation sector emitted 1,902 MMT CO_2—37 percent of the national total CO_2 emissions—compared to 1,744 MMT CO_2 in the electric power sector, 34 percent of the national total. Moreover, transportation sector emissions have increased every year since 2012. U.S. transportation-related emissions vastly outstrip those of any other country; in 2015, for instance, U.S. CO_2 emissions from the transportation sector were more than double those of China and were more than 83 percent greater than those of all 26 of Europe's OECD countries combined. Meanwhile, light-duty cars and trucks are responsible for nearly 60% of transportation sector GHG emissions. Emissions from the transportation sector continue to rise dramatically—increasing by 22% between 1990 and 2016, due in substantial part to light-duty vehicles. It is clear that without rapid and substantial progress in reducing U.S. transportation sector emissions in the coming years and decades—particularly those from light-duty cars and trucks—the U.S. will be unable to stay within the confines of its carbon budget.

Maintaining the existing standards is critical to ensure that emissions reductions from the transportation sector are locked in, and that the U.S. continues to innovate and transitions towards clean transportation technologies. Indeed, because of the extreme urgency of the climate threat, the vehicle standards should be significantly strengthened in the upcoming, crucial decade. The Proposal's plan to

[55] Gignac, Renaud and H. Damon Matthews, Allocating a 2C cumulative carbon budget to countries, 10 ENVTL. RES. LETT. 075004 (2015). In a contraction and convergence approach, national emissions are allowed to increase or decrease for some period of time until they converge to a point of equal per capita emissions across all regions at a given year, at which point all countries are entitled to the same annual per capita emissions.

instead freeze vehicle standards for six of those crucial years would vastly increase transportation sector emissions, and is unlawful, arbitrary and capricious.

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The climate damage generated by each additional ton of greenhouse gas emissions depends on the background concentration of greenhouse gases in the global atmosphere. Once emitted, greenhouse gases can linger in the atmosphere for centuries, building up the concentration of radiative-forcing pollution and affecting the climate in cumulative, non-linear ways.[56] As physical and economic systems become increasingly stressed by climate change, each marginal additional ton of emissions has a greater, non-linear impact. The climate damages generated by a given amount of greenhouse pollution is therefore a function not just of the pollution's total volume but also the year of emission, and with every passing year an additional ton of emissions inflicts greater damage.

As a result, focusing just on the volume or rate of emissions is insufficient to reveal the incremental effect on the climate. The change in the rate of emissions (flow) must be assessed given the background concentration of emissions (stock). A percent comparison to national emissions is perhaps even more misleading. A project that adds, for example, 23 million additional tons per year of carbon dioxide would have contributed to 0.43% of total U.S. carbon dioxide emissions in the year 2012.[57] In the year 2014, that same project with the same carbon pollution would have contributed to just 0.41% of total U.S. carbon dioxide emissions—a seemingly smaller relative effect, since the total amount of U.S. emissions increased from 2012 to 2014.[58] However, because of rising background concentrations of global greenhouse gas stock, and because of growing stresses in physical and economic systems, the marginal climate damages per ton of carbon dioxide (as measured by the social cost of carbon) increased from $33 in 2012 to $35 in 2014 (in 2007$). Consequently, those 23 million additional tons would have caused marginal climate damages costing $759 million in the year 2012, but by 2014 that same 23 million tons would have caused $805 million in climate damages. To summarize: the percent comparison to national emissions misleadingly implied that a project adding 23 million more tons of carbon dioxide would have a relatively less significant effect in 2014 than in 2012, whereas monetizing climate damages would accurately reveal that the emissions in 2014 were much more damaging than the emissions in 2012—almost $50 million more.

Capturing how marginal climate damages change as the background concentration changes is especially important because NEPA requires assessing both present and future impacts.[59] Different project alternatives can have different greenhouse gas consequences over time. Most simply, different alternatives could have different start dates or other consequential changes in timing. For example, Alternative 5 has a higher minimum standard for domestic passenger cars for MY 2021 than Alternatives

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[56] Carbon dioxide also has cumulative effects on ocean acidification, in addition to cumulative radiative-forcing effects.

[57] Total U.S. carbon dioxide emissions in 2012 were 5,366.7 million metric tons (for all greenhouse gases, emissions were 6,529 MMT CO_2 eq). See EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016* at ES-6, tbl. ES-2 (2018).

[58] Total U.S. carbon dioxide emissions in 2014 were 5,568.8 million metric tons (and for all greenhouse gases, 6,763 MMT CO_2 eq.) *Id.*

[59] NEPA requires agencies to weigh the "relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity," as well as "any irreversible and irretrievable commitments of resources." 42 U.S.C. § 4332(2)(C).

6 and 7 do, but a lower standard for subsequent model years, and the associated emissions will have different climate effects in early years than in later years. For the reasons explained above, calculating volumes or percentages is insufficient to accurately compare the climate damages of project alternatives with varying greenhouse gas emissions over time.

By factoring in projections of the increasing global stock of greenhouse gases as well as increasing stresses to physical and economic systems, the social cost of greenhouse gas metrics enable accurate and transparent comparisons of projects with varying greenhouse gas emissions over time.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

The DEIS states that "drastic reductions" of emissions from the U.S. transportation sector (and other sources) are necessary to avoid dire impacts of climate change to the U.S. economy and public health. DEIS at 5-30. The Proposal, however, would do the opposite: it would *increase* cumulative GHG emissions from passenger cars and light trucks by nearly 10% over the coming century. *See id.*

Climate change results from the total buildup of CO_2 and other GHGs in the atmosphere from many human sources over a long period of time. *See* DEIS at 5-4. This is because GHGs remain in the atmosphere for many years after being emitted (as long as millennia in the case of much of the emitted carbon dioxide), causing them to accumulate over time and amplifying their harms. In other words, climate change is a "stock" problem (based on the total quantity of GHGs in the atmosphere) rather than a "flow" problem (based on the quantity of GHGs emitted at a given time). Increases in emissions rates are harmful because they quicken the rate at which the "stock" of atmospheric GHG pollution rises, thereby pushing the world faster toward even more dangerous levels of warming. Conversely, reductions in emissions must occur incrementally and continuously to ensure that the stock of GHGs in the atmosphere does not get too large.

Another way of expressing the cumulative nature of the problem is through the concept of a "carbon budget." A carbon budget is a way of expressing the total amount of human-made GHGs that can be emitted and accumulate in the atmosphere before global temperatures exceed a certain warming threshold. DEIS at 5-29. To avoid exceeding the carbon budget for less dangerous levels of warming, annual emissions must be reduced and, eventually, zeroed-out.

The DEIS examines the Proposal's impacts on a total budget consistent with staying below 2°C of warming. DEIS at 5-29–30. This is the maximum level of warming set by the Paris Agreement, the international agreement on climate change mitigation to which the U.S. is still a party. 2°C of warming would be much less harmful to the United States than the 4°C of warming projected in the DEIS, with less damaging wildfires, lower rates of heat-related human morbidity, and less costly river and coastal flooding.

The DEIS's carbon budget analysis shows that the Proposal's contribution to climate change is not "small"—despite its repeated use of that adjective—while also demonstrating that current fuel economy and GHG emission standards are but an initial step that must be pursued and expanded via further reductions in emissions. According to the DEIS's analysis, even when maintaining the current fuel economy and GHG emission standards, the U.S. transportation sector would burn through about 5% of the entire global budget consistent with avoiding 2°C warming by 2100. If the Proposal were implemented, the DEIS projects that the U.S. transportation sector's share would tick up to nearly 6%.

Id. Limiting warming to 1.5°C (a level of warming still less harmful than 2°C) requires an even tighter budget. With the current standards, U.S. transportation sector emissions between 2016 and 2100 would account for nearly 20% of the total. If the Proposal were implemented, that share rises to approximately 22%. In other words, the Proposal would exhaust nearly 2% of the remaining carbon budget for the *entire* planet.

Given these facts and for these reasons, the DEIS correctly recognizes that "drastic reductions" of emissions from the U.S. transportation sector, and all other sectors of the global economy, are necessary to stay within a 2°C budget. DEIS at 5-30. The Proposal, however, would do the opposite. Compared to leaving the current fuel standards in place, it would *increase* total passenger car and light truck emissions over the 21st century by nearly 10%.[60]

Not only will the Proposal significantly *increase* emissions, but it will also significantly increase costs to the United States. Continuing to reduce emissions between 2021 and 2026 will be cheaper in the long run than stalling progress now, which will require much more sudden and extreme reductions later. The longer the United States (and other major economies) wait to meaningfully bring down their GHG emissions, the greater the atmospheric buildup of pollution and the more drastic—and expensive—the emissions reductions will need to be to avoid severe global warming. Sudden, drastic reductions in emissions will be more expensive to implement than the gradual, incremental reductions represented by the existing regulations. This fact not only demonstrates the irrationality of the Proposal, but also contradicts the Proposal's conclusion that it will save the public "a considerable amount of money." *See* 83 Fed. Reg. at 42,997.

Response

In developing the Proposed Action and alternatives, NHTSA considered the four EPCA statutory factors that guide the agency's determination of maximum feasible standards: technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy. In addition, NHTSA considered relevant safety and environmental factors, including climate change. This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions, including those documented in the IPCC *Fifth Assessment Report*. As noted in this EIS, each of the alternatives represents a different level of stringency NHTSA considered in balancing policies and considerations in setting the standards.

NHTSA recognizes that several studies have shown that delaying mitigation of GHG emissions: 1) results in a greater accumulation of CO_2 in the atmosphere, thereby increasing the risk of crossing tipping points and triggering abrupt changes, 2) would require more stringent reductions in overall GHG emissions in the future to limit climate change impacts, and 3) would increase later climate damage costs for similar levels of emissions. NHTSA has added a brief discussion of this topic in Section 8.6.5.2, *Sectoral Impacts of Climate Change*.

One way to frame these concepts is in terms of a global carbon "budget," which NHTSA does in Section 5.4.1.2, *Global Carbon Budget*. Another way is by using a social cost of GHG metric, which NHTSA discusses in Section 5.3.2, *Social Cost of Greenhouse Gas Emissions.* NHTSA's actual quantification of this

[60] DEIS at 5-30 (reporting that the Proposal would release an additional 8,000 MMT CO_2e between 2016 and 2100). The increase would be more than a century's worth of emissions from Portugal, assuming Portugal itself breaches its Paris commitments and does not reduce its emissions. *See* EDGAR, *GHG Emissions*, *supra* note 5 (Portugal 2012 values).

metric is done in Section VII.A.4 of the preamble to the final rule and in the FRIA. Because one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis. NHTSA has considered this information, the information provided by commenters, the information in this EIS, and other information in the administrative record in balancing the statutory factors that guide its determination. For more information about NHTSA's balancing of the statutory factors, see Section VIII of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-4, Table 5.1.1-1. Standard Terms to Define the Likelihood of a Climate-Related Event and Figure 5.1.1-2. Confidence Level as a Combination of Evidence and Argument: While the table and figure do present the explanation of terms used by the IPCC, it is not at all clear that these terms represent the framing that is appropriate for consideration in this EIS. For example, EPA takes on action on substances such as pesticides that might have a 1 in a 1000 or even lower odds of causing health impacts, and surely NHTSA has design standards for highways and vehicles intended to reduce risks to far lower levels than indicated in these materials, wanting to avoid accidents and injuries with far lower likelihood. It just not appropriate to be suggesting that actions are not needed for changes on the climate that have lower than high probability—that is simply not the basis for regulatory actions that are mandated under U.S. law, and the EIS needs to make this clear.

Response

In this EIS, NHTSA uses the standard IPCC terminology to describe uncertainty associated with various climate change impacts, as defined in Section 5.1.1, *Uncertainty in the IPCC Framework*. The meanings of these IPCC terms, which range from *exceptionally unlikely* to *virtually certain*, are different from the language used to describe uncertainty elsewhere in this EIS. Contrary to the commenter's assertion, NHTSA has considered the risks associated with climate change, including the potential impacts of the Proposed Action and alternative on GHG emissions and climate change attributes. However, NHTSA must balance these impacts with the other EPCA statutory factors, including economic practicability. NHTSA discusses its balancing of the statutory factors in Section VIII of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-4 and 5-5, Section 5.1.2. Climate Change and Its Causes: We are pleased to see that the EIS cites and is supportive of the finding in the IPCC international assessment that "it is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century"[italics in original]. We also are in agreement with the identification of the main drivers of climate change listed in this section, although we would note that (1) while natural aerosols are mentioned, that these are injected by volcanic eruptions is not mentioned; and (2) that it is misleading to say that "Clouds" are a driver of climate change, rather than mainly a feedback process internal to the system (it might be appropriate to mention that contrails can affect the climate, though this is a quite small effect and without quantification should likely be omitted). To give a sense of the relative importance of each of these terms, it would be helpful to include the table from the most recent IPCC assessment that indicates the estimated changes in radiative forcing that have resulted from these various influences over the Industrial Period.

This might also be the location in the text to summarize what has been learned about the causes of natural climate change over the course of Earth history. We would suggest that one key insight is that the significant changes in climate in the past have not been random, but have resulted from various causal factors (changes in the Earth's orbit, changes in atmospheric composition, periods with major volcanic eruptions, changes in the Earth's geography and mountain building, and more). In addition, the changes that have occurred have involved major changes in landscapes; for example, with the reconstructed global average temperature ~5-6°C colder at the Last Glacial Maximum, global sea level was about 120 meters (~390 feet) lower, suggesting an equilibrium sea level sensitivity to global average temperature of order 20 meters per degree C (~36 feet/°F) warming, and back a few tens of millions of years with reconstructed global average temperature perhaps 4-6°C degrees warmer than at present, palm trees have been present in high northern latitudes and the Greenland and Antarctic ice sheets, which hold of order 70 meters (~230 feet) of sea level equivalent, were not present, suggesting an equilibrium sea level sensitivity to global average temperature of order 15 meters per degree C (~28 feet/°F). Thus, what paleoclimatic records make clear is that the Earth's climate, sea level, and landscapes have changed in response to radiative forcings comparable to the changes in radiative forcing that human activities, primarily combustion of fossil fuels, are causing today. We would suggest that the lessons taught by analysis of Earth's climate history merit mention in the EIS.

Response

NHTSA has revised Final EIS Section 5.1.2, *Climate Change and Its Causes*, to clarify the volcanic nature of natural aerosols. Overall, NHTSA believes that the discussion of anthropogenic and natural contributions to climate change in this EIS provides sufficient context for the reader to understand the outsized human influence on global climate change.

This EIS is consistent with the IPCC reports on the drivers of climate change, including clouds as a driver. For its understanding of climate science, NHTSA relies on existing expert panel- and peer-reviewed climate change studies and reports.

NHTSA relied on the best available science to inform the climate change projections in this EIS. NHTSA believes that both Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts,* adequately present how climate change may affect the globe. To provide additional context on the scale of potential sea-level rise caused by climate change, Final EIS Section 5.2.2.1, *Climate Change Attributes,* includes text that paleo sea-level records indicate that, when global mean temperatures were up to 2 degrees Celsius (°C) (3.6 degrees Fahrenheit [˚F]) above preindustrial levels, global mean sea level was 5 meters (16.4 feet) higher than current levels, as described in the IPCC *Fifth Assessment Report*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-6, Section 5.2 Affected Environment, first paragraph: While we concur that it is important to be including this section in the EIS, the text is not consistent in presenting "current and anticipated trends in emissions and climate." This deficiency needs to be corrected, making clear the value (or range) of natural levels prior to industrialization, the changes that have occurred over the last century (and possibly more) and then projections into the future.

Response

NHTSA agrees with the commenter that both current trends and future projections of climate change should be presented to the reader. As such, NHTSA made revisions throughout Final EIS Section 5.2, *Affected Environment*, to ensure that each subsection presents both observed and projected changes in climate.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-6, Section 5.2.1 Greenhouse Gas Emissions and Aerosols—Historical and Current Trends: While the subsections of this section do cover the most important causes of climate change listed on Page 5-5, it would also be helpful to be mentioning that neither changes in solar radiation nor in volcanic eruptions have been having a cumulative effect on climate change over the industrial period. Mentioning natural factors as potential causes of climate change in section 5.1.2 would seem to merit reporting regarding variations in these factors over the period of consideration, and, specifically, that such variations have been relatively small and are not nearly the primary cause of the climate change that has been occurring.

Response

Section 5.1.2, *Climate Change and Its Causes,* cites IPCC's findings that it is "*extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC 2013a). NHTSA has added language in this section of the Final EIS to clarify the relative contribution of natural contributors to climate change, which has been minimal since the start of the industrial era (IPCC 2013a).

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-7, second and third full paragraphs, regarding use of Global Warming Potential (GWP): The GWP is a rough approximation of the radiative forcing of various gases relative to that of CO_2 over a specified period. The length of the period used must be mentioned (here, it is presumably 100-years) and it needs to be explained that the GWP for relatively short-lived gases as methane and ozone are very different for different periods, becoming very large for periods of 20 years and less. Clarification of this is important because over decadal periods, changes in emissions of methane and the precursors of tropospheric ozone can have quite large influences on temperature whereas use of the 100-yr GWP as is done here is used as the basis for not considering the climatic influences of changes in methane and tropospheric ozone that will result from the policy alternatives under consideration. In that a significant share of human-induced methane emissions, for example, are a result of refining petroleum to make gasoline, use of the 100-year GWP instead of a full consideration of the radiative forcing of methane is an omission from this analysis that needs to be remedied.

At the same time, the use of the 100-year GWP greatly underplays the long-term significance of CO_2 emissions, which contribute to an elevation of the atmospheric CO_2 concentration that will persist for many millennia (and longer). By looking out only to 2100, the EIS fails to consider how the increase in the atmospheric CO_2 concentration and the resulting impacts to the environment and for society will extend for many, many centuries, especially in that the warming that is projected is very likely to lead to the substantial melting of the Greenland and Antarctic ice sheets over the next few millennia and thus a sea level rise of perhaps 50 meters (~164 feet) or more. Coming out of the Last Glacial Maximum that peaked roughly 20,000 years ago, sea level rose on an average of 1 meter/century for 120 centuries when the rate of warming was about 1°C (1.8°F) every 2000 years; this EIS uses a baseline scenario that would lead to a 3°C (5.4°F) rise during the 21st century, so a rate that is 60 times greater than caused sea level to rise a meter per century. These insights regarding the likely equilibrium sea level rise and the implications for the rate of rise that are drawn from paleoclimatic analysis merit presentation and full consideration in the EIS—that is, rather than just considering the amount of rise projected for 2100, what needs to be considered is the commitment to the equilibrium change in sea level that paleoclimatic analysis suggests is plausible, even likely.

Response

NHTSA has clarified that 100-year global warming potentials (GWP) are used, noting this in Final EIS Section 5.2.1.1, *Global Greenhouse Gas Emissions.* NHTSA recognizes that alternative GWPs could be considered. However, NHTSA believes 100-year GWPs are the most appropriate for use in its analysis because the Model for the Assessment of Greenhouse Gas-induced Climate Change (MAGICC) used by NHTSA to model climate impacts of the rulemaking uses 100-year GWPs and they are, by far, the most widely used GWPs.

NHTSA has not modeled results past 2100 given the scientific uncertainty beyond this period, which is consistent with IPCC projections. Additionally, given the difficulty of inferring climate impacts from paleoclimatology, considerable uncertainties remain when using this type of analysis to consider projected rates of change. Therefore, NHTSA believes its current approach to projecting climate change impacts is appropriate.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-10, Section 5.2.2, bulleted points on climate impacts: We concur with the summarization of the climatic effects presented here as drawn from IPCC 2013 and GCRP 2017. What is lacking, however, is a summary of the impacts on the environment and society of these changes in the climate that are presented in the Working Group II report from the most recent IPCC Assessment Report. The USGCRP has a report in final review on these impacts covering the United States and the World Bank has reports on such effects around the world. It would seem essential to be indicating the consequences for the environment and society of what is occurring.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

The analysis in the DEIS was developed before the October 2018 release of IPCC's *Global Warming of 1.5°C* report. Do any of its findings or recommendations—such as the significantly worse harms at 2°C warming, compared to 1.5°C—impact those of the DEIS?

Response

A summary of projected climate change impacts on human health, society, and environmental resources areas is provided in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*. This summary largely draws from recent studies and reports, including the IPCC *Fifth Assessment Report* (IPCC 2013a, 2013b, 2014a, 2014c), the IPCC *Special Report: Global Warming of 1.5°C* (IPCC 2018), the *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* (IPCC 2019a), the IPCC *Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (IPCC 2019b), and the GCRP *National Climate Assessment Reports* (GCRP 2014, 2017, 2018). Four of these reports were published after the initial Draft EIS publication and were, therefore, reviewed and incorporated for this Final EIS. These include the following: Volume 2 of the *Fourth National Climate Assessment* (GCRP 2018), the IPCC *Special Report: Global Warming of 1.5°C* (IPCC 2018), the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (IPCC 2019a), and the IPCC *Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (IPCC 2019b).

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-10, final paragraph of section 5.2.2, on responsibility for the problem: It is disingenuous to be attributing the ongoing and increasing effects of future CO_2 emissions to "developing nations" without both making clear that developed nations, particularly the United States with its significant global carbon footprint, have not only been the primary cause of the climate change to date but also continue to have a per capita contribution to CO_2 emissions that is several times the global average value. Halting climate change will require that essentially all emissions of CO_2 be ended because ocean and land systems have quite limited and slow capabilities for taking up all of the human-induced CO_2 emissions and so much a significant fraction will remain in the atmosphere for many millennia. Because of this, it is simply not appropriate to just be talking about responsibility for future emissions for the effects of past emissions, for which developed nation contributions dominate, will also be persisting long into the future.

Response

In response to this comment, NHTSA added text to Final EIS Section 5.2.2, *Climate Change Trends*, to address CO_2 emissions from developed countries and their contribution to past emissions.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-10, sub-section on temperature: In that, given Alaska, the US is an Arctic nation, the brief mention of temperature change in the Arctic and its influence on mid-latitude weather merits elaboration explaining how the warming in Alaska is dramatically and rapidly causing changes and major impacts. In addition, the US is also an island nation, having commonwealth and trust responsibilities for islands in the Caribbean and Pacific Oceans, and mention of the impacts of climate change on these regions is also merited. Also, referring back to the commitment in the opening sentence of section 5.2, there is no report on the anticipated trends in climate.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

The United States is both an Arctic nation (Alaska) and an island nation (Hawaii, Puerto Rico, Guam, and others). How have the Agencies considered the unique threats to these parts of the United States?

Docket Number: NHTSA-2017-0069-0526-10
Organization: Oregon Department of Environmental Quality
Commenter: Richard Whitman

The overwhelming scientific consensus is that global warming is caused primarily by human activity, and that major reductions in GHG emissions are urgently needed across all sectors in order to avert the worst effects of climate change.

Global warming has had a serious impact in Oregon. We've seen a very rapid increase in the frequency and severity of forest fires that are generating hazardous air quality in many communities for longer and longer periods of time. Smoke from wildfires caused the southern Oregon metropolitan area of Medford to experience 34 days of unhealthy or hazardous levels of air pollution this past year. Last year, Oregon experienced 2,000 wildfires that burned roughly 665,000 acres of forest and rangeland. It cost the state nearly half a billion dollars to suppress these fires. Recent peer-reviewed literature finds that the leading cause of these increases in wildfire is the increase in temperature and change in hydrology caused by climate change. Oregon also is experiencing more frequent and more severe drought, flooding, disease and health impacts, as well as sea level rise, erosion of Oregon's coastline, and damage to ecosystems.

Response

In Section 8.6.5.3, *Regional Impacts of Climate Change*, NHTSA recognizes the public interest in understanding the potential regional impacts of climate change. NHTSA incorporates by reference prior discussions of these issues by referring readers to Section 5.5.2 of the *MY 2017–2025 CAFE Standards Final EI*S (NHTSA 2012), Section 5.5.2 of the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c), and the *Fourth National Climate Assessments* (GCRP 2017, 2018) for more information on the projected impacts of climate change on regions of the United States.

NHTSA added information on temperature projections in Final EIS Section 5.2, *Affected Environment*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-10, sub-section on radiative forcing: Referring back to the commitment in the opening sentence of section 5.2, there is no description of the anticipated trends in radiative forcing.

Response

In response to this comment, NHTSA added a description of the anticipated trends in radiative forcing as it relates to the Representative Concentration Pathways (RCPs) in Final EIS Section 5.2.2.1, *Climate Change Attributes*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-11 and 5-12, subsection on Average Temperatures, third paragraph: The third paragraph of this sub-section (which is really describing changes in *Global* Average Temperature) does provide a summary of anticipated trends in this variable, its statement that "IPCC predicts" is simply incorrect. First, IPCC's role is to summarize findings in the scientific community, and what it summarizes about such conditions are "projections" and not "predictions"—the difference being that projections are based on scenarios and so are conditional whereas predictions are independent of conditions and scenarios. This is an important distinction to be made for its clear implication is that the scenario that we choose makes a difference (indeed, can make a very significant difference) and this makes clear that our choice of an energy policy and **efforts to reduce (mitigate) emissions can make a difference**. So, this paragraph needs to provide an elaboration of the different consequences that would result from different scenarios (i.e., different inputs for the projections). Fine to say that present trends are along the highest of the emission scenarios that IPCC studied, but that should not be the only description of what could happen (e.g., we might "anticipate" that the rest of the world would fulfill its Paris commitments and even more).

Response

NHTSA agrees that "predict" is not the correct term and modified language in Final EIS Section 5.2.2, *Climate Change Trends*, to reflect IPCC's role in presenting projections for different climate change scenarios. NHTSA is aware that IPCC projections are contingent on different mitigation scenarios, which may include global efforts to stabilize or reduce GHG emissions and acknowledges different mitigation scenarios in the EIS analysis. This EIS uses the RCP6.0 trajectory to project emissions in Chapter 8, *Cumulative Impacts*, and uses both the RCP 4.5 and GCAM6.0 trajectories in the sensitivity analysis presented in Section 8.6.4, *Cumulative Impacts on Greenhouse Gas Emissions and Climate Change*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-12, subsection on Extreme Temperatures: In addition to the material here, this section should describe the analyses of observations that have been reported by Hansen and colleagues (see https://www.giss.nasa.gov/research/briefs/hansen_17/ and earlier references). Basically, Hansen et al. analyze data on occurrence of summer-average land surface variations over a period from the mid-20th century to the present. Among their findings is that the temperature anomaly that characterized the warmest third of occurrences now is exceeded about 75% of the time, and that what were 1 in a thousand warm temperature extremes are now occurring about one-sixth of the time, so an increase of about 150 times in their occurrence. It is such shifts in the distribution of extreme events that is leading to situations where 100-year flood events, for example, are occurring much more often, even twice in some years at some locations. The discussion provided here thus merits elaboration.

This section also fails to provide an indication of "anticipated trends" as promised in the first sentence of section 5.2. With the increase in extremes already so large with "only" about 1 C (1.8 F) global warming, the occurrence of what have been considered extremes in the past will become very much larger, and this needs to be made clear.

Response

NHTSA has reviewed the report from Hansen and colleagues. The shifting distribution of temperature anomalies attributed to climate change has been documented by IPCC, GCRP, and the National Research Council, which are referenced in this EIS. As these issues are already thoroughly documented in the EIS, additional references are not necessary.

In response to this comment, NHTSA has added a discussion of projected extreme heat trends in Final EIS Section 5.2.2.1, *Climate Change Attributes*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-13, first full paragraph (last paragraph of subsection on Contributions to Sea-Level Rise): The choice of units here is not at all helpful in communicating the important aspects of sea level rise. First, converting ocean thicknesses of 200 and 700 meters to a distance in miles rather than feet seems inappropriate and an effort to minimize the impression of how much of the ocean is showing warming; we would urge expressing 200 meters as about 650 feet and 700 meters as about 2300 feet. On the rate of warming, the amounts should be given as amounts per decade as is done on page 5-14, especially given that year-to-year variability could well hide the change of an individual year.

More importantly, this subsection does not give a quantitative indication of how much ice (in terms of sea level equivalent) is stored in the Greenland and Antarctic ice sheets and so could melt in the future, or of the current rates. In addition, it would be appropriate here to give an indication of how much change in sea level has resulted in the past due to changes in temperature—in particular that the 6 C cooling of the Last Glacial Maximum stored the equivalent of 120 meters of sea level rise on, mainly, Northern Hemisphere continents, and that at the last interglacial (the Eemian dates about 125,000 years ago) sea level was up roughly 4-8 meters when the global average temperature was up no more than about a degree Celsius, and this must have come from loss of mass from the Greenland and Antarctic ice sheets). Basically, this section simply does not provide the context needed for a proper evaluation.

Page 5-13, subsection on Observed Global Sea-Level Rise: Again, this subsection should be using units of changes per decade as is done on Page 5-14. Also, in that the section is also covering projections of change, having the sub-section title include "Observed" seems a bit strange.

Greater clarity and linking is needed between the last sentence of the first paragraph and the first sentence of the second paragraph, making clearer not only that the IPCC projections have largely omitted the contribution from the dynamic moving and calving from major ice sheets, but also that this is expected to be the largest term in calculations of future sea level change (mountain glaciers include only the equivalent of about a meter or less of sea level rise, and thermal expansion is similarly limited). Thus, the IPCC estimates must be viewed as likely serious underestimates—how Sweet et al. (2017a) could come up with a lower bound of 0.2 meter of sea level rise during the 21st century seems quite suspicious—and certainly far less likely that the 2.7 meters; we'd suggest some further elaboration of possibilities, taking into account the lesson from paleoclimatic studies that it takes far longer for ice on land to be built up that for it to melt or calve.

Response

NHTSA agrees with the commenter on choice of units in this section of the EIS and has modified Final EIS Section 5.2.2.1, *Climate Change Attributes,* to present sea level rise impacts in terms of feet. NHTSA has also removed "Observed" from the subsection title in the Final EIS to make it consistent with the subsequent text covering projections. In the paragraph identified by the commenter in the subsection *Contributions to Sea-Level Rise*, this EIS presents the global ocean warming that has occurred between 1971 and 2010. NHTSA believes that this provides sufficient context to communicate this contributor to sea-level rise.

NHTSA is aware that IPCC projections of global sea level rise do not include potential sea-level rise from the dynamic calving of major ice sheets. NHTSA considers this limitation to be adequately documented by IPCC and in this EIS. However, in order to provide additional context on the scale of potential sea level rise caused by climate change, the Final EIS provides information on paleo sea level records that indicate when global mean temperatures were up to 2°C (3.6˚F) above preindustrial levels and global mean sea level was 5 meters (16.4 feet) higher than current levels, as described in the IPCC *Fifth Assessment Report*. This information was added in Section 5.2.2.1, *Climate Change Attributes*, of this EIS.

NHTSA also added a description of the extent of projected global glacier loss projected by the end of the 21st century to further describe the potential contribution of the Greenland and Antarctic ice sheets to global sea level rise. This text was added to Final EIS Section 5.2.2.1. NHTSA believes this adequately addresses the potential contribution of these ice sheets to global sea level rise and provides the needed context for the evaluation.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-14, sub-section on Observed Regional Sea-Level Rise: It would seem appropriate to explain why values of sea level rise can vary regionally, indicating that there are good reasons for this to occur. In the third paragraph, it would again be appropriate to consider horizontal retreat in units of distance per decade rather than per year. In that the U.S. is also responsible for a number of island entities in the Caribbean and Pacific, the effects on islands also merits mention.

Response

In response to this comment, NHTSA has augmented its description of the causes of regional variability in sea-level rise and the decadal horizontal retreat in Final EIS Chapter 5, *Greenhouse Gas Emissions and Global Climate Change*. NHTSA incorporates by reference prior discussions of the projected impacts of climate change on regions of the United States, including Caribbean and Pacific Islands, by referring readers to Section 5.5.2 of the *MY 2017–2025 CAFE Standards Final EIS* (NHTSA 2012), Section 5.5.2 of the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c), and the Fourth National Climate Assessments (GCRP 2017, 2018).

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-14 and 5-15, section on Precipitation: Regarding this section in general, it would really help were the text to explain that overall global warming leads to an intensification of rainfall in the tropics, an expansion of the subtropics further toward the poles, and a poleward shift in the jet stream, so that there will be regions where more and where less precipitation is to be expected-the locations of these changes are not random. It would also help to make clear that not only can a warm atmosphere hold more water vapor, but that increased surface warming leads to faster and greater evaporation and that what goes up must come down, and so there will be both more precipitation and that it will tend to come in more intense events—so the observations are recording just the types of changes that are being projected by model simulations. Right now, the text just describes the changes without providing needed geographical and theoretical context.

Response

This EIS includes a discussion of projected changes in precipitation due to climate change and its impacts on humans and environmental resource areas in Section 5.2.2.1, *Climate Change Attributes,* Table 5.4.2-6, *Regional Changes to Precipitation in the Year 2100 Compared to Current Conditions, Summarized from the IPCC Fifth Assessment Report*, and Section 8.6.5.2, *Sectoral Impacts of Climate Change.* NHTSA believes that this provides adequate context for the reader to understand the magnitude and type of impacts that may be associated with changes in precipitation.

Comments

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-14 and 5-15, section on Precipitation: [* * * * *] The subsection on Precipitation on page 5-15 needs to describe what is happening with tropical cyclones and hurricanes, namely that the greater amount of atmospheric moisture is leading to greater amounts of rainfall from such systems and in doing so providing the energy that allows them to become more powerful and larger.

Docket Number: NHTSA-2017-0069-0492
Commenter: Andrew Yamamoto

The ongoing Hurricane (now storm) Florence also provides new evidence that must be considered in a new draft EIS. On September 13, 2018, the Washington Post reported: In the case of Hurricane Florence and the Carolinas, some six inches of the coming storm surge is attributable to climate change because sea levels have risen in the past 100 years or so.

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

Climate change poses grave threats to public health. The changing climate threatens the health of Americans alive now and that of future generations. Growing evidence clearly demonstrates that climate change amplifies multiple and profound risks to public health for all Americans, from extreme heat events to hurricanes to winter storms to wildfires. According to the National Oceanic and Atmospheric Administration, 2017 was the third warmest year nationally, behind 2012 and 2016. This heat has contributed to widespread increases in unhealthy ozone pollution.

The western states are experiencing historic and catastrophic wildfires at an alarming rate, with particulate matter and other pollutant exposures impacting large swaths of the United States. Millions of Americans have been displaced by storms, flooding and other extreme weather events, such as Hurricanes Harvey, Maria, and Florence, that grow more commonplace. The most recent national climate assessment conducted by the US Global Change Research Program (USGCRP) highlights the fact that recent years have seen "record-breaking, climate-related weather extremes, and the last three years have been the warmest years on record for the globe. These trends are expected to continue…" The USGCRP's 2016 assessment of health impacts of climate change in the Unites States detailed the wide – and increasing – range of risks that "endanger our health by affecting our food and water sources, the air we breathe, the weather we experience, and our interactions with the built and natural environments."

Response

NHTSA has added information on attribution of the increasing magnitude of extreme weather events, including hurricanes, to climate change in Final EIS Section 5.2.2.1, *Climate Change Attributes*. Section 8.6.5.2, *Sectoral Impacts of Climate Change*, also contains multiple sections on the impacts of climate change on human health.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-14 and 5-15, section on Precipitation: [* * * * *] There is also no presentation of anticipated trends as committed to at the start of section 5.2.

Page 5-15, sub-section on Drought: [* * * * *] There is also no presentation of anticipated trends as committed to at the start of section 5.2.

Page 5-15, subsection on Streamflow: There is no presentation of anticipated trends as committed to at the start of section 5.2.

Page 5-16, sub-section on Snow Cover: There is no presentation of anticipated trends as committed to at the start of section 5.2.

Page 5-16, subsection on Ocean pH: There is no presentation of anticipated trends as committed to at the start of section 5.2.

*   *   *   *   *

Page 5-17, Section 5.2.2.3, Changes in Ice Cover and Permafrost: [* * * * *] There is also no presentation of anticipated trends in ice cover and permafrost as committed to at the start of section 5.2.

Response

In response to this comment, NHTSA has added information on anticipated trends on these topics to Final EIS Section 5.2.2.1, *Climate Change Attributes*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-15, sub-section on Drought: What is happening is not really "drought," which has the implication that the drier conditions are temporary and that there will be a return to what has been normal in the past when the Earth's global average temperature was lower. This is simply not the case—global warming is leading to poleward expansion of the subtropics and so leading to aridification in those regions where this is occurring, such as in the southwest. These changes will not be temporary, but will persist as long as there is a significant positive radiative forcing from the higher CO_2 concentration. It is thus really misleading to the public to be calling the drying a drought rather than much more long lasting aridification.

*   *   *   *   *

Page 5-40, sub-section on Precipitation, first paragraph: It is wishful thinking to refer to the increasing and prolonged occurrence of dry periods as "droughts" with the term's implication that what is happening is going to at some time change around. This is simply not the case—what is happening is mainly a result of the expansion of the subtropics and so is aridification. We do not call what is happening over the Sahara a drought as compared to the period over 6000 years ago when the region was vegetated and experienced greater rainfall. What is happening is aridification, a transformation that will persist for millennia unless the CO_2 concentration is brought back down.

Response

Use of the term “drought” in this EIS is consistent with the language and definitions used by IPCC and GCRP. In the Final EIS, NHTSA has added language to clarify that aridification is projected in some locations such as the southwest United States, and NHTSA has revised Final EIS Section 5.4.2., *Direct and Indirect Impacts on Climate Change Indicators*, to clarify the findings from the GCRP and IPCC reports, and other peer-review studies.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-17, Section 5.2.2.3, Changes in Ice Cover and Permafrost: There is no discussion of how the warming and changes in sea ice cover in the Arctic (the sea ice disappearance greatly increasing surface air temperatures) appear to be affecting mid-latitude weather patterns, basically by reducing the tendency to a strong zonal jet stream and allowing large meanders (i.e., troughs and ridges) that are slower moving and thus causing larger and longer-lasting, so more extreme, weather conditions.

Response

The science on the impact of arctic climate on mid-latitude circulation is rapidly evolving. Currently, there is low confidence in any conclusive findings regarding the connection, with the National Climate Assessment (GCRP 2017) stating that "While some observational studies suggest a linkage between blocking affecting the U.S. climate and enhanced arctic warming (arctic amplification), specifically for an increase in highly amplified jet stream patterns in winter over the United States, other studies show mixed results." Due to the low confidence in this connection, NHTSA has chosen not to add a discussion of this topic to the Final EIS.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-31 and 5-32, Table 5.4.2-2 indicating changes due to the 8 alternatives: First it would be helpful to have the values for each variable provided for preindustrial and the year 2000 and perhaps 2020 so that the full extent of change is evident:

While the values given for 2100 are sufficiently close to the equilibrium values that would result from the proposed alternatives, this is not the case for sea level rise. The equilibrium adjustment time is of order a few thousand years, and as explained in another of the submitted comments, the estimated effect on sea level is likely roughly a factor of 100 less than the expected equilibrium change (and the actual amount of change being calculated is of order 60-70 times too low, this value being less than 100 in that a bit longer time for adjustment has occurred). To address this shortcoming, the table needs to include a column that gives an estimated equilibrium value for sea level change for both the baseline and for the various alternatives.

Response

The purpose of the EIS is to provide information that is useful for the decision-maker. NHTSA believes the information provided in Section 5.2, *Affected Environment*, provides sufficient context to make its comparison of the alternatives meaningful. The approach in this EIS, which presents indicators in 2040, 2060, and 2100, is consistent with the previous approach for the MY 2011–2015 CAFE standards, MY 2012–2016 CAFE standards, Phase 1 HD standards, MY 2017–2025 CAFE standards, and the Phase 2 HD standards. NHTSA chose to present these intermediary years between current conditions and 2100 to provide a sufficient presentation of the pace of impacts for the foreseeable future. Projections beyond 2100 are too uncertain to provide useful information for decision-making.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5.37 to 5.39, Table 5.4.2-3 Regional Changes to Warming and Seasonal Temperature Summarized from the IPCC Assessment Report: This table gives a serious distortion of the consequences of climate change that are projected and reported on by IPCC. First, the title of the table needs to indicate the reference period for the included data—just including it in the note below the table is not adequate. It is also misleading to just be considering the warming from the present to 2100 without indicating all of the warming and effects that have already taken place. Further, it is not really made clear that the other types of changes are really on top of the changes in the mean. Finally, the table is totally qualitative and thus provides no indication of how different the outcomes can be for the different emissions scenarios. It would be much more appropriate to be drawing from the careful reports prepared by the World Bank to indicate the changes in the various domains around the world where it is engaged and the impacts that will result, including the forced reductions in food production, the extents of coastal inundation, the serious disruptions to water resources in many areas of the world, and more. We just do not think that the Table is a suitable means for conveying the seriousness of climate change for these regions.

Response

In response to this comment, NHTSA updated the title of Table 5.4.2-3 to reflect the period covered. The table presents the warming from today through 2100 so that the reader can better interpret how the MAGICC model results, which covers the same period, could be differentially experienced around the globe. Information on the impacts of climate change on human health, society, and environmental resource areas, including information on differential impacts under different emissions scenarios, are provided in Final EIS Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*. NHTSA is unable to provide a regional analysis of potential global changes to the environment, as such an analysis is beyond the scope of the agency's capability. Furthermore, based on the impacts of this rulemaking on global climate attributes, such as global mean surface temperature, regional impacts associated solely with this rulemaking (if calculable) would likely be small.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-38 and 5-39, sub-section on Sea-Level Rise: This section provides no sense of the extent of coastal lands, marshlands, communities, and islands around the world that will result from the IPCC-projected rises in sea level, much less the much larger extents that would be projected to be inundated were the largest of the contributions to sea-level rise (i.e., glacial ice moving and calving) actually included in the estimate—and the much, much greater areas subject to inundation as sea level rise continues after 2100 toward its equilibrium amount of rise, which is about 100 times larger than what is included in the analysis in this EIS.

Response

In Section 8.6.5.2, *Ocean Systems, Coasts, and Low-Lying Areas*, NHTSA provides information on the number of people in coastal communities who may be affected by climate change. To provide additional information for the reader on the geographic extent of sea-level rise, Final EIS Section 5.2.2.1, *Climate Change Attributes* directs the reader to NOAA's online sea-level rise viewer at https://coast.noaa.gov/digitalcoast/tools/slr.

NHTSA is aware that IPCC projections of global sea-level rise do not include potential sea-level rise from the dynamic calving of major ice sheets. NHTSA considers this limitation to be adequately documented by IPCC and in this EIS. To provide additional context on the scale of potential sea-level rise caused by climate change, NHTSA added to the Final EIS a brief discussion of how paleo sea-level records indicate that, when global mean temperatures were up to 2°C (3.6˚F) above preindustrial levels, global mean sea level was 5 meters (16.4 feet) higher than current levels, as described in the IPCC *Fifth Assessment Report.*

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-41 and 5-44, Table 5.4.2-5, Global Mean Precipitation: It is virtually meaningless to present changes in precipitation in terms of the global average. The atmospheric circulation creates regions of the world like the tropics where precipitation will be strong, regions like the subtropics where it will be quite weak, and regions of the world such as the midlatitudes where it can be variable for quite a number of reasons (and the variability really matters). Surface temperatures also determine where there is enough water in the world for there to be very significant downpours and regions of the world where it is relative cool and downpours are considerably less. In addition, it is not just how much rain that falls that matters, but how it is distributed over time, how much runs off, how much is evaporated, and so what the available and useful water resources will be. Just giving the change in the global average is simply not at all helpful for indicating how the change in precipitation will matter. The greater detail provided in Table 5.4.2-6 gives an initial sense of how regions may be affected, but provides no information on evaporation, no indication of how the hydrogeography of the region is or is not adapted to the changes that are occurring and are projected to occur (e.g., an intense rainfall on southeastern states might be much more readily handled by the streams and rivers than if the same amount of precipitation occurred over the northern Great Plains)-lots more matters than is presented in this table. We would urge drawing information about the amounts and impacts of changes in rainfall from the reports of the World Bank.

Response

The type of regional evaluation requested would require substantial additional analysis and would not provide useful information for the decision-maker. As noted, this EIS captures the qualitative impacts on projected change in precipitation in Table 5.4.2-6, which is based on the IPCC *Fifth Assessment Report*. The kind of information requested by the commenter is available in other sources, such as the IPCC *Fifth Assessment Report*, which NHTSA cites to frequently and incorporates by reference. Because NHTSA must consider a wide array of global data points, it is reasonable for the agency to consider global mean values as part of its evaluation of impacts.

NHTSA has reviewed the World Bank references provided and believes additional references are not necessary to document climate change impacts. The climate change impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts,* reflect the best available science regarding climate change and its impacts on health, society, and the environment. NHTSA relied on existing expert panel- and peer-reviewed climate change studies and reports when preparing this EIS, including several of the resources cited by the commenter. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and GCRP, supplemented with additional peer-reviewed literature.

Comment

Docket Number: NHTSA-2017-0069-0544-6
Commenter: David Bella

In the first page of these comments, I claimed that this EIS could and should open up discourse on matters of great importance. Now, briefly consider how such discourse could lead to actions beyond those addressed in the EIS itself.

This EIS claims that stronger fuel-efficiency U.S. standards for cars and light trucks would make a negligible difference in climate change outcomes. In making this claim, it employs creditable models and peer reviewed science, including recent IPCC reports (available at the time). It does not deny the growing risks of climate change. Nor does it deny that transportation is a major contributor to greenhouse gas emissions.

Given the above, this EIS should be seen as providing powerful support for the following.

We need to recognize how *ceteris paribus* assumptions (largely hidden) can "distance ourselves from reality" with serious and even disastrous consequences for the future. Then, we should be more open to actions and alternatives beyond those in the EIS.

We need to seriously consider and promote creative alternatives to our current course of expanding infrastructure that promotes dependency upon cars and light trucks for people to go about their daily lives.

For growing numbers of people, we should provide viable, convenient, and attractive options for living without the need to drive on a daily basis. We need to be more creative than current transit options.

Creative options should draw upon appropriate technology (practical, available, etc.) rather than depending upon unprecedented scales of technological fixes (complex, expensive, unproven, and risky) to reduce the consequences of **locked in** energy demands.

We need to address the institutional **lock in** that continues our current course and prevents such alternatives.

Finally, all of the above need to be widely discussed and acted upon as soon as possible. This requires imagination and leadership at many levels.

Response

NHTSA recognizes that other policy options, such as alternative transportation infrastructure, could mitigate the impacts of climate change. NHTSA discusses some of these options in Chapter 9, *Mitigation*. Ultimately, however, these options are beyond the scope of this rulemaking.

Comments

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The relevant NEPA regulations require NHTSA to "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public." 40 C.F.R. § 1502.14. But here, the absence of direct comparisons over time in the DEIS itself masks the crucial differences between alternatives. The omission of this data is glaring because it departs from the presentation and comprehensive analysis in the 2012 Final EIS. NHTSA must show these comparisons and disclose the results in the DEIS under both (1) the flawed modeling assumptions it uses throughout the DEIS should it chose to retain them despite these comments, and (2) under the same assumptions it used in the 2012 DEIS and the 2016 TAR to enable the reader meaningfully to compare the current Proposal with the No Action Alternative. NEPA commands agencies to examine "both short- and long-term effects." 40 C.F.R. § 1508.27(a). Here, lack of readily understandable comparative data over time in the DEIS prevents an informed decision by the general public and the decision makers.

Notably, missing from the DEIS itself are crucial data tables, each of which was present in the 2012 Final EIS accompanying the MY2017-2025 standards:

- Tables quantifying total CO_2 emissions differences (in $MMTCO_2$) from 2020-2100 by alternative (*see e.g.*, 2012 Final EIS, 5-41 – 5-43) and in meaningful time increments;
- Tables showing emission increases compared to the No Action Alternative for each action alternative (*see e.g.*, 2012 Final EIS, 5-41 – 5-44) in meaningful time increments;
- Tables showing the percentage emission increases for each alternative compared to the No Action Alternative (*see e.g.*, 2012 Final EIS, 5-41 – 5-43) in meaningful time increments.

The DEIS itself also does not spell out the amount of extra greenhouse gases added per alternative just during the years at issue, 2021 through 2026, as total amounts are stated in the DEIS only as of 2100. The only comparison of emission increases from 2021 through 2026 is given in terms of the approximate *annual* emissions of extra vehicles on the road, leaving the reader in the dark as to what the extra near-term greenhouse gas emissions will be.

NHTSA must, at a minimum, present in the DEIS the outcomes for its greenhouse gas analysis for each alternative at 2035 (the end of modeling for health impacts), 2050 (the end point of its analysis for criteria pollutants, MATS, and additional fuel combustion), the time periods it selected in the 2012 DEIS so readers can make meaningful comparisons, and 2100 (the only date for which NHTSA currently provides greenhouse gas emissions data). In addition, the DEIS's disclosure that by 2050, 206 billion additional gallons will have been combusted under the Preferred Alternative is insufficiently meaningful in light of the fact that greenhouse gas emission calculations have been performed through 2100, and that NHTSA has the tools to calculate the additional gallons burned through 2100 as well and the duty to share this information with the public. A "hard look" at the direct and indirect effects of the proposed action and alternatives requires the reader to be informed of the total amount of combusted fuel that causes the greenhouse gas emissions described.

NHTSA has tucked some of this data into the appendix. However, crucial information necessary for the reader to comprehend the impact of the Proposal should be presented in the DEIS document itself. As the Ninth Circuit noted in *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1214 (9th Cir. 1998): "We do not find adequate support for the Forest Service's decision in its argument that the 3,000 page administrative record contains supporting data. The EA contains virtually no references to any material in support of or in opposition to its conclusions. That is where the Forest Service's defense of its position must be found." *See also Sierra Club v. Bosworth*, 199 F. Supp. 2d 971, 980 (N.D. Cal. 2002) ("It is not an adequate alternative ... to merely include scientific information in the administrative record. NEPA requires that the EIS itself 'make explicit reference ... to the scientific and other sources relied upon for conclusions in the statement'"). NHTSA understood this when it presented the relevant information in clearly understandable, side-by side tables in the 2012 Final EIS; it must do so now as well.

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The DEIS seems to only quantify methane and nitrous oxide emissions in an appendix, and there the DEIS provides only selected quantifications for 5 individual years (in year 2020, 2040, 2060, 2080, and 2100); the DEIS fails to provide a clear cumulative tally of the change in methane and nitrous oxide emissions between the no-action alternative and the proposed action. For example, Section 6.2.2.1 of the DEIS ("Methane Emissions from Oil and Natural Gas") does not contain any quantitative estimates of emissions from any of the alternatives under consideration. This lack of adequate attention and context given to methane and nitrous oxide emissions is compounded by how the methodology overlooks significant upstream emissions resulting from the proposed action just because the emissions happen to originate outside U.S. borders, as described above. Methane especially is a significant component of upstream emissions, and its greater near-term potency in its radiative-forcing effects warrant much greater attention than the DEIS has given these non-carbon greenhouse emissions.

Response

NHTSA inadvertently omitted some tables, figures, and text from Draft EIS Chapter 5, *Greenhouse Gas Emissions and Climate Change*, including the tables specified by the commenter. This information has been restored to Chapter 5 in the Final EIS.

NHTSA has reviewed the inadvertently omitted material and determined that the information was either available elsewhere in the Draft EIS or could be easily calculated from information reported elsewhere in the Draft EIS. The Draft EIS table corresponding to Final EIS Table 5.4.1-1 was briefly described in the Draft EIS summary, and the total emissions by alternative for 2021–2100 were reported in Draft EIS Table 2.5.2-1. From those values, the decision-maker and the public could calculate absolute and percent emissions increases compared to the No Action Alternative. In addition, this information could be obtained from Table D-13 and Table D-14 in Draft EIS Appendix D, *U.S. Passenger Cars and Light Truck Results Reported Separately*, for passenger cars and light trucks separately. The Draft EIS figure corresponding to Final EIS Figure 5.4.1-2 was presented as Figure S-4 in the Draft EIS summary and described there. Finally, the Draft EIS table corresponding to Final EIS Table 5.4.1-2 could be recreated by summing together Table D-15 and Table D-16 in Draft EIS Appendix D.

In short, the information was still available in the Draft EIS itself for consideration by the decision-maker and the public. The appendices were circulated with the Draft EIS in all cases, including on the agency's website and on CD-ROM disks affixed to the back of paper copies of the Draft EIS. The Draft EIS also referenced the availability of Appendix D to obtain passenger car and light truck results separately. In fact, the commenter specifically identified this material as being available in that appendix, indicating that it was reviewed. NHTSA, therefore, took a "hard look" in the Draft EIS at this material, and restored it to Chapter 5 in the Final EIS.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

As discussed in more detail below in connection with NHTSA's cumulative impacts analysis, the DEIS's climate change section also fails to describe the consequences of the increased greenhouse gas emissions in real-world terms that make them clear to the reader. NHTSA calculates that the direct and indirect impacts of its Preferred Alternative would lead to atmospheric concentrations of CO_2 of 789 ppm, a temperature increase of 3.48°C, sea level rise of 30 inches, precipitation increases of 5.85 percent, and an increase in ocean acidification to 8.27 pH. But NHTSA does not explain or describe what life on a planet this catastrophically overheated would look like, even though materials that translate these numbers to facts on the ground (such as heat maps for all areas of the United States) are readily available. (*See* discussion and references under "cumulative impacts" below.) Nor does it provide any estimate of the numbers of human deaths reasonably foreseeable under these intolerable conditions. In sum, NHTSA's direct/indirect impacts analysis falls far short of the "hard look" required.

Response

NHTSA's analysis in this EIS constitutes a "hard look" as required under NEPA. Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change,* includes a discussion of the health, societal, and environmental impacts of climate change. NHTSA is unable to distinguish between the alternatives under consideration in that section because NHTSA cannot quantify the various impacts described by alternative; however, it does provide a review of projected impacts from increases in GHG emissions. NHTSA also incorporates by reference many reports that do report the information described by the commenter, and the summaries of those reports in the EIS provide adequate context to the reader.

Comment

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

EDF's analysis of the climate pollution impacts of the proposed alternatives, using the NHTSA Volpe model, shows that the DEIS analysis is flawed and improperly underestimates the climate pollution increases that will occur under the various rollback alternative scenarios.

While the DEIS concedes that climate pollution will increase under all rollback scenarios considered, NHTSA significantly underestimated the increase in greenhouse gas emissions at stake. The DEIS concludes that NHTSA's preferred alternative—which flattens the fuel economy standards at 2020 levels through MY 2026—would result in additional annual carbon dioxide emissions of 95 million metric tons ("MMT") by 2040, compared to levels if the Clean Car Standards remain in place. Using a corrected model, EDF projects that CO_2 emission increases in 2040 will actually be *double* what NHTSA states in the DEIS: 189 million metric tons per year.

Figure A below shows the wide gap between the DEIS analysis and the numbers calculated by EDF when we corrected the model to conform to the underlying factual data and to NHTSA's traditional modeling approaches. A corrected model consistently concludes that the rollback scenarios will yield significantly higher levels of climate pollution than those disclosed in NHTSA's DEIS.

[See original comment for Figure A: Additional Annual CO_2 Emissions Resulting from Rollback]

Accordingly, the DEIS analysis severely underestimates the greenhouse gas emission impacts of the proposed CAFE and GHG standards being considered by NHTSA and EPA, respectively.

Such faults with the underlying data violate NHTSA's legal obligations under NEPA. NHTSA cannot claim to have thoroughly assessed and properly informed the public regarding the environmental impacts of the alternatives if its analysis distorts the climate pollution impacts at stake.

Response

NHTSA recognizes that EDF's analysis, being based on different assumptions, yields results different from those in the Draft EIS. NHTSA has made changes to the CAFE model based on comments it received during the public comment period, as described in the final rule. The Final EIS presents the revised fuel use and associated GHG emissions projections based on the updated CAFE model.

Comment

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

The DEIS fails to address the urgent need to act on climate, including the importance of protecting the Great Lakes and the Midwest. Essential natural resources located in the Midwest are already suffering adverse impacts due to climate change and will face greater degradation in the future. The Great Lakes are an international gem of incalculable ecological, cultural, and economic value. They are the largest freshwater ecosystem on earth, containing 20% of the world's freshwater supply and providing drinking water for over 40 million people.

The Great Lakes support a wealth of biodiversity across their large geographic range, including diverse and rich populations of fish, wildlife, and plants. Their economic importance is also evident: commercial and recreational fishing in the Great Lakes alone inject over $5 billion into the economies of the surrounding states. Climate change is, and will be, impacting the Great Lakes region through increased harmful algal outbreaks, changes to native species and habitat, and other impacts. Hotter temperatures and changes to the frequency and severity of storms will also affect public, environmental and economic health of the people and communities in Michigan, Ohio, Indiana, Minnesota, Iowa and Wisconsin to the Dakotas. Climate change is a significant threat to the U.S. and to the Great Lakes, public health, Midwest cities, agriculture, and forests. The DEIS demonstrates that freezing standards will exacerbate climate impacts across the globe and in the Midwest more than any other option considered.

In our comments on the NOI, ELPC urged NHTSA to fully recognize the extensive body of peer reviewed climate science. The IPCC's recent Special Report issued on October 8, 2018 provides an updated look at climate change and the broad range of adverse impacts expected sooner than anticipated, as well as the urgent need to reduce emissions. While the DEIS considers climate change research and modelling, it fails to address the issues in a way that provides meaningful context to the reader or decision maker. In fact, NHTSA essentially details a devastating future in which runaway climate change happens because of no action to curb carbon pollution—showing a future of as much as 7 degrees of warming over this century. In this context of "it will happen anyway" the DEIS fails to address the impacts 7 degrees of warming will have in the U.S., the Great Lakes region, or globally in a transparent manner. Runaway climate change will have devastating impacts and these are not assessed in the DEIS in terms of the actual toll on the environment or public health. In fact, NHTSA makes every effort to minimize the impacts of its preferred option by contrasting this one policy against complete global inaction on climate change.

The DEIS is flawed for failing to fairly and fully account for the fact that all of its options, as compared to the No Action Alternative or augural standards, will increase a broad range of pollutants and climate pollution in particular. Significantly, NHTSA recognizes that its preferred option alone will worsen the impacts of climate change by raising global temperatures, elevating sea levels and impacting precipitation globally, among other impacts. NHTSA, however, fails to provide a meaningful context for its emissions increases in terms of the domestic emissions budget or in terms of time scales that are meaningful to decision makers or the public. Finally, NHTSA does not account for present steps the administration is taking that will also increase U.S. greenhouse gas pollution and exacerbate the impacts of this action.

Response

In Section 8.6.5.3, *Regional Impacts of Climate Change*, NHTSA recognizes the public's interest in understanding the potential regional impacts of climate change. In the NEPA context, there are limits to the utility of drawing from assessments to characterize the regional climate impacts of the Proposed Action and alternatives. The existing assessment reports do not have the resolution necessary to illustrate the effects of this action, because they typically assess climate change impacts associated with emission scenarios that have much larger differences in emissions—generally between one and two orders of magnitude greater than the difference between the No Action Alternative in 2100 and the emissions increases associated with all the action alternatives in 2100. The differences between the climate change impacts of the Proposed Action and alternatives are far too small to address quantitatively in terms of their impacts on the specific resources of each region. Attempting to do so may introduce uncertainties at the same magnitude or more than the projected change itself (i.e., the projected change in regional impacts would be within the noise of the model). Agencies' responsibilities under NEPA involve presenting impacts information that would be useful, relevant to the decision, and meaningful to decision-makers and the public. NHTSA refers readers to Section 5.5.2 of the MY 2017–2025 CAFE Standards Final EIS (NHTSA 2012), Section 5.5.2 of the Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS (NHTSA 2016c), and the Fourth National Climate Assessments (GCRP 2017, 2018) for more information on the projected impacts of climate change on regions of the United States.

In drafting Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts,* both of which address climate change, NHTSA relied upon the best available science regarding climate change and its impacts on health, society, and the environment. Final EIS Chapter 5 and Final EIS Chapter 8 have been revised to include additional resources that were published after the Draft EIS, including the IPCC Special Report: Global Warming of 1.5°C, the GCRP *Fourth National Climate Assessment*, and other relevant peer reviewed literature. NHTSA believes that Final EIS Chapter 5 and Final EIS Chapter 8 provide adequate context for the reader to understand the magnitude of the climate effects associated with the action under consideration. NHTSA also considers the GHG impacts of its fuel economy actions in terms of a global carbon "budget" in Section 5.4.1.2, *Global Carbon Budget*.

NHTSA uses several scenarios to assess the impact of the action in the context of global emission scenarios in this EIS, rather than just one as the commenter implies. The GCAM Reference scenario is used by NHTSA for the direct and indirect analysis, which does not assume comprehensive global actions to mitigate GHG emissions. The GCAM6.0 scenario is used in the cumulative analysis. GCAM6.0 does not include specific climate change mitigation policies; it does, however, represent a plausible future pathway of global emissions in response to a moderate global action to mitigate climate change. For further discussion, see Final EIS Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact*. In order to conduct a sensitivity analysis, NHTSA also models the RCP4.5 scenario, a more aggressive emission stabilization scenario. This approach ensures that a range of consequences of the Proposed Action and alternatives are considered within the context of other actions.

The commenter suggests that NHTSA is minimizing the impacts of its action by comparing it against "complete global inaction on climate change." But regardless of which scenario is used to frame its analysis, the relative impacts of the Proposed Action and alternatives, as compared to each other, are approximately the same. The Draft EIS fully recognizes that the Proposed Action and alternatives would all result in increases in global temperatures, sea level, and precipitation, among other climate impacts. In all cases, the impact on climate attributes as a result of this action would be small.

NHTSA agrees that an additional discussion of administrative actions would provide further context for its cumulative impact analysis and, in response to this comment, has added a discussion of federal actions that are already underway or reasonably foreseeable that will increase GHG emissions in Section 8.6.3.2, *United States: Federal Actions*.

Comment

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Under NEPA, agencies must analyze the direct, indirect and cumulative impacts of an agency action on GHG emissions. *See, e.g., CBD v. NHTSA*, 538 F.3d at 1216 ("The impact of GHG emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."); *Sierra Club v. FERC*, 867 F.3d 1357, 1371 (D.C. Cir. 2017) (NEPA review must consider the direct and indirect effects of greenhouse gas emissions of the alternatives). In 2016, the Department of Transportation published for comment DOT Order 5610.1D, setting forth procedures to address climate change when conducting a NEPA analysis of its proposed actions. DOT Order 5610.1D(2)(a) and (c)(6).

Although the data provided by NHTSA, which is a division of the Department of Transportation, is both limited and skewed by the fundamentally flawed models discussed in Section II., B above, the DEIS admits that the Proposed Rollback will increase GHG emissions. NHTSA estimates that the preferred alternative would increase U.S. fuel consumption by a half million barrels per day, or 2-3% of total daily consumption and increase CO_2 emissions by 7,400 million metric tons (MMT) by 2100 when compared to augural standards. Given the flaws in how NHTSA conducted its technical analysis, NHTSA's discussion of the effect of the Proposed Rollback on GHG emissions substantially understates the outcome. The figure below demonstrates the significant difference in emission estimates by partially correcting the inputs and assumptions in the CAFE model.

> [See original comment for Figure 3 titled Total Additional Lifetime GHG Emissions From Proposed Rollback]

Nevertheless, the DEIS concludes that the action alternatives would, "to a small degree, increase the impacts and risks of climate change" (S-14), that the effects would be "small, occur on a global scale, and would not disproportionately affect the United States" (S-14), and that global warming "could be further exacerbated to a very small degree under the Proposed Action…compared to the No Action Alternative" (9-2). The transportation sector, however, represents over a third of the nation's GHG emissions, the largest of any single sector. And light duty vehicles account for approximately 60% of total U.S. CO_2 emissions from transportation. That means U.S. light-duty vehicles account for approximately 3 percent of total global emissions. Simply put, light-duty vehicles in the United States are among the largest single opportunities for GHG emission reductions anywhere in the world. Leaving these emissions on the table, as the Proposed Rollback's preferred alternative would do, will set global efforts to address climate change back significantly, contrary to the conclusions of the DEIS. The Proposed Rollback is particularly egregious because the nation's vehicle fleet is the single largest source of GHGs in the U.S. If, in NHTSA's view, a rulemaking that adds 7,400 $MMTCO_2$ to the climate crisis has nothing but *de minimis* results, the inevitable conclusion is that no action on any front is warranted. If this is NHTSA's view, NHTSA must disclose it.

In order to assess the importance of vehicle emissions reductions, it helps to have a measuring stick. One of the ways in which scientists calculate and express what it will take to hold the increase in temperatures to a certain level is using a "carbon budget." The carbon budget is used to identify an amount of cumulative GHG emissions from human activity (starting in late 1800s) that provides a two-thirds chance of going over a particular increase in global mean temperatures. The budget is measured in billions or "gigatons" of carbon ("GtC"), which can be converted into billions of tons of CO_2. In 2018, the Intergovernmental Panel on Climate Change (IPCC) calculated that the world could emit no more than 420 $GtCO_2$ to retain a two-thirds chance of limiting the global average temperature increase to 1.5°C. The IPCC further estimated that the budget is being depleted by approximately 42 $GtCO_2$ per year. Thus, if global emissions continue at the current pace, the carbon budget will be exhausted in 10 years. Despite the drastic reductions needed to achieve climate stabilization, the Agencies have instead proposed an action that, by their own admission, would increase CO_2 emissions by almost 7.5 billion tons by 2100. Even assuming these emission estimates are accurate, the Proposed Rollback constitutes a significant depletion of the remaining carbon budget.

Taking a "hard look" requires a recognition – absent in this DEIS -- that climate change presents an extremely challenging cumulative emissions problem. This is because a large percentage of the GHGs already in the atmosphere will remain there for decades, and the CO_2 emissions from vehicles sold during the 2021 to 2026 model years will remain in the atmosphere for centuries. The emissions resulting from the Proposed Rollback will continue long past 2021 through 2026, as vehicles remain in service for many years, sometimes many decades. Further compounding these more direct harms, the Proposed Rollback would also create a "technology cliff." That is, removing one of the major federal technology drivers would jeopardize other federal and state programs for reducing vehicular GHG emissions,[61] as those programs will no longer benefit from one of the primary complementary GHG-reducing programs.

Further, NHTSA may not bury the GHG increases the Proposed Rollback would cause simply by noting the vastness of the problem. Citing myriad expert reports, including from the IPCC, US National Research Council, NOAA, the US Global Change Research Program, and EPA's Endangerment Finding, NHTSA acknowledges that climate change is real, temperatures are increasing, and that human influence is the dominant cause. NHTSA then cannot attempt to disguise the true impact of its proposed action in a vast quantity of ever-rising cumulative GHG emissions. In fact, rather than demonstrating that the GHG emissions from the Proposed Rollback are *de minimis*, this approach shows they are quite significant. The courts have already rejected the contention that agencies need not take incremental steps to address climate change because their contribution to that problem is relatively small. This principle is especially powerful here, where NHTSA proposes not just to do nothing to address a developing global crisis, but rather proposes to flatline existing standards that are already in place to help address it. NHTSA must evaluate the "incremental impact" that the Proposed Rollback will have on climate change, and the NEPA analyses must carefully consider the Proposed Rollback's incremental impact in light of past, present, and reasonably foreseeable future actions. See Am. Rivers v. Fed. Energy Regulatory Comm'n, No. 16-1195, 2018 WL 4610726 (D.C. Cir. Sept. 7, 2018).

This is precisely what NHTSA fails to do in its DEIS: NHTSA begins the DEIS by concluding that CO_2 emissions resulting under the augural standards would result in a pessimistic world in which the global mean surface temperature rises by a colossal 6.27 degrees Fahrenheit by 2100, and global sea level rises by 30.03 inches with attendant impacts to extreme and regional temperature and precipitation trends. It then uses those high figures to minimize the GHG changes from the Proposed Rollback, only looking at global average trends in air temperature, sea level rise and ocean pH. For example, it concludes that global mean surface temperature would increase by only 0.005 degrees Fahrenheit, and sea levels would rise only 0.02 inch, compared to the No Action Alternative. No analysis is performed on the effect of any alternatives on the many other impacts from climate change NHTSA acknowledges, for example,

[61] Such programs include, for example, California's ZEV and vehicular GHG programs.

such as extreme and regional temperatures, extreme weather including heat waves, droughts, regional sea level rise, coastal flooding and erosion, snow cover, human health, ecosystems, and Arctic impacts including melting of permafrost. While NHTSA's 2012 draft and final EIS also used comparisons on a global scale, that was in the context of conservatively framing essential emissions reductions from the proposed 2012 standards against a massive global environmental issue; it was not in the context of attempting to minimize GHG emissions *increases* as part of an action contrary to remedial statutes directing protection of the environment and conservation of resources.

NHTSA compounds this minimization of the impacts by failing to show the real-world consequences of the expected dramatic increases in global mean surface temperatures and sea level rise in ways the public can understand. Absent from the DEIS are any maps showing the loss of property and infrastructure due to increased sea levels and commensurate storm surges that would affect tens of millions of Americans. Rather, beyond discussion regarding the sea level rise risk posed by climate change generally, the DEIS provides only three paragraphs of text specifically describing the potential impacts of the Proposed Rollback on this critical point. The change in ocean acidity likewise receives only two paragraphs and a few brief scattered statements generally noting that ocean acidity is a climate-induced change, with no mention of the bleaching of coral reefs or imperilment of shellfish-dependent industries. The sole quantifications regarding changes to ocean acidity are very brief and unexplained in terms of their actual physical effects on the environment. Furthermore, the quantifications for sea level rise and ocean acidification due to the Proposed Rollback also suffer from the same problem plaguing NHTSA's GHG impacts analysis (described above), in that NHTSA minimizes the ocean PH and sea level rise impacts by showing them in the context of a world that has utterly failed to take appropriate action to address catastrophic climate change. Nor does there appear to be any discussion of the impact of warming ocean temperatures on ocean ecosystems, which is already resulting in the dramatic northward migration of economically and culturally important species, such as New England's American lobster. Enormous changes in temperature are mentioned matter-of-factly without acknowledgment of their impact on wild fires, safety of agricultural workers, or even suspension of airport operations—all of which have already begun to manifest themselves in the Southwest. The DEIS spends three pages on a table of "Regional Changes to Warming and Seasonal Temperatures" that provides skeletal, bareboned one-sentence descriptions that use vague terms such as "increase in frequency and duration of heat waves" and "more frequent droughts." NHTSA cannot claim that better and more descriptive information is not available—multiple recent reports by the federal government are replete with informative, graphic and digestible presentations of information on the impacts of climate change.

In summary, the Proposed Rollback would have tremendous GHG consequences, as it would essentially eviscerate one of the significant federal climate measures, without adequately disclosing the magnitude of that change to the public, and without providing any mitigation for the increased GHG emissions it would cause. The overwhelming scientific consensus finds that immediate and continual progress toward a near-zero GHG emission economy by mid-century is necessary to avoid truly catastrophic climate change impacts. In the face of these stark scientific facts, NHTSA recklessly proposes to gut the primary emission reduction program for the United States' single-largest sector for GHGs. Slamming the brakes on reductions in GHG emissions from U.S. light-duty vehicles for over half a decade would deal the fight against climate change a substantial blow. As it stands, the federal government's own scientists believe that the commitments made by the U.S. and other nations through the Paris Agreement process provide less than a 10 percent chance of holding to a 3.6 degrees F (2 degrees C) temperature rise, and "there would be virtually no chance if emissions climbed to levels above those implied by the country announcements." Yet, that is precisely the direction EPA's Proposed Rollback points us, increasing the U.S.' emissions above its commitment levels and hurling the nation and the world toward a point of calamity. NHTSA should revise the DEIS to inform the public of the magnitude of the GHG impacts of the Proposed Rollback.

Docket Number: NHTSA-2017-0069-0597-21
Organization: National Coalition for Advanced Transportation
Commenter: Devin OConnor

In addition, NHTSA's fundamental approach with regard to GHG emissions and climate change is unsound. The most recent evidence and analysis with regard to climate change is that the planet is rapidly approaching a tipping point. If substantial reductions in GHG emissions are not achieved within the next decade, it will become increasingly difficult to avoid catastrophic impacts to human health and the environment. In this context, the notion that large absolute impacts on GHG emissions should be disregarded because they are not a large percentage of total global emissions is based on flawed logic. NHTSA projects that its proposal will increase GHG emissions by 872 million metric tons (CO_2 equivalent) over the lifetime of the relevant vehicles; though, here again, this is a significant underestimate because of the modeling flaws discussed above. Multiplying the emissions impacts of NHTSA's proposal by the social cost of carbon (SCC) helps to give a better sense of the magnitude of the impact. Even under the inappropriately constrained SCC applied by the agencies, coupled with the underestimate of resulting emissions, the increased emissions resulting from the proposal would impose over $4 billion in incremental damages. Applying the more appropriate SCC used in the prior Administration and a more accurate estimate of the emissions impacts, the damages attributable to the proposal would be over an order of magnitude greater.

NHTSA's approach is a self-fulfilling prophesy: Because no single action can achieve a large proportional impact on global climate change, the agency argues, no effort to reduce emissions is material or worthy of being taken—hence impacts will increase and the incremental effect of any actions will be yet further reduced. This is false logic that should be rejected; it is arbitrary and capricious and is not a reasonable or permissible interpretation of the "need of the United States to conserve energy" under EPCA.

For all these reasons, the need to conserve energy is not limited to reducing oil imports and is not obviated, or even significantly diminished, by current or projected changes in oil markets. Where more efficient technology is available and economically practicable (meaning that it can be deployed without "adverse economic consequences, such as a significant loss of jobs or the unreasonable elimination of consumer choice"), failure to employ such technology results in unnecessary or wasteful consumption of the resource. This includes more rapid consumption of a scarce and finite domestic resource, increased costs to consumers, adverse impacts on the balance of payments, and adverse environmental impacts, among others.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School
Commenter: Michael Oppenheimer

The Proposal is founded on a fallacy: that because the difference between projected passenger car and light truck GHG emissions under existing regulations and under the Proposal is "small," those incremental emissions reductions are not worth pursuing. The first problem with this characterization is that the U.S. transportation sector is not a small source of GHG emissions. The DEIS recognizes as much, stating that "transportation is the single leading source of U.S. emissions from fossil fuels, causing over one-third of total CO_2 emissions from fossil fuels." According to EPA analysis, the U.S. transportation sector produced 28% of U.S. GHG emissions in 2016, tied with the power sector as the largest source of emissions in the country. Passenger cars and light trucks, the vehicles regulated by the Proposal, account for more than half of U.S. transportation sector GHG emissions, releasing 1,109 million metric tons of CO_2 equivalent ("MMT CO_2e") in 2016. This scale rivals the total national emissions of other countries. If emissions from U.S. passenger cars and light trucks were considered their own country, they would rank 7th-largest worldwide: bigger than Germany and Indonesia and slightly smaller than Brazil.

Because the U.S. transportation sector is very large, increases or reductions in its emissions are correspondingly significant. The DEIS predicts that the Proposal will release an additional 95 MMT CO_2e into the atmosphere in 2040, per year, compared with keeping the current standards in place. DEIS at 5-25. This increase in emissions would be greater than recent emissions totals of entire countries such as Austria, New Zealand, or Sweden. Even just one part of the Proposal—elimination of non-CO_2 GHG emissions standards for passenger cars and light trucks, *see* 83 Fed. Reg. at 42,990, Tbl. I-4—would deregulate GHG emissions controls for more than 50 MMT CO_2e per year. That is roughly the same amount as New York City's annual GHG emissions and more than 7 times that of Boston's.

Yet the DEIS describes the Proposal's impacts as "small" when compared to the overall global "emissions trajectories" projected. DEIS at 5-30. This is an unreasonable comparison to make. Any source of GHG emissions, even that of entire countries with advanced economies, could be made to seem small when compared to global GHG totals. If the DEIS's approach were applied by other governments worldwide, virtually all emissions sources could be exempted from regulatory intervention due to the "small[ness]" of their corresponding harms. *See id.* This approach irrationally commits the U.S. to the "reasonably foreseeable" high-emissions scenario that the DEIS has projected, *see id.* at 8-20, which will worsen climate change impacts on the United States. The undersigned ask the Agencies: If U.S. passenger car and light truck GHG emissions are too small to be worth targeting for immediate, incremental reductions, which sources of emissions—if any—would the Agencies consider worth regulating?

Response

As described by the commenters, NHTSA concludes that the Proposed Action and alternatives would, to a small degree, increase the impacts and risks of climate change. NHTSA does not, however, suggest that "no action on any front is warranted" or that "no effort to reduce emission is material or worthy of being taken." While NHTSA considers the potential environmental impacts of the rule as part of its decision-making, it must consider the four statutory factors (technological feasibility, economic practicability, the effect of other motor vehicle standards of the government on fuel economy, and the need of the United States to conserve energy) and other relevant considerations when setting "maximum feasible" CAFE standards. NHTSA makes no conclusions on behalf of other federal agencies or other actors regarding whether any actions they undertake are warranted. For more information regarding NHTSA's consideration of the four statutory factors, see Section VIII of the preamble to the final rule.

The commenters also fault NHTSA for not distinguishing among alternatives with regard to other potential impacts of climate change, such as extreme and regional temperatures, regional sea-level rise, snow cover, etc. In the NEPA context, there are limits to the utility of drawing from assessments to characterize the regional climate impacts of the Proposed Action and alternatives. The existing assessment reports do not have the resolution necessary to illustrate the effects of this action, because they typically assess climate change impacts associated with emissions scenarios that have much larger differences in emissions—generally between one and two orders of magnitude greater than the difference between the No Action Alternative in 2100, and the emissions increases associated with all the action alternatives in 2100. The differences between the climate change impacts of the Proposed Action and alternatives would be far too small to address quantitatively in terms of their impacts on the specific resources of each region. Attempting to do so may introduce uncertainties at the same magnitude or more than the projected change itself (i.e., the projected change in regional impacts would be within the noise of the model). NHTSA cannot feasibly undertake such a widespread, global analysis on a regional basis. The commenter suggests that the standard for analysis was lower for NHTSA's 2012 action because that resulted in emissions reductions; however, this action also results in increasing stringency on a year-by-year basis. Even assuming the commenter's assertion were true, if NHTSA had promulgated these standards in 2012, when instead it published nonenforceable "augural" standards, it would be entitled to the same level of review alleged by the commenter.

NHTSA reviewed the commenters' recommendations regarding the current global carbon budget and the need for additional emission mitigation activities. NHTSA considers the GHG impacts of its fuel economy actions in terms of a global carbon "budget" in Section 5.4.1.2, *Global Carbon Budget*.

The commenters note that additional quantification is required to describe the impacts of sea-level rise and ocean acidification that would result from the proposed action. The sections the commenter refers to, Section 5.3, *Analysis Methods,* and Section 5.4, *Environmental Consequences*, describe NHTSA's modeling approach and the results for these two climate change attributes. NHTSA has included additional context to improve the discussion of ocean acidification with a footnote indicating both the preindustrial and current pH levels to Final EIS Section 5.3.3.3, *Ocean pH*. Section 5.2 *Affected Environment,* and Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, provide additional discussion on the impacts of climate change, including from sea-level rise and ocean acidification.

The commenters also allege that NHTSA has not discussed the "real-world consequences" of climate change. However, Section 8.6.5 provides a thorough discussion of the health, societal, and environmental impacts of climate change. For example, this section addresses the migration of fish species to deeper or colder water and the impacts of both warmer water and ocean acidification on corals. For the reasons described above, this section does not distinguish between the alternatives under consideration; however, it does provide a review of projected impacts from increases in GHG emissions. Section 5.2.2.1, *Climate Change Attributes,* also discusses current climate attributes and projected impacts. NHTSA believes that these sections provide adequate context for the reader to understand the magnitude of the climate effects associated with the action under consideration.

Comment

Docket Number: NHTSA-2017-0069-0563
Organization: Pennsylvania Department of Environmental Protection
Commenter: Patrick McDonnell

The agencies' analysis is largely silent on the effects of eliminating the augural CO_2 standards for MYs 2022 through 2026. They conclude that the effects of the forgone CO_2 reduction benefits would have a negligible impact between the 2012 standards and the Proposed Rule. 83 Fed. Reg. 42,996 and 42,997.

PADEP believes that the Proposed Rule does not fully consider the potential effects of global climate change resulting from these forgone reductions or the interests of states in preventing or mitigating the impacts of climate change on their citizens and environment. In Pennsylvania alone, the impacts of climate change range from more frequent and severe inland waterway flooding from increased storm intensity, increased landslides and sedimentation runoff resulting in water pollution and infrastructure damage, an increase in the number of days with dangerously high temperatures, increased energy consumption, disruption of commerce, and an increase in the number of invasive species. For example, Pennsylvania experienced severe flooding from extreme weather events throughout the Ohio and Susquehanna River Basins in 2018. The volume of extreme weather events and other effects of climate change will drastically increase mitigation and recovery costs to the Commonwealth, including its counties and municipalities, as well as to businesses and homeowners. The Proposed Rule fails to consider the costs of these impacts on state, county, and municipal governments and the harm to human health and welfare and the environment.

Response

In Section 8.6.5.3, *Regional Impacts of Climate Change*, NHTSA recognizes the public interest in understanding the potential regional impacts of climate change. NHTSA incorporates by reference prior discussions of these issues by referring readers to Section 5.5.2 of the *MY 2017–2025 CAFE Standards Final EIS* (NHTSA 2012), Section 5.5.2 of the P*hase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c), and the *Fourth National Climate Assessments* (GCRP 2017, 2018) for more information on the projected impacts of climate change on regions of the United States. NHTSA discusses the impact of the Proposed Action and alternatives on human health and welfare in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.* Ultimately, NHTSA does factor these findings into its balancing of the statutory factors set forth by EPCA. For more information on its balancing of the statutory factors, see Section VIII of the preamble to the final rule.

10.5.1 Methodology

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Regarding selection of the baseline scenario: Recognizing that the Administration's position is to neither take actions to limit human-generated CO_2 emissions nor to encourage other nations to take such actions, we commend EPA and the NHTSA for being forthright about the Administration's policy positions by choosing a baseline scenario that "does not assume comprehensive global actions to mitigate GHG emissions". The draft EIS calculates that this decision to take no policy actions would cause the atmospheric CO_2 concentration to increase from its present value of just over 410 parts per million (ppm) to 789.11 ppm in 2100 (with continued rise thereafter); such a level approaches three times the preindustrial concentration of about 280 ppm. As has been presented in intergovernmental and national assessments and in findings of the U.S. National Academy of Sciences, **we concur with the finding in the Draft EIS prepared by EPA and NHTSA that taking no policy actions to limit human-generated fossil-fuel CO_2 emissions would cause the global average temperature in 2100 to increase**

to over 4°C (~7°F) above the global average temperature of the late 19th century.[62] The analysis also indicates a base case rise in sea level of 76.28 cm (~30 inches) relative to 1986-2005 [so atop of a rise of near 19 cm (7.5) inches from 1901 to 2010] and drop in pH of a few tenths of a unit (equivalent to a rise in the hydrogen ion concentration by well over 100%) with associated impacts on the marine ecosystem.

Response

NHTSA presents an analysis that does not assume comprehensive global actions to mitigate GHG emissions in order to present a "business-as-usual" scenario reflecting current emissions trends. NHTSA has taken this approach in all of its recent EISs addressing the CAFE and Medium- and Heavy-Duty programs. With regard to the timeframe presented in the EIS, the MAGICC model runs simulations from a preindustrial starting point through 2100, meaning that the warming since that period is accounted for in the EIS results. Section 5.2.2.1, *Climate Change Attributes*, notes that the pH of the world's oceans has decreased by 0.1 unit since the preindustrial period.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-2, Section 5.1.1 Uncertainty in the IPCC Framework: While this section does report on how IPCC characterizes uncertainty, there is no consideration given as to whether this is the appropriate framing for considering potential actions by NHTSA and EPA. The IPCC framing is an attempt to translate the traditional scientific and expert frameworks for uncertainty into commonly understood language, but the EIS fails to explain that the traditional scientific framing is based on the objective of scientific and expert findings being very firmly based as the proverbial "pyramid of knowledge" is constructed to be solid and without error. This framing, however, is not how broader society and regulatory agencies tend to frame their actions, generally choosing a framing based on avoiding risks. For the situation considered in this EIS, while uncertainties do exist in the details of how climate change will evolve, there is no question that significant changes in the atmospheric concentrations of greenhouse gases will lead to several degree changes in the global average temperature, and there is no question that such changes in climate would represent a substantial change relative to the range of climatic conditions that have occurred over the last few hundred million years and well beyond the natural fluctuations and variations in climate that have occurred during the development of the world's civilizations. In our view, this EIS needs to be reformulated based on the type of risk- based framing that has been used in development of air and water quality, medical, building and highway construction standards and more. At the very least, this issue of risk and uncertainty requires a much more thorough discussion.

[62] Section 5.4.2.2 indicates that, as a result of the baseline scenario, "global surface air temperature is projected to increase from 1986 to 2005 average levels by 1.29°C (2.32°F) by 2040, 2.01°C (3.61°F) by 2060, and 3.48°C (6.27°F) by 2100." Observed global warming from the 19th century to the 1986-2005 reference period used in the baseline scenario has been ~0.8°C (~1.4°F). To determine the warming since the 19th century (preindustrial period), the reference period used in international negotiations and calculations of total human-induced global warming, the ~0.8°C (~1.4°F) needs to be added to the values given in the text, thus totaling over 4°C (7°F) in 2100.

Response

NHTSA recognizes that there are different approaches to framing complex environmental issues, such as climate change, in the context of agency decision-making. However, NHTSA does not believe risk-based framing is the most appropriate framing for informing its decision-making in this action. NHTSA considers the systematic approach to uncertainty developed by IPCC to be the most appropriate means to assess the various uncertainties associated with climate change impacts. The agency then considers the potential impacts, and the various uncertainties associated with those impacts, in balancing the four statutory factors and other relevant considerations under EPCA. The IPCC approach to uncertainty is described in Section 5.1.1, *Uncertainty in the IPCC Framework*.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-19 and 5-20, set of bulleted sources of uncertainty and accompanying discussion to end of section: While it is the case that there are uncertainties in the calculations, there is no question that there will be significant effects as a result of the human-induced changes in atmospheric composition. Having such an extended discussion on uncertainties really underplays what is understood from theoretical analyses, laboratory and field experiments, paleoclimatic reconstructions, comparative planetary analyses, and more—namely that there will be a substantial change in the climate as a result of the rising CO_2 concentration. While the details are gradually being better worked out, the basic science of the greenhouse effect and the consequences of a higher CO_2 concentration have been understood for several decades and simply cannot be dismissed; saying the "[s]cientific understanding of the climate system is incomplete" needs to be put in context—making clear that the limits in scientific understanding are mainly related to details as compared to overall understanding. This section thus needs greater context making clear that human-induced climate change is occurring, that human-induced changes in sea level are occurring, and that human-induced changes in ocean acidification are occurring and, given geological understanding, will be significant for both the environment and society.

Response

NHTSA acknowledges the general scientific consensus that human emissions of GHGs have been the dominant cause of global warming since the mid-20th century (Section 5.1.2, *Climate Change and Its Causes*). NHTSA also acknowledges that the scientific understanding of the climate system is evolving and improving through time. As with other analyses of complex, long-term changes to support decision-making, evaluating reasonably foreseeable impacts of climate change on the human environment involves assumptions and uncertainties. The impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, reflect the best available science regarding climate change and its impacts on health, society, and the environment.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-23 and 5-24, Section 5.3.3.2 Sea-Level Rise: It needs to be explained why the analyses that are done for temperature and sea-level rise are not being run from pre-industrial to 2100 (and even beyond)—the MAGICC model runs very quickly. Given that the model is based on the build-up of changes over time such as the movement of heat into the ocean, the model simulations would seem to need to be run from the starting point out to 2100 and not started up at 1950 for temperature and 2010 for se-level rise (especially as material on page 5- 31 and 5-32 indicate that the baseline is 1986-2005, which seems inconsistent). There is no explanation for why simulation of the overall time period is cut short, and this would seem to need to be done.

The extent to which the model simulations being done treat the melting and loss of mass from the ice sheets, especially in that the ice sheet contribution is becoming and will in the future be the largest term contributing to sea level change.

It is also essential in considering potential sea-level consequences to go well beyond the year 2100 as the time constant for ice sheet adjustment may be as much as several thousand years. Paleoclimatic analyses suggest, as described elsewhere in these comments, that the equilibrium response of sea level to a change in global average temperature is roughly 15-20 meters per degree Celsius (so roughly 28-33 feet per degree Fahrenheit). Jumping ahead in the EIS to Table 5.4.2-2, the responsiveness of sea level to temperature there is roughly 0.2 meters per degree C, so roughly a factor of 100 less than equilibrium (so perhaps not surprising in that only about 60 years have passed out of the few thousand year response time to small variations in temperature). This limitation of only considering the sea level implications of the warming needs to be included in the EIS.

Response

In response to this comment, NHTSA has added a footnote to Final EIS Section 5.3.3.2, *Sea-Level Rise*, noting that the MAGICC model used in the analysis does run simulations from a preindustrial starting point through 2100. NHTSA has not modeled results past 2100 given the scientific uncertainty beyond this period, which is consistent with IPCC projections. Additionally, given the difficulty of inferring climate impacts from paleoclimatology, considerable uncertainties remain when using this type of analysis to consider projected rates of change. Therefore, NHTSA believes its current approach to project climate change impacts is appropriate.

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-24, Section 5.3.3.3 Ocean pH: While the table later in the EIS provides the estimated values of pH in the future, the EIS does not provide the preindustrial baseline value of pH nor the value at present, so it is difficult to fully evaluate the changes being simulated. This section would seem to be the place in the EIS to include these values.

Response

In response to this comment, NHTSA has added a footnote indicating both the preindustrial and current pH levels to Final EIS Section 5.3.3.3, *Ocean pH*.

Comments

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-26 and 5-27, Section 5.3.3.6 Sensitivity Analysis: In that the baseline scenario is that all nations have together followed the No Action Alternative, it seems strange, given the globally interconnected automobile manufacturing sector, that it is assumed that the proposed policy Alternatives are being applied only to the United States. Were the rest of the world to follow the U.S. lead in making these changes, the effects on the climate would be several times larger.

Docket Number: NHTSA-2017-0069-0544
Commenter: David Bella

STATEMENT 1: This EIS draws upon a vast body of peer reviewed science, including the IPCC. Its review of climate change is comprehensive and well written. It employs peer reviewed models and scenarios. Its methods and reasoning are clearly stated. It does **not** deny the evidence of climate change or its seriousness. The EIS acknowledges risks not included in models such as “tipping points”, and abrupt climate changes that “could occur so quickly and unexpectedly that human systems would have difficulty adapting to them.” Model simulations are carried out to the year 2100. Uncertainties are acknowledged and demonstrated by employing different scenarios and climate sensitivities. In brief, this EIS does **not** fit the “science denial” label.

STATEMENT 2: This EIS assesses mileage requirements for model years 2021-2026 passenger cars and light trucks (I will simply use the term “cars”). Its assessment finds that higher mileage standards (on the books but, not final; the “No Action Alternative” in the EIS) would result in extremely small differences in climate change impacts (CO_2 concentration, global mean surface temperature, sea-level rise and ocean pH). These results show that the “preferred alternative” of lower mileage requirements (higher CO_2 emissions) would make very little difference in outcomes.

For some, these two statements may seem paradoxical because together they do not fit into labels of either side of a long lasting and polarized debate. We need such paradox! The tension between these two statements creates an opening, an opportunity, for discourse of a different and challenging kind.

I, along with others, could question particular parts of the EIS, citing references not included. My comments, however, take a radically different course. I seek to use this EIS to question and challenge a common assumption widely practiced but seldom discussed: *ceteris paribus*. Then, I briefly reconsider alternatives for climate change mitigation.

Ceteris Paribus: Why It Matters

For climate change, the basic claim of this EIS is this: <u>higher U.S. mileage requirements for passenger vehicles and light trucks (lower CO_2 emissions) would only reduce climate change impacts by extremely</u>

small amounts. Thus, the "preferred alternative" was to **not** increase U.S. mileage requirements. This claim was supported through the use of a peer reviewed model that computed impacts with different mileage requirements. The differences, computed to the year 2100, were so small (e.g. 0.003 degrees C or less) that the impacts of all alternatives (all with higher emissions) were insignificant.

The EIS did not deny the risks of climate change either in its text or model outputs. Instead, it claimed that higher U.S. mileage requirements would make essentially no difference. My comments will not question the science employed. Instead, I will question one assumption employed in all these computed comparisons.

This assumption is known as *ceteris paribus*, a Latin phase meaning "other things equal". Translations include "**all else unchanged**" or "**other things held constant**". You can check this out on Wikipedia.

The *ceteris paribus* assumption lies behind many scientific studies to determine the effect of some particular cause in isolation. It certainly has practical value. It allows straightforward comparisons as done in the EIS evaluations of its alternatives. But, there are dangers; read the statement of Alfred Marshal in Wikipedia. Marshal states, "**The more we apply the rule of *ceteris paribus* the farther we distance ourselves from reality**".

Consider how *ceteris paribus* was applied in this EIS. Climate change computations require scenarios that provide inputs to models that compute impacts over time. The computations the EIS used to compare each alternative all involved a *ceteris paribus* change in a scenario.

For any scenario, the model does, of course, compute many changes over time. These changes depend upon the scenario that provides the emission inputs to the model. Each alternative was evaluated making a *ceteris paribus* change in a No Action Alternative scenario. That is, emissions in a No Action reference scenario were altered only by the emissions changes produced by an alternative; all else in the scenario was unchanged (*ceteris paribus*). Then, two sets of model outputs were computed using a No Action scenario with and without the alternative. The differences in these model outputs determined the impacts of the alternative (see page 5-25 in the EIS). These differences were based on the *ceteris paribus* assumption, "*all else unchanged*", applied to each scenario that included an alternative.

With three different scenarios used as references and six different climate sensitivities in the model, the computed impacts of the "preferred alternative" were all found to be extremely small. But remember, all such computations compared scenarios with and without the alternative. *Ceteris paribus* was assumed in the with and without scenarios that produced these results.

For the assessments in the EIS, *ceteris paribus* (assuming "all else unchanged") is not a problem for the climate model. However, it is a fundamental problem for the scenarios employed as inputs to the climate model. These scenarios represent human actions throughout the world that determine emissions which, in turn, determine the impacts computed and used to evaluate alternatives. *Ceteris paribus* assumes *all else unchanged* in these scenarios. That is, given a U.S. action, it is assumed (*ceteris paribus*) that no other actions throughout the world are changed as a result.

In its use of scenarios, the EIS assumes, *ceteris paribus*, that all other human actions would be unchanged if the U.S. carries out any of the EIS alternatives. More generally, the EIS assumes no U.S. leadership (positive or negative) in the examples set by U.S. actions. It is an assumption that minimizes the consequences of U.S. actions. This, in turn, allows U.S. policy makers to cite the EIS to justify a policy that increases emissions (the "preferred alternative"). And, this same EIS bases its analyses upon science that provides abundant evidence that serious and potentially catastrophic global consequences will occur from continuing emissions.

Problems solved in the past (river pollution from domestic waste, smog) were reversible and local; specific actions had direct impacts and improvements could be quickly observed. Then, *ceteris paribus* assumptions were reasonable and practical; they led to effective actions. But, global climate change is a radically different! *Ceteris paribus* precedents from the past will lead us to “distance ourselves from reality”.

Threats of global climate change arise from many thousands of actions throughout the world. If these actions are evaluated with the *ceteris paribus* method of this EIS, very few alternatives to reduce emissions would be “preferred”. A bad precedent would be set! Then, higher emission scenarios would be more realistic and, even with the models employed in the EIS, the outcomes could be disastrous.

Because *ceteris paribus* is so widely assumed, even taken-for-granted, this critique can be easily dismissed as esoteric when, in practice, *ceteris paribus* methods (presumed in this EIS) could contribute to disastrous outcomes.

Brief 1: Method and Leadership

In order to clarify my concerns, I will employ a format that briefly states observations followed by comments and questions. I will refer to these as “Briefs”. The previous discussion of *ceteris paribus* is covered in Brief 1 below.

<u>OBSERVATIONS</u>

Global GHG emissions arise from many thousands of actions throughout the world.

The method this EIS employs to evaluate its alternative actions assumes all else remains the same (*ceteris paribus*); this is a “no leadership” assumption.

With *ceteris paribus* presumed in its method, this EIS can be used to justify the “preferred action” (higher emissions) because its impacts are computed to be extremely small.

If all actions throughout the world were evaluated and justified with this same (*ceteris paribus*) approach, very few actions would be taken to reduce emissions.

Then, on the basis of material employed in this EIS (models, descriptions of “tipping points” etc.) the global outcomes could be disastrous.

<u>COMMENTS AND QUESTIONS</u>

This EIS draws upon peer reviewed scientific reports, evidence, scenarios and models. However, the way the scenarios and models were employed to evaluate alternatives assumes *ceteris paribus* without stating so. This matters because this assumption - taken for granted in the calculations - has the hidden effect of *assuming no U.S. leadership in the examples we set*.

Given that the U.S. a powerful and influential leader in the world, the *ceteris paribus* assumption is likely to underestimate the impacts of the examples the U.S. sets. This should be clearly stated even if the amounts cannot be quantified.

An assessment that serves to inform the public and decision makers should clearly state the implications of the *ceteris paribus* assumption it used to evaluate alternatives. To not do so is to withhold relevant information.

Because it is hidden in the computations, the *ceteris paribus* assumption as used in this EIS could set a very dangerous precedent!

Has this matter been considered? If so, where can I find it?

Brief 2: Carbon Budget

The EIS includes the concept of a carbon budget (page 5-29 and 5-30). This is good because the carbon budget provides clarity on the problem we face. But, given this concept, as stated in the EIS, the reader is left wondering what the DOT is really saying about our future. These concerns are stated in the Brief below.

<u>OBSERVATIONS</u>

This EIS has considered emissions in terms of a global carbon “budget”.

This notion of a “budget” is based upon recent research that finds that global surface temperature are approximately a linear function of cumulative carbon emissions.

In terms of end use, transportation is the largest source of U.S. CO_2 emissions with cars and light trucks contributing the most.

The EIS states that significant steps to stay within the carbon budget “would require substantial increases in technology innovation and adoption compared to today’s levels and would require the economy and the vehicle fleet to move substantially away from fossil fuels, which is not currently technologically feasible or economically practical” (see page 5-30 of the EIS).

<u>COMMENTS AND QUESTIONS</u>

Where does all this lead?

The EIS calculations show, as real possibilities, global surface temperatures rising to levels seen as dangerous, even catastrophic. And, it appears that the EIS scenarios include more emissions beyond 2100 (is this correct?).

Unless some clarification is provided, this EIS implies that cumulative carbon emissions will continue to grow until disasters occur and/or some unspecified and drastic technological fix (e.g. geoengineering) is attempted.

Yes, there are uncertainties as shown in the EIS. But, the risks shown in the EIS are substantial and cannot be ignored. Given that transportation is a large source of GHG emissions, the DOT needs to say something more than its alternatives only increase these risks a tiny amount!

In the past, *ceteris paribus* assumptions were reasonably and successfully applied for assessments and designs. But, for the global problems we now face (e.g. climate change), such assumptions are not justified and could contribute to disastrous inactions.

To paraphrase Alfred Marshal, the more we apply the assumption of ceteris paribus, the more the world will depart from our assumptions.

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch et al.

Second, the assumptions used to forecast global CO_2 concentrations were developed over a decade ago and do not reasonably reflect the likelihood of global response to climate change. NHTSA's analysis assumes that the globe is on an irreversible path towards catastrophic climate change with massive levels of CO_2 in the atmosphere by 2100. If federal agencies continue to make decisions blindly disregarding climate science and the need for global action, perhaps NHTSA's assumptions might become a self-fulfilling prophecy. The world is taking action, however – with or without the current federal administration – so it is not reasonable to assume a catastrophic climate change scenario as part of an analysis that is supposed to take a "hard look" at the environmental impacts of a regulatory action.

Response

NHTSA has no way to reasonably predict whether other countries will change their fuel economy standards in response to this action. Furthermore, NHTSA is unable to project or model potential changes in international fuel economy that may or may not follow from this rulemaking or future actions taken by foreign countries. Therefore, NHTSA has only modeled the impact of the Proposed Action and alternatives on the U.S. light-duty vehicle fleet.

NHTSA cannot reasonably assume a particular global level of effort based solely on the actions taken in this rulemaking. However, NHTSA does present two analyses in the EIS, which may provide insight into the potential impact of other countries less strictly regulating GHG emissions. In Chapter 5, *Greenhouse Gas Emissions and Climate Change*, NHTSA used the GCAM Reference scenario for the direct and indirect analysis, which does not assume comprehensive global actions to mitigate GHG emissions. In Chapter 8, *Cumulative Impacts*, NHTSA used the GCAM6.0 scenario. GCAM6.0 does not include specific climate change mitigation policies; it does, however, represent a plausible future pathway of global emissions in response to a moderate global action to mitigate climate change. The different results in these sections provide some insight into plausible future scenarios regarding the level of global effort to address GHG emissions and climate change. But, regardless of which scenario is used to frame its analysis, the relative impacts of the Proposed Action and alternatives, as compared to each other, are approximately the same.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

While NHTSA purports to undertake an analysis of its action's effect on the planet's remaining carbon budget, it fails to present any alternative that would allow the U.S. fleet's emissions to stay within that budget. According to the IPCC, the total cumulative anthropogenic emissions of CO_2 from 2011 onward must remain below about 1,000 gigatonnes of carbon ($GtCO_2$) for a 66 percent probability of limiting warming to 2°C above pre-industrial levels, and to 400 $GtCO_2$ from 2011 onward for a 66 percent probability of limiting warming to 1.5°C. The U.S. carbon budget for limiting temperature rise to well below 2°C has been estimated at 25 $GtCO_2eq$ to 57 $GtCO_2eq$ on average,[63] depending on the sharing principles used to apportion the global budget across countries,[64] while the U.S. budget for limiting temperature rise to 2°C ranges from 34 $GtCO_2$ to 123 $GtCO_2$. Although the cited studies differ in terms of certain assumptions and normative emphases, they all tell the same fundamental story: under any conceivable scenario, the remaining U.S. carbon budget for limiting global average temperature rise to 1.5°C or 2°C is extremely small and is rapidly being consumed. In the DEIS, NHTSA concludes that from 2016 to 2100, the fleet would consume 23 GTC, or 5.2% of the total budget under the No Action Alternative, and 25 $GtCO_2$, or 5.7 %, under the Preferred Alternative. But NHTSA fails to analyze by how much emissions would have to be reduced between 2021 and 2100 to stay within a U.S. allocation of the carbon budget, and perfunctorily concludes that remaining within it is "not currently technologically feasible or economically practicable." In light of the fact that NHTSA does undertake a projection of carbon emissions 82 years into the future, NHTSA's refusal to consider reasonable alternatives resulting in avoiding the exceedance of the U.S. carbon budget is unreasonable. This superficial dismissal of what is a crucially important inquiry stands in stark contrast to NHTSA's strenuous efforts to justify weakening the standards, reduce the social cost of carbon and obscure the real world effect of a 3.6°C temperature rise. In order to undertake a hard look at what its Proposal will do to the remaining carbon budget, NHTSA must also take account of the findings of the IPCC Special Report.

The tools to perform this type of analysis exist. Studies conclude that, when analyzing the transportation sector as one of seven "stabilization wedges" (or activity bundles) from which carbon emission reductions can be achieved to hold global CO_2 concentrations to certain levels of ppm, the average fuel

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[63] Yann Robiou du Pont et al., *Equitable Mitigation to Achieve the Paris Agreement Goals*, 7 Nature Climate Change 38 (2017). Quantities measured in $GtCO_2eq$ include the mass emissions from CO_2, as well as the other well-mixed greenhouse gases (CO_2,methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and SF6) converted into CO_2-equivalent values, while quantities measured in $GtCO_2$ refer to mass emissions of just CO_2 itself.

[64] Robiou du Pont et al. (2017) averaged across IPCC equity sharing principles to estimate the U.S. carbon budget from 2010 to 2100 for a 50 percent chance of returning global average temperature rise to 1.5°C by 2100, consistent with the Paris Agreement's "well below 2°C" target, and based on a cost-optimal model. The study estimated the U.S. carbon budget consistent with a 1.5°C target at 25 $GtCO_2eq$ by averaging across four equity principles: capability, equal emissions per capita, greenhouse development rights, and equal cumulative emissions per capita. The study estimated the U.S. budget at 57 $GtCO_2eq$ when averaging across five sharing principles, adding the constant emissions ratio to the four above-mentioned principles. However, the constant emissions ratio, which maintains current emissions ratios, is not considered to be an equitable sharing principle because it is a grandfathering approach that "privileges today's high-emitting countries when allocating future emission entitlements." Sivan Kartha et al., *Cascading Biases Against Poorer Countries*, 8 Nature Climate Change 348 (2018) (discussion of sharing principles).

economy the world's passenger cars and light truck fleet would have to achieve can be determined. A similar analysis can estimate what stringency increases are required from the U.S. light duty vehicle fleet to contribute proportionally to the goal of keeping within the remaining U.S. carbon budget, or to keep temperature increases at or below 2°C.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School

Second, the DEIS sets an arbitrary and unreasonable standard as an excuse for justifying the rollback of U.S. emissions reductions. Specifically, in its discussion of a carbon budget, the DEIS states that "[t]he emission reductions necessary to keep global emissions within this carbon budget could not be achieved solely with drastic reductions in emissions from the U.S. passenger car and light truck vehicle fleet." DEIS at 5-30. This is not an appropriate standard or point of reference; no reasonable policymaker or scientist asserts that the necessary emissions reductions can be achieved through reductions in the U.S. transportation sector alone (or indeed any single sector). It is illogical to argue against taking a single step on the basis that a single step is insufficient to reach one's goal.

The DEIS's assertion, furthermore, that such reductions are not "technically feasible," *see id.*, is both factually wrong and ignores the technology-forcing nature of the Clean Air Act's mobile source provisions. It also conflicts with the DEIS's separate finding that "government regulations [and economic factors] could cause manufacturers to revise product and investment plans over time." DEIS at 8-7. This market shift is already underway: Volvo, Volkswagen, Toyota, Renault-Nissan, BMW, Daimler, Ford, Tesla, and General Motors have all "announced investments to meet higher [electric vehicle] targets in 2019 and beyond." *Id.*

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 6. The scope of the EIS must include an accounting of exactly how the proposed changes in fuel economy standards will fit within national and international carbon budgets and the efforts to reduce these emissions.

As stated in the Draft EIS, the total carbon emitted by cars and trucks is a small fraction of total global carbon emissions and global coal production. But the impact will be far from negligible. Think not only of the specific impact but the manner in which the emissions from cars and trucks must fit within fixed national and global total carbon emission budgets and the efforts to reduce these emissions.

The IPCC has called for a cap of about 1000 trillion tons of cumulative carbon emissions for the entire globe and we have already emitted about half of that quantity. The carbon budget for the United States must be just a fraction of that and we know there are very large portions of that fraction that are already committed.

There is considerable international efforts to reduce CO_2 emissions that may possibly keep the global CO_2 concentrations well below the 789 ppm assumed on page S-15 so that the impact of the proposed changes will be substantially greater compared to a lower level of CO_2 concentrations. The analysis should consider what parts of these budgets are committed (not subject short-term to reduction) and discretionary (what has not yet been committed to). The distinction is important. What fraction of the US commitment under international agreements to reduce carbon emissions, such as the Paris Climate accord, would the new carbon emissions made possible by these terminals be responsible for? This is important to do even if the US withdraws from the accord. Much of our current carbon emissions are very difficult to reduce and our best bet is to try and stop any new massive sources of fossil carbon emissions. How exactly do these new rules fit within likely US budgets for new carbon emissions?

Please consider postponing the rule changes until the US can establish a legally binding national and international carbon budget and a binding mechanism to adhere to it. There is absolutely no reason to rush...the current standards are not unduly burdensome. It is clearly within the purview of the regulatory agencies to postpone projects until the required regulatory framework is established. This is particularly true when there is a fixed total allowable expenditure of a resource.

Response

NHTSA considers the GHG impacts of its fuel economy actions in terms of a global carbon "budget" in Section 5.4.1.2, *Global Carbon Budget*. In that section, NHTSA states that the emissions reductions necessary to keep global emissions within this carbon budget could not be achieved solely with drastic reductions in emissions from the U.S. passenger car and light truck vehicle fleet, but rather would require drastic reductions in all U.S. sectors and from the rest of the developed and developing world. The purpose of this statement is not to argue for or against CAFE standards at a particular level of stringency, but rather to provide context to the decision-maker and the public. NHTSA has removed the statement about whether a substantial reduction in GHG emissions from the light-duty fleet to avoid using all of the carbon budget is technologically feasible or economically practicable, as such an assessment based on the EPCA statutory factors extends beyond the model years for which this assessment is made in this rulemaking.

NHTSA does not believe it is practical or appropriate to conduct the types of analyses requested by the other commenters. As noted in the comment, estimates for the U.S. carbon budget vary widely depending on the chosen temperature and the sharing principles used to apportion the global budget across countries. Even if a carbon budget could be selected, it is not clear how the budget should be allocated across sectors in the United States (e.g., electricity, transportation, and residential). For example, reductions may not be equally practical and feasible across sectors, and NHTSA lacks the expertise to assess the proportionate reduction that is appropriate for each sector. NHTSA also does not have enough information to meaningfully determine the proportions of the carbon budgets that are "committed" or "discretionary," as emissions across sectors are impacted by the activities of many State and Federal agencies. NHTSA's responsibility under EPCA is to set maximum feasible CAFE standards based on balancing the four statutory factors and other relevant considerations. Therefore, it is appropriate for NHTSA to consider other factors in developing the proposed alternatives, rather than considering alternatives that would be based solely on a single factor.

Comment

Docket Number: NHTSA-2017-0069-0557
Organization: Natural Resources Defense Council
Commenter: Pete Huffman

NHTSA's analysis of the environmental implications is flawed and inadequate. Although NHTSA characterizes the National Climate Assessment as suggesting that "[m]any argue that is it likely that human activity . . . contribute[s] to the observed climate warming," NPRM at 43215, the National Climate Assessment in fact "concludes, based on extensive evidence, that it is extremely likely that human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming." Both the Department of Transportation and EPA, as defendants in current federal litigation, "aver that current and projected atmospheric concentrations of six well-mixed GHGs, including CO_2, threaten the public health and welfare of current and future generations, and this threat will mount over time as GHGs continue to accumulate in the atmosphere and result in ever greater rates of climate change." Answer, *Juliana v. U.S.*, 15-cv-1517 (D. Ore. Jan. 13, 2017) (ECF 98).

The agencies assume that greenhouse gas emissions will continue unchecked and cause a catastrophic increase in average global temperatures. NHTSA suggests that because fuel economy standards cannot solely prevent this, the standards do not "merit their costs." NPRM at 43215. This appeal to futility is an invalid basis to decline to regulate. "Agencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop." *Massachusetts*, 549 U.S. at 524. Transportation is the largest single contributor to U.S. greenhouse gas emissions and NHTSA's cursory treatment of environmental considerations is insufficient to meet its statutory duty under EPCA. If the agencies determine that the existing GHG and augural fuel economy standards are an insufficient step toward averting a catastrophic fate, the only legally-valid response is to strengthen the standards, not to slash them.

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA)
Commenter: Frank Kohlasch

The augural standards are a step along the path to further GHG emissions reductions in the transportation sector and other sectors. If we do not take that step, we will grow further and further behind. Many analyses, including the 2014 Cost of Delaying Action to Stem Climate Change report by the Council of Economic Advisors, have showed that delaying actions to reduce carbon emissions will simply increase the cost of those actions in future years. Additionally, climate change impacts continue to grow and cause even deeper economic damage. In the face of this threat, eventually the economics will force society to act, but action now is the prudent decision both economically and environmentally. As of calendar year 2016, U.S. greenhouse gases had declined about 11% from their 2007 peak levels, or at a rate of about 1.35% per year, providing substantial evidence of the responsiveness of market economies to the perceived costs and future risks of climate change. For all of these reasons, it is not reasonable to assume that the globe will take no action in the face of impending climate disaster during the entire 100-year time horizon examined in the DEIS.

The assumptions about inevitable, massive increases in CO_2 concentrations are then used to calculate diminished impacts of action to reduce CO_2 emissions. NHTSA calculates the 100 year effects of the program on global atmospheric CO_2 concentration, mean global surface temperature and precipitation, ocean acidification, and sea level rise. Using the Integrated Assessment Model MAGICC and a baseline forecast for global CO_2 concentrations developed more than a decade ago, NSHTA determines what global atmospheric CO_2 levels would be with the augural standards and with the preferred alternative. The difference in global atmospheric CO_2 levels at 2100 for those two cases – about 0.65 ppmv on a base of about 789.11 ppmv – is said to be the net effect of the revised program. The change in global surface temperature of 0.5 ppmv, on a baseline of 789.11 ppmv, is about +0.003 degrees Celsius, a value extracted from MAGICC. Incremental impacts of the program on sea level rise and ocean acidification are similarly model-derived. The incremental change in precipitation is assessed on a pro rata basis, using the average change in precipitation for each 1 degree Celsius warming.

Mean global surface temperature varies with the logarithm of the change in CO_2 concentration. As a result, the change in mean global surface temperature from the CAFE program depends as much on the background level of CO_2 that is assumed for calculation purposes as the assumed change in atmospheric concentration itself. If calculated against an assumed year 2100 background level of 789.11 ppmv, the effects of the fuel economy rollback would be, as noted above, 0.003 degrees Celsius globally, but, if evaluated at an assumed background CO_2 level at 2011 of 450 to 500 ppmv, the effect of the program would be roughly double, 0.006 degrees Celsius.

This rough doubling of impact from a change in the assumed background CO_2 level at 2100 in turn filters down to all other DEIS measures of environmental effect with the exception of ocean acidification. Consequently, the assumed background CO_2 level matters, and the background levels used in the DEIS reflect NHTSA's assumption that modern economies will do nothing in the face of global climate catastrophe. At the very least, the DEIS should adopt a baseline that reflects the adaptive and responsive nature of modern society.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School

Although the DEIS correctly observes that "drastic reductions" in GHG emissions are necessary, it also contains an analysis that is misleading at several points. First, it distorts the scale of the Proposal's impacts by comparing them against a global emissions scenario that assumes only unrealistic, partial, and grossly insufficient efforts to mitigate climate change. For example, in projecting atmospheric CO_2 levels and related impacts for the year 2100, the DEIS projects that neither the United States nor any other nation will have taken any additional steps to address climate change beyond those currently in effect. DEIS at 5-31.[65] This scenario does not realistically portray what is happening elsewhere in the world or even in the United States, where states and businesses continue to take a variety of actions to reduce GHG emissions.[66] If the United States and other nations take their Paris Agreement obligations seriously and continue to take incremental steps beyond those embodied in current law, then the world could see less than 2°C of warming by the end of the century. Against this baseline, the relative impact of the Proposal, which instead charts a path of climate inaction, would be much greater than those analyzed in the DEIS.

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 2. Why was the Global Change Assessment Model Reference scenario used to represent the Reference Case emissions scenario (i.e., future global emissions assuming no additional climate policy)? A range of scenarios needs to be considered.

This scenario assumes no reductions in emissions by the global community. The global community may be able to keep the CO_2 concentrations much below the 789 ppm projected in this analysis even if we are not able to keep the concentration low enough to prevent significant warming. **A number of different scenarios for CO_2 emissions should be considered that show different levels of international success at curbing emissions.**

[65] The DEIS's description of its baseline emissions projections as reflecting a "moderate level of global actions to address climate change" is incorrect. See DEIS at 8-20. Though it may approximate the "middle-ground" between lower and much higher-emissions scenarios, see id. at 5-25, it results in atmospheric concentrations of CO_2 much too dangerous for mitigation efforts to be called "moderate."

[66] It also contradicts the DEIS's reporting on emissions reductions efforts in other countries, with China, Norway, France, Britain, India, and the Netherlands requiring or considering significant shifts in their passenger vehicle fleets to zero- or low-emissions vehicles. DEIS at 8-5.

Response

In the EIS, NHTSA does not make conclusions about whether global GHG emissions would be reduced or "continue unchecked." Rather, NHTSA assesses the potential impacts of the action in the context of several global emissions scenarios. The GCAM Reference scenario, which is used by NHTSA for the direct and indirect analysis, does not assume comprehensive global actions to mitigate GHG emissions. The GCAM6.0 scenario is used in the cumulative analysis. GCAM6.0 does not include specific climate change mitigation policies; it does, however, represent a plausible future pathway of global emissions in response to a moderate level of global actions to mitigate climate change.[67] For further discussion, see Final EIS Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact*. To conduct a sensitivity analysis, NHTSA also models the RCP4.5 scenario, a more aggressive emissions stabilization scenario. This approach ensures that a range of consequences of the Proposed Action and alternatives are considered within the context of other potential actions. Regardless of the global emissions scenario used, NHTSA's analysis shows that the magnitude of the impact of each of the alternatives is approximately the same.

NHTSA recognizes the benefits that incremental reductions in GHG emissions may provide. However, NHTSA is obligated to balance the four statutory factors and other relevant considerations in setting maximum feasible fuel economy standards. NHTSA considered the environmental impacts of this rulemaking, including the contents of this Final EIS, as it developed its final rule. For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards, and that the maximum feasible standards for MYs 2021–2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. While CO_2 emissions (and other environmental impacts) will be higher under this final rule than if NHTSA had determined that the augural standards were maximum feasible, they will be lower than they would have been under the proposal. As a result, the final rule will still accomplish reductions in GHG emissions over time.

Comment

Docket Number: NHTSA-2018-0067-11693
Commenter: Ben Pfeiffer

The DEIS needs to use a 0% long-term discount rate. Our GHG emissions will still have an effect for 1000 years. How can we discount the welfare of future generations? It is wrong to study only the effects of emissions during the service life of several model years on emissions. The effects last many hundreds of years after those vehicles are scrapped. The analysis needs to be revised to consider the global effects of our GHG emissions. Emissions don't stop at the border. The DEIS needs to be revised to show how emissions will increase due to stronger CAFE standards. Recent analysis indicates that CAFE standards have been a factor restraining GHG emissions. The draft now asserts that any stronger standards would increase GHG emissions. Please detail the analysis supporting this.

[67] NHTSA's use of "moderate" in this context is akin to the "middle-ground" language referenced by the commenter. The EIS's use of this term is clear and appropriate to provide context to the decision-maker and the public.

Response

In Chapter 5, *Greenhouse Gas Emissions and Climate Change*, NHTSA discusses potential environmental impacts through the year 2100. In addition, in Chapter 5 and Chapter 8, *Cumulative Impacts*, NHTSA addresses potential global impacts related to climate change and the Proposed Action and alternatives.

Comment

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

Unclear Treatment of Refueling Emissions: The proposed rule notes that greenhouse gas savings under CAFE standards from not have to drive as often to refuel are “implicitly accounted for elsewhere” in the model, though the rule does not clearly explain where or how those emissions are quantified. The proposed rule admits that, while the related fuel savings from not having to drive as often to refuel (which it also assumes are “implicitly captured” elsewhere) may seem to be a small benefit per individual consumer, the effect “is much more significant at the macro level.” It is not clear if or how the DEIS quantifies the similarly “significant” greenhouse gas emissions from refueling trips.

Response

The EIS relies on the CAFE model to quantify the fuel consumption and associated GHG emissions associated with the Proposed Action and alternatives. With regard to refueling emissions, the EIS assumptions are the same as for the modeling for the final rule and FRIA. For a discussion of the treatment of refueling by the CAFE model, see Section VI.D.1.b.10 of the preamble to the final rule.

Comments

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The DEIS claims that it “estimated both domestic and international upstream emissions” of greenhouse gases, criteria pollutants, and toxic air pollutants, and that “emissions estimates include global CO_2, CH_4, and N_2O emissions resulting from direct fuel combustion and the production and distribution of fuel and electricity (upstream emissions).” That would absolutely be the proper scope for NHTSA to take on estimating upstream emissions, not only because NEPA requires a global perspective on impacts, but also because pollution emitted outside U.S. borders can still directly impact U.S. interests. Unfortunately, both these statements about considering global upstream emissions are incorrect, and the DEIS in fact ignores entire and important categories of upstream emissions.

On page 5-22, in a section on “Methods for Modeling Greenhouse Gas Emissions,” the DEIS specifies that its upstream estimates from fuel production and distribution were based on the Volpe model. Footnote 20 then clarifies that “Some modifications were made to the estimation of upstream emissions, consistent with NHTSA and EPA assumptions in the NPRM. Section 10.2.3 of the PRIA provides more information regarding these modifications.” Section 10.2.3 of the PRIA clarifies that it is only quantifying "the resulting increases in domestic emissions" from upstream fuel production and distribution. In particular, the PRIA's methodology for quantifying upstream effects counts emissions only if the fuel extraction, refining, distribution, and storage activities happened within U.S. borders. The PRIA assumes that 50% of the increased fuel consumption that results from lowering CAFE standards will be satisfied by imported finished gasoline products: it therefore ignores all emissions from extracting, refining, and transporting the crude oil to supply that 50% of finished gasoline products. The other 50% of increased fuel consumption is estimated to come from increased domestic refining, but the PRIA further assumes that 90% of the crude oil feeding into that increased domestic refining will come from imported crude petroleum: the PRIA therefore further ignores all emissions from extracting that imported crude, and likely some portion of emissions from transporting that crude before it was imported. Altogether, the PRIA ignores 95% of upstream emissions from fuel extraction, 50% of upstream emissions from refining, at least 50% of upstream emissions from distribution of crude, and some unclear portion of upstream emissions from distribution of finished gasoline.[68]

These same assumptions—50% imported finished gasoline, 90% imported crude—also appear in the proposed rule, as well as in the spreadsheet on parameters for the reference case in NHTSA's sensitivity analysis files. The reference case parameters file also confirms that these "fuel import assumptions" are held constant from 2015 through 2050.

There are several significant problems with ignoring upstream emissions just because they originate outside U.S. borders.

First, as further detailed *infra* in the section on the global social cost of greenhouse gases, NEPA requires a worldwide perspective. NEPA contains a provision on "International and National Coordination of Efforts" that broadly requires that "all agencies of the Federal Government *shall* . . . recognize the worldwide and long-range character of environmental problems." Other agencies recognize that, under NEPA, the best practice is to count how their actions will contribute to emissions that originate out of the United States. For example, in the 2017 Environmental Assessment prepared for a modification of the King II Mine in Colorado, the Bureau of Land Management and Office of Surface Mining acknowledged that the bulk of the coal produced "will be combusted . . . potentially anywhere in northern Mexico and in the southwestern U.S." Even though the greenhouse gas emissions from the downstream combustion of that coal could originate in Mexico or elsewhere, the agencies had no troubling quantifying and disclosing all the expected greenhouse gas emissions.

Second, emissions that originate abroad can still have direct impacts on the United States. This is especially true of greenhouse gases, which are global pollutants that readily mix in the atmosphere and affect global climate. All greenhouse gases, regardless of their point of origin anywhere on the planet, will cause the same climate damages for the United States. Though criteria and toxic pollutants are usually thought of as local pollution, even some criteria and toxic pollutants emitted abroad can directly impact the United States. For example, in 2017, Canada supplied 43% of all crude imported into the United States, 45% of imported finished motor gasoline, and 30% of imported gasoline blending

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[68] It is not immediately clear which distribution, transportation, and storage activities were counted. For example, crude may be extracted in Country A, transported to Country B for refining, transported again to Country C for storage, until finally imported to the United States. It is not clear which portion of emissions during the transportation between Countries A, B, and C—if any—is counted.

components; Mexico further supplied another 8% of crude imported into the United States.[69] EPA has in the past recognized that U.S. emissions of criteria and toxic pollution can affect health and welfare in our neighboring countries;[70] similarly, depending on the location of Canada and Mexico's fuel production and distribution facilities and on prevailing winds, their emissions can affect health and welfare in the United States. None of these upstream emissions—and especially the global greenhouse gas pollutants—should be completely ignored.

Third, as detailed further *infra* on the global social cost of greenhouse gases, through international spill-over effects, foreign reciprocity, the extraterritorial interest of the U.S. government and its citizens, and altruism, worldwide climate effects also affect U.S. welfare and matter to U.S. decisionmakers and the public under NEPA.

Fourth, the assumptions are also questionable, especially over the long term. Much of the PRIA explicitly relies on the assumption that the United States will very soon become a net exporter of petroleum products. Indeed, the PRIA uses that assumption as a justification for not counting other potential social costs of the proposed reduction in CAFE standards, such as military and security costs. It is unclear why NHTSA thinks that, solely for the purposes of quantifying upstream emissions, the United States will continue to import 50% of its gasoline and 90% of its crude through the year 2050 to satisfy increased fuel consumption. By failing to adjust these assumptions over time, NHTSA is not only undercounting all upstream emissions, but in particular it is undercounting future upstream emissions. Because the climate systems will continue to become even more stressed over time, future emissions are increasingly damaging,[71] and it is precisely these emissions that NHTSA is ignoring.

NHTSA also compounds these problems by not providing a cumulative tally of methane and nitrous oxide emissions, and not (except in a sensitivity analysis) monetizing the climate damages from methane and nitrous oxide emissions. These additional problems are discussed further below.

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[69] In 2017, the United States imported from all countries: 2.9 billion barrels of crude, 11 million barrels of finished motor gasoline, 220 million barrels of motor gasoline blending components. Of that, Canada supplied 1.25 billion barrels of crude (43%), 5 million barrels of finished motor gasoline (45%), and 66 million barrels of motor gasoline blending components (30%). Mexico supplied 222 million barrels of crude (8%), 1.5 million barrels of blending components (<1%). EIA, Petroleum & Other Liquids, https://www.eia.gov/dnav/pet/pet_move_impcus_d_nus_Z00_mbbl_a.htm.

[70] In the analysis of the Cross-State Air Pollution Rule, EPA noted—though could not quantify—the "substantial health and environmental benefits that are likely to occur for Canadians" as U.S. states reduce their emissions of particulate matter and ozone—pollutants that can drift long distances across geographic borders. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,210, 45,351 (proposed Aug. 2, 2010). Similarly, in the Mercury and Air Toxics Standards, EPA concluded that a reduction of mercury emissions from U.S. power plants would generate health benefits for foreign consumers of fish, both from U.S. exports and from fish sourced in foreign countries. EPA did not quantify these foreign health benefits, however, due to complexities in the scientific modeling. U.S. ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSIS FOR THE FINAL MERCURY AND AIR TOXICS STANDARDS 65 (2011) ("Reductions in domestic fish tissue concentrations can also impact the health of foreign consumers . . . [and] reductions in U.S. power plant emissions will result in a lowering of the global burden of elemental mercury.").

[71] For example, the social cost of greenhouse gases increases over time because an additional ton of emissions will inflict greater damages in the future when total atmospheric concentrations of greenhouse gases are already much higher. As emissions accumulate in the atmosphere, each additional ton becomes that much more damaging. See e.g., IWG, Technical Update of the Social Cost of Carbon (2016, hereinafter 2016 TSD), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf.

Docket Number: NHTSA-2018-0067-11154
Organization: International Mosaic
Commenter: Andrew Yamamoto et al.

The DEIS is fatally flawed because it fails to acknowledge that the EPA has underestimated methane gas emissions by energy companies. https://www.reuters.com/article/us-usa-methane/u-s- oil-gas-system-methane-leaks-larger-than-epa-estimates-study-idUSKBN1JH2TP (PDF copy attached). This error undercuts and invalidates DEIS because DEIS understates the climate change impacts of the Proposed Repeal by ignoring the repeal's climate change impact by increasing fossil fuel extraction (the consequences of which are in addition to those of increased vehicle emissions).

Response

As documented in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, and further detailed in the FRIA, the Greenhouse Gases and Regulated Emissions in Transportation (GREET) model developed by the U.S. Department of Energy Argonne National Laboratory is used to estimate upstream emissions associated with production, transportation, and storage of gasoline and diesel from crude oil, as well as emissions associated with the generation of electricity. NHTSA's analysis only considers domestic upstream emissions, an approach which is consistent with analyses for previous rulemakings. This EIS included contradictory text in Section 2.4.1, *Types of Emissions*, that indicated upstream emissions were estimated from both domestic and international sources. NHTSA has revised its description of its upstream emissions analysis in Section 2.4, *Resource Areas Affected and Types of Emissions*, and Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, to clarify its approach.

Estimates of upstream emissions include domestically refined fuel using imported crude petroleum as a feedstock and fuel that is imported to the United States after being refined overseas. NHTSA uses GREET's emissions factors for domestic crude transportation and storage to estimate emissions associated with transporting imported petroleum from United States coastal ports to refineries and storing it in preparation for domestic refining. For finished fuel that is imported to the United States after being refined overseas, NHTSA uses GREET's emissions factors for domestic fuel transportation, storage, and distribution. All other upstream emissions are based on crude petroleum that has been extracted, recovered, and produced within the United States. NHTSA believes that this approach adequately captures the impact of upstream emissions on total GHG emissions. NHTSA also addresses its assumptions regarding petroleum imports and emissions in Section VI.D.3.c of the preamble to the final rule.

NHTSA addressed an issue in the Final EIS in which some tables and figures were inadvertently omitted from the Draft EIS, including a table with the cumulative tally of methane and nitrous oxide emissions requested by the commenter. As described in a comment response above, NHTSA has reviewed the inadvertently omitted material and determined that the information was either available elsewhere in the Draft EIS or could be easily calculated from information reported elsewhere in the Draft EIS. Table 5.4.1-2 in this EIS provides a cumulative tally of methane and nitrous oxide emissions from all passenger cars and light trucks by alternative.

Comment

Docket Number: NHTSA-2017-0069-0626
Organization: Urban Air Initiative
Commenter: James Conde

Blending ethanol into gasoline greatly reduces greenhouse gas emissions. The DEIS correctly notes that "when ethanol crops are grown, they capture CO_2 and offset the GHG emissions later released through fuel combustion. The higher the blend of ethanol in the fuel, the lower the net GHG emissions." DEIS at 6-29. As the DEIS further notes, "Wang et al. (2007) found that, depending on the energy source used during production, corn-based ethanol can reduce well-to-wheels GHG emissions by up to 52 percent compared to gasoline. Similarly, Canter et al. (2016) estimate that corn grain ethanol can lead to a 40 percent reduction in GHG emissions." *Id.* at 6-30. These statements are correct and are appropriate for helping assess the environmental impacts of substituting ethanol for gasoline as a fuel or of substituting ethanol for gasoline components as a fuel additive in gasoline.

The 2016 estimate and other recent analyses supersede an older analysis issued by EPA in 2010. The 2010 analysis estimated that by 2022, corn ethanol plants using natural gas and corn oil fractionation technology would achieve median annual lifecycle greenhouse gas (GHG) emissions savings of 21% compared to EPA's 2005 gasoline carbon intensity baseline. As EPA predicted would occur, the 2010 estimate now requires updating.

A recent 2018 study largely tracks the methodology of EPA's 2010 analysis.[72] As the 2017 study explains, "a large body of information has become available since 2010—including new data, scientific studies, industry trends, technical reports, and updated emission coefficients. Collectively, the new information indicates that . . . actual emissions . . . differ, sometimes significantly, from those projected" previously. The 2018 study estimates that under current conditions, corn ethanol was on average 39% less carbon-intensive than EPA's 2005 gasoline baseline, and that corn ethanol's advantage will grow to 44.3% by 2022. And there is room for improvement. With wide implementation of certain agricultural practices that promote soil carbon sequestration and with the adoption of low-emission ethanol plant technologies that are available today, current corn ethanol production could be 46.7% less carbon-intensive than 2005 baseline gasoline on an energy-equivalent basis.[73]

Moreover, the USDA analysis does not account for the fuel efficiency gains that would be possible if ethanol were blended above the 10% level of most U.S. gasoline.[74] By enabling the auto industry to

[72] The study was commissioned by the U.S. Department of Agriculture. See *ICF*, A Life-Cycle Analysis of the Greenhouse Gas Emissions of Corn-Based Ethanol (Sept. 5, 2018) ("2018 USDA LCA"). The Draft EIS refers to a prior, 2017 version of this study as Flugge et al. 2017. *See* DEIS 6-30 – 6-31, 12-32.

[73] *Id.*; *see also* David E. Clay et al., *Corn Yields and No-Tillage Affects Carbon Sequestration and Carbon Footprints*, 104 Agron. J. 763 (2012); *compare* DEIS at 6-31 (citing Flugge et al. 2017 for proposition that "[b]y 2022, the carbon intensity of corn grain ethanol is projected to decline from 2014 levels by nearly 10 percent under a business as usual scenario and by nearly 60 percent under a scenario with increased agricultural conservation, making ethanol 48 percent to 76 percent less GHG-intensive than gasoline").

[74] *Compare* Draft EIS at 6-30 - 6-31 (describing study by three Department of Energy national laboratories examining "impact on well-to-wheels GHG emissions from high-octane fuel vehicles resulting from miles per gallon of gasoline-equivalent … gains of 5 and 10 percent, various ethanol blend levels (E10, E25 and E40), and changes in refinery operation with high-octane fuel production relative to baseline E10 gasoline vehicles").

produce engines with higher compression ratios and more fuel- efficient vehicles, high-octane mid-level ethanol fuel blends could achieve significant downstream and upstream GHG reductions.

In brief, new evidence and improved modeling show that:

- Increased demand for corn causes much less land-use change and related emissions than was initially predicted in 2010.
- Improved practices and technologies are reducing the carbon intensity of ethanol by increasing the amount of soil carbon that is captured from the atmosphere by the corn plant and sequestered underground. In fact, the evidence suggests that many corn fields are net carbon "sinks," capturing more carbon than is released by land-use change and by farming.
- Improved practices and technologies have reduced nitrogen fertilizer losses of the greenhouse gas nitrous oxide (N_2O), and updated guidance has reduced the weight given to N_2O compared to other GHG pollutants.
- As yields have continued to increase, ethanol plants have become much more efficient. Ethanol plants are also producing new co-products that reduce the carbon intensity of ethanol.
- Petroleum-based fuels are becoming increasingly carbon-intensive. That increases the comparative benefit of corn ethanol.

Response

NHTSA has reviewed the information provided by the commenter and updated Section 6.2.4.2, *Ethanol*, as appropriate. NHTSA has also updated the Flugge et al. 2017 reference to reflect the updated report results. The updated report includes projection scenarios that assess a significant decline in carbon intensity of corn-ethanol fuels through the points discussed by the commenter.

Comment

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

NHTSA's carbon emissions estimates are inconsistent with its own data, rendering the DEIS confusing and flawed. NHTSA claims that, between 2021 and 2100, the Preferred Alternative would result in 7**,400 MMT** more CO_2 emissions from light-duty vehicles than would have been produced under the No Action Alternative. This estimate is inconsistent with the agency's own data.

In Table 2.5.2-1, NHTSA claims that under the No Action Alternative, CO_2 emissions from light-duty vehicles between 2021 and 2100 would total 77,800 MMT. It also estimates that under the Preferred Alternative, CO_2 emissions from light-duty vehicles between 2021 and 2100 would total 85,100 MMT. Therefore, according to the data provided in Table 2.5.2-1, light-duty vehicles under the Preferred Alternative would produce **7,300 MMT** more CO_2 by 2100 than they would under the No Action Alternative.

NHTSA has therefore provided multiple, contradictory estimates of the GHG emissions which would result from its proposal: Page S-18 claims that the difference between the Preferred Alternative and the No Action Alternative is 7,400 MMT but Table 2.5.2-1 claims that the difference is 7,300 MMT. This discrepancy–100 MMT–is substantial. To put this discrepancy in perspective, the entire U.S.

transportation sector emitted 1,538 MMT in 2014. This means that the discrepancy between NHTSA's two estimates is 6.5% of the entire transportation sector's CO_2 emissions in 2014.

The DEIS does not present these two numbers–7,300 and 7,400–as part of a range of possible values designed to account for uncertain variables. NHTSA does not claim that the difference in CO_2 emissions between the No Action Alternative and the Preferred Alternative could be as little as 7,300 MMT or as great as 7,400 MMT. Page S-18 indicates that the difference between the No Action Alternative and the Preferred Alternative *will* be 7,400 MMT. Table 2.5.2-1 indicates that the difference *will* be 7,300 MMT.

This inconsistency in the DEIS' emissions calculations is large enough to seriously impede the public's ability to adequately understand the agency's proposed action. NHTSA must first resolve this inconsistency in order to meet its legal obligation under 40 C.F.R. 6.203(c)(3)(vi) to provide the public with a meaningful opportunity to comment on the agency's DEIS.

Response

The supposed "discrepancy" identified by the commenter is just a natural result of rounding, as disclosed in the Draft EIS. For presentation purposes, the emissions values are rounded to the nearest 100 million metric tons (MMT). NHTSA did not round the emissions values before calculating the difference, as is appropriate. The unrounded cumulative emissions are 77,752 MMT for Alternative 0 and 85,136 MMT for Alternative 1. The unrounded difference between Alternative 1 and Alternative 0 is 7,384 MMT, which when rounded to the nearest 100 MMT, is 7,400 MMT. As described in a prior comment response, some tables were inadvertently omitted from Draft EIS Chapter 5, *Greenhouse Gas Emissions and Climate Change*. However, the corresponding tables in Appendix D, U*.S. Passenger Cars and Light Truck Results Reported Separately*, (Table D-13 and Table D-14) disclosed that the numbers were rounded for presentation purposes. That disclosure is included on the restored tables in Chapter 5 of the Final EIS; those tables form the basis for the summary and the tables in Section 2.5, *Comparison of Alternatives.*

Comment

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 5. The temporal scope of the EIS must include the impact on the climate system (ocean and atmosphere) of the full life of the greenhouse gases emitted by burning fossil fuels by both cars and light trucks as well as of other elements of US energy production

According to CFR-2012-title33-vol3-part230, page 317

> The initial broad or programmatic EIS must present sufficient information regarding ***overall impacts*** of the proposed action so that the decision-makers can make a reasoned judgment on the merits of the action ...[italics added for emphasis]

Carbon dioxide created by burning fossil fuels stays in the atmosphere and ocean for many centuries. Carbon dioxide flows into and out of the ocean and biosphere in the natural breathing of the planet and CO_2 that is dissolved in the ocean, contributing to ocean acidification, can be easily released back to the atmosphere. The atmospheric concentration of CO_2 cannot markedly decline until the CO_2 in the ocean has once again been captured by living organisms and sunk to form deposits on the ocean floor or incorporated in swamps to create new rich coal and oil deposits for a civilization many millions of years hence.

This means that climate changes caused by carbon dioxide are expected to persist for many centuries even if emissions were to be halted now. It does not greatly matter much how rapidly we burn the fossil fuels. What really matters is the total carbon released. The world has entered a new geologic epoch, the Anthropocene, in which human activities are controling the future evolution of Earth's environment in substantial ways. Carbon emissions during this century will essentially determine the magnitude of eventual impacts and whether the Anthropocene climate impact is a short-term, relatively minor change from the current climate or an extreme deviation that lasts thousands of years. The higher the cumulative carbon dioxide emitted and the higher the resulting atmospheric concentration, the higher the peak warming that will be experienced and the longer the duration of that warming will last.

This fact has been highlighted in the recent IPCC 5th Assessment Report:

> A large fraction of anthropogenic climate change resulting from CO_2 emissions is irreversible on a multi-century to millennial time scale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period. Surface temperatures will remain approximately constant at elevated levels for many centuries after a complete cessation of net anthropogenic CO_2 emissions. Due to the long time scales of heat transfer from the ocean surface to depth, ocean warming will continue for centuries. Depending on the scenario, about 15 to 40% of emitted CO_2 will remain in the atmosphere longer than 1,000 years.

One hundred years is entirely inadequate and arbitrary. A scientific justification for this time period is required based on peer-reviewed publications. Greenhouse gases, specifically CO_2, have a time scale in the atmosphere and oceans on the order of centuries. Much of the CO_2 emitted to the atmosphere is dissolved in the oceans forming a large reservoir of available CO_2 that can reenter the atmosphere if atmospheric levels are lowered over time. The 2007 IPCC report states "About 50% of a CO_2 increase will be removed from the atmosphere within 30 years, and a further 30% will be removed within a few centuries. The remaining 20% may stay in the atmosphere for many thousands of years."

The impacts far into the future are of course much less certain, but that does not mean they are minimal. **In all cases a worse-case scenario should be considered and the consequences outlined in the EIS so that decision makers can know what is a possible worst outcome if rules are changed.**

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School

Finally, the DEIS analyzes the Proposal's impacts only through an arbitrarily selected endpoint (e.g., an additional 0.003°C in warming by 2100, *see* DEIS at 5-31; *see also id.* at 5-30–45). The DEIS's quantitative analysis arbitrarily and unreasonably ends at 2100 despite its observation that "the effects of the CO_2 emissions that have accumulated in the atmosphere prior to 2100 will persist well beyond 2100 . . . . [T]his elevation in atmospheric CO_2 concentrations will persist for many centuries, with the potential for temperature anomalies continuing much longer." DEIS at 5-10. Some impacts, like sea level rise, are assured to occur over the course of several centuries in the projected baseline high-emissions scenario. Given that such impacts are not uncertain, but, to the contrary, are the inevitable consequences of the do-nothing approach to climate change embodied by the Proposal, there is no reason to exclude them from the NEPA analysis.

These shortcomings within the DEIS result in a siloed analysis that provides cover for the false conclusion that the impacts are too insignificant to justify regulatory costs. Yet the scientific consensus cited throughout the DEIS says precisely the opposite.

Response

NHTSA recognizes that global climate change and associated impacts may occur beyond the time horizon used for projections in this EIS analysis. However, long-term time projections have large uncertainties, making it difficult to model impacts at these time scales. For example, climate system processes, GHG concentrations, and potential human mitigation actions are all highly uncertain past 2100, which precludes confident simulations of their future combined behavior and impacts. As a result, this EIS analysis and the majority of scientific studies focus on changes occurring over this century. This approach is consistent with broad panel-reviewed climate change assessments, including those prepared by the IPCC.

Section 8.6.5.2, *Sectoral Impacts of Climate Change*, under *Tipping Points and Abrupt Climate Change*, does, however, provide a qualitative analysis of the many ways in which global climate change impacts may manifest over the long term and beyond the 21st century. This section also includes an acknowledgement that a large fraction of anthropogenic climate change resulting from CO_2 emissions (e.g., global mean temperature increase and a decrease in ocean pH) is irreversible on a multicentury to millennial time scale. NHTSA believes this and the other references to the EIS cited by the commenters provide adequate context for the reader to understand the magnitude and type of impacts that may be associated with climate change over an extended time horizon, including beyond this century.

NHTSA also disagrees with the commenter that it must present a "worst case" analysis for the EIS. Such an analysis would not assist in providing a reasoned choice among alternatives, nor is it required under NEPA. In fact, CEQ has substantively amended its NEPA regulations only once, at 40 CFR § 1502.22, to replace its "worst case" analysis requirement with a provision for the consideration of incomplete or unavailable information regarding reasonably foreseeable significant adverse effects.[75] NHTSA acknowledges the uncertainty related to the long-term impacts of climate change in the EIS in conformity with the requirements of this section.

10.5.2 Social Cost of Carbon

NHTSA received a number of comments pertaining to the substance of NHTSA's analysis and valuation of the social cost of carbon (SC-CO_2), including cost methodology, discount rates, domestic versus global social cost of GHG emissions, the Interagency Working Group's findings, integrated assessment models, and sensitivity analysis. Because one of the primary purposes of NHTSA's RIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis. Therefore, comments regarding these issues are addressed in NHTSA's final rule and FRIA, where the analysis is conducted and the results are discussed, and NHTSA is not including these comments in this chapter.

[75] 51 FR 15618 (Apr. 25, 1986).

Comment

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Pages 5-18 and 5-19, second bullet: There are serious omissions in the valuing of impacts, such as in calculating the Social Cost of Carbon. Such calculations typically do not account for the impacts resulting from ocean acidification, the long-term and ongoing effects of sea level rise, biodiversity loss, inundation of island nations (do note the U.S. is responsible for/encompasses many island territories, etc.), future destruction of ecosystems, and more. While such numbers can be helpful in comparing the relative influences of various alternatives on the impacts covered, in no way are they an estimate of the total cost implications of the actions. Calling these results "monetized damages" thus merits a good bit of qualification, not just in a separate chapter, but in suggesting here that doing this comes close to encompassing the full costs of climate change, either for the absolute change or for the change caused by various policy alternatives.

*   *   *   *   *

Page 5-22, Section 5.3.2 Social Cost of Greenhouse Gas Emissions: This section, in addition to whatever is presented elsewhere, needs to be much clearer on the many shortcomings of using the Social Cost of Carbon. One enumeration of the shortcomings is available at: MacCracken, M.C., and L. J. Richardson, 2010: Challenges to Providing Quantitative Estimates of the Environmental and Societal Impacts of Global Climate Change, pp. 41-65 in Assessing the Benefits of Avoided Climate Change: Cost Benefit Analysis and Beyond, J. Gulledge, L. J. Richardson, L. Adkins, and S. Seidel (eds.), Proceedings of Workshop on Assessing the Benefits of Avoided Climate Change, March 16-17, 2009, Pew Center on Global Climate Change, Arlington, VA. Available at: http://www.pewclimate.org/events/2009/benefitsworkshop.

While use of SCC can be helpful in comparing how one alternative or another is affecting the particular (generally quite limited set of) impacts included in the creation of SCC, it is essential to make clear that the SCC estimates generally available are far below what the actual cost of impacts are and what the long-term implications are of the impacts that have been initiated.

Response

The comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in the FRIA. Because one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis. NHTSA recognizes the limitations and uncertainties associated with the SC-CO_2 as a metric. The EIS, therefore, provides a qualitative discussion of the potential impacts of climate change on key natural and human resources in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.*

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Equally unprofessional is NHTSA's failure to correct most of the errors in its analysis pointed out to it by senior EPA staff members in a memorandum submitted to NHTSA on June 18, 2018, which documented those errors and faulty assumptions underlying NHTSA's technical work. In the DEIS, NHTSA fails to disclose that numerous problems inherent in its work had been discovered by EPA staff and discussed with NHTSA before the NPRM and the DEIS were published, much less explain why EPA's analysis was incorrect. These are fundamental failures of disclosure and discussion, and render the DEIS invalid.

VI. The Agency's Cost-Benefit Analysis is Fatally Flawed in Other Ways

When agencies perform a cost-benefit analysis of their rulemaking, they must do so fairly by examining both the costs and the benefits, and they may not put a thumb on the scale to skew the outcome. *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1198 (9th Cir. 2008) ("[e]ven if NHTSA may use a cost-benefit analysis to determine the 'maximum feasible' fuel economy standard, it cannot put a thumb on the scale by undervaluing the benefits and overvaluing the costs of more stringent standards").

As a threshold matter, regulations may impose substantial costs to achieve their protective mandates as long as those costs are not "excessive," "exorbitant," or "more than the industry could bear and survive." *See, e.g., Lignite Energy Council v. EPA*, 198 F.3d 930, 933 (D.C. Cir. 1999); *Sierra Club v. Costle*, 657 F.2d at 383; *Portland Cement Ass'n v. Train*, 513 F.2d 506, 508 (D.C. Cir. 1975). In the context of setting fuel economy standards for the light duty vehicle fleet, the Ninth Circuit has stated that

> "not equating cost-benefit considerations with economic practicability is consistent with the goal of achieving maximum feasible fuel economy by allowing economically and technologically possible standards which will improve fuel economy but which an analysis, subject to many practical limitations, might indicate are not cost-beneficial ... A cost-benefit analysis would be useful in considering [economic practicability], but sole reliance on such an analysis would be contrary to the mandate of the Act."

Ctr. for Biological Diversity v. NHTSA, 538 F.3d at 1196-97 (internal citations omitted). And, whatever method NHTSA uses to determine costs and benefits, "NHTSA cannot set fuel economy standards that are contrary to Congress's purpose in enacting the EPCA—energy conservation." *Id.* at 1197. And even if NHTSA cannot quantify specific benefits, it must express and consider them qualitatively.

Here, the DEIS at every turn underestimates the benefits of the augural standards and inflates their costs. Conversely, the agency overestimates the benefits of the Preferred Alternative and undervalues its costs. It uses faulty cost-benefit arguments to nullify, by agency fiat, the Congressional mandate of energy conservation. It accomplishes this by putting a sledgehammer to the cost-benefit scale itself, wiping away the catastrophic effects of climate change nearly altogether.

As discussed above, the agency's discussion of the direct, indirect, and cumulative impacts of climate change and its erroneous social cost of carbon calculations are fundamentally flawed and require the DEIS to be withdrawn. NHTSA also skews the results in the following ways:

- While it purports to be able to quantify with precision the traffic fatalities allegedly caused by the rule it seeks to replace, it does not quantify the fatalities attributable to global warming beyond 2035, leaving the effects of what are certain to be very large increases in premature mortality during 65 additional years unmentioned.
- The DEIS has not disclosed or discussed, and much less monetized, the huge costs of the more frequent and more extreme weather events in the recent decade, such as floods to droughts to heat waves to wildfires, even though peer-reviewed studies have concluded that last year alone, those damages attributable to climate change were in the hundreds of billions of dollars under conservative estimates. NHTSA must take into account these actual damage figures and the high probability that they will recur and increase in frequency and severity as temperatures rise into account.
- In light of the recent advances in climate science, attribution studies, and detailed understanding of regional impacts, NHTSA cannot rely only on GCAM 6.0 or similar models to project climate change damages.
- Upstream GHG emissions from oil production are significantly underestimated. NHTSA also predicts that, as a result of the recent Executive Order directing increases in domestic oil production, the percentage of unconventional oil in the fuel mix will increase further. Because unconventional extraction methods and the extraction of shale oil are much more energy intensive, upstream GHG emissions associated with the consumption of that oil is higher than NHTSA estimates.

In sum, the DEIS ignores rather than takes a hard look at the large-scale environmental and human health damage its Proposal inflicts and does not comply with NEPA's requirements.

Response

The commenters assert that the existence of deliberative communications between the agencies "render the DEIS invalid." NHTSA addresses the issues referenced by those communications in the preamble to the final rule.

NHTSA conducts a cost-benefit analysis in the preamble to the final rule and in the FRIA. That analysis incorporates the SC-CO_2. To the degree to which that metric does not account for certain climate impacts, NHTSA provides a qualitative discussion of potential climate change impacts in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*. Due to the limits of available information, NHTSA is not able to quantify the impacts of the alternatives on many of the issues discussed in that section. NHTSA also disagrees with the commenters that it must quantify all fatalities attributable to climate change and the costs of all extreme weather events. Doing so would improperly ascribe all global climate change impacts to this action, which is a gross mischaracterization of the impacts of this action. NHTSA also believes it would be inappropriate to attempt to calculate its proportional share of any such impacts, as there is no evidence that could "connect the dots" between the emissions associated with this rulemaking and any particular extreme weather event or fatality.

The commenters assert that NHTSA cannot rely on "GCAM6.0 or similar models" to project climate change damages. It is not clear from the commenters why all such models are invalid. The GCAM is widely available and commonly used in the scientific community. For this reason, NHTSA believes that

GCAM6.0 is an appropriate model to project climate change damages. Conducting more detailed regional analyses is unnecessary and does not provide useful information for the decision-maker. On the contrary, NHTSA incorporates by reference and cites extensively to expert panel- and peer-reviewed climate change studies and reports throughout the EIS. NHTSA need not undertake a comprehensive analysis rivaling the extensiveness of these reports in order to take a "hard look" under NEPA.

As documented in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, and further detailed in the preamble to the final rule and FRIA, the GREET model developed by the U.S. Department of Energy Argonne National Laboratory is used to estimate emissions associated with production, transportation, and storage of gasoline and diesel from crude oil. While recent Executive Orders and administration actions may result in changes to these emissions, NHTSA may continue to rely on the GREET model as it remains the best-available source for this information.

Comments

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The National Environmental Policy Act (NEPA) requires agencies like NHTSA to fully and accurately estimate the environmental, public health, and social welfare differences between the no-action alternative and the proposed action, and to contextualize that information for decision-makers and the public. By inaccurately quantifying greenhouse gas emissions and failing to contextualize climate information using the social cost of greenhouse gas metrics, NHTSA has violated its responsibilities under NEPA.

*   *   *   *   *

NEPA requires sufficient informational context. Yet without proper context, numbers like a 60 $MMTCO_2e$ increase in year 2040, or an increase of global emissions of 0.15%, or a temperature increase of 0.003 degrees, will be wrongly misinterpreted by people as meaningless, as zero. Indeed, in a country of over 300 million people and over 6.5 billion tons of annual greenhouse gas emissions, it is far too easy to make highly significant effects appear relatively "miniscule." For example, presenting all weather-related deaths as less than 0.1% of total U.S. deaths makes the risk of death by weather event sound trivial, but in fact that figure represents over 2,000 premature deaths per year—hardly an insignificant figure.[76]

Economic theory explains why monetization is a much better tool than volume estimates or percent comparisons to provide the necessary contextual information on climate damages. For example, many decisionmakers and interested citizens would wrongly reduce down to zero the climate risks associated with a 0.15% increase in global emissions, simply due to the leading zero before the decimal in that percentage. As Professor Cass Sunstein has explained—drawing from the work of recent Nobel laureate economist Richard Thaler—a well-documented mental heuristic called "probability neglect" causes people to irrationally reduce small probability risks entirely down to zero. People have significant

[76] The public willingness to pay to avoid mortality is typically estimated at around $9.6 million (in 2016$). E.g., 83 Fed. Reg. 12,086, 12,098 (Mar. 19, 2018) (U.S. Coast Guard rule using the Department of Transportation's value of statistical life in a recent analysis of safety regulations). Losing 2,000 lives prematurely to weather-related events is equivalent to a loss of public welfare worth over $19 billion per year.

“difficulty understanding a host of numerical concepts, especially risks and probabilities.” Reducing a cumulative increase of 7400 $MMTCO_2$ down to 0.15% of global emissions misleadingly makes the climate impacts appear vanishingly small. By comparison, by applying the social cost of carbon dioxide (about $72 per ton for year 2040 emissions in 2017$), decisionmakers and the public can readily comprehend that a 60 million ton increase of carbon dioxide emitted just in the year 2040 will generate over $4 billion in climate damages.[77]

Similarly, many people will be unable to distinguish the significance of project alternatives or scenario analyses with different emissions: for example, 580 million metric tons versus 582 million metric tons. As the Environmental Protection Agency’s website explains, “abstract measurements” of so many tons of greenhouse gases can be rather inscrutable for the public, unless “translat[ed] . . . into concrete terms you can understand.” Abstract volume estimates fail to give people the required informational context due to another well-documented mental heuristic called “scope neglect.” Scope neglect, as explained by Nobel laureate Daniel Kahneman, among others, causes people to ignore the size of a problem when estimating the value of addressing the problem. For example, in one often-cited study, subjects were unable to meaningfully distinguish between the value of saving 2,000 migratory birds from drowning in uncovered oil ponds, as compared to saving 20,000 birds.

Scope neglect means many decisionmakers and members of the public would be unable to meaningfully distinguish between the climate risks of 582 million metric tons of carbon emissions versus the climate risks of 580 million metric tons. While decisionmakers and the public certainly can discern that one number is higher, without any context it may be difficult to weigh the relative magnitude of the climate risks. In contrast, the different climate risks would have been readily discernible through application of the social cost of greenhouse gas metrics. In this example, while the difference between 582 million metric tons under the proposed action versus 580 million metric tons under the no action alternative may seem trivial, in fact those 2 million extra tons emitted in a single year will inflict over $100 million in climate damages. (Again, because NHTSA’s quantification of upstream and downstream emissions is likely a severe underestimate, the real climate consequences between the alternatives would likely be much greater. NHTSA’s numbers are just used here for illustrative purposes.)

In general, non-monetized effects are often irrationally treated as worthless. On several occasions, courts have struck down administrative decisions for failing to give weight to non-monetized effects. Most relevantly, in *Center for Biological Diversity v. NHTSA*, the U.S. Court of Appeals for the Ninth Circuit found it arbitrary and capricious to give zero value “to the most significant benefit of more stringent [fuel economy] standards: reduction in carbon emissions.” Monetizing climate damages provides the informational context required by NEPA, whereas a simple tally of emissions volume and rote, qualitative, generic description of climate change are misleading and fail to give the public and decisionmakers the required information about the magnitude of discrete climate effects.[78]

For all the above reasons, NHTSA must monetize climate damages directly in the final EIS, rather than relying on the misleading and incomplete incorporation by reference of the PRIA.

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[77] This calculation in no way accepts NHTSA’s quantification of only 60$MMTCO_2e$ for the year 2040 as accurate or complete. In a proper cost-benefit analysis, future costs and benefits would be discounted to present value.

[78] See 42 U.S.C. § 4332(2)(B) (requiring agencies to “identify and develop methods and procedures . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations”).

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The DEIS' discussion of the alternatives' climate change effects also does not analyze or disclose the benefits that come from reducing these emissions, let alone compare them by alternative and against the No Action Alternative. In particular, the DEIS only cursorily discusses its social cost of carbon ("SCC") calculations, referring the reader to the PRIA instead. Given how crucial this information is, the DEIS itself must disclose them. See *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d at 12.

Omitting from the DEIS a comparison of the environmental and health benefits of the No Action Alternative and the other alternatives from the DEIS is far less than what NEPA requires: the agencies proposing major actions must, "to the fullest extent possible," prepare a detailed statement on environmental impacts of the proposed action and alternatives. 42 U.S.C. § 4332(2). Omitting meaningful descriptions of the benefits derived from reducing carbon pollution plainly fails to describe the alternatives to the fullest extent possible.

Response

NHTSA recognizes that there are many different frames through which to present and evaluate the potential impacts of the Proposed Action and alternatives on GHG emissions and climate change. One frame is to describe the potential environmental impacts themselves, as not every impact can be monetized. Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, includes a discussion of such impacts of climate change. This section does not distinguish between the alternatives under consideration because such an analysis is neither practical nor feasible. The climate change impacts of the Proposed Action and alternatives would be too small to address quantitatively in terms of the impacts of the specific resources. Additionally, it is inappropriate to identify increases in GHG emissions associated with a single source or group of sources as the single cause of any particular climate-related impact or event. The reports cited do not provide the tools to quantify impacts, and attempting to do so may introduce uncertainties at the same magnitude or more than the projected change itself. However, the chapter does provide a review of projected impacts from increases in GHG emissions in general. Section 5.2.2.1, *Climate Change Attributes*, also discusses current climate attributes and projected impacts. NHTSA believes that this provides adequate context for the reader to understand the magnitude of the climate effects associated with the action under consideration.

NHTSA agrees that the SC-CO_2 provides another frame for evaluating potential impacts. Though not required by NEPA, this calculation has the added benefit of being includable in the agency's cost-benefit analysis, as presented in the preamble to the final rule and in the FRIA. As one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis. The preamble summarizes the cost-benefit analysis as well, as that is where the decision-maker weighs the information available and makes a final decision.

NHTSA disagrees that it must monetize potential climate damages in the Final EIS rather than incorporating them by reference. In fact, CEQ regulations encourage agencies to incorporate by reference material to cut down on bulk (40 CFR § 1502.21) and to combine documents to reduce duplication (40 CFR § 1506.4). It is only required that this information be available to the decision-maker and the public contemporaneously with the availability of the Final EIS, and that the decision-maker have the opportunity to consider this information as part of the official record. Inarguably, including the SC-CO_2 analysis in the preamble to the final rule and FRIA, and incorporating this material by reference in the Final EIS, accomplishes this.

Comment

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The tons of greenhouse gases emitted by a project are not the "actual environmental effects" under NEPA. Rather, the actual effects and relevant factors are the incremental climate impacts caused by those emissions, including:[79]

- property lost or damaged by sea-level rise, coastal storms, flooding, and other extreme weather events, as well as the cost of protecting vulnerable property and the cost of resettlement following property losses;
- changes in energy demand, from temperature-related changes to the demand for cooling and heating;
- lost productivity and other impacts to agriculture, forestry, and fisheries, due to alterations in temperature, precipitation, CO_2 fertilization, and other climate effects;
- human health impacts, including cardiovascular and respiratory mortality from heat-related illnesses, changing disease vectors like malaria and dengue fever, increased diarrhea, and changes in associated pollution;
- changes in fresh water availability;
- ecosystem service impacts;
- impacts to outdoor recreation and other non-market amenities; and
- catastrophic impacts, including potentially rapid sea-level rise, damages at very high temperatures, or unknown events.

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[79] These impacts are all included to some degree in the three integrated assessment models (IAMs) used by the IWG (namely, the DICE, FUND, and PAGE models), though some impacts are modeled incompletely, and many other important damage categories are currently omitted from these IAMs. *Compare* Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis* at 6-8, 29-33 (2010), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf [hereinafter 2010 TSD]; with Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* (Cost of Carbon Project Report, 2014), http://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf [Hereinafter Howard 2014]. For other lists of actual climate effects, including air quality mortality, extreme temperature mortality, lost labor productivity, harmful algal blooms, spread of West Nile virus, damage to roads and other infrastructure, effects on urban drainage, damage to coastal property, electricity demand and supply effects, water supply and quality effects, inland flooding, lost winter recreation, effects on agriculture and fish, lost ecosystem services from coral reefs, and wildfires, *see* EPA, *Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment* (2017); U.S. Global Change Research Program, *Climate Science Special Report: Fourth National Climate Assessment* (2017); EPA, *Climate Change in the United States: Benefits of Global Action* (2015); Union of Concerned Scientists, *Underwater: Rising Seas, Chronic Floods, and the Implications for U.S. Coastal Real Estate* (2018).

Even in combination with a general, qualitative discussion of climate change, by calculating only the tons of greenhouse gases emitted or a percent comparison to sectoral or national emissions, an agency fails to meaningfully assess the actual incremental impacts to property, human health, productivity, and so forth. An agency therefore falls short of its legal obligations and statutory objectives by focusing just on volume estimates. Similarly, courts have held that just quantifying the acres of timber to be harvested or the miles of road to be constructed does not constitute a "description of actual environmental effects," even when paired with a qualitative "list of environmental concerns such as air quality, water quality, and endangered species," when the agency fails to assess "the degree that each factor will be impacted."

By monetizing climate damages using the social cost of greenhouse gas metrics, NHTSA can satisfy the legal obligations and statutory goals to assess the incremental and actual effects bearing on the public interest. The social cost of greenhouse gas methodology calculates how the emission of an additional unit of greenhouse gases affects atmospheric greenhouse concentrations, how that change in atmospheric concentrations changes temperature, and how that change in temperature incrementally contributes to the above list of economic damages, including property damages, energy demand effects, lost agricultural productivity, human mortality and morbidity, lost ecosystem services and non-market amenities, and so forth. The social cost of greenhouse gas tool therefore captures the factors that actually affect public welfare and assesses the degree of impact to each factor, in ways that just estimating the volume of emissions cannot.

Response

This EIS estimates and reports the projected changes in GHG emissions, particularly CO_2, that would result from the alternatives. The changes in CO_2 emissions, in turn, cause indirect effects on five attributes of climate change: CO_2 concentrations, temperature, sea level, precipitation, and ocean pH. Quantitative estimates of the effects on these attributes are documented in Section 5.4, *Environmental Consequences*, and Section 8.6, *Greenhouse Gas Emissions and Climate Change*.

Many specific impacts on health, society, and the environment (e.g., number of species lost) cannot be estimated quantitatively. Recognizing this, NHTSA provides a detailed qualitative discussion of the impacts of climate change on various resource sectors in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*.

The comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in Section VII of the preamble to the final rule and in the FRIA.

Comments

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

NEPA requires agencies to weigh the "relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity," as well as "any irreversible and irretrievable commitments of resources." That requirement is prefaced with a congressional declaration of policy that explicitly references the needs of future generations:

> The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment . . . declares that it is the continuing policy of the Federal Government . . . to use all practicable means and measures . . . to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

When the Congressional Conference Committee adopted that language, it reported that the first "broad national goal" under the statute is to "fulfill the responsibilities of each generation as trustee of the environment for future generations. It is recognized in this [congressional] statement [of policy] that each generation has a responsibility to improve, enhance, and maintain the quality of the environment *to the greatest extent possible for the continued benefit of future generations*."

Because applying a 7% discount rate to the social cost of greenhouse gases could drop the valuation essentially to $0, use of such a rate effectively ignores the needs of future generations. Doing so would arbitrarily fail to consider an important statutory factor that Congress wrote into the requirements of NEPA.

* * * * *

Third, a 7% discount rate **ignores catastrophic risks and the welfare of future generations**. As demonstrated in NHTSA's graph of the frequency distribution of social cost of carbon estimates, the 7% rate truncates the long right-hand tail of social costs relative to the 3% rate's distribution. The long right-hand tail represents the possibility of catastrophic damages. As Pindyck explains "the possibility of a catastrophic outcome is an essential driver of the [social cost of greenhouse gases]." The 7% discount rate effectively assumes that present-day Americans are barely willing to pay anything at all to prevent medium- to long-term catastrophes. This assumption violates NHTSA's statutory duty under NEPA to protect the future needs of Americans. At the same time, the 7% distribution also misleadingly exaggerates the possibility of negative estimates of the social cost of greenhouse gases.[80] A negative social cost of greenhouse gases implies a discount rate so high that society is willing to sacrifice serious impacts to future generations for the sake of small, short-term benefits (such as slightly and temporarily improved fertilization for agriculture). Again, this assumption contravenes NHTSA's statutory responsibilities under NEPA to protect the welfare of future Americans.

Fourth, a 7% discount rate would be inappropriate for climate change because it is based on **outdated data and diverges from the current economic consensus**. Circular A-4 requires that assumptions—including discount rate choices—are "based on the best reasonably obtainable scientific, technical, and economic information available."[81] Yet Circular A-4's own default assumption of a 7% discount rate was published 14 years ago and was based on data from decades ago.

[80] In the Monte Carlo simulation data, the 7% discount rate doubles the frequency of negative estimates compared to the 3% discount rate simulations, from a frequency of 4% to 8%.

[81] CEQ regulations implementing NEPA similarly require that information in NEPA documents be "of high quality" and states that "[a]ccurate scientific analysis . . . [is] essential to implementing NEPA." 40 C.F.R. § 1500.1(b).

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

The use of a 7% discount rate in the social cost of carbon calculations is inappropriate when trying to calculate the multi-generational effects of GHG emissions and climate change. A 7% discount rate might be appropriate for cost-benefit analysis that occur over a decade or two but GHG emissions have costs that last hundreds of years so such a high discount rate will fail to properly account for the lasting impact of increased emissions. The EPA has previously used discount rates of 5%, 3%, 2.5%, and 3% at the 95th percentile when calculating the social cost of carbon because the Interagency Working Group on Social Cost of Carbon (IWG) and the OMB had both agreed that "the climate change problem is highly unusual". The EPA has previously accepted the IWG argument that GHG emissions are a global externality that damage the entire world not just the United States and therefore the only appropriate figure to use is the full global social cost of carbon when calculating the damages. This argument should still hold because the damage of climate change in other countries can still have an impact on the United States due to changes in trade and agriculture.

Response

The comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in Section VII of the preamble to the final rule and in the FRIA. Because one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis. NHTSA recognizes the congressional declaration of policy stated by the commenters; however, we note that the responsibility to value long-term impacts does not dictate the degree to which they should be valued. NHTSA has considered the appropriate discount rate, as described in Section VI.D.1.b.12 of the preamble to the final rule and in Section VI.D of the FRIA, for purposes of applying the SC-CO_2.

Comments

Docket Number: NHTSA-2017-0069-0588
Organization: Alliance of Automobile Manufacturers
Commenter: John T. Whatley

Against that backdrop, there is no requirement, as part of the NEPA process, for NHTSA to monetize the impacts of climate change. As the DEIS noted, estimating the social cost of carbon is only "[o]ne approach to assessing the potential impact associated with changes in GHG emissions." (DEIS at 5-22.) The DEIS presents monetization of potential climate effects as an issue to be considered elsewhere, in Docket No. 2018- 0067. See 40 C.F.R. § 1502.23 ("For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis"). No federal decision with precedential force would require a different approach.[82]

[82] The Draft EIS evaluates and quantifies the impact of GHG emissions under various regulatory alternatives without reliance on the social cost of carbon. The current process is quite different from the situation in *Sierra Club v. FERC*, 867 F.3d 1357 (D.C. Cir. 2017), in which FERC was faulted for neither "quantify[ing] nor consider[ing] the project's downstream carbon emissions" nor "explain[ing] in more detail why it [could] not do so." *Id.* at 1375. Stakeholders who have cited *Zero Zone v. US. Dep't of Energy*,

Docket Number: NHTSA-2017-0069-0602
Organization: Alliance of Automobile Manufacturers
Commenter: Susan T Conti

The DEIS states that NHTSA is using "methods and data to analyze climate impacts that represent the best and most current information available on this topic and that have been subjected to extensive peer review and scrutiny." (DEIS at 5-20.) NHTSA's approach is consistent with NEPA, the regulations implementing NEPA and with the relevant caselaw. For example, in *EMR Network v. FCC*, 391 FJd 269 (D.C. Cir. 2004), an agency "relied on other government agencies and non-governmental expert organizations with specific expertise on the health effects of RF radiation" in deciding whether to tighten regulations on such radiation. *Id.* at 273. The D.C. Circuit rejected the argument that the agency had "abdicated its responsibilities" by doing so, concluding that it was proper for the agency to rely on the "leading experts in this area." *Id.* The FCC's decision not to undertake its own study "represent[ed] the sort of priority-setting in the use of agency resources that is least subject to second-guessing by the courts." *Id.*[83]

Precedent from other courts and involving other agencies is in accord. *See, e.g., Wild.Earth Guardians v. NPS*, 703 F.3d 1178, I 185 (10th Cir. 2013) ("NEPA does not prohibit an agency from gathering information from outside sources ...."); *Nw. Envtl. Def Ctr. v. Nat'l Marine Fisheries Serv.*, 647 F. Supp. 2d 1221, 1247 (D. Or. 2009) (in conducting NEPA analysis, "[i]t was proper for the Corps to rely on [NMFS's opinion] because NMFS is the expert agency with regard to the effects of federal actions on listed salmonids"); *Lesser v. City of Cape May*, 110 F. Supp. 2d 303, 329 (D.N.J. 2000) ("The NEPA review process often involves the consideration of specialized scientific fields about which the reviewing agency itself lacks the knowledge to make an informed decision. To forbid consultation with outside experts would result in uninformed agency decisions."). And, of course, "an agency must have discretion to rely on the reasonable opinions of its own qualified experts even if, as an original matter, a court might find contrary views more persuasive." *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 378 (1989); *see also Ground Zero Ctr. for Non-Violent Action v. US. Dep't of the Navy*, 860 F.3d 1244, 1254 (9th Cir. 2017) ("Agencies are normally entitled to rely upon the reasonable views of their experts over the views of other experts."); *WildEarth Guardians*, 703 F.3d at 1185; *Bear Lake Watch, Inc. v. FERC*, 324 F.3d 1071, 1076-77 (9th Cir. 2003).

Chapters 5 and 8 of the DEIS include a thorough and more than adequate discussion of the relevant possible effects of GHG emissions attributable for purposes of NEPA to the regulatory alternatives that are under consideration in Docket No. 2018-0067. To the extent some experts might disagree with the approach taken on those issues in the DEIS, a lack of consensus or the existence of uncertainty should not upend either the NEPA process or the regulatory proceeding. See *The Lands Council v. McNair*, 537 FJd 981, 1001 (9th Cir. 2008) ("[E]xperts in every scientific field routinely disagree," and a requirement to "present every uncertainty ... might inadvertently prevent the Forest Service from acting due to the burden it would impose"), *overruled on other grounds by Winter v. Nat. Res. Def Council, Inc.*, 555 U.S. 7 (2008). "Agencies are entitled to select their own methodology as long as that methodology is

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832 F.3d 654 (7th Cir. 2016) and *Ctr. for Biol. Diversity v. NHTSA*, 538 F.3d 1172 (9th Cir. 2008) as establishing a rule that agencies "must" rely on estimates of the social cost of carbon, misread those decisions, neither of which held NEPA creates a duty to do so.

[83] The D.C. Circuit also relied on a similar case from the Second Circuit "reject[ing] a claim that the [FCC] had improperly relied on expert standard-setting organizations" in deciding not to tighten its regulations. *Id.* (citing *Cellular Phone Taskforce v. FCC*, 205 FJd 82, 90 (2d Cir. 2000)); *see City of Boston Delegation v. FERC*, 897 FJd 241, 255 (D.C. Cir. 2018) (agencies may rely on the opinion of "other government agencies and non-government expert organizations with specific expertise").

reasonable." *Hughes River Watershed Conservancy v. Johnson*, 165 FJd 283, 289-90 (4th Cir. 1999) (citing *Baltimore Gas & Elec. v. Nat. Res. Def Council*, 462 U.S. 87, 100-01 (1983)).

Against that backdrop, there is no requirement, as part of the NEPA process, for NHTSA to monetize the impacts of climate change. As the DEIS noted, estimating the social cost of carbon is only "[o]ne approach to assessing the potential impact associated with changes in GHG emissions." (DEIS at 5-22.) The DEIS presents monetization of potential climate effects as an issue to be considered elsewhere, in Docket No. 2018- 0067. See 40 C.F.R. § 1502.23 ("For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis"). No federal decision with precedential force would require a different approach.[84]

Response

NHTSA agrees with the commenters. Although not required by NEPA, the comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in Section VII of the preamble to the final rule and FRIA. Because one of the primary purposes of NHTSA's FRIA is to monetize and compare the potential costs and benefits of the Proposed Action and alternatives for the benefit of the decision-maker and the public, NHTSA believes that is the appropriate place for this analysis.

Comment

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

NHTSA grossly underestimates the social cost of carbon by relying on a number that is dramatically lower than any that was used in hundreds of regulatory proceedings at the federal level through January 2017. NHTSA admits that the reduction in its social cost of carbon calculation is primarily due to its decision to calculate on a domestic rather than a global basis. Not only does NHTSA's new social cost of carbon calculation depart from agency practice, it also violates Executive Order 13783 and the Office of Management and Budget's (OMB) Circular A-4—both of which NHTSA concedes guide its analysis here—by failing to use the best available science and appropriate discount rate.

It was arbitrary and capricious for NHTSA to completely ignore the global costs of increased GHG emissions, and the DEIS fails to give the public and decision-makers the necessary context to assess the significance of the climate consequences associated with the action alternatives, as NEPA requires. See 42 U.S.C. § 4332 (F) (requiring federal agencies to "recognize the worldwide and long-range character of environmental problems…").

[84] The Draft EIS evaluates and quantifies the impact of GHG emissions under various regulatory alternatives without reliance on the social cost of carbon. The current process is quite different from the situation in *Sierra Club v. FERC*, 867 F.3d 1357 (D.C. Cir. 2017), in which FERC was faulted for neither "quantify[ing] nor consider[ing] the project's downstream carbon emissions" nor "explain[ing] in more detail why it [could] not do so." *Id.* at 1375. Stakeholders who have cited *Zero Zone v. US. Dep't of Energy*, 832 F.3d 654 (7th Cir. 2016) and *Ctr. for Biol. Diversity v. NHTSA*, 538 F.3d 1172 (9th Cir. 2008) as establishing a rule that agencies "must" rely on estimates of the social cost of carbon, misread those decisions, neither of which held NEPA creates a duty to do so.

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

NEPA contains a provision on "International and National Coordination of Efforts" that broadly requires that "all agencies of the Federal Government shall . . . recognize the worldwide and long-range character of environmental problems."[85] Using a global social cost of greenhouse gases to analyze and set policy fulfills these instructions. Furthermore, the Act requires agencies to, "where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment." By continuing to use the global social cost of greenhouse gases to spur reciprocal foreign actions, federal agencies "lend appropriate support" to the NEPA's goal of "maximize[ing] international cooperation" to protect "mankind's world environment." Focusing solely on a domestic-only metric fails to fulfill these requirements of NEPA.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

Furthermore, the foregone climate benefits shown in tables 11-25 through 28 and subsequent summaries do not adequately describe the impact of this proposal. Costs and impacts of the rule will be felt by the entire planet not just the car manufacturers, vendors, and users of vehicles. Utilizing the full social costs of greenhouse gases is a more equitable method than merely relying on 'domestic' social costs when identify impacts of greenhouse gases. While social costs of greenhouse gases do not address all costs (such as possible tipping points of global warming and feedback or secondary ground level ozone formation) they are reasonable tools to use to make informed decisions about policy. This is particularly true when addressing decisions that affect entire sectors of the economy, perhaps more so for transportation emissions as they represent a very large portion of the nation's emissions and there are no other national standards to limit greenhouse gas emissions from these vehicles. As road transportation emissions make up 23% of all U.S. emissions, it is unlikely that the U.S. could reduce a commensurate amount of emissions from other sources. This is particularly true as the EPA is simultaneously seeking to roll back policies that reduce emissions from other major sources, including power plants, oil and gas production, solid waste, and ozone-depleting substance substitutes.

The use of a 'domestic' social cost of carbon by the NHTSA results in a failure to consider the true costs and damage that GHG emissions have on the United States economy . GHG emissions have global impacts so using anything less than the global social cost of carbon will result in damages not being calculated. The use of this 'domestic' social cost of carbon deliberately reduces the costs faced by increased GHG emissions by reducing them to as little as $7 or $1 depending on the use of a 3% or 7% discount rate respectively in 2020. These estimates are far too low and recent research suggests that the true global social cost of carbon is between $177/ton of CO_2 and $805/ton of CO_2 with a median of $417/ton of CO_2 (Ricke et al. 2018). The EPA and NHTSA are using a global social cost of carbon that is

[85] 42 U.S.C. § 4332(2)(f) (emphasis added). In the Notice of Inquiry, FERC writes that cumulative impacts "must occur within the same geographic area and same time period in which the proposed project's impacts will occur." 83 Fed. Reg. at 18,023. Note that, for purposes of global climate change, the relevant geographic area is the earth, and the relevant time period is the foreseeable future.

much lower than many economists believe and further reducing it in an attempt to minimize the full costs of additional GHG emissions. This recent work by Ricke et al. even goes as far as to estimate a 'domestic' social cost of carbon for the United States of $48/ton of CO_2, nearly 7 times the EPA's figure at a 3% discount rate. The proposal's use of a 'domestic' social cost of carbon alters the cost-benefit calculations by reducing the true costs while also reducing the benefits of approaches that reduce more emissions.

*   *   *   *   *

Fighting climate change is a global problem that requires global cooperation and by using a 'domestic' social cost of carbon it signals that the United States is not willing to work with the global community as it has in the past to try and solve this problem threatening the planet. If the EPA and NHTSA insist on using a 'domestic' social cost of carbon they send a signal to other countries that they too should only focus on the emissions that effect their country which will result in the failure to stop the damaging effects of climate change. This 'domestic' social cost of carbon also only focuses on the damage GHG emissions in the United States do to the United States and ignores the fact the United States is being impacted by emissions from other countries. If the EPA and NHTSA insist on using this figure they are encouraging other countries to do the same, with the result that actions taken by any nations to address climate change will be severely undervalued.

Response

The comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in Section VII of the preamble to the final rule and FRIA. NHTSA addresses the use of a domestic versus a global SC-CO_2 in Section VI.D.1.b.12(b) of those documents. NHTSA acknowledges the language in NEPA that is cited by the commenters. NHTSA addresses the potential impacts of climate change on key natural and human resources, including international resources, in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.*

Comments

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

Finally, the cumulative tallies of direct and indirect carbon dioxide emissions that do appear in the DEIS (a difference of 4500 $MMTCO_2$ from passenger cars between the no-action alternative and alternative 1; and a difference of 2900 $MMTCO_2$ from light trucks between the no-action alternative and alternative 1) are markedly different than the quantifications that appear in the PRIA and proposed rule (a difference of 329 $MMTCO_2$ from passenger cars between the no-action alternative and alternative 1; and a difference of 480 $MMTCO_2$ from light trucks between the no-action alternative and alternative 1). Not just the magnitude of the numbers but also the relative share of responsibility between cars and trucks seems to be different between the DEIS estimates and the PRIA estimates. Given that the DEIS and PRIA both rely on the same models, it is possible that the different cumulative estimates are explained by different timescales and by the DEIS's reliance on GCAM to estimate emissions from cars and trucks over the years 2061-2100 by applying a projected rate of change. Yet neither the DEIS nor the PRIA fully explains the different estimates in the two interrelated documents. The lack of a full explanation is especially problematic because, as discussed below, NHTSA states that it need not apply the social cost of greenhouse gas metrics in the DEIS because readers can refer to the calculations in the PRIA. In fact, the PRIA's monetization of climate damages based on the PRIA's estimated change in greenhouse gas emissions cannot provide the public or decisionmakers with the context needed to understand the climate damages from the DEIS's estimated cumulative change in emissions, because the quantitative estimates appearing in the two documents are so very different.

*   *   *   *   *

The DEIS acknowledges that monetizing climate damages using the social cost of greenhouse gases provides "the decision-maker and the public . . . with the full context of the potential impacts of GHG emissions and climate change." Nevertheless, NHTSA opts not to use the social cost of greenhouse gas metrics in the DEIS to provide that necessary "full context," and instead relies on incorporating the PRIA by reference. NHTSA gives two reasons for this decision, both of which are misleading.

NHTSA's first reason is that this decision "is consistent with past practice." That statement is misleading. In previous CAFE rulemakings, NHTSA has monetized climate effects both directly in the EIS as well as in the regulatory impact analysis. Most importantly, when NHTSA finalized its standards for Model Years 2017-2021 and announced its augural standards for Model Years 2022-2025, its accompanying Final EIS comprehensively reviewed the environmental effects for the full range of model years (2017 through 2025) and directly monetized climate effects. Because the earlier EIS documents for standards for Model Years 2021-2025 monetized climate effects, and because climate effects remain the most central environmental impact of the CAFE standards, failing to monetize the climate effects in the new EIS creates confusion among the public and agency reviewers.

NHTSA's second reason for incorporation by reference is that the PRIA is "the most appropriate place for discussing the SC-CO_2 and including it in the decision-making process," because the PRIA "monetizes [all] the potential costs and benefits" and so provides "the full context of the potential impacts of GHG emissions and climate change." There are at least four problems with this argument.

One, as already mentioned, the DEIS and the PRIA contain markedly different quantitative estimates of the cumulative increases in carbon dioxide resulting from choosing the proposed action over the no-action alternative: the DEIS estimates an increase of 4500 MMTCO_2 from passenger cars and 2900 MMTCO_2 from light trucks, while the PRIA estimates a difference of 329 MMTCO_2 from passenger cars and 480 MMTCO_2 from light trucks. The fact that PRIA monetized climate damages from an increase of 809 MMTCO_2 (using a severely undervalued and manipulated social cost of carbon metric, see *infra*) does not help the public and decisionmakers understand the full context of the climate damages from the 7400 MMTCO_2 increase estimated under the DEIS.

Two, as discussed more fully below, the PRIA buries any consideration of monetized climate damages from increases in methane and nitrous oxide emissions in a sensitivity analysis (which uses the wrong methodology for estimating the social cost of greenhouse gases), which hardly provides the full context on methane and nitrous oxide emissions for readers of the DEIS.

Three, as explained in more detail in the next subsection, it is exceedingly difficult for most readers to comprehend the significance of the associated climate impacts from mere quantitative estimates of greenhouse gas emissions. The DEIS is full of attempts to use quantitative information to trivialize what are actually billions or trillions of dollars' worth of climate damages. To fulfill NEPA's requirements to provide readers with enough context to understand the difference between alternatives under consideration, climate damages must be monetized using the social cost of greenhouse gas metrics within the NEPA documents themselves to prevent misleading the public and decisionmakers.

Four, the PRIA's description of the methodology for estimating the social cost of greenhouse gases is incomplete or inapplicable in several ways. For example, when discussing a sensitivity analysis using a 2.5% discount rate, the PRIA starts reporting different estimates of monetized climate damages "under the rate-based and mass-based scenarios, respectively." There are no rate-based versus mass-based alternatives under the proposed CAFE standards. Evidently, this language and the monetized estimate of climate damages ($3.8 to $3.9 billion) were copied and pasted directly from a different rulemaking (namely, from the stay, repeal, or replacement of the Clean Power Plan). It is unclear how much of the PRIA's description of its methodology or its monetized values using the social cost of greenhouse gases are also copied from a different rulemaking and so inapplicable to this rulemaking—and consequently uninformative and in fact misleading as incorporated into this DEIS.

In addition, the PRIA promises several critical documents to enable the public to understand the derivation of the social cost of greenhouse gas estimates—documents which are, in fact, not currently in the rulemaking dockets. Specifically, the PRIA promises, on page 1101, that "the full set of SC-CO_2 results through 2050 is available in the docket." Page 1100 further promises that "to better understand how the results" for estimates of the social cost of carbon "vary across scenarios, results of each model run are available in the docket." Additionally, on page 1534, footnote 910 says that "a detailed description of the methods used to construct these alternative values" for the social cost of methane and nitrous oxide "is available in the docket for this rule." None of that promised information is available in either docket for this rulemaking, at least according to our best searches of the docket. The promised but missing information is essential to allow the public to fully understand, among other things, how the discount rates and socioeconomic scenarios affect the estimates. The frequency distribution chart on page 1101, for example, provides insufficiently fine-grained information on how negative estimates of the social cost of carbon may be skewing the overall result. As the PRIA itself states, the full "results of each model run" are needed to "better understand how the results vary across scenarios." The frequency distribution chart also gives no information on the runs conducted at a 2.5% discount rate, and dockets contain none of the promised information on the methodology for calculating the social cost of methane and nitrous oxide.

For all these reasons, incorporating the PRIA by reference fails to provide the complete context necessary for readers to understand the scale of the climate damages that will be caused by the proposed action, and indeed will create confusion among readers. Agencies are only supposed to incorporate material by reference if they can do so "without impeding agency and public review of the action." Given the significant confusion that this incorporation by reference has caused, NHTSA must monetize climate damages directly within the final EIS and not through incorporate by reference.

The rest of this section further explains why monetizing climate damages is required by NEPA.

Monetizing Climate Damages Fulfills the Obligations and Goals of NEPA

When a project has climate consequences that must be assessed under NEPA, monetizing the climate damages fulfills an agency's legal obligations under NEPA in ways that simple quantification of tons of greenhouse gas emissions cannot. NEPA requires "hard look" consideration of beneficial and adverse effects of each alternative option for major federal government actions. The U.S. Supreme Court has called the disclosure of impacts the "key requirement of NEPA," and held that agencies must "consider and disclose the *actual environmental effects*" of a proposed project in a way that "brings those effects to bear on [the agency's] decisions." Courts have repeatedly concluded that an environmental impact statement must disclose relevant climate effects. NEPA requires "a reasonably thorough discussion of the significant aspects of the probable environmental consequences," to "foster both informed decisionmaking and informed public participation." In particular, "[t]he impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impact analysis that NEPA requires," and it is arbitrary to fail to "provide the necessary contextual information about the cumulative and incremental environmental impacts." Furthermore, the analyses included in environmental assessments and impact statements "cannot be misleading." An agency must provide sufficient informational context to ensure that decisionmakers and the public will not misunderstand or overlook the magnitude of a proposed action's climate risks compared to the no action alternative. As this section explains, by only quantifying the volume of greenhouse gas emissions, agencies fail to assess and disclose the actual climate consequences of an action and misleadingly present information in ways that will cause decisionmakers and the public to overlook important climate consequences. Using the social cost of greenhouse gas metrics to monetize climate damages fulfills NEPA's legal obligations in ways that quantification alone cannot.

Docket Number: NHTSA-2017-0069-0560
Organization: Environmental Defense Fund
Commenter: Erin Murphy

The U.S. Supreme Court has called the disclosure of impacts the "key requirement of NEPA," and held that agencies must "consider and disclose the actual environmental effects" of a proposed project in a way that "brings those effects to bear on [the agency's] decisions." Courts have repeatedly concluded that an EIS must disclose relevant climate effects. Though NEPA does not require a formal cost-benefit analysis, agencies' approaches to assessing costs and benefits must be balanced and reasonable. Courts have warned agencies that "[e]ven though NEPA does not require a cost-benefit analysis," an agency cannot selectively monetize benefits in support of its decision while refusing to monetize the costs of its action—particularly where, as here, there is a readily available, peer-reviewed metric for doing so.

NHTSA purports to include the social cost of carbon in its DEIS and PRIA analysis, but this is deceptive. The agency's version of a social cost of carbon analysis applies a flawed so-called "domestic estimate," uses an improper discount rate, and does not include an adequate sensitivity analysis, among other issues. These concerns are reviewed in more detail in joint comments filed by the Institute for Policy Integrity, joined by EDF.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

Given the statutory obligation and the need to properly Inform the public regarding the rulemaking, EPA and NHTSA must include the full societal costs of the non-CO_2 GHG in their regulatory evaluation. Nitrous oxide, methane, and the GHG refrigerants, along with CO_2, are all associated with the operation of vehicles in the covered size classes. Each of these pollutants has been previously addressed by the OEMs through technological improvements driven by compliance requirements. The agencies' evaluation of the proposed rule only includes the damages from the social cost of CO_2 and ignores the costs of these other GHG emissions that will also increase. The social cost of methane and social cost of nitrous oxide that the EPA has calculated in the past are much higher than the social cost of CO_2, so ignoring them in the cost calculations greatly reduces the actual costs to society of the proposal. Although EPA and NHTSA find fault with the mechanisms used to incorporate these pollutants, removing controls entirely from this program would be unjustified and would result in significant increases in GHG emissions and leaving them out of cost benefit calculations results in costs that are much lower than the true costs faced by society.

Response

In general, NHTSA disagrees that it must monetize potential climate damages in the Final EIS rather than incorporating them by reference. In fact, CEQ regulations encourage agencies to incorporate by reference material to cut down on bulk (40 CFR § 1502.21) and to combine documents to reduce duplication (40 CFR § 1506.4). It is only required that this information be available to the decision-maker and the public contemporaneously with the availability of the Final EIS, and that the decision-maker have the opportunity to consider this information as part of the official record. Inarguably, including the SC-CO_2 analysis in the preamble to the final rule and FRIA, and incorporating this material by reference in the Final EIS, accomplishes this.

NHTSA's use of the phrase "consistent with past practice" in Draft EIS Chapter 1, *Purpose and Need for the Proposed Action*, was intended to mean only that inclusion of the SC-CO_2 in the agency's Regulatory Impact Analysis was consistent with past practice. That is true; NHTSA customarily includes the SC-CO_2 as part of its cost-benefit analysis in that document. However, NHTSA announced in its scoping notice that it would no longer include the monetized climate change impacts of its rulemaking in its EIS to eliminate duplicative information and cut down on bulk. NHTSA does not agree that this "creates confusion among the public," as the EIS explicitly references the SC-CO_2 and refers the reader to where that information may be found.

NHTSA acknowledges that the data provided in the EIS and in the preamble to the final rule and the FRIA are not directly comparable. The EIS shows total CO_2 reductions for passenger cars and light trucks from 2021 to 2100. The preamble to the final rule and the FRIA show the cumulative changes in CO_2 emissions over the lifetimes of vehicles through MY 2029. Although these analyses present different perspectives, they are independently valid ways to assess emissions impacts from the Proposed Action and alternatives. NHTSA may, therefore, rely on one of those perspectives for calculating the SC-CO_2.

NHTSA has reviewed its presentation of the SC-CO_2 for the final rule and addresses substantive comments related to this calculation in Section VI.D.1.b.12 of the preamble to the final rule and in Section VI.D of the FRIA.

Comment

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

The PRIA repeatedly talks about its proposed action's "total net benefits," without acknowledging that the proposal may entail significant unquantified forgone benefits. In fact, over the course of 1621 pages, the PRIA has only a single section, passingly a mere paragraph, that includes the word "unquantified" in the heading. Though the DEIS does contain some scattered additional discussion of some qualitative effects, by incorporating the PRIA into the DEIS and referring readers to the PRIA's monetization of costs and benefits to understand "the full context of the potential impacts of GHG emissions and climate change," the DEIS implies that the PRIA's presentation of the social cost of greenhouse gases fully captures all relevant climate impacts from the rule. It does not, since the PRIA gives no serious weight to the unquantified forgone benefits to climate, as well as other unquantified forgone benefits, such as the unquantified public health consequences of various criteria and toxic pollution. Even putting aside NHTSA's severely manipulated underestimates of the monetized forgone climate benefits, the PRIA fails to explain why the proposed action's estimated cost savings justify the sum of both the monetized and unmonetized forgone benefits.

Response

NHTSA quantifies the reductions in monetized damages attributable to each action alternative (in the social cost of carbon analysis), but many specific impacts on health, society, and the environment cannot be estimated quantitatively. Recognizing this, NHTSA provides a detailed qualitative discussion of the impacts of climate change on various resource sectors in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*.

Final EIS Section 5.3.2, *Social Cost of Greenhouse Gas Emissions,* does not refer to the RIA as providing "the full context of the potential impacts of GHG emissions and climate change." NHTSA acknowledges that the material in the EIS supplements the material in the preamble to the final rule and the FRIA, and the agency considers all of these sources and the entirety of the administrative record in making its final decision. NHTSA discusses its consideration of the statutory factors in Section VIII of the preamble to the final rule.

10.5.3 Tipping Points

Comments

Docket Number: NHTSA-2017-0069-0495
Organization: Climate Institute
Commenter: Michael MacCracken

Page 5-27, Section 5.3.4 Tipping Points and Abrupt Climate Change: Given the severe consequences that the baseline climate scenario describes and then the potential risk of passing tipping points described in this section, it is hard to understand how the Administration can be choosing to do worse than nothing about it by adding any amount at all to the No Action Alternative that is projected to cause over a 4 C global warming by 2100 and more beyond. Quite clearly, this EIS does not face up to considering all of the possible and appropriate policy alternatives for addressing the threat and risks of human-induced climate change.

Docket Number: NHTSA-2017-0069-0544
Commenter: David Bella

Brief 3: Alternatives

This EIS appears to say that stronger fuel-efficiency requirements will make very little difference in climate change outcomes. One would think that such a finding would lead the DOT to say, "hence, other alternatives must be considered". But, as far as I can find, the EIS does not say this.

OBSERVATIONS

Transportation has become a leading contributor to carbon emissions.

The calculations in this EIS show that, under a range of scenarios, GHG emissions lead to global surface temperatures above the 2 degree C level where serious consequences are likely to arise.

In addition, this EIS describes "tipping points" and abrupt climate changes that "could occur so quickly and unexpectedly that human systems would have difficulty adapting to them" (see page 5-27 of the EIS). The higher cumulative emissions become, the higher the probabilities of catastrophic possibilities become.

Once higher temperatures and other impacts are reached, society cannot "dial back" these temperatures by reducing or even eliminating emissions.

COMMENTS AND QUESTIONS

Despite these observations, all eight of the alternatives in this EIS produce emissions higher than the No Action Alternative.

Has the DOT proposed other alternatives with emissions lower than the No Action Alternative? If "yes", where can I find them? If "no", why not?

This EIS provides strong evidence that the DOT needs to consider other alternatives to reduce the continuing CO_2 emissions from transportation.

Docket Number: NHTSA-2017-0069-0706
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto

While the misleading nature of the EIS's handling of the climate change issue was apparent when first published as a draft, subsequent developments have repeatedly and consistently underscored the EIS's flaws.

First, for example, in the 2018 report by D. Laffoley and J.M. Baxter entitled: Ocean Connections: An Introduction to Rising Risks From A Warming Ocean (copy attached), the authors note:

"The real and urgent question is therefore when will we reach tipping points where mitigation and adaptation actions to reduce the risks arising are no longer an option, and risks to humans and our ocean life support systems become unmanageable? It is becoming increasingly clear that this may be sooner than some think (Figures 11 and 12), and the issue is what action must be taken to avoid reaching such tipping points."

Id. at p. 16.

Docket Number: EPA-HQ-OAR-2018-0283-5486
Organization: Environmental Law & Policy Clinic at Harvard Law School

Even if it were correct to characterize the emissions associated with the Proposal as "small,"[86] even small increases in global emissions can have harmful impacts. The DEIS acknowledges as much, stating more emissions means more warming and more sea level rise. *See* DEIS at 5-30. The impacts of the Proposal's additional emissions, further, will be "long-lasting" and "global [in] scale," *id.*, and will intensify as the climate continues to warm.

"Tipping points" multiply the severity of these incremental increases in emissions many times over. Tipping points are "disproportionately large or singular" changes in climate-affected systems resulting from relatively "moderate additional change" in GHG emissions and other variables. DEIS at 5-27. If emissions remain unchecked, some tipping points could unfold so "abrupt[ly][,]. . . quickly, and unexpectedly" that human systems would have difficulty adapting to them." *Id.*

The DEIS describes some of these potential tipping points as "catastrophic." DEIS at 8-72. Specifically, a certain amount of warming would cause "a catastrophic release of methane" from permafrost and the bottom of the ocean. *Id.* The amount of methane suddenly released would exceed the global warming potential of all human-caused GHG emissions since the beginning of the Industrial Age. *Id.* (noting that the Arctic methane reservoir is estimated to be about 82,000,000 MMT CO_2e.). Other dangerous tipping points involve disintegration of the West Antarctic and Greenland ice sheets which would raise the level of the sea by about 35 feet. The DEIS recognizes this threat, citing several studies showing that ice sheet melt is underway in parts of the West Antarctic ice sheet, that ice loss beyond a certain threshold of warming would become "self-sustaining," and that little in the region's geography could prevent its "irreversible collapse," given enough warming. Collapse, however, is not inevitable. A sharp reduction in emissions over the next several decades, in line with international climate goals, would likely allow Antarctica's ice sheets to remain largely stable.

The DEIS's discussion of these tipping point risks is extremely misleading. It explains that "the current state of science does not allow for quantifying how increased emissions from a specific policy or action might affect the probability and timing of abrupt climate change." DEIS at 5-28. Though it is true that the precise thresholds are unknown, there is scientific consensus around the range of warming within which some of these tipping points will occur. For example, the tipping point for the eventual complete melting of the Greenland ice sheet will occur somewhere between 1°C and 4°C of warming. DEIS at 8-68. This is squarely within the climate impacts projected by the DEIS, which predicts more than 4°C of warming by 2100.[87] Thus, even though the precise tipping-point threshold is uncertain, it is reasonably foreseeable based on the DEIS's own projections that it will be crossed sometime during the 21st century. This is of the utmost importance because the anticipated melting of the Greenland ice sheet will cause up to 23 feet of sea level rise over several centuries. See DEIS at 8-68.

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[86] This characterization is not correct, as established by the Draft EIS.

[87] Draft EIS at 5-31 (projecting about 3.5°C warming by 2100, relative to 1986-2005, see id. at 5-32 note "b"); see also id. at 5-11 (reporting 0.9°C of warming between 1880 and 2016). The Draft EIS's presentation of this information is confusing because it does not forecast the Proposal's impacts relative to preindustrial CO_2 concentrations, global average temperature, sea levels, or ocean acidity.

Precise quantification of a risk of this magnitude is unnecessary to appreciate its significance and compel appropriate regulatory action. As the D.C. Circuit stated when interpreting a statutory standard identical to the one upon which EPA must base its GHG emissions standards for passenger cars and light trucks:

> A statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action may be taken before the threatened harm occurs; indeed, the very existence of such precautionary legislation would seem to demand that regulatory action precede, and, optimally, prevent, the perceived threat . . . [The Clean Air Act] is such a precautionary statute.

The Proposal, however, embodies the opposite of this precautionary approach. It will make it more likely that this tipping point, and others, will be crossed because every incremental increase in emissions makes it more likely that a tipping point will be reached. Because the Proposal will increase emissions and global average temperatures, it will "contribute to the marginal increase or acceleration of reaching these tipping-point thresholds . . . [being] one of many global actions that, together, could contribute to abrupt and severe climate change." DEIS at 8-72. This risk analysis demonstrates the Proposal's impacts are not "small" and that it is not rationally founded on the analyses in the DEIS.

Response

As noted in this EIS, given the difficulty of simulating the large-scale processes involved in tipping points, or inferring their characteristics from paleoclimatology, considerable uncertainties remain on tipping points and the rate of change. Despite the lack of a precise quantitative methodological approach, NHTSA has provided a qualitative and comparative analysis of tipping points and abrupt climate change in Section 8.6.5.2, *Tipping Points and Abrupt Climate Change*. The analysis applies equally to direct and indirect impacts, as well as to the cumulative impacts described in Chapter 8, *Cumulative Impacts*.

Commenters generally express their opposition to the agency's Preferred Alternative (as identified in the Draft EIS) because of the potential of crossing tipping points and triggering abrupt climate change. NHTSA considered these potential impacts as part of its decision-making process. For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the Preferred Alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards, and that the maximum feasible standards for MYs 2021-2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. While CO_2 emissions (and other environmental impacts) will be higher under this final rule than if NHTSA had determined that the augural standards were maximum feasible, they will be lower than they would have been under the proposal. NHTSA recognizes the risks associated with tipping points, but it must also balance that against other statutory factors in its decision-making process.

Comment

Docket Number: NHTSA-2017-0069-0559
Organization: Institute for Policy Integrity, Environmental Defense Fund, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists
Commenter: Jason Schwartz

Climate tipping elements are environmental thresholds where a small change in climate forcing can lead to large, non-linear shifts in the future state of the climate (over short and long periods of time) through positive feedback (i.e., snowball) effects.[88] Tipping points refer to economically relevant thresholds after which change occurs rapidly (i.e., Gladwellian tipping points), such that opportunities for adaptation and intervention are limited. Tipping point examples include the reorganization of the Atlantic meridional overturning circulation (AMOC) and a shift to a more persistent El Niño regime in the Pacific Ocean. Social tipping points—including climate-induced migration and conflict—also exist.

These various tipping points interact, such that triggering one tipping point may affect the probabilities of triggering other tipping points. There is some overlap between tipping point events and fat tails in that the probability distributions for how likely, how quick, and how damaging tipping points will be are unknown. Accounting fully for these most pressing, and potentially most dramatic, uncertainties in the climate-economic system matter because humans are risk averse and tipping points—like many other aspects of climate change—are, by definition, irreversible

Response

As noted in this EIS, given the difficulty of simulating the large-scale processes involved in these tipping points, or inferring their characteristics from paleoclimatology, considerable uncertainties remain on tipping points and the rate of change. Despite the lack of a precise quantitative methodological approach, NHTSA has provided a qualitative and comparative analysis of tipping points and abrupt climate change in Section 8.6.5.2, *Tipping Points and Abrupt Climate Change*. The analysis applies equally to direct and indirect impacts, as well as to the cumulative impacts described in Chapter 8, *Cumulative Impacts*.

10.6 Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts

10.6.1 Energy Sources

Comment

Docket Number: NHTSA-2017-0069-0183
Commenter: David Nadel

In paragraph 6.2.4.2. it was written that farm and agricultural waste can be converted to cellulosic ethanol. This is not yet commercially viable, but cellulosic methanol is 150 year old chemistry. I would recommend to rewrite the regulations to permit cellulosic and non-cellulosic (natural gas) based methanol be included with ethanol in the nations fuel tanks. Newer vehicles shall upgrade the gaskets in their fuel systems.

The increasing of engine compression can make all alcohol fuels competitive with gasoline. The nation's fuel tank is large enough for ethanol, methanol and gasoline refined from domestically produced oil.

[88] Tipping elements are characterized by: 1) deep uncertainty, 2) absence from climate models, 3) larger resulting changes relative to the initial change crossing the relevant threshold, and 4) irreversibility. Kopp et al. (2016), *supra* note 328.

Please note the highest expense in oil refineries is the cost of operating the reforming furnace that produce benzene and toluene, both octane additives. In a normal market, benzene cost 30% more than RBOB gasoline and toluene, 30% above benzene. Alcohol is cost effective.

Thank you for your careful consideration.

Response

In EIS Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, NHTSA analyzes and summarizes the most recent and relevant life-cycle assessment (LCA) research for light-duty transportation fuel and vehicle technologies. This EIS does not consider methanol because of its lack of current and projected use in light-duty vehicles, but carefully considers ethanol, natural gas, and gasoline production, which are referenced in this comment. See Sections 6.2.1, *Diesel and Gasoline*, 6.2.2, *Natural Gas*, and 6.2.4.2, *Ethanol.*

In preamble Section VI.C.1, the agencies discuss the use of alternative fuels, like ethanol, in the context of fuel octane levels. The agencies describe EPA's authority to regulate fuels, prescribed in Clean Air Act Section 211(c), and state in response to comments that the present rulemaking is not the appropriate vehicle to either establish a higher minimum octane for gasoline, or to provide additional incentives for flex-fueled vehicles (i.e., vehicles designed to operate on gasoline or E85 or a mixture), as some commenters suggested.

This commenter's suggestion to rewrite regulations to permit cellulosic and non-cellulosic-based methanol be included with ethanol in the nation's fuel tanks similarly falls outside the scope of this action, and as described in preamble Section VI.C.1, falls under EPA's authority to regulate fuels under the Clean Air Act.

Comment

Docket Number: NHTSA-2017-0069-0530
Organization: Ohio Corn & Wheat Growers Association
Commenter: John Torres

[Excerpt from 2017 "Literature Review of Ethanol Use for High Octane Fuels" by Ricardo, Inc. prepared for Renewable Fuels Association:]

The DOE (Theiss, et al. 2016) has recently published a summary of its efforts investigating the potential of High Octane Fuel (HOF) with 25-40% ethanol blends. DOE investigators came together from Oak Ridge National Laboratory, National Renewable Energy Laboratory, and Argonne National Laboratory with the objective of providing a quantitative picture of the barriers to adoption of HOF and the highly efficient vehicles it enables, and to quantify the potential environmental and economic benefits of the technology. The results of these studies, considered together, show that HOF mid-level ethanol blends could offer significant benefits for the United States. These benefits include a 5-10% efficiency increase in vehicles designed for increased ethanol content and a miles-per-gallon fuel economy parity with E10.

Furthermore, dedicated HOF vehicles exhibit nearly 15% lower well-to-wheels GHG emissions resulting from increased vehicle efficiency and corn ethanol production and use; future corn stover use shows potential to increase the well-to-wheels (WtW) savings to around 30%, Figure 18. By increasing the percentage of ethanol in the fuel supply, the amount of gasoline consumed decreases, thereby further reducing the nation's dependency on crude oil imports and enhancing U.S. energy security.

[See original comment for Figure 18, titled "WTW GHG Emissions Reductions in Vehicles Fueled [*sic*] by HOFs with Different Ethanol Blending Levels Relative to Regular Gasoline (E10) Baseline Vehicles (From Theiss 2016)]

Kwasniewski et al (Kwasniewski, Blieszner and Nelson 2016) also studied the impact on refinery GHG emissions for 10% and 30% ethanol blends with varying octane ratings. The study found that refinery GHG emissions decline 12% to 27% from a 2017 baseline for the various 30% ethanol cases due to both the extensive effect of lower crude oil throughput and the generally-overlooked intensive effects of differences in the severity of refining operations.

Response

NHTSA has included the Theiss 2016 study in Section 6.2.4.2, *Ethanol*, to highlight LCA findings for GHG emissions reductions between ethanol and gasoline from well to wheel. While the Kwasniewski study provides relevant research, NHTSA has focused on analyzing studies that take into account full fuel life cycles. Other studies referenced in Section 6.2.4.2 consider fuel production and refinery GHG emissions as part of the assessment scope. Section 6.2.4.2 has been updated to clarify the scope and life-cycle phases considered as part of the well-to-wheel analysis.

Comment

Docket Number: NHTSA-2017-0069-0545
Organization: Texas Corn Producers Association (TCPA)
Commenter: David Gibson

To meet future emissions and efficiency standards cost effectively and safely for drivers, automakers need the appropriate tools. Octane is a key tool to make that happen – and affordable, readily available, low-carbon and clean-burning ethanol is a desirable octane source. Corn farmers have a vested interest in the future of transportation fuels – as they produce the primary component for ethanol production.

Efficiency gains from technology changes are reaching its limits – and a change in fuel can enable further advances for automakers. We urge consideration of fuels and vehicles as a system of high- octane fuel used with optimized engines.

Echoing the National Corn Growers Association's detailed comments, the benefits for fuel economy and emissions reduction from the use of high-octane fuels in vehicles with optimized engines is clearly evident. Ethanol use to meet higher octane levels would minimize changes in fuel cost, compared to hydrocarbon aromatics – which are both costly and not as environmentally-friendly. Though there are other sources of fuel octane, we assert that ethanol offers the lowest carbon and lowest cost octane source on the market. Further, corn ethanol's carbon footprint is on the decline.

TCPA supports a single, national program for vehicle standards. High-octane, low-carbon fuel can be an essential unifying piece for federal and state standards. We appreciate your consideration of these comments.

Response

NHTSA has included a detailed analysis of ethanol and the life-cycle GHG emission reductions relative to gasoline. This assessment includes projections for ethanol carbon intensity reductions. See Section 6.2.4.2, *Ethanol*, for details.

In preamble Section VI.C.1, the agencies discuss the use of alternative fuels, like ethanol, in the context of fuel octane levels. The agencies describe EPA's authority to regulate fuels, prescribed in Clean Air Act Section 211(c), and state in response to comments that the present rulemaking is not the appropriate vehicle to either establish a higher minimum octane for gasoline, or to provide additional incentives for flex-fueled vehicles (i.e., vehicles designed to operate on gasoline or E85 or a mixture), as some commenters suggested.

Comment

Docket Number: NHTSA-2017-0069-0577
Organization: National Corn Growers Association
Commenter: Kathy Bergren

5) Adopt the Argonne National Laboratory GREET model to determine updated lifecycle carbon emissions for ethanol.

The Energy Independence and Security Act of 2007 established lifecycle GHG emission thresholds for different types of renewable fuel when compared to lifecycle GHG emissions for gasoline or diesel. EPA last updated its lifecycle analysis for corn-based ethanol in 2010, projecting that corn-based ethanol would produce 21 percent fewer GHG emissions when compared to gasoline by 2022.

In comparison, the Department of Energy developed a system to account for full lifecycle emissions, the Greenhouse gas and Regulated Emissions and Energy use in Transportation (GREET) model, more than 30 years ago. The GREET model measures GHG emissions for all corn production and ethanol manufacturing activities. The assumptions used in the GREET model are perpetually under review, and the model is updated regularly. The 2016 GREET model shows the carbon intensity of corn-based ethanol is 45 percent below that of baseline gasoline.

To be effective, model assumptions must incorporate the latest science and data. The lifecycle profile of biofuels shows continuous improvement. But—with EPA's reliance on outdated modeling—the agency's conclusions understate the significant production and sustainability improvements by corn and corn ethanol industries over the last decade. Accurately quantifying ethanol's GHG reductions is imperative when assessing vehicle standards.

Response

Section 6.2.4.2, *Ethanol*, includes the most recent 2018 GREET model results for corn ethanol, as well as other research performed by Argonne National Laboratory (Theiss et al. 2016). Section 6.2.4.2 includes updated research regarding improvements to the previous EPA LCA corn ethanol research (see Rosenfeld et al. 2018 references in Section 6.2.4.2). The studies cited in Section 6.2.4.2 include both current and projected carbon intensities for corn ethanol, incorporating potential efficiency and GHG emission reduction improvements throughout the corn ethanol life cycle. The discussion in Section

6.2.4.2 has been updated to clarify the scope and life-cycle phases considered as part of the well-to-wheel analysis.

Comment

Docket Number: NHTSA-2017-0069-0577
Organization: National Corn Growers Association
Commenter: Kathy Bergren

As DOE explained in its well-to-wheels (WTW) GHG analysis of high-octane fuel (HOF), determining GHG impacts of HOF relative to current gasoline requires accounting for vehicle efficiency gains, refinery operation changes and GHG emissions changes from ethanol blending. DOE's results show the largest impacts on WTW emissions from HOF come from efficiency gains and the level of ethanol blending.

- DOE's modeling compared 100 RON E25 and E40 fuels to baseline E10. When used in HOF vehicles, the E25 reduced WTW GHG emissions by a total of 8 to 9 percent (or 36-40 g CO_2e/mile driven) compared to baseline E10. The vehicle efficiency gains from HOF reduced GHG emissions by 4 percent of that total, and the additional 4 percent of GHG reductions with the E25 fuel were realized from ethanol offsetting petroleum. For the E40 HOF, the ethanol content provides a 9 percent reduction in WTW GHG emissions.
- A 2016 study modeled the impact on refinery emissions related to producing E10 and E30 blends across varying octane ratings. Results showed GHG reductions of 12 and 27 percent, respectively.
- Researchers at MIT modeled a scenario where the country transitioned to a 98 RON gasoline by 2040. If this high-octane fuel represented 80 percent of liquid fuel consumption by 2040, total gasoline energy consumption would decrease by 3 to 4.4 percent, which is equivalent to a reduction of 19 to 35 million metric tons of CO_2 in 2040, or nearly 3 to 5 percent of tailpipe emissions from light duty vehicles.

Response

NHTSA notes that this comment included footnotes providing citations to the studies underlying the information provided. NHTSA has included the Theiss 2016 study cited by the commenter, and several others, in Section 6.2.4.2, *Ethanol*, to highlight LCA findings for GHG emissions reductions between ethanol and gasoline from well to wheel. While the Kwasniewski et al. and Speth et al. studies referenced by the commenter provide relevant research, NHTSA has focused on analyzing studies that take into account full fuel life cycles. Other studies referenced in Section 6.2.4.2 consider fuel production, refineries, and tailpipe GHG emissions as part of the assessment scope. The discussion in Section 6.2.4.2 has been updated to clarify the scope and life-cycle phases considered as part of the well-to-wheel analysis.

Comment

Docket Number: NHTSA-2017-0069-0577
Organization: National Corn Growers Association
Commenter: Kathy Bergren

Corn ethanol's carbon footprint is shrinking as agricultural practices and technologies improve, while the fossil fuel carbon footprint is expanding as the oil production from tar sands and tight oil supplies increases. LCA estimates are dynamic, so previous estimates do not capture advancements. EPA last updated its LCA for corn-based ethanol in 2010, projecting that corn-based ethanol would produce 21 percent fewer GHG emissions by 2022 when compared to gasoline. These numbers do not reflect all the positive sustainability advances by the corn and ethanol industries throughout the past decade. However, the USDA LCA and Argonne National Laboratory's GREET model include more recent data pertinent to these gains.

Argonne's GREET model continues to show steady improvement in corn ethanol's lifecycle GHG profile. The 2016 GREET model shows corn-based ethanol's carbon intensity is 45 percent below the carbon intensity of baseline gasoline; the 2010 GREET model has corn-based ethanol's carbon intensity 19 percent below that of baseline gasoline.

USDA's 2017 analysis shows corn-based ethanol currently results in 43 percent fewer life cycle GHG emissions when compared to conventional gasoline. If current GHG-reducing technologies and trends continue, GHG emissions reductions could reach 48 percent by 2022. Furthermore, if new ethanol and corn production technologies become more widespread, emissions reductions could be 76 percent less than gasoline, according to USDA.

These increasing benefits have occurred even before accounting for corn's carbon sequestration. Corn as a crop can serve as a carbon sink. As a photo-synthetically superior C4 plant, corn has an extraordinary ability to sequester carbon and move fertilizer nutrients back to the surface for plant growth rather than polluting ground water. Corn's extensive, deep root system makes it one of the few plants with this important capability to make crop production sustainable.

High-yield corn—combined with the steady adoption of best practices such as reductions in tillage intensity—is sequestering carbon from the atmosphere into the soil. This sequestration is increasing soil carbon levels and reducing atmospheric CO_2. According to the Journal of Soil and Water Conservation, the potential to sequester atmospheric carbon in soil is greatest on lands currently used for annual crops; most remarkably, there is potential to sequester carbon in the soil at an annual growth rate of 0.4 percent each year. The results of tracking soil organic carbon (SOC) advancements on select USDA-specified agricultural land areas is estimated to have sequestered an estimated 309 metric tons of CO_2-equivalent in less than a decade. Although GHG lifecycle models do not currently account for this direct GHG reduction from corn production, NCGA believes research increasingly indicates the need to account for these direct effects corn and biofuel feedstock crops have on soil carbon stocks.

Argonne National Laboratory continues to review the GREET model, including gaps in the emissions accounting. We believe the effect of corn crops on soil carbon sequestration, among other considerations, should be incorporated into current LCA models. This increase in soil carbon from corn production, when included, could result in a 20 gram/MJ carbon credit for corn-based ethanol. Fully accounting for corn's carbon sequestration would further demonstrate significant low-carbon advantages of a high-octane midlevel ethanol blend.

* * * * *

While corn growers continue paving the way in terms of sustainability and productivity, ethanol producers have demonstrated similar advances. Together, corn ethanol's LCA continues to improve across the supply chain. The same cannot be said for the route chosen by oil companies and their product's overall LCA. With conventional reserves increasingly exhausted, oil companies are harnessing unconventional techniques and new technologies to extract resources once thought unreachable. These developments—namely hydraulic fracturing (fracking) for tight oil and tar sand bitumen production—

are many times more energy- and water-intensive. This trend provides a stark comparison and reiterates, today more than ever, the importance of using clean, renewable biofuels to offset petroleum.

Response

Section 6.2.4.2, *Ethanol*, has been updated to include both the analysis of carbon intensity estimates from both GREET and the most recent U.S. Department of Agriculture corn ethanol LCA (Rosenfeld et al. 2018) among other LCA studies of corn ethanol. This section analyzes both current emissions reductions relative to gasoline and projects future emissions reductions from efficiency gains and management practices throughout the fuel life cycle.

Carbon sequestration in domestic and international land-use change is addressed in these studies, the consideration of which is addressed in the Final EIS, as noted above. This includes changes in sequestration rates due to land directly and indirectly related to the expansion of corn growth both domestically and internationally.

Section 6.2.1, *Diesel and Gasoline*, details recent developments in oil production and the effect on overall life-cycle GHG emissions for diesel and gasoline, including fracking and tar/bituminous sands.

Comment

Docket Number: NHTSA-2017-0069-0582
Organization: Illinois Corn Growers Association
Commenter: David Loos

Illinois Corn Growers Association worked closely with University of Illinois-Champaign, University of Illinois-Chicago, Purdue University and Argonne National Laboratory on updating the life cycle analysis of corn ethanol utilizing the latest input data, models, and advanced technologies including remote imaging, infrared scanning and ground truthing. The work included modeling yield increases and input reductions, both direct and indirect land use changes, co-product modeling and assessments as co-products changed, and we surveyed and analyzed changes in energy uses at the plants and new process for increased efficiencies and increased production. The results of this work concluded that the carbon footprint of corn ethanol is 43% better than 2005 base gasoline as used by USEPA to compare greenhouse gas emissions in the 2007 RFS. https://www.usda.gov/media/press-releases/2017/01/12/usda-releases-new-report-lifecycle- greenhouse-gas-balance-ethanol

Response

The recent USDA corn ethanol LCA (Rosenfeld et al. 2018) has been included in Section 6.2.4.2, *Ethanol*. The analysis of this report included both current and future projections for the carbon intensity of corn ethanol, as well as comparisons to the original EPA estimates and gasoline carbon intensity.

Comment

Docket Number: NHTSA-2018-0067-12303
Organization: Ingevity Corporation
Commenter: Todd Schroeder

Second, is the fact that recent studies, such as that by Argonne National Laboratory in 2016, show that when subjected to a full life-cycle analysis, natural gas-fueled vehicles compare well to electric vehicles in terms of greenhouse gas emissions and deserve parity with electric vehicles.

Docket Number: NHTSA-2018-0067-12303
Organization: VNG and Aeriel Corporation
Commenter: Robert Friedman

Third, the use of renewable natural gas (also referred to as RNG or biogas) has increased from practically nothing in 2012 to about 25% to 40% of all NGV fuel use in the US and 64% in California. RNG offers lifecycle GHG emission reductions of 84% to 129%, outperforming even the cleanest forms of electric generation, and is projected to have far greater production potential than it has today.

Response

Section 6.2.2, *Natural Gas,* includes an analysis of life-cycle emissions from natural gas resources. Because recent U.S. Energy Information Administration (EIA) reporting only projected natural gas to supply 0.2 percent of passenger cars and light duty vehicles by 2040, Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, considers natural gas for electricity generation purposes. Section 6.2.3, *Electricity*, contains an analysis of natural gas's increasing share of U.S. electricity generation and comparison of natural gas-powered electric vehicles with other sources of electricity. The analysis shows that regions that rely on natural gas and renewable sources for powering electric vehicles experience fewer impacts than those that rely on conventional vehicles.

Comment

Docket Number: NHTSA-2017-0069-0626
Organization: Urban Air Initiative
Commenter: James Conde

III. THE ENVIRONMENTAL IMPACT STATEMENT SHOULD AVOID POTENTIALLY OVERBROAD GENERALIZATIONS WITH RESPECT TO THE SAFETY OF USING ETHANOL BLENDS OVER E15 IN VEHICLES OTHER THAN FLEX FUEL VEHICLES (FFVS).

The DEIS states: "Ethanol blends over E15, including E85, should only be used in flexible fuel vehicles, because ethanol has a high alcohol content and can soften and degrade gaskets, seals, and other equipment in nonflexible fuel vehicles." However, the source that the DEIS cites for this broad generalization does not appear to support the generalization. The generalization is likely more appropriate for ethanol blends close to E85 than it is for blends between E15 and (say) E30.

Indeed, some existing non-flex-fuel gasoline-fueled vehicles on the U.S. market are already described in their owner's manuals as E25-capable, which implies that past concerns about equipment softening and degradation have been mitigated and even eliminated in recent years as manufacturers have improved the resiliency of equipment components. Relatedly, EPA recently approved a pilot project requested by the state of Nebraska to study the use of higher-ethanol blends. In the pilot program, Nebraska will study the use of E30 in conventional vehicles owned by the state, assessing the effects of E15 and E30 blends on vehicle performance, fuel economy, and emissions control systems.

Of course, midwestern states already have a substantial fueling infrastructure for flex- fuel vehicles, which can be used and adapted for mid-level ethanol blends such as E25 or E30. Stations in these states are already dispensing mid-level ethanol blends in significant volumes. For example, Minnesota statistics show that drivers in the state are purchasing and using substantial volumes of E20 and E30 blends. This evidence suggests that many drivers with access to mid-level blends may be electing to use them in their non-FFV vehicles.

We acknowledge that EPA officials have previously taken the position that section 211(f) of the Clean Air Act limits the concentration of ethanol that may be blended into gasoline for use in gasoline-fueled vehicles. We respectfully submit that that past position has been superseded by supervening legal developments. Section 211(f) restricts the sale of fuel additives that are not “substantially similar” to additives in the EPA-approved test fuels used to certify new vehicles. But ethanol is already used in an EPA-approved test fuel and therefore satisfies the “substantially similar” requirement. As of 2017, the gasoline certification fuel contains 10% ethanol. EPA should reinterpret “substantially similar” for gasoline to recognize that ethanol is now a fuel additive used in certification, and section 211(f) therefore no longer controls ethanol content in market fuel. For this reason, the Clean Air Act authorizes EPA to regulate ethanol only under section 211(c)—the same provision that authorizes EPA to regulate other fuel components. For more detailed information on this legal issue, please see the Urban Air Initiative et al., Midterm Evaluation Comments, EPA-HQ-OAR-2015-0827-9904, Addendum B (Aug. 21, 2017), https://bit.ly/2NgfiSZ (attached as Exhibit A).

Response

NHTSA acknowledges the steps and equipment that vehicle manufacturers are taking to introduce materials and products compatible with mid-level ethanol blends. Section 6.2.4.2, *Ethanol*, has been updated accordingly.

This commenter’s suggestion that EPA reinterpret provisions of the Clean Air Act similarly falls outside the scope of this EIS document and action, and as described in preamble Section VI.C.1., falls under EPA’s authority to regulate fuels under the Clean Air Act.

Comment

Docket Number: NHTSA-2018-0067-12078
Organization: American Fuel & Petrochemical Manufacturers
Commenter: James Wedeking

The Draft EIS concludes that “[e]lectricity will decline in carbon intensity if renewable energy and natural gas replace existing coal power.” This is a big "if." Although natural gas has exceeded coal as the primary source of fuel for electricity generation, wind and solar power generation continue to play a marginal role. According to the EIA, wind and solar combine to provide just over 7.5% of the United States' electricity generation.[89] No reasons are provided to support the assumption that wind and solar will come to play the significant role that the Draft EIS imagines by 2050. DEIS at 6-17, Figure 6.2.3-6.

The source of this optimism is an EIA forecast. The EIA provides almost no information supporting these projections other than an assumption that (1) federal production tax credits, which are necessary to support solar and wind power projects, will continue indefinitely, and (2) "[c]ontinued favorable economics relative to other generating technologies" will see nearly 3% annual growth for wind and solar. The second assumption is tied to the first, which is simply not tenable given that renewable energy production tax credits are subject to constant phase-downs for new construction and have only survived through a series of extensions. The current production tax credit for wind energy facilities will expire in January 2020. Neither NHTSA nor EIA can predict whether it will be renewed, or if it is renewed, that it will provide the same level of financial support. These forecasts are, at best, uncertain. NHTSA could better inform the public of future GHG emissions from electricity generation by examining alternative scenarios where wind and solar power showed low growth and electricity generation from natural gas continued to increase. Under such a scenario, GHG emissions from the use of electrified vehicles would be higher and offset, to some degree, any increased GHG emissions under the Proposed Rule.

Response

NHTSA recognizes the uncertainty in electricity generation forecasts and their relation to electric vehicle emissions. The commenter is correct that a lower growth renewables scenario could potentially result in higher GHG emissions from electric vehicles than currently forecast under the AEO reference case. However, such a scenario is also uncertain to occur, and Section 8.6.3, *Other Past, Present, and Reasonably Foreseeable Future Actions*, describes some regional, state, federal, and international actions that could result in the continued development of wind and solar power generation.

The use of the AEO reference case in projecting changes in electricity generation in Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, is intended to provide a discussion on how GHG emissions from electric vehicles in the future compare to current conditions. The assessment in Section 6.2.3, *Electricity*, generally discusses how electric vehicle emissions can fluctuate depending on the electricity mix for charging. NHTSA highlights the uncertainties in this assessment and comparison in Section 6.1, *Introduction*, noting that the assessment does not seek to quantitatively differentiate between alternatives and is intended to better understand the implications of these types of variations in vehicle life-cycle impacts.

NHTSA relies on the AEO projections as they are widely used throughout the government and publicly available. For more information about the use of AEO in this EIS, see Section 2.3.4, *Energy Market Forecast Assumptions.*

[89] EIA, Electricity Explained, Electricity in the United States, available at, https://www.eia.gov/energyexplained/index.php?page=electricity_in_the_united_states#tab1. By comparison, natural gas provided 32%, coal provided 30%, and nuclear energy provided 20%. Id.

10.6.2 Vehicle Materials and Technologies

Comment

Docket Number: NHTSA-2018-0067-12078
Organization: American Fuel & Petrochemical Manufacturers
Commenter: James Wedeking

The Draft Environmental Impact Statement ("Draft EIS" or "DEIS") requires additional information regarding the environmental impacts of the No Action Alternative to enable an informed comparison with the Proposed Rule's preferred alternative and other alternatives. Under the No Action Alternative, there would be a dramatic increase in the use of lithium-ion batteries to accommodate conventional hybrids and electrified vehicles, however, the environmental impacts associated with this aspect of the No Action Alternative require additional analysis. Further, the Draft EIS appears to make assumptions regarding emissions from future electricity generation and petroleum refinery emissions that are speculative and should be re-evaluated.

The Draft EIS Should Include the Environmental Impacts of Vehicle Battery Manufacturing and the Extraction and Transportation of Minerals Necessary for Manufacturing

The Draft EIS includes a life cycle analysis for crude oil extraction and gasoline refining, but a true "apples-to-apples" life cycle comparison between internal combustion engine vehicles and vehicles utilizing lithium-ion batteries requires a life cycle analysis for battery manufacturing as well.[90] The Draft EIS does not include any consideration of air emissions from battery manufacturing, and makes no mention of the mineral extraction and transportation impacts required for battery production.

The Draft EIS Should Provide Information Regarding the Environmental Impacts of Mining and Processing Minerals Needed for Battery Manufacturing

Batteries used for electrified vehicles require several different minerals for their manufacture, including aluminum, cobalt, copper, graphite, lithium, manganese, and nickel. Mineral mining and processing operations can have significant environmental impacts, including the emissions of air toxics, criteria pollutants, and GHGs, surface and groundwater impacts, and solid and hazardous waste generation. It is important to provide a full analysis of the environmental impacts of the increased mining and processing operations that will occur under the No Action Alternative to illustrate the environmental harms that will be avoided under the Proposed Rule's alternatives.

The need to provide further environmental analysis is briefly illustrated through the Draft EIS's discussion of magnesium. Although the Draft EIS considered magnesium as a material that may be used for light-weighting, it provides a basic overview of the energy-intensity of its refining processing as compared to similar materials, GHG emissions from fuel sources and cover gases, air toxics and ozone-depleting emissions from that process, and air emissions associated from magnesium recycling. Although the Draft EIS's review omits environmental impacts from mining and solid and hazardous waste impacts from the refining process, it still provides the public with useful information on the GHGs involved in the process, including the use of sulfur hexafluoride and perfluorocarbons. Only through

[90] The Draft EIS provides some information on lithium-ion batteries, lead acid batteries, and vanadium redox flow batteries. DEIS at 6-44 to 6-47. Since lithium-ion batteries are the preferred batteries for electrified vehicles, *id.* at 6-44, all references to vehicle batteries here are to lithium-ion batteries.

such a comparison can the reader conclude that using magnesium parts to reduce vehicle weight has far more significant environmental impacts than the use of steel or aluminum parts. A similar review of the environmental impacts of mineral mining and processing for key battery components, as well as more robust review of battery recycling and disposal impacts (discussed below), will allow for a more informed view of the environmental impacts avoided by the Proposed Rule.

<u>The Draft EIS's Discussion of Lithium-Ion Battery Recycling Requires More Details on Environmental Impacts</u>

The Draft EIS provides some information on battery disposal, including recycling or reuse. It notes that pyrometallurgy is the most commonly used battery recycling technology but only gives a single sentence description of that process. Even this sentence, however, reveals that the process likely has serious environmental impacts to the areas surrounding pyrometallurgical recycling operations: "Pyrometallurgy uses a combination of smelting followed by leaching to recover slag and valuable metals." NHTSA should provide additional information on the smelting process, the air pollutants—particularly hazardous air pollutants such as metals and dioxins—emitted through the process, GHG emissions, the potential environmental impacts of the chemicals used in the leaching process, and the production of solid wastes, such as slag. This will provide a significant improvement in understanding the environmental impacts of the No Action Alternative.

Response

Section 6.3.3, *Vehicle Batteries*, discusses the technologies and trends used in lithium-ion battery life cycles, including life-cycle assessment results for GHG emissions and energy consumption. These environmental metrics are consistent with other sections in Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, which primarily focus on GHG emissions and energy consumption. The focus on GHG emissions and energy consumption for lithium-ion batteries is also a reflection of the availability of life-cycle assessment results in the related literature. Section 6.2.3, *Electricity*, in the Final EIS incorporates a discussion around rare metals consumption in addition to the Section 6.3.3 results for GHG emissions and energy consumption.

The commenter is correct that lithium ion battery production and recycling (through pyrometallurgy) can have adverse environmental impacts outside of energy consumption and GHG emissions. To address this, NHTSA has added conclusions from related LCAs on this topic in Section 6.3.3, *Vehicle Batteries.*

Comment

Docket Number: NHTSA-2017-0069-0189
Commenter: Michael Remington

Recent hail storms in the Colorado Springs area has shown that the lighter more fuel efficient vehicles are being damaged and totaled out by insurance companies due to extensive body damage and glass damage.

Our older vehicles have not had the extensive damage due to hail.

The totaled vehicles will go to salvage and be recycled using up more energy and increasing the carbon foot print.

While high fuel efficiency is a commendable goal. If you have to deal with frequent repairs and deal with the energy use to salvage and recycle a destroyed vehicle the net gain on energy saved is nil.

While my family 1994 vehicle is not a paragon of fuel efficiency due to its weight. It has not had to have its glass or body repaired due to hail damage. Its suspension is also able to cope with our crumbling roads.

There has to be an economic and energy efficient model to design a vehicle that is not totaled or damaged during normal weather events.

The current energy model does not take into account the very real potential total loss of the vehicle to achieve an arbitrary fuel efficiency standard.

More energy will be saved keeping a reliable robust vehicle for many years. Recycling costs energy and has a carbon foot print.

Response

NHTSA appreciates this anecdotal comment. Because the commenter did not identify any studies regarding the claims in the comment, a literature search was conducted to identify any studies on this topic. No studies were found that would justify any changes to the EIS to reflect this comment; therefore, no revisions to Chapter 6, *Life-Cycle Assessment of Vehicle Energy, Material, and Technology Impacts*, have been made.

10.7 Other Impacts

10.7.1 Endangered Species Act

Comments

Docket Number: NHTSA-2017-0069-0511
Commenter: Harold Draper

The EIS also asserts that an Endangered Species Act analysis is not required due to uncertain and remote impacts. However, an increase in oil extraction would affect federal lands, the locations of which are known, which in turn would affect endangered species. Selection of alternative 1 would potentially result in some species like the greater sage grouse being added to the list of endangered and threatened species. Climate change is having adverse effects on numerous endangered and threatened species such as the Florida panther and polar bear. Under the ESA. Contrary to what is said in the EIS, these impacts do not seem to be uncertain and remote. We know where these species live, and we know which Forest Service, FWS, and BLM properties are being opened to oil and gas exploration (Other EISs are in progress to add additional lands within national forests, the national system of public lands, and the Arctic National Wildlife Refuge to oil and gas exploration). NHTSA, EPA, and DOE should explain how its action is consistent with the ESA and the agencies affirmative duty to promote the recovery of endangered species.

Docket Number: NHTSA-2017-0069-0605
Organization: Center for Biological Diversity et al.
Commenter: Alejandra Núñez

In addition, the agencies have improperly concluded that a consultation under the ESA is unnecessary, and these comments address that subject. Any finalization of the Proposal or the accompanying draft Environmental Impact Statement ("DEIS") would be unlawful unless the agencies first comply with the ESA's consultation provisions. All references cited in these comments, and listed in the attachment at the end of this document, will be uploaded to the dockets on the Proposal and the DEIS.

* * * * *

A. The Proposed Repeal is a non-ministerial action that triggers the ESA's duty to consult.

Where an agency action that is non-ministerial – such as the promulgation of a rule or the repeal or revision of a rule – may adversely affect ESA-listed species, the agency must first comply with the ESA. Here, the Proposal would freeze the fuel efficiency and greenhouse emission standards for the nation's light duty vehicle fleet at MY 2020 levels through MY 2026, rescinding existing and augural standards for MY 2022 through MY 2025 and foregoing any increases for MY 2026. Those actions would vastly increase greenhouse gas and nitrogen oxide (NO_X) air pollutants above the levels that would be achieved if that rule were left unchanged; accordingly, the agencies must conduct a consultation under Section 7 of the ESA before finalizing the Proposal or DEIS.

Section 7 requires the agencies to consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (collectively "the Services") to "insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the adverse modification of [critical] habitat." Agency "action" is broadly defined in the ESA's implementing regulations to include "(b) the promulgation of regulations . . ." Once the consultation duty is triggered, agencies must use the "best scientific and commercial data available" in completing the consultation process.

Any agency action that may affect a listed species or its critical habitat triggers the consultation requirement. The threshold for a finding of "may affect" is extremely low: "any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement."

In the DEIS, NHTSA itself projects that the agencies' preferred alternative, which freezes fuel economy standards at 2020 levels through MY 2026 (i.e., for six years), will increase CO_2 emissions by 95 million metric tons ("MMT") by 2040, compared to emissions if the existing standards remain in place. Without question, 95 additional MMTs of CO_2 emissions within the next 22 years constitute an enormous amount of greenhouse gas pollution. But as pointed out in separate comments submitted to this docket by the Environmental Defense Fund ("EDF"), the numerous technical and modeling errors suffusing the Proposal result in a vast underestimation of the greenhouse gas pollution that would be caused if the Proposal were finalized. When correcting the model NHTSA used for the agencies' errors, the total greenhouse gas emissions nearly double through 2040, amounting to 189 MMT. This amounts to a staggering emissions increase.

Similarly, the combustion of fossil fuel by vehicles produces nitrogen oxide (NO_X) air pollutants, including nitrous oxide (N_2O), nitric acid (HNO_3), nitrate (NO_3-), and ammonia (NH_3) (collectively, "NO_X"). In the

DEIS, NHTSA, counterintuitively, asserts that NO_X emissions would be lower without the standards in 2025 and 2035. But EDF's analysis demonstrates that NHTSA's modeling errors vastly understate NO_X emissions, and that emissions will in fact increase in each of 2025, 2035 and 2050, to 23,225, 53,181, and 63,902 tons per year respectively.

The Proposal clearly crosses the "may affect" threshold as it is likely to injure many federally-listed threatened and endangered species that are at risk of extinction due to human- caused climate change, as well as those that are at risk of extinction due to NO_X emissions. Accordingly, the agencies' mandate to conduct consultation as required under Section 7 is triggered. The agencies must meaningfully evaluate the consequences of their action on endangered species before making any decision to finalize the Proposal, and in no circumstances may the agencies jeopardize listed species or destroy their critical habitat.

B. Climate change has clear and documented adverse impacts on federally protected species.

The best available science shows that anthropogenic climate change is causing widespread harm to life across the planet. Climate change is already affecting 82 percent of key ecological processes that underpin ecosystem function and support basic human needs. Climate change-related local extinctions are already widespread and have occurred in hundreds of species, including almost half of 976 species surveyed. Nearly half of terrestrial threatened mammals and nearly one-quarter of threatened birds may have already been negatively affected by climate change in at least part of their range.

Numerous studies have projected catastrophic species losses during this century if climate change continues unabated. A 2013 study projected a loss of more than half of the present climatically suitable range for 58 percent of plants and 35 percent of animals by the 2080s under the current emissions pathway, in a sample of 48,786 species. In fact, it is predicted that within a century, over 300 North American bird species will lose at least half of their current ranges due to climate change.

Greenhouse gas emissions harm endangered species in several ways that are not only measurable but also causally understood. Climate change impacts relating to sea-ice loss, thermal stress and ocean acidification, seal-level rise and attendant precipitation extremes, decreasing snowpack and elevational and latitudinal shifts in habitat all must be assessed prior to the finalization of the Proposal.

Loss of sea ice. The loss of sea ice is one of the clearest and most obvious consequences of global warming. Sea-ice loss, and the loss of sea-ice dependent prey, led the U.S. Fish and Wildlife Service to list the polar bear (*Ursus maritimus*) as a threatened species in 2008. As a top Arctic predator, the polar bear relies on sea ice for all its essential activities, including hunting for prey, moving long distances, and building dens to rear cubs. Federal documents admit that shrinkage and premature breakup of sea ice due to climate change is the primary threat to the species, leaving bears with vastly diminished hunting grounds, less time to hunt, and a shortage of sea ice to rest. In the southern Beaufort Sea of Alaska, evidence indicates that polar bears have declined by 40 percent in recent years, are starving, utilizing unusual and desperate foraging behaviors to try to catch seals, and even resorting to cannibalism.

If current emissions trends continue, scientists estimate that two-thirds of global polar bear populations will be lost by 2050, while the remaining third will near extinction by the end of the century due to the disappearance of sea ice. However, aggressive emissions reductions will allow substantially more sea ice to persist and increase the chances that polar bears will survive in Alaska and across their range. As such, the U.S. Fish and Wildlife Service's 2016 Final Polar Bear Conservation Management Plan clearly stated that the polar bear cannot be recovered without significant reductions in the greenhouse gas emissions driving Arctic warming and sea ice loss. If the Proposal is finalized, the vast additional greenhouse gases emitted from the nation's light duty vehicle fleet will exacerbate the loss of sea ice, causing the likelihood of survival and recovery of the species to diminish appreciably. The agencies must consult on how the Proposal would affect sea ice loss for a listed species like the polar bear.

Thermal stress and ocean acidification. Two other incontrovertible environmental impacts caused by greenhouse gas pollution are thermal stress and ocean acidification which are wreaking havoc on our ocean's coral reef systems. Currently, 25 species of corals are listed under the Endangered Species Act. Once abundant throughout the Caribbean Sea, elkhorn and staghorn corals (*Acropora palmata* and *A. cervicornis*) precipitously declined 92 to 97 percent due largely to disease driven by thermal stress from rising ocean temperatures. Global average sea surface temperature has risen by 1.3°F per century since 1900 as a result of the world's oceans absorbing more than 90 percent of the excess heat caused by greenhouse gas warming. Anthropogenic ocean warming is linked to the catastrophic, mass coral bleaching events that have been documented since 1980 and are increasing in frequency and intensity as atmospheric CO_2 increases.

Exacerbating the harms from warming, the global oceans have absorbed more than a quarter of the CO_2 emitted to the atmosphere by human activities, which has significantly increased the acidity of the surface ocean in a process called ocean acidification and has reduced the availability of key chemicals—aragonite and calcite—that many marine species use to build their shells and skeletons. Ocean acidification caused by the ocean's absorption of anthropogenic CO_2 has already resulted in more than a 30 percent increase in the acidity of ocean surface waters, at a rate likely faster than anything experienced in the past 300 million years. Ocean acidification has been linked to reduced coral calcification rates in reefs worldwide. Climate models and experimental research indicate that elkhorn and staghorn corals are directly threatened by increasing ocean temperatures combined with acidification resulting from rising global atmospheric CO_2 levels. Scientific research and federal documents conclude that conservation and recovery actions must rapidly reduce greenhouse gas emissions and return atmospheric CO_2 levels below 350 ppm in for corals to survive and recover. Since the ocean has absorbed more than 90 percent of the excess heat caused by greenhouse gas warming and more than a quarter of the CO_2 emitted by human activities, it is critical for the survival of the elkhorn and staghorn corals to prevent an additional 415 million short tons of CO_2 from being released. At a minimum, the agencies must assess how the increases in carbon dioxide emissions will affect these climate-sensitive ocean species.

Sea level rise. According to the 2017 U.S. Climate Science Special Report, global average sea level is likely to rise by 1.0 to 4.3 feet by the end of the century relative to the year 2000, with sea level rise of 8.2 feet possible. Sea level rise will be much more extreme under higher emissions scenarios. According to a 2013 analysis, on the current emissions trajectory, rising seas driven by warming temperatures threaten at least 17 percent of our nation's federally protected species, totaling 233 species in 23 coastal states. For example, more than half of Florida's endangered species are threatened by rising sea levels and associated groundwater contamination. Most (87 percent) loggerhead sea turtle (*Caretta caretta*) nesting occurs on the east coast of Florida, where 43 percent of the turtle's nesting beaches are expected to disappear with just 1.5 feet of sea level rise. Finalizing the Proposal is likely to result in a significant increase of CO_2 emissions and affect sea level rise. The Proposal thus triggers the agencies' legal duty under the ESA to consult on how continued habitat loss due to sea level rise will adversely affect the loggerhead sea turtle.

The single most important action to avoid further jeopardizing climate-threatened species is achieving emissions reductions that keep warming well below two degrees Celsius, and meaningfully lessens carbon-induced acidification. Consultation under the ESA is the critical first step to preventing the worst impacts of climate change and acidification on endangered species. The agencies' Proposal, if finalized, would directly contribute to significantly higher emissions and their attendant climate change and acidification effects, and thus triggers the duty to consult on those impacts to climate-threatened species like polar bears and corals to ensure that any final agency is not likely to jeopardize these and other species or result in the adverse modification of their critical habitat. Failure to conduct this consultation would render any final repeal unlawful.

C. Nitrogen oxide pollution has clear and documented adverse impacts on federally protected species.

Fossil fuel combustion from vehicles produces nitrogen oxide (NO_X) air pollutants including nitrous oxide (N_2O), as well as nitric acid (HNO_3), nitrate (NO_3), and ammonia (NH_3), which have contributed to the significant increase in nitrogen deposition globally and in many parts of the United States, resulting in widespread impacts to species and ecosystems.

A recent study of the effects of nitrogen pollution on federally listed species, based on analysis of U.S. Fish and Wildlife Service and National Marine Fisheries Service documents, found that this threat is "substantial" and "geographically widespread." The study found evidence for harm from nitrogen pollution for at least 78 federally protected taxa. This includes at least 50 invertebrates such as mollusks and anthropods, at least 18 vertebrate species of fish, amphibians, and reptiles, and at least 8 plants. Harms from nitrogen pollution fell into four main categories: (1) direct toxicity or lethal effects of nitrogen, (2) eutrophication lowering dissolved oxygen levels in water or causing algal blooms that alter habitat by covering up substrate, (3) nitrogen pollution increasing nonnative plant species that directly harm a plant species through competition, and (4) nitrogen pollution increasing nonnative plant species that indirectly harm animal species by excluding their food sources.

For example, nitrogen deposition from vehicle exhaust is a well-documented threat to the bay checkerspot butterfly *(Euphydryas editha bayensis*), which is restricted to patches of low- nutrient serpentinite soil in the San Francisco Bay area. Nitrogen deposition has allowed exotic grasses to replace native forbs, including the bay checkerspot's larval host plant, leading to butterfly population declines and local extirpations. U.S. Fish and Wildlife Service, in its most recent 5-year review for the bay checkerspot butterfly, found that nitrogen deposition from smog-created soil conditions allowed for rapid invasion of non-native plants where the level of impact increased with proximity to a major interstate highway:

> Weiss (1999, p. 1476) determined that while the initial cause of the butterfly declines were the result of rapid invasion by nonnative annual grasses that crowded out the butterfly's larval host plants, the evidence indicated that dry nitrogen deposition from smog was responsible for creating soil conditions that allowed the observed grass invasion. Weiss (1999, p. 1482) estimated nitrogen deposition rates south of San Jose to be 10-15 kg of nitrogen per hectare per year (kg-N/ha/yr). Weiss (2002, p. 31) further demonstrated these effects by analyzing the pattern of non-native grass invasion resulting from nitrogen deposition at Edgewood Park, and observed that the cover of non-native Italian ryegrass (*Lolium multiflorum*) decreased with distance from Interstate Highway 280 (I-280), while *Plantago erecta* cover increased with distance. *Plantago erecta* cover was also higher upwind of I-280 than downwind.

In its 5-year review, U.S. Fish and Wildlife Service concluded that “the butterfly is still at great risk from invasion of non-native vegetation, exacerbated by nitrogen deposition from air pollution.”

Similarly, U.S. Fish and Wildlife Service has determined that nitrogen pollution threatens the federally protected Quino checkerspot butterfly (*Euphydryas editha quino*) and the desert tortoise (*Gopherus agassizii*) by facilitating the spread of non-native species that displace the butterfly’s host plants and the tortoise’s forage plants, reducing the nutritional quality of available food for the desert tortoise.

Likewise, a review on the effects of nitrogen deposition in the western United States highlighted the need for policy changes at the national level for reducing air pollution to protect endangered species from nitrogen deposition: “[L]ocal land management strategies to protect these endangered species may not succeed unless they are accompanied by policy changes at the regional or national level that reduce air pollution.”

NHTSA’s and EPA’s joint proposal to freeze fuel efficiency standards for the nation’s light duty vehicle fleet for a full six years will result in vast amounts of additional NO_X emissions not just for those six years, but also for the decades during which these higher- polluting vehicles will continue to be on the road. The Proposal thus triggers the agencies’ legal duty under the ESA to consult on how these additional pollutants will adversely affect the species threatened by them.

In sum, for the numerous reasons set forth in other joint and separate comments submitted to this docket by the Commenters and other environmental and health organizations, we urge the agencies to withdraw the Proposal and instead protect the public and the environment by implementing and even strengthening the vehicle fuel efficiency and greenhouse gas standards. Should the agencies nonetheless go forward, they must conduct a meaningful consultation under Section 7 or the ESA and proceed accordingly. Any failure to do so would render the Proposal unlawful for this separate and independent reason.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

The DEIS fails to take a “hard look” at the effect the Proposed Rule’s action alternatives will have on species listed under the federal Endangered Species Act (ESA), and NHTSA wrongly concludes that it need not consult with the United States Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NOAA Fisheries) about these impacts. Section 7(a)(2) of the ESA requires that federal agencies consult with the FWS or NOAA Fisheries to ensure the actions they fund, authorize, or implement are “not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat of such species.” 16 U.S.C. § 1536(a)(2). The consultation procedures clarify that this requirement is intended for actions that “may affect” listed species or critical habitat, 50 C.F.R. § 402.14, and it is generally the agency’s responsibility to determine whether consultation is required. See 51 Fed. Reg. 19,926, 19,949 (June 3, 1986). In making this determination, agencies must consider whether there is a causal connection between the proposed action and direct or indirect effects on species or critical habitats. 50 C.F.R. § 402.02.

NHTSA admits that all action alternatives will increase GHG emissions compared to the augural standards. NHTSA claims, however, that consultation under ESA section 7(a)(2) is not required because “any potential for a specific impact on particular listed species and their habitats associated with emissions changes" are "too uncertain and remote to trigger the threshold of such a consultation."[91] NHTSA's claims are baseless. FWS recognizes there is a large body of evidence that GHG emissions accelerate climate change and drastically affect listed species. Additionally, policies that increase GHG emissions lead to compounding effects that make mitigation increasingly difficult by accelerating climate change.

Thus, NHTSA's proposed action resulting in a significant increase in GHG emissions "may affect" many federally-listed threatened and endangered species that are at the risk of extinction because of climate change. Indeed, peer-reviewed scientific demonstrates that increased climate change fueled by GHG emissions is already and increasingly will become a significant driver of species decline, extinction, and biodiversity loss. NHTSA must consult with FWS and NOAA Fisheries under Section 7(a)(2) of the ESA to ensure that NHTSA's proposed actions will not jeopardize listed species or destroy or adversely modify their critical habitat.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Where an agency action that is non-ministerial – such as the setting of fuel efficiency standards – may adversely affect ESA-listed species, agencies must first comply with the ESA. 16 U.S.C. § 1531 et seq. Here, the Proposal would undo the augural standards and freeze the existing MY2017-2025 light duty vehicle greenhouse gas standards at 2020 or 2021 levels, and thus increase pollution that would otherwise be avoided, with predictable detrimental effects on numerous listed species; accordingly, NHTSA must conduct a consultation under Section 7 of the ESA before finalizing its Proposal.

Section 7 requires agencies to consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (collectively "the Services") to "insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the adverse modification of [critical] habitat."16 U.S.C § 1536(a)(2). Agency "action" is broadly defined in the ESA's implementing regulations to include "(b) the promulgation of regulations ..." 50 C.F.R. § 402.02. Once the consultation duty is triggered, agencies must use the "best scientific and commercial data available" in completing the consultation process. U.S.C § 1536(a)(2).

Any agency action that may affect a listed species or its critical habitat triggers the consultation requirement. The threshold for a finding of "may affect" is extremely low: "any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement." Interagency Cooperation—Endangered Species Act of 1973, as Amended; Final Rule, 51 Fed. Reg. 19,926, 19,949 (June 3, 1986); U.S. Fish and Wildlife Service and National Marine Fisheries

[91] DEIS at 7-1. NHTSA appears to rely on the determination by FWS that GHG emissions from individual stationary sources are "too remote" to warrant consultation. See Memorandum from H. Dale Hall, Director, U.S. Fish and Wildlife Service re: "Expectations for Consultation on Actions that Would Emit Greenhouse Gases" (May 14, 2008), available at https://www.fws.gov/policy/m0331.pdf. That determination is not applicable here. That determination concerned only whether the emissions resulting from the oil extracted at an individual oil field were too remote to warrant consultation. (Id. at 2.) By contrast, NHTSA's CAFE standards regulate all light-duty vehicles, which account for 60% of U.S. emissions in the transportation sector and are the largest contributor of GHG emissions in the nation.

Service, Endangered Species Consultation Handbook (March 1998) at xvi (defining “may affect” as “the appropriate conclusion when a proposed action may pose any effects on listed species ... .”).

The Proposal would cause a massive amount of additional greenhouse gas emissions. Under NHTSA’s own skewed assumptions, the extra emissions through 2100 caused by its Preferred Alternative will add 7,400 $MMTCO_2$ to the total, an amount that is enormous by any measure; but as discussed above, analysis by the Environmental Defense Fund indicates that the actual emission increases are even larger. The light duty vehicle fleet is the largest contributor of greenhouse gases in the transportation sector, which itself is the largest source of all U.S. greenhouse gas emissions; rules that weaken reduction measures and contribute thousands of additional MMTs cross the “may affect” threshold under any definition. The additional pollution is likely to injure many federally-listed threatened and endangered species that are at risk of extinction due to human-caused climate change. Accordingly, NHTSA’s mandate to conduct consultation as required under Section 7 is triggered. NHTSA must meaningfully evaluate the consequences of its action on endangered species before it makes any decision to finalize its Proposal, and in no circumstances may NHTSA jeopardize listed species or destroy their critical habitat.

Docket Number: NHTSA-2017-0069-0706
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto

Second, as another example, climate change has accelerated the extinction of endangered species. Online May 12, 2019 and in the May 20, 2019 print issue of the New Yorker, Elizabeth Kolbert reported that the “first documented extinction of 2019 occurred on New Year’s Day, with the death of a Hawaiian tree snail named George.” *Cf*. Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (2015).

Response

In the NPRM, NHTSA noted that it had considered the effects of the proposed standards and alternatives in light of applicable Endangered Species Act (ESA) regulations, case law, and guidance to determine what, if any, impact there might be to listed species or designated critical habitat. The agency also considered the discussion in the Draft EIS, where NHTSA incorporated by reference its response to a public comment on page 9-101 of the MY 2017–2025 CAFE Standards Final EIS. Based on that assessment, NHTSA determined that the action of setting CAFE standards did not require consultation under Section 7(a)(2) of the ESA. Accordingly, NHTSA wrote that it had concluded its review of this action under Section 7 of the ESA.

NHTSA has reviewed these comments disagreeing with its assessment. In light of these comments, NHTSA reevaluated its obligations under the ESA and applicable regulations, case law, and guidance. Ultimately, the agency arrives at the same conclusion. Although there is a general association between the actions undertaken in the final rule and environmental impacts described in the preamble to the final rule and this Final EIS, the action of setting CAFE standards results in no effects on listed species or designated critical habitat and, therefore, does not require consultation under Section 7(a)(2) of the ESA. Furthermore, NHTSA lacks sufficient discretion or control to bring its action under the consultation requirement of the ESA.

For a full explanation of the reasoning behind this conclusion, see Section X.E.6 of the preamble to the final rule. In the interest of eliminating duplication, NHTSA addresses the issues raised by these comments in Section X.E.6. NHTSA's conclusion regarding Section 7(a)(2) of the ESA, which is contained in the preamble, is incorporated by reference in this Final EIS.

NHTSA has reviewed the references provided in comment NHTSA-2017-0069-0605 and added additional information on sea ice, ocean acidification, and sea-level rise to Final EIS Section 8.6.5.2, *Ocean Systems, Coasts, and Low-Lying Areas*.

10.7.2 Historical and Cultural Resources

Comments

Docket Number: NHTSA-2017-0069-0506
Organization: Maryland Department of Planning
Commenter: Myra Barnes

The Maryland Department of Environment and the Maryland Historical Trust found this project to be consistent with their plans, programs, and objectives.

The Maryland Historical Trust has determined that the project will have "no effect" on historic properties and that the federal and/or State historic preservation requirements have been met.

Docket Number: NHTSA-2017-0069-0511
Commenter: Harold Draper

Similarly, an increase in oil and gas extraction would potentially adversely affect properties eligible for the National Register of Historic Places. What mitigation measures are being put in place to require historic properties to be taken into account as a result of selection of Alternative 1?

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

The National Historic Preservation Act requires that the "head of any Federal agency" embarking on a project, "prior to the approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license, shall take into account the effect of the undertaking on any historic property." Climate change and air pollution imperil historic properties throughout the country via direct degradation, sea level rise, fire, flood, and other forms of harm. As former National Park Service Director Jon Jarvis explained: "[c]limate change poses an especially acute problem for managing cultural resources because they are unique and irreplaceable — once lost, they are lost forever. If moved or altered, they lose aspects of their significance and meaning." If NHTSA completes an undertaking that may further imperil these resources, it must properly consult with the relevant federal and state authorities and fully disclose any impacts. The DEIS concludes the Proposed Rollback would not significantly impact historical and cultural resources. NHTSA claims it would reduce NO_X emissions, and because "it is not possible to distinguish between acid deposition deterioration impacts and natural weathering (rain, wind, temperature, and humidity) impacts on historical buildings and structures and the varying impact of a specific geographic location on any particular historical resource." (DEIS at 7-7.) As explained above, the Proposed Rollback would not reduce NO_X emissions. NHTSA must consult with relevant federal and state authorities, and must properly support its determination that it is not possible to identify impacts on historical buildings and structures.

Response

Section 106 of the National Historic Preservation Act of 1966[92] and its implementing regulations[93] state that agencies of the Federal Government must take into account the impacts of their actions on historical properties. This process, known as the Section 106 process, is intended to support historic preservation and mitigate impacts on significant historical or archaeological properties through the coordination of federal agencies, states, and other affected parties. NHTSA did not engage in the Section 106 process because the Proposed Action does not have the potential to cause effects on historical properties or cultural resources.

Climate change and certain air pollutants have the potential to increase flooding and acid deposition, which may in turn affect historic properties and/or cultural resources. However, NHTSA's Preferred Alternative establishes CAFE standards that increase each year for MYs 2021–2026, resulting in reductions in climate change-related impacts and most air pollutants compared to the absence of regulation. Furthermore, any impacts on particular historic properties that could be related to emissions changes associated with this rulemaking are not reasonably certain to occur, would be *de minimis* in their level of impact if they did occur, and are too attenuated to be attributed directly to this action. There is no evidence that the changes in air pollution or GHG emissions associated with this rulemaking, in and of themselves, would alter the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register of Historic Places. Therefore, NHTSA concludes that any potential impacts have been accounted for in the Final EIS and other analyses associated with this rulemaking, and that no consultation is required under the NHPA.

10.7.3 Noise

Comment

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The VMT estimates in the Agencies' analysis are a crucial input into the CAFE Model's calculation of the costs and benefits of the proposed rule. However, the proposed rulemaking uses a 20 percent rebound effect, which does not follow the best evidence available. This results in a larger differences in VMT estimated in the proposed rollback versus the existing standards. To estimate economic cost associated with traffic externalities, the Agencies' analysis multiplies the differences in VMT estimates in the rollback and existing standards by estimates of per-mile congestion and noise costs caused by increased use of automobiles and light trucks that were previously developed by the Federal Highway Administration. To estimate economic cost associated with traffic externalities, the Agencies multiply the differences in VMT estimates in the rollback and existing standards by estimates of per-mile congestion and noise costs caused by increased use of automobiles and light trucks that were previously developed by the Federal Highway Administration. As a result of the inappropriate choice of rebound effect, the congestion and noise impacts are overstated. For example, when the model is run with a

[92] 54 U.S.C. § 100101 et seq. (codified in 2014).
[93] 36 CFR Part 800.

more appropriate choice of the rebound effect of 10 percent, the noise and congestion benefits of the proposed rule are reduced by approximately 40 percent.

Assumptions regarding scrappage and fleet size also play a role in overstating the noise and congestion benefits presented in the Agencies' analysis. As stated previously, poor modeling decisions with the new vehicle sales model and dynamic scrappage model has resulted in a ballooning vehicle fleet under the existing standards. Because the Agencies' analysis does not adjust vehicle-specific VMT based on the total fleet size, there will be a more noise and congestion impacts when the vehicle fleet is larger. As stated previously, poor modeling decisions with the new vehicle sales model and dynamic scrappage model has resulted in a ballooning vehicle fleet under the existing standards. This also results in overstated congestion and noise benefits for the rollback. With a more appropriate choice of rebound effect of 10 percent and the dynamic scrappage model turned off, the noise and congestion benefits of the proposed rule are more than six times smaller than what is presented in the proposed rulemaking.

Response

NHTSA describes its analytical approach for calculating the impacts of CAFE standards on noise and traffic congestion, as described by the commenter, in Section VI.D.1.b(13) of the preamble to the final rule and in Section VI.D the FRIA. The agency acknowledges that these impacts would be different depending on the assumptions made around the rebound effect. NHTSA discusses its choice of rebound effect in Section VI.D.1.b(4) of the preamble to the final rule and in Section VI.D the FRIA. The agency provides a qualitative discussion of potential noise impacts in Final EIS Section 7.4, *Noise*.

10.7.4 Environmental Justice

Comments

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

The adverse effects of climate change are keenly, and uniquely, felt by Tribes and Alaskan Native Villages.[94] Like the rest of the nation, Tribes are seeing the effects of climate change through increased storm surge, erosion, flooding, prolonged droughts, wildfires, and insect pest outbreaks in their forests. However, Tribal peoples are more deeply affected than most American citizens, as their cultures are rooted in the natural environment and closely integrated into the ecosystem. Tribal members hunt and fish, use native flora and fauna for medicinal and spiritual purposes, and associate their identities and histories closely with the land and water under their care. In addition, many Tribal economies are heavily dependent on fish, wildlife, and native plants. We, therefore, expect that climate change will cut more deeply at the Tribal lifeways and standard of living than other sectors of society.

As climate change disrupts ecosystems, even the very survival of some Tribes as unique and distinct cultures are at risk. The loss of traditional cultural practices, due to climate-driven die-off or range shift of culturally significant flora and fauna, may prove too much to withstand on top of other external pressures faced by Tribes and Alaskan Native Villages. The extent and magnitude of these changes

[94] National Tribal Air Association (NTAA) has presented the facts of climate change's impact to Tribes and Alaskan Native Villages before, NTAA Impacts of Climate Change on Tribes in the United States submitted December 11, 2009 to EPA's Office of Air and Radiation by the National Tribal Air Association, and we refer the agencies again to that analysis.

depend on the amount of GHG emissions released into the atmosphere today and in the future, and thus the Sac and Fox Nation believes it is essential to maintain the current, protective standards.

Docket Number: NHTSA-2017-0069-0528
Organization: Minnesota Pollution Control Agency (MPCA) et al.
Commenter: Frank Kohlasch et al.

Low-income communities and communities of color are disproportionately exposed to vehicle pollution. It is critical that the DEIS captures reasonable estimates of changes in tailpipe emissions and how that will impact those vulnerable communities.

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

Low income people and some racial and ethnic groups are among those who often confront higher exposure to pollutants and who may experience greater responses to such pollution. Many studies have explored the differences in harm from air pollution to racial or ethnic groups and people who are in a low socioeconomic position, have less education, or live nearer to major sources. Even healthy adults can be affected by increased air pollution, especially if their work requires them to be outdoors, as the study of lifeguards in Galveston, Texas demonstrated.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The DEIS's illogical conclusion extends to other nonattainment areas which have refineries within their boundaries across the nation. See the table below for additional examples. As discussed in Section XI below, many of these refineries are located in communities in the U.S. with the highest percentiles of people of color and low-income populations, who already are adversely affected by the refineries' operations.

> [See original comment for table titled Nonattainment Areas with Refineries and Criteria Pollutant Emission "Benefits"]

* * * * *

Executive Order ("EO") 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, provides that "[t]o the greatest extent practicable and permitted by law … each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." Exec. Order No. 12898, § 1-101 (emphasis added). It is the Department of Transportation's policy "to promote the principles of environmental justice (as embodied in the Executive Order) through the incorporation of those principles in all DOT programs, policies, and activities. This will be done by fully considering environmental justice principles throughout planning and decision making processes in the development of programs, policies, and activities, using [among other authorities] the principles of the National Environmental Policy Act of 1969 (NEPA) [and] Title VI of the Civil Rights Act of 1964 (Title VI).” Order 5610.2(a), 77 Fed. Reg. 27,534 (May 10, 2012). As discussed below, in the DEIS NHTSA has failed to meet its mandate to assess and address the environmental justice implications of its proposed action under EO 12898 and Order 5610.2(a) by failing to adequately analyze the environmental justice implications of its proposal to roll back the standards, which would result in disproportionately adverse impacts to these populations.

In the DEIS, NHTSA concludes that the proposed action and alternatives will not have adverse human or environmental effects on people of color and low-income communities, for three reasons. First, even though NHTSA acknowledges that the potential increase in fuel production and consumption as a result of the proposed action and alternatives would result in higher emissions of conventional and toxic air pollutants, the agency concludes that disproportionate impacts on these communities are not foreseeable because “a correlation between proximity to oil refineries and the prevalence of low-income and minority populations has not been established in the scientific literature.” Second, the agency claims that the magnitude of the increase in upstream emissions from oil production and distribution from the proposed action, compared to the baseline, is “very minor” and cannot be characterized as disproportionate. Third, the agency claims that downstream emissions would decrease under all action alternatives. As we explain below, each of these claims is incorrect.

The correlation between proximity to oil refineries and the prevalence of low-income people and people of color is well established in the scientific literature. In the DEIS, NHTSA acknowledges that the expected increase in fuel production and consumption associated with the action alternatives could lead to an increase in the emissions of criteria and toxic air pollutants from several sources, including refineries. Nonetheless, the agency misrepresents several academic studies to support its claim that there is only “mixed” and “anecdotal” evidence to support a correlation between low-income and minority populations and proximity to refineries. NHTSA itself undermines its conclusion when it acknowledges that low-income people and people of color are more exposed to environmental hazards from refinery and roadway pollution and are more vulnerable to the effects of climate change.

Studies on the environmental justice implications of proximity to refineries. NHTSA cites scientific literature to conclude that “disproportionate impacts on minority and low-income populations due to proximity to refineries are not predicted.” However, the agency misrepresents and cites these studies out of context. NHTSA relies on the United Church of Christ’s *Toxic Wastes and Race at Twenty: 1987 – 2007* and Fischbeck et al.’s *Using GIS to Explore Environmental Justice Issues: The Case of US Petroleum Refineries* studies to conclude that the evidence is “mixed.” It also uses Kay and Katz’s *Pollution, Poverty and People of Color: Living with Industry* and O’Rourke and Connolly’s *Just Oil? The Distribution of Environmental and Social Impacts of Oil Production and Consumption* studies to conclude that the evidence is only “anecdotal.”

The *Toxic Wastes and Race at Twenty* report provides concrete evidence that contradicts NHTSA’s interpretation of the study regarding the location of refineries and marginalized communities. According to the report, “[m]ore than nine million people (9,222,000) are estimated to live in circular host neighborhoods within 3 kilometers of the nation’s 413 commercial hazardous waste facilities [which includes around 140 oil refineries].” The report explains that 5.1 million of the roughly 9 million people living near hazardous waste facilities are people of color. The report also notes that refineries have contaminated the local environment and increased the incidences of lung cancer and respiratory illnesses in tribal communities. Further, the report highlights several case studies of communities of color and low-income communities that were, and still are, disproportionately affected by the pollution from oil refineries. In *Using GIS to Explore Environmental Justice Issues*, the authors explain the limits of their study, which only evaluated a small fraction of the refineries in the U.S:

> "[B]oth the individual maps and the descriptive statistics suggest there are *systematic differences for populations immediately adjacent to these industrial facilities and a control group in the surrounding area*. Our conclusion is certainly that our results warrant further investigation into environmental justice around refineries and other industrial facilities," (emphasis added).

Pollution, Poverty and People of Color evaluates the issue of environmental justice and refineries through a case study of Richmond, CA. In the DEIS, NHTSA claims that this article offers mere anecdotal evidence, but, in fact, it presents several quantitative data points that prove the environmental injustice occurring in Richmond. People of color constitute 82.9% of the population in Richmond. In North Richmond, people of color make up 97% of residents and, in 2010, the median household income was $36,875 [compared to the median household income in California of $54,283]. Not only are the residents almost entirely people of color and low-income populations, but they also live close to 5 major oil refineries and dozens of other toxic waste sites and facilities. In *Just Oil?*, the authors combined data from the EPA's Sector Facility Indexing Project and the Toxic Release Inventory. The study found that "56% of people living within 3 miles of refineries in the United States are minorities--almost double the national average." The authors noted that "[a]necdotal evidence from areas surrounding particularly polluting refineries seems to confirm [the quantitative data] that low-income and communities of color are disproportionately affected by these facilities," a statement that NHTSA cites out of context to support its "anecdotal" evidence claim.

Numerous studies (not cited in the DEIS) highlight the prevalence of people of color and low- income populations in proximity to refineries. The percentage of African Americans living in "refinery counties" is itself indicative of the adverse and disproportionate impact of refineries' location and pollution on these communities. On average, the African American population in refinery counties makes up 17% of the total population--5% above the national African American population. In Tennessee, Louisiana, and Michigan--the states with the highest percentages of African Americans in refinery counties--the African American population in those counties is 54%, 40%, and 40%, respectively. Further, a study evaluating the distribution of health risks from the oil refining process found that the minority share of health risks is 51.3%, approximately twice the population percentage of minorities in the U.S. Additionally, the low-income share of health risk from refining is 19%, which is 6 percentage points above the national low-income population percentage of 12.9%. African Americans, in particular, share 27.9% of the health risks from refineries while only constituting 11.8% of the U.S. population.

Studies on the environmental justice implications of proximity to roadways. Studies have amply documented the correlation between traffic-related air pollution exposure and the increased risk of respiratory and neurological illnesses and other adverse impacts in adults and children. They have also concluded that low-income populations and populations of color are disproportionately affected by this pollution.

In the Proposed Regulatory Impact Analysis, NHTSA conducted its own evaluation of two national datasets--the U.S. Census Bureau's American Housing Survey for calendar year 2009 and the U.S. Department of Education's database of school locations. The agency concludes that more people of color than white people live and go to school close to roadways. NHTSA also acknowledges this fact in the DEIS, but refrains from concluding that these facts will lead to an adverse and disproportionate impact on low-income people and people of color under the action alternatives.

Rowangould's *A Census of the US Near-Roadway Population: Public Health and Environmental Justice Considerations*, which the agency cites, used demographic data and Average Annual Daily Traffic (AADT) volume data for 2008 from the Highway Performance Monitoring system (HPMS) road network included in the DOT's 2010 National Transportation Atlas Database to determine disparities in residential proximity to highways. The study found that people of color and low-income communities are more likely to live near roads with high volumes of traffic. For roads with the highest volumes of traffic, the non-white population living within 200-300m of the road averages 65.3%.

Not only do people of color and low-income populations live in close proximity to mobile sources of pollution, but children in these communities attend schools within close proximity of these sources, too. In major metropolitan areas, approximately 30% of public schools are located within 300m of a major roadway and have significantly higher populations of students of color. Students of color are therefore exposed to high levels of respiratory risks and other effects of frequent exposure to toxic air pollutants, including, but not limited to, neurobehavioral health problems, DNA damage, autism, and poor academic performance. A report of the United States Center for Disease Control (CDC) confirms these findings and adds that there is a causal relationship between exposure to traffic-related air pollution and morbidity and mortality. People of color and low-income populations share a disproportionate burden of exposure and risk from traffic related air pollution and the health risks from said exposure.

People of color and low-income communities are more vulnerable to the impacts of climate change. In the DEIS, NHTSA acknowledges that people of color and low-income populations are disproportionately vulnerable to the effects of climate change. Yet, the agency claims that "[t]he increases in adverse health impacts [for low-income and minority populations] under the action alternatives compared to the No Action Alternative would range from 0.3 percent (under Alternative 8 in 2025) to 5.2 percent (under Alternative 1 in 2050). These increases would be incremental in magnitude and would not be characterized as high." The 0.3% to 5.2% figure (which is a methodological error related to the flawed characterization of fuel use and miles traveled, as we explained above) cannot be considered in isolation; on the contrary, since low- income and minority populations are more vulnerable to the effects of the adverse health impacts, the effects would indeed be *disproportionately* adverse and high.

Among the groups that are particularly vulnerable to the health impacts of climate change are the elderly, children, the sick, the poor, the socially isolated, and people of color. The stresses associated with being part of these populations are exacerbated by climate change, affecting health outcomes, access to food and quality water, and exposure to extreme heat. Increases in extreme heat events in cities in conjunction with the increase in toxic air pollution to which low- income and minority populations are disproportionately exposed are expected to be drivers of increased morbidity and mortality. Non-urban populations are adversely affected by climate change impacts as well. Coastal tribal communities are rapidly having to relocate due to sea- level rise, erosion, and permafrost thaw, all of which are contributing to a loss of cultural heritage, negative health impacts, and further impoverishment.

Using EPA's environmental justice mapping tool, EJScreen, we pulled data highlighting the percentile rankings for the populations of people of color, low-income households, and PM2.5 pollution within 3 miles of 10 major refineries in the U.S. Table 1 shows the vexing results of this data collection. Not only do the communities surrounding these refineries rank high in their respective states for population of people of color, but also are amongst the highest percentiles for people of color nationally. Further, particularly in the national context, the surrounding communities have high low-income populations. The surrounding communities are exposed to exorbitant amounts of toxic air pollution, several ranking as high as the 96th percentile nationally. In conjunction, these facts reveal clear trends in the disproportionate impact of refineries on people of color and low-income populations.

[See original comment for table titled People of Color Population, Low-Income Population, and PM2.5 Pollution Percentiles]

In addition, using EJSCREEN we pulled demographic and pollution burden reports for the communities within 3 miles of two of the largest refineries in the US--the Valero refinery in Houston, Texas, and the Andeavor refinery in Wilmington, CA. First, for the Valero refinery, the surrounding community is in the 92nd percentile nationally and in the 85th percentile of the state of Texas for the population of color. Additionally, the surrounding community is in the 83rd percentile nationally and in the 76th percentile of the state of Texas for the population of low-income residents. Particulate matter, which is a common pollutant emitted from oil refineries known to cause myriad health impacts, is prevalent in this area, too. The community is in the 84th percentile nationally and 90th percentile within Texas for PM2.5 pollution. There are two additional refineries within the same 3-mile radius that also contribute to the severe pollution in this area.

[See original comment for figure titled Demographic percentiles for the community within 3 miles of the Valero oil refinery in Houston, TX. Generated using EJScreen.]

[See original comment for figure titled PM2.5 pollution percentiles for the community within 3 miles of the Valero oil refinery in Houston, TX. Generated using EJScreen.]

Affected population and pollution impacts 3 miles of Andeavor’s refinery in Wilmington, CA are similar. The population of people of color in the surrounding community is in the 91st percentile nationally and in the 82nd percentile in California. The low-income population ranks in the 79th percentile nationally and in the 75th percentile in California. As with the Valero refinery, the PM2.5 concentrations are alarming, particularly the national percentile ranking. The community surrounding the Andeavor refinery ranks in the 96th percentile nationally and in the 76th percentile in California. There are 4 additional refineries within 3 miles of the Andeavor facility, and the cumulative impact of the pollution from these refineries has resulted in troubling health issues in the community.

[See original comment for graph titled Demographic percentiles for the community within 3 miles of the Andeavor oil refinery in Wilmington, CA. Generated using EJScreen.]

[See original comment for graph titled PM2.5 pollution percentiles for the community within 3 miles of the Andeavor oil refinery in Wilmington, CA Generated using EJSCREEN.]

In addition, as explained above, NHTSA’s highly dubious modeling assumptions used to derive the Preferred Alternative action and alternatives provide an incorrect evaluation of the environmental and health impacts of the agency’s Proposal. Those effects are likely to be much worse than depicted in the DEIS and are likely to affect communities of color and low-income communities to a greater degree. NHTSA has not assessed the adverse effects of its proposed action on communities of color and low-income communities, as required under Executive Order 12898.

In sum, the DEIS’ discussion of environmental justice impacts is based on incorrect data and excludes data pertinent to the issues. It reaches incorrect conclusions and must be withdrawn.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

Removal of CARB's ZEV regulation under the proposed rollback will cause increased air pollution exposures for people living within 200-500 meters of high-volume roadways. This will increase rates of health impacts associated with vehicle air pollution such as cancer, lung disease, asthma, and increased rates of mortality. These impacts are disproportionately imposed on low-income communities and communities of color in California because there are disproportionally higher concentrations of these communities living near major roadways, and this concentration is expected to increase in the next two decades. CARB is committed to prioritizing environmental justice and ensuring that regulatory efforts focus on communities facing cumulative environmental and economic burdens, which include disadvantaged communities. Hindering CARB's regulatory efforts to increase the number of zero-emission cars operating on California's roadways, therefore also hinders environmental justice and CARB's efforts to improve health and quality of life in disadvantaged communities. Specifically, the removal of even one of CARB's mobile source control regulations impedes CARB's efforts to significant reduce air toxic contaminant and criteria pollutant emissions in the most burdened communities under California Assembly Bill Number 617.

* * * * *

Many communities in California are located near major roadways. California has three cities in the top ten largest U.S. cities by population, and some of the largest freight corridors in the U.S. are located in or near those cities. Busy traffic corridors have been built adjacent to and through existing neighborhoods (sometimes as a result of planning policies), and new developments have been built near existing roadways due to a variety of factors, including economic growth, demand for built environment uses, and the scarcity of land available for development in some areas. Estimations based on the 2000 Census suggest that 24 percent of all Californians live within 500 meters of a highway and 44 percent within 1000 meters of a highway. In Los Angeles, more than a third of the population lives within 300 meters of a major roadway.

Of those living near major roadways, there is a disproportionate concentration of low income communities and communities of color. In California, Latinos, African Americans, Asian/Pacific Islanders, and low-income individuals and families are more likely to live next to a major roadway than whites or high-income earners. And almost half of Californians living next to major roadways are "poor or near-poor." Economically disadvantaged neighborhoods and individual residences have been linked to higher levels of traffic air pollution and more asthma symptoms, among other health impacts. Near-roadway exposures exacerbate existing health impacts experienced by these communities, and a lack of resources inhibit responses that might otherwise promote healthy outcomes. For instance, lack of access to health care, historical discrimination, and the inability to move to an affordable, healthier location can present obstacles to fair and equal health and economic outcomes for low income communities and communities of color.

Ultimately, historical inequities can be compounded by the continuation and increase in air pollution, by disproportionately burdening these communities with the health impacts of harmful pollutants from traffic. These unfair outcomes for particular communities are a result of decades of decision-making that did not prioritize fundamentally fair outcomes for all Californians regardless of their economic, racial, or ethnic background. Environmental justice is of critical importance to reduce and eliminate health, environmental, and economic disparities that disproportionately negatively affect communities of color and low-income communities in California and to create a more fair economy and quality of life for all Californians. A priority for CARB is to achieve environmental justice and to make it an integral part of its activities to improve their health outcomes and quality of life. This reflected in the ZEV regulation, which ultimately works to directly reduce near-roadway exposures, improving health outcomes for those living near major roadways.

Despite the EPA's reaffirmed commitment to environmental justice, the proposed rollback does not adequately analyze the effect of removing the ZEV regulation on furthering environmental justice, particularly as a result of increasing near-roadway exposures. In 1994, a federal Executive Order directed federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. The order also directed each agency to develop a strategy for implementing environmental justice. This executive order has not been revoked and is a core statement of federal policy in effect today. Further, EPA's Environmental 2020 Action Agenda creates procedures to consider environmental justice routinely throughout agency decision-making. Additionally, the February 23, 2018 memo by EPA Associate Administrator Samantha Dravis notes that EPA will "[a]chieve measurable environmental outcomes for underserved and overburdened communities in areas of [. . .] reduction of air pollutants [. . .] and [s]trengthen the ability of our partner agencies to integrate [environmental justice] in their work through enhanced coordination and collaboration with states, tries and local governments to address [environmental justice] concerns."

However, this commitment is not reflected in the proposed rollback, which would eliminate CARB's ability to enforce its ZEV regulation. A statement of commitment to environmental justice is ineffective without corresponding action to ensure the commitment and its expected benefits are realized. In the proposed rollback's Environmental Justice section, it attempts to delegitimize the disproportionate health impacts experienced by low-income communities and communities of color and makes an unfounded and unanalyzed conclusion that the emissions reductions from the proposed rule will have the most direct air quality improvements by those living near- roadways.

Moreover, the proposed rollback's Environmental Justice section appears to misunderstand the purpose of implementing environmental justice. The proposed rollback states that it is other stressors associated with low-income communities and communities of color that are largely to blame for any worsened health outcomes; however, it fails to acknowledge the significant impact social and economic disparities have on exposure disparities. There is no analysis or description in the proposed rollback of how economic circumstances; historical, social, and economic discrimination and inequities; and health are interrelated and can work to exacerbate negative outcomes. As stated above, the proposed rollback acknowledges that vehicle pollution causes significant health impacts for those living near major roadways and the importance of reducing such exposures. Nonetheless, the rollback's Environmental Justice section concludes by stating that direct emissions reductions will occur from the proposed rollback, and thus reduce near-highway exposures, without any supporting analysis.

The fact that there are disproportionate stressors within low-income communities and communities of color is a significant reason for prioritizing environmental justice and fair treatment by government actions. Reducing pollution exposures and improving health can in turn increase economic and social benefits, thereby reducing other disparities experienced in these communities. For example, reducing rates of asthma or asthma symptoms can increase school and work attendance. The existence of other stressors that affect health does not lessen the connection between vehicle pollution and health impacts, as the proposed rollback appears to imply, it strengthens the justification for the necessity of the ZEV regulation to cause direct reductions of near-roadway exposures.

*   *   *   *   *

The needs of minority and low-income communities must also be accorded great weight. Per Executive Order 12898, as well as Title VI of the Civil Rights Act, NHTSA must also consider how the impacts of weakened CAFE and greenhouse gas emissions standards impacts will be especially burdensome to disadvantaged communities. As discussed above, these communities are disproportionately located near highways and other sources of vehicle pollution. They are also disproportionately disadvantaged by high fuel costs, as such costs consume a higher portion of their incomes. More efficient and lower-polluting vehicles are critical to the health and well-being of these communities. The federal Agencies have failed to recognize the benefits of the existing standards. The federal Agencies have also concluded that the Proposed Rule will benefit disadvantaged communities without providing an underlying analysis and thereby failed to meet the requirements of Executive Order 12898.

Docket Number: NHTSA-2017-0069-0593
Organization: Center for Biological Diversity et al.
Commenter: Irene Gutierrez

The agencies' proposal is inconsistent with Executive Order 12898 – In the Proposal, EPA and NHTSA conclude that the proposed rollback will not have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. This conclusion is not supported by an adequate justification and is incorrect on several grounds. First, EPA and NHTSA have failed to meet their mandate to assess and address the environmental justice implications of their proposed rollback under Executive Order 12898 and their own policies. Second, the agencies' claim that this action will exert no disproportionate climate impacts on these populations is based on faulty economics and junk science, and contradicts the agencies' own recognition that communities of color and low-income communities are more vulnerable to the effects of climate change. Third, the agencies' conclusion that their proposal will not adversely affect these populations due to increased conventional air pollution is the result of faulty modeling assumptions that greatly underestimate the harmful impacts from their proposal, and ignores or misrepresents the literature on the environmental justice implications of proximity to refineries and roadways. If they finalize the standards as they have proposed, the agencies will be in violation of Executive Order 12,898.

*   *   *   *   *

1. **The proposal is inconsistent with the Agencies' obligation to assess and address adverse impacts on minority and low-income populations.**

In the Proposal, EPA and NHTSA conclude that the proposed rollback will not have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. 83 Fed. Reg. at 43,474-75. The agencies have failed to provide an adequate justification for their position. As explained below, this conclusion is inconsistent with Executive Order 12,898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*.

Executive Order 12898 provides that "[t]o the greatest extent practicable and permitted by law … each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low- income populations in the United States." Exec. Order No. 12898, § 1-101. Under the Order, all federal agencies, including EPA and NHTSA, "shall collect, maintain, and analyze inforsmation S and comparing environmental and human health risks borne by populations identified by race, national origin, or income … [and] shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations." *Id.* § 3-302(a).

The language of §§ 1-101 and 3-302 indicates that the agencies are required to perform an analysis to identify and address adverse impacts on people of color and low-income populations from their proposed action, "to the greatest extent practicable and permitted by law." *Id.* § 1-101. *See Coal. for Advancement of Reg'l Transp. v. Fed. Highway Admin.*, 576 Fed. Appx. 477, 494 (6th Cir. 2014) (recognizing compliance with the "procedural and substantive requirements for evaluating environmental justice impacts in Executive Order 12898"); *Mid States Coal. for Progress v. Surface Transp. Bd.*, 345 F.3d 520, 541 (8th Cir. 2003) ("[t]he purpose of an environmental justice analysis is to determine whether a project will have a disproportionately adverse effect on minority and low income populations.").

Incorporating environmental justice into rulemaking processes is one of EPA's goals under its EJ2020 Action Agenda, which aims to institutionalize "rigorous assessments of environmental justice analyses in rules." The Department of Transportation also has a policy that "promote[s] the principles of environmental justice (as embodied in the Executive Order) through the incorporation of those principles in all DOT programs, policies, and activities." Order 5610.2(a), 77 Fed. Reg. 27,534 (May 10, 2012).

In the Proposal, EPA and NHTSA have failed to meet their mandate to assess and address the environmental justice implications of their proposed rollback under EO 12898 and their own policies. EPA makes a cursory description of its conclusions on environmental justice in the preamble, and NHTSA provides its relevant analysis in the Draft Environmental Impact Statement. Both agencies also provide a brief discussion of environmental justice issues in the Preliminary Environmental Impact Analysis ("PRIA"). As we discuss below and in our Joint Comments on NHTSA's DEIS, these conclusions are wrong and do not fulfil the analysis required under EO 12898.

2. **The agencies' conclusion that the proposal will not have disproportionately adverse climate pollution impacts on environmental justice communities is incorrect.**

In the preamble, EPA concludes that, with respect to greenhouse gases, the proposal will not have disproportionate impacts on communities of color and low-income communities because the final rule will affect the level of environmental protection for all affected populations, without regard to specific populations. 83 Fed. Reg. at 43,474. This statement contradicts EPA's own conclusion in its Endangerment Finding that certain populations, including poor people, are most vulnerable to climate-related effects and, therefore, deserve special attention. 74 Fed. Reg. 66,496, 66,526 (Dec. 15, 2009). In addition, as we explain in other comments to the docket, the PRIA omits nearly any discussion of climate impacts, and the analysis has deeply discounted the forgone public health and environmental benefits by using faulty economics and junk science.

EPA also concludes that the potential increases in climate change impacts resulting from this proposal are so small that cannot be considered "disproportionately high" and "adverse" on EJ communities. 83

Fed. Reg. at 43,474.[95] In *Massachusetts v. EPA*, 549 U.S. 497, 523 (2007), the Supreme Court rejected this very same argument--that incremental greenhouse gas emission reductions make no difference. The Supreme Court had this to say about EPA's claims:

> EPA ... maintains that its decision not to regulate greenhouse gas emissions from new motor vehicles contributes so insignificantly to petitioners' injuries that the Agency cannot be haled into federal court to answer for them. For the same reason, EPA does not believe that any realistic possibility exists that the relief petitioners seek would mitigate global climate change and remedy their injuries. That is especially so because predicted increases in greenhouse gas emissions from developing nations, particularly China and India, are likely to offset any marginal domestic decrease. But EPA overstates its case. Its argument rests on the erroneous assumption that a small incremental step, because it is incremental, can never be attacked in a federal judicial forum. Yet accepting that premise would doom most challenges to regulatory action ... Nor is it dispositive that developing countries such as China and India are poised to increase greenhouse gas emissions substantially over the next century: A reduction in domestic emissions would slow the pace of global emissions increases, no matter what happens elsewhere.

In the DEIS, NHTSA acknowledges that people of color and low-income populations are disproportionately vulnerable to the effects of climate change. Yet, the agency claims that "[t]he increases in adverse health impacts [for low-income and minority populations] under the action alternatives compared to the No Action Alternative would range from 0.3 percent (under Alternative 8 in 2025) to 5.2 percent (under Alternative 1 in 2050). These increases would be incremental in magnitude and would not be characterized as high." The 0.3% to 5.2% figure (which is a methodological error related to the flawed characterization of fuel use and miles traveled, as we explained above) cannot be considered in isolation; on the contrary, since low- income and minority populations are more vulnerable to the effects of the adverse health impacts, the effects would indeed be disproportionately adverse and high.

Among the groups that are particularly vulnerable to the health impacts of climate change are the elderly, children, the sick, the poor, the socially isolated, and people of color. The stresses associated with being part of these populations are exacerbated by climate change, affecting health outcomes, access to food and quality water, and exposure to extreme heat. Increases in extreme heat events in cities in conjunction with the increase in toxic air pollution to which low- income and minority populations are disproportionately exposed are expected to be drivers of increased morbidity and mortality. Non-urban populations are adversely affected by climate change impacts as well. Coastal tribal communities are rapidly having to relocate due to sea- level rise, erosion, and permafrost thaw, all of which are contributing to a loss of cultural heritage, negative health impacts, and further impoverishment.

3. **The agencies' conclusion that the proposal will not have disproportionately adverse conventional pollution impacts on environmental justice communities is incorrect.**

With respect to conventional air pollutants, EPA and NHTSA conclude that the proposal will not have adverse human or environmental effects on people of color and low-income communities. 83 Fed. Reg. at 43,474. First, even though NHTSA acknowledges in the DEIS that the potential increase in fuel production and consumption as a result of the proposal would result in higher emissions of conventional

[95] In our joint comments on NHTSA's Draft Environmental Impact Statement, we explain the agencies' (in that case, NHTSA) proposal to freeze the standards from 2021 to 2026 increase greenhouse gases. NHTSA's assessment of climate impacts as immaterial relates to the fact that the agency wrongly compares these emissions to total worldwide emissions by 2100.

and toxic air pollutants, the agency concludes that disproportionate impacts on these communities are not foreseeable because “a correlation between proximity to oil refineries and the prevalence of low-income and minority populations has not been established in the scientific literature.” NHTSA makes this incorrect conclusion, despite the fact that in the PRIA, the agencies acknowledge a correlation between proximity to oil refineries and roadways, and the prevalence of low-income and minority populations. Second, NHTSA claims that the magnitude of the increase in upstream emissions from oil production and distribution from the proposal is “very minor” and cannot be characterized as disproportionate. Third, both agencies claim that downstream emissions under the proposal will decrease, and thus benefit communities of color and low-income communities.

a. The correlation between proximity to oil refineries and the prevalence of low-income people and people of color is well established in the scientific literature.

In the DEIS, NHTSA acknowledges that the expected increase in fuel production and consumption associated with the action alternatives could lead to an increase in the emissions of criteria and toxic air pollutants from several sources, including refineries. Nonetheless, the agency misrepresents several academic studies to support its claim that there is only “mixed” and “anecdotal” evidence to support a correlation between low-income and minority populations and proximity to refineries. NHTSA itself undermines its conclusion when it acknowledges that low-income people and people of color are more exposed to environmental hazards from refinery and roadway pollution and are more vulnerable to the effects of climate change.

i. Studies on the environmental justice implications of proximity to refineries.

NHTSA cites scientific literature to conclude that “disproportionate impacts on minority and low-income populations due to proximity to refineries are not predicted.” However, the agency misrepresents and cites these studies out of context. NHTSA relies on the United Church of Christ’s *Toxic Wastes and Race at Twenty: 1987 – 2007* and Fischbeck et al.’s *Using GIS to Explore Environmental Justice Issues: The Case of US Petroleum Refineries* studies to conclude that the evidence is “mixed.” It also uses Kay and Katz’s *Pollution, Poverty and People of Color: Living with Industry* and O’Rourke and Connolly’s *Just Oil? The Distribution of Environmental and Social Impacts of Oil Production and Consumption* studies to conclude that the evidence is only “anecdotal.”

The *Toxic Wastes and Race at Twenty* report provides concrete evidence that contradicts NHTSA’s interpretation of the study regarding the location of refineries and marginalized communities. According to the report, “[m]ore than nine million people (9,222,000) are estimated to live in circular host neighborhoods within 3 kilometers of the nation’s 413 commercial hazardous waste facilities [which includes around 140 oil refineries].” The report explains that 5.1 million of the roughly 9 million people living near hazardous waste facilities are people of color. The report also notes that refineries have contaminated the local environment and increased the incidences of lung cancer and respiratory illnesses in tribal communities. Further, the report highlights several case studies of communities of color and low-income communities that were, and still are, disproportionately affected by the pollution from oil refineries. In *Using GIS to Explore Environmental Justice Issues*, the authors explain the limits of their study, which only evaluated a small fraction of the refineries in the U.S:

> “[B]oth the individual maps and the descriptive statistics suggest there are *systematic differences for populations immediately adjacent to these industrial facilities and a control group in the surrounding area*. Our conclusion is certainly that our results warrant further investigation into environmental justice around refineries and other industrial facilities,” (emphasis added).

Pollution, Poverty and People of Color evaluates the issue of environmental justice and refineries through a case study of Richmond, CA. In the DEIS, NHTSA claims that this article offers mere anecdotal evidence, but, in fact, it presents several quantitative data points that prove the environmental injustice occurring in Richmond. People of color constitute 82.9% of the population in Richmond. In North Richmond, people of color make up 97% of residents and, in 2010, the median household income was $36,875 [compared to the median household income in California of $54,283]. Not only are the residents almost entirely people of color and low-income populations, but they also live close to 5 major oil refineries and dozens of other toxic waste sites and facilities. In *Just Oil?*, the authors combined data from the EPA's Sector Facility Indexing Project and the Toxic Release Inventory. The study found that "56% of people living within 3 miles of refineries in the United States are minorities--almost double the national average." The authors noted that "[a]necdotal evidence from areas surrounding particularly polluting refineries seems to confirm [the quantitative data] that low-income and communities of color are disproportionately affected by these facilities," a statement that NHTSA cites out of context to support its "anecdotal" evidence claim.

Numerous studies (not cited in the DEIS or the PRIA) highlight the prevalence of people of color and low-income populations in proximity to refineries. The percentage of African Americans living in "refinery counties" is itself indicative of the adverse and disproportionate impact of refineries' location and pollution on these communities. On average, the African American population in refinery counties makes up 17% of the total population--5% above the national African American population. In Tennessee, Louisiana, and Michigan--the states with the highest percentages of African Americans in refinery counties--the African American population in those counties is 54%, 40%, and 40%, respectively. Further, a study evaluating the distribution of health risks from the oil refining process found that the minority share of health risks is 51.3%, approximately twice the population percentage of minorities in the U.S. Additionally, the low-income share of health risk from refining is 19%, which is 6 percentage points above the national low-income population percentage of 12.9%. African Americans, in particular, share 27.9% of the health risks from refineries while only constituting 11.8% of the U.S. population.

ii. Studies on the environmental justice implications of proximity to roadways.

Studies have amply documented the correlation between traffic-related air pollution exposure and the increased risk of respiratory and neurological illnesses and other adverse impacts in adults and children. They have also concluded that low-income populations and populations of color are disproportionately affected by this pollution.

In the PRIA, NHTSA and EPA describe that they conducted an evaluation of two national datasets--the U.S. Census Bureau's American Housing Survey for calendar year 2009 and the U.S. Department of Education's database of school locations. The agencies conclude that more people of color than white people live and go to school close to roadways. NHTSA also acknowledges this fact in the DEIS, but refrains from concluding that these facts will lead to an adverse and disproportionate impact on low-income people and people of color under the proposal.

Rowangould's *A Census of the US Near-Roadway Population: Public Health and Environmental Justice Considerations*, which NHTSA cites in the DEIS, used demographic data and Average Annual Daily Traffic (AADT) volume data for 2008 from the Highway Performance Monitoring system (HPMS) road network included in the DOT's 2010 National Transportation Atlas Database to determine disparities in residential proximity to highways. The study found that people of color and low-income communities are more likely to live near roads with high volumes of traffic. For roads with the highest volumes of traffic, the non-white population living within 200-300m of the road averages 65.3%.

Not only do people of color and low-income populations live in close proximity to mobile sources of pollution, but children in these communities attend schools within close proximity of these sources, too. In major metropolitan areas, approximately 30% of public schools are located within 300m of a major roadway and have significantly higher populations of students of color. Students of color are therefore exposed to high levels of respiratory risks and other effects of frequent exposure to toxic air pollutants, including, but not limited to, neurobehavioral health problems, DNA damage, autism, and poor academic performance. A report of the United States Center for Disease Control (CDC) confirms these findings and adds that there is a causal relationship between exposure to traffic-related air pollution and morbidity and mortality. People of color and low-income populations share a disproportionate burden of exposure and risk from traffic related air pollution and the health risks from said exposure.

Using EPA's environmental justice mapping tool, EJScreen, we pulled data highlighting the percentile rankings for the populations of people of color, low-income households, and PM2.5 pollution within 3 miles of 10 major refineries in the U.S. Table 1 shows the vexing results of this data collection. Not only do the communities surrounding these refineries rank high in their respective states for population of people of color, but also are amongst the highest percentiles for people of color nationally. Further, particularly in the national context, the surrounding communities have high low-income populations. The surrounding communities are exposed to exorbitant amounts of toxic air pollution, several ranking as high as the 96th percentile nationally. In conjunction, these facts reveal clear trends in the disproportionate impact of refineries on people of color and low-income populations.

> [See original comment for table titled People of Color Population, Low-Income Population, and PM2.5 Pollution Percentiles]

In addition, using EJSCREEN we pulled demographic and pollution burden reports for the communities within 3 miles of two of the largest refineries in the US--the Valero refinery in Houston, Texas, and the Andeavor refinery in Wilmington, CA. First, for the Valero refinery, the surrounding community is in the 92nd percentile nationally and in the 85th percentile of the state of Texas for the population of color. Additionally, the surrounding community is in the 83rd percentile nationally and in the 76th percentile of the state of Texas for the population of low-income residents. (See Figure 1.) Particulate matter, which is a common pollutant emitted from oil refineries known to cause myriad health impacts, is prevalent in this area, too. The community is in the 84th percentile nationally and 90th percentile within Texas for PM2.5 pollution. (See Figure 2.) There are two additional refineries within the same 3-mile radius that also contribute to the severe pollution in this area.

> [See original comment for Figure 1: Demographic percentiles for the community within 3 miles of the Valero Oil refinery in Houston, TX. Generated using EJScreen]

> [See original comment for Figure 2: PM pollution percentiles for the community within 3 miles of Valero oil refinery in Houston, TX Generated using EJScreen]

Affected population and pollution impacts 3 miles of Andeavor's refinery in Wilmington, CA are similar. The population of people of color in the surrounding community is in the 91st percentile nationally and in the 82nd percentile in California. The low-income population ranks in the 79th percentile nationally and in the 75th percentile in California (See Figure 3). As with the Valero refinery, the PM2.5 concentrations are alarming, particularly the national percentile ranking. The community surrounding the Andeavor refinery ranks in the 96th percentile nationally and in the 76th percentile in California (See Figure 4). There are 4 additional refineries within 3 miles of the Andeavor facility, and the cumulative impact of the pollution from these refineries has resulted in troubling health issues in the community.

> [See original comment for Figure 3: Demographic percentiles for the community within 3 miles of the Andeavor oil refinery in Wilmington CA Generated using EJScreen]

> [See original comment for Figure 4: PM2.5 pollution percentiles for the community within 3 miles of the Andeavor oil refinery in Wilmington, CA Generated using EJScreen]

In addition, as explained in other comments submitted to this docket, NHTSA's highly dubious modeling assumptions used to derive the proposal provide an incorrect evaluation of the environmental and health impacts of the agencies' proposal. Those effects are likely to be much worse than depicted in the proposal and the DEIS and are likely to affect communities of color and low-income communities to a greater degree.

In sum, the agencies' discussion of environmental justice impacts is based on incorrect data and incorrect interpretation of the relevant literature, and is missing a robust analysis pertinent to these issues. If they finalize the standards as they have proposed, the agencies will be in violation of Executive Order 12898.

Docket Number: NHTSA-2017-0069-0595
Organization: 1854 Treaty Authority
Commenter: Tyler Kaspar

The proposed rule will contribute to climate change by increasing GHG emissions from the United States transportation sector. The agencies estimate that their rule will increase total vehicle emissions by 10%. This will not adequately address climate change and may exacerbate impacts. Climate change impacts to treaty resources have already occurred in the 1854 Ceded Territory and are projected to continue/increase with higher GHG emissions (SRES A2) by mid-century (2041-2070).

The adverse effects of climate change are keenly, and uniquely, felt by Tribes and Alaskan Native Villages.[96] Like the rest of the nation, Tribes are seeing the effects of climate change through increased storm surge, erosion, flooding, prolonged droughts, wildfires, and insect pest outbreaks in their forests. However, Tribal peoples are more deeply affected than most American citizens, as their cultures are rooted in the natural environment and closely integrated into the ecosystem. Tribal members hunt and fish, use native flora and fauna for medicinal and spiritual purposes, and associate their identities and histories closely with the land and water under their care. In addition, many Tribal economies are heavily dependent on fish, wildlife, and native plants. We, therefore, expect that climate change will cut more deeply at the Tribal lifeways and standard of living than other sectors of society.

As climate change disrupts ecosystems, even the very survival of some Tribes as unique and distinct cultures are at risk. The loss of traditional cultural practices, due to climate-driven die-off or range shift of culturally significant flora and fauna is a real threat faced by Tribes and Alaskan Native Villages. Like many Tribes and Alaskan Native Villages, Tribes in the 1854 Ceded Territory are confined by treaty

[96] National Tribal Air Association (NTAA) has presented the facts of climate change's impact to Tribes and Alaskan Native Villages before, NTAA Impacts of Climate Change on Tribes in the United States submitted December 11, 2009 to EPA's Office of Air and Radiation by the National Tribal Air Association, and we refer the agencies again to that analysis.

boundaries and cannot simply change location to follow shifts in range or availability of resources. Once a resource is lost within treaty boundaries, it is a permanent loss to the Tribes and their culture. The extent and magnitude of these changes depend on the amount of GHG emissions released into the atmosphere today and in the future, and thus it is essential to maintain the 2012 standards and reduce GHG emissions.

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

EPA and NHTSA's environmental justice analysis in the NPRM and DEIS is based on a factually incorrect position and falls far short of EPA's own guidelines for analyzing environmental justice. First, EPA and NHTSA present their analysis as if the proposed rulemaking is new, and not as an attempt to abandon the original final rule for MY2017-2025. In their environmental justice analysis, EPA and NHTSA rely on potential general air quality improvements to conclude that low-income and minority populations will disproportionately benefit from the proposal, ignoring their own assertions that the preferred alternative will decrease emission reduction benefits and increase expected pollution and associated health impacts. Additionally, EPA and NHTSA's environmental justice analysis fails to consider disproportionate impacts, ignores contributors of susceptibility, and does not include meaningful participation of low-income and minority populations in contrast to the goals of Executive Order 12898, EPA's environmental justice strategic plan, and EPA's guidance materials for environmental justice.

First, EPA and NHTSA begin their environmental justice analysis from a false position leading to a contradictory conclusion as to whether there are disproportionate impacts on low-income populations and minority populations from the proposed rulemaking. EPA recognized in its original final rule for MY2017-2025 that fuel efficiency standards provide substantial benefits in reducing harmful air pollutants associated with the transportation sector including PM, NO_X, and VOCs. Additionally, EPA recognized that reducing these pollutants also reduces the public health problems they cause. The current NPRM briefly mentions that people who live or attend school near major roadways, and directly impacted by tailpipe emissions, are more likely to be non-white, Hispanic ethnicity, and/or low-income. In their flawed analysis, EPA and NHTSA contend that decreases in tailpipe emissions would then most benefit low-income and minority populations in terms of emission reductions because of this proximity to tailpipe emissions. But this proposed rulemaking is not new and is an attempt to abandon the long term fuel economy standards previously established for MY2017-2025. Weakening the MY2021-2026 standards from those established in EPA's original final rule would increase the number of asthma attacks, aggravate chronic lung disease, and lead to earlier deaths. Following EPA's above proximity analysis, low-income populations and minority populations will disproportionately bear the burden of the decreased emission reduction benefits and the increase in expected pollution and associated health impacts leading to a clear environmental justice concern.

Next, EPA and NHTSA's environmental justice analysis does not meet EPA's own environmental justice goals and guidelines. Executive Order 12898: "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" directs federal agencies to make environmental justice part of their mission, to the greatest extent possible, by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the U.S. EPA developed environmental justice (EJ) policies, programs, and guidelines consistent with Executive Order 12898 including their most recent strategic plan, the EJ 2020 Action Agenda (EJ 2020).

EPA's EJ 2020 sets forth goals and objectives as part of its strategic plan to advance environmental justice. Specifically, one of EPA's objectives is to ensure environmental justice is appropriately analyzed, considered and addressed in EPA rules. To ensure this objective is met, EPA provides training and guidance for agency rule writers including the Guidance on Considering Environmental Justice During the Development of an Action (EJ Action Guide) and the Technical Guidance on Assessing for Environmental Justice in Regulatory Analysis (Technical Guidance). In fact, EJ 2020 establishes that "EPA will implement the Guidance on Considering Environmental Justice During the Development of a Regulatory Action and Technical Guidance on Assessing for Environmental Justice in Regulatory Analysis". However, EPA's analysis in the NPRM does not follow the EJ Action Guide or the Technical Guidance and contradicts its established environmental justice goals and objectives.

The EJ Action Guide defines a potential environmental justice concern as "disproportionate and adverse impacts on minority populations, low-income populations, and/or indigenous peoples that may exist prior to or that may be created by the proposed regulatory action" including instances where a proposed action will "present opportunities to address existing disproportionate impacts on minority populations, low-income populations, and/or indigenous peoples...." In the NPRM and DEIS, EPA and NHTSA acknowledge that environmental hazards are more prevalent in communities with greater percentages of low-income populations and minority populations and that these same populations face disparities in exposures to near roadway pollution levels. Despite recognizing that an existing disproportionate impact exists, EPA does not further consider the impacts of the proposed rulemaking on minority or low-income populations in contravention to the EJ Action Guide. Similarly, EPA and NHTSA briefly discuss the existence of pre-existing health disparities in minority communities but do not acknowledge a potential EJ concern. Instead, the NPRM and DEIS rely on general potential air quality improvements to conclude the EJ discussion.

However, relying on expected general air quality improvements negates the objective of Executive Order 12898, EPA's EJ 2020, and EPA's Technical Guidance. First, both Executive Order 12898 and EJ 2020 focus on disproportionate effects of agency action. Additionally, the Technical Guidance discourages relying on expectations of reduced overall environmental burden. Most importantly, EPA's reliance on general air quality improvements begins from a factually incorrect position and leads to a conclusion in contradiction to its own guidance for EJ in rulemaking.

Additionally, EPA and NHTSA fail to consider contributors of susceptibility as provided for in EPA's Technical Guidance as part of an EJ analysis. EPA's EJ 2020, EJ Action Guide, and Technical Guidance all discuss at length the disparity in health outcomes and the potential impact of agency actions contributing to these outcomes. However, EPA briefly touches on the disparity in health outcomes experienced in low-income populations and minority populations but the NPRM and DEIS do not discuss the impact of their rulemaking nor the increase in pollution with known health impacts on low-income and minority populations more susceptible to pollution triggered health issues due to pre-existing health concerns.

EPA and NHTSA also sparsely discuss the impact of climate change projections on low-income and minority populations and do not follow through with an EJ analysis including contributors to susceptibility. EPA estimates that global CO_2 concentrations will increase by 0.65 parts per million (ppm) and concludes that "the potential increases in climate change impacts resulting from this rule are so small that the impacts are not considered 'disproportionately high and adverse"' on low-income and minority populations. However, this conclusion is short sighted and does not reflect the global scale of climate change and related impacts nor the pre-existing vulnerabilities of low-income populations and minority populations. EPA recognized that low-income communities and communities of color are likely to be disproportionately affected by, and be less resilient in absorbing and adapting to, the impacts of climate change in EJ 2020. Also, EPA's Technical Guidance discusses climate change using the analysis from the prior final rule for MY2017-2025. In this example, localized effects of heat and severe weather events are analyzed as part of addressing EJ concerns. EPA and NHTSA touch on urban heat island effect in one sentence of the DEIS but do not engage in an EJ analysis of the disproportionate impact of their climate change projections on low-income and minority populations.

Finally, EPA and NHTSA do not provide for meaningful participation of low-income populations and minority populations in the NPRM and DEIS. EPA defines EJ as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Meaningful involvement means that: (1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity (i.e., rulemaking) that may affect their environment and/or health; (2) the populations' contributions can influence the EPA's rulemaking decisions; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) the EPA will seek out and facilitate the involvement of populations potentially affected by the EPA's rulemaking process. EPA and NHTSA did not consult with near road communities nor communities with low-income populations and minority populations before proposing to weaken the standards established in their prior final rule for MY2017-2025. Additionally, EPA and NHTSA are holding only three public hearings, all at 10am during week days, and accepting comments for only 60 days. Given the extensive impact of the proposed weakening of the standards established in its prior final rule, EPA must provide a longer comment period and engage with low-income and minority populations following the guidelines in the EJ Action Guide.

Docket Number: NHTSA-2017-0069-0616
Organization: National Tribal Air Association
Commenter: Wilfred J. Nabahe

The proposed rule will contribute to climate change by increasing GHG emissions from the United States transportation sector. The agencies estimate that their rule will increase total vehicle emissions by 10%. This will not adequately address climate change and fails to protect future generations. Climate change impacts are felt across the United States and are already dramatically altering our environment, causing more frequent and intense heat waves, more intense precipitation events, and more prolonged drought.

The adverse effects of climate change are keenly, and uniquely, felt by Tribes and Alaskan Native Villages.[97] Like the rest of the nation, Tribes are seeing the effects of climate change through increased storm surge, erosion, flooding, prolonged droughts, wildfires, and insect pest outbreaks in their forests. However, Tribal peoples are more deeply affected than most American citizens, as their cultures are rooted in the natural environment and closely integrated into the ecosystem. Tribal citizens hunt and fish, use native flora and fauna for medicinal and spiritual purposes, and associate their identities and histories closely with the land and water under their care. In addition, many Tribal communities are

[97] NTAA has presented the facts of climate change's impact to Tribes and Alaskan Native Villages before, NTAA Impacts of Climate Change on Tribes in the United States submitted December 11, 2009 to EPA's Office of Air and Radiation by the National Tribal Air Association, and we refer the agencies again to that analysis.

heavily dependent on fish, wildlife, and native plants for sustenance. We, therefore, expect that climate change will cut more deeply at the Tribal lifeways and standard of living than other sectors of society.

As climate change disrupts ecosystems, even the very survival of some Tribes as unique and distinct cultures are at risk. The loss of traditional cultural practices, due to climate-driven die-off or range shift of culturally significant flora and fauna, may prove too much to withstand on top of other external pressures faced by Tribes. The extent and magnitude of these changes depend on the amount of GHG emissions released into the atmosphere today and in the future, and thus NTAA believes it is essential to maintain the current, protective standards.

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

NHTSA's environmental justice analysis is incomplete and inadequate. Executive Order 12,898 directs agencies to identify and address "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." In response to this Executive Order, the Council for Environmental Quality published guidance on how federal agencies should consider environmental justice under NEPA. The EJ Guidance provides principles for considering environmental justice in NEPA analyses, including: ensuring sufficient opportunities for public input by minority, low income, and Native American populations; considering relevant public health data concerning potential health and environmental hazards of an action; and recognizing the "interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed action."

In the DEIS, NHTSA concludes that the proposed action and alternatives will not have adverse human or environmental effects on people of color and low-income communities. NHTSA itself undermines its conclusion when it acknowledges that low-income people and people of color are more exposed to environmental hazards from refinery and roadway pollution and are more vulnerable to the effects of climate change. Nevertheless, NHTSA claims that downstream emissions would decrease under all action alternatives. Relying on studies that demonstrate "a disproportionate prevalence of minority and low-income populations living near mobile sources of pollutants," the DEIS concludes that the action alternatives will result in "a net benefit to minority and low-income populations proximate to roadways in terms of reduced exposure to tailpipe emissions" compared to the augural standards. This conclusion is premised entirely on the assumption that the action alternatives will reduce downstream emissions of criteria and toxic air pollutants. But, as stated above, the DEIS's air quality impacts analysis is erroneous due to NHTSA's reliance on baseless economic assumptions and flawed modeling. In fact, the Proposed Rollback will result in an increase in tailpipe emissions. These increased emissions *will* adversely affect people living within 200-500 meters of high-volume roadways, including disproportionate impacts to low-income communities and communities of color, as discussed in detail in CARB's Comments. NHTSA must therefore reconsider its conclusion that the Proposed Rollback will result in a "net benefit" to environmental justice communities located near mobile sources.

Likewise, NHTSA claims that the magnitude of the increase in upstream emissions from oil production and distribution from the proposed action, compared to the augural standards, is "very minor" and cannot be characterized as disproportionate. Again, because of the inaccuracy of the DEIS air quality impacts analysis, NHTSA's claim is incorrect. NHTSA also claims that the potential increase in fuel production and consumption as a result of the Proposed Rollback will result in higher emissions of criteria and toxic air pollutants, but concludes that disproportionate impacts on environmental justice communities are not foreseeable because "a correlation between proximity to oil refineries and the prevalence of low-income and minority populations has not been established in the scientific literature." Contrary to NHTSA's assertions, the correlation is well established in the scientific literature. Indeed, the Office of Environmental Health Hazard Assessment recently issued a report finding that 15 of 20 refineries in California are located in or within ½ mile of a disadvantaged community. For these reasons, NHTSA must revise the DEIS to adequately disclose the environmental impacts of the Proposed Rollback on minority and low-income communities.

Docket Number: NHTSA-2017-0069-0693
Commenter: Rafael Pagán and Madeleine Green

Moreover, the DEIS notes that the proposed alternatives would result in nationwide increased adverse health impacts (mortality, acute bronchitis, respiratory emergency room visits, and work-loss days) due to the increased emissions of PM2.5, DPM, and SO_X. These impacts could be greater for vulnerable populations such as lower-income populations, the elderly, those with existing health conditions, and young children.

Docket Number: EPA-HQ-OAR-2018-0283-4030
Organization: Fond du Lac Band of Lake Superior Chippewa
Commenter: Joy Wiecks

The proposal fails to recognize that climate change impacts tribes to a greater degree than the general population. This is due to the following factors:

- Tribes' greater dependence on a subsistence lifestyle;
- Water-related Issues (water scarcity, lack of access to clean water, land subsidence and erosion, flooding, and droughts);
- Damage to infrastructure (that is oftentimes already outdated) from extreme weather;
- Economies that are closely linked with climate-sensitive resources;
- Location in areas prone to extreme weather events;
- A vulnerable population that suffers to a greater degree than the general public from extreme heat and cold due to generally poor housing stock and locations in isolated, rural settings.

In particular, the state of Minnesota has warmed by 2.9 degrees F between 1875 and 2017, with this trend expected to continue. This will make it difficult for a number of the state's most iconic and tribally significant species to continue to exist here. These include moose, birch trees, wild rice, and walleye. Wild rice in particular is very important to the Band as a culturally significant species.

Further, the loss of the coldest winter nights will enable the emerald ash borer (EAB) to continue its march across the state, potentially decimating most of the roughly 1 billion ash trees in the state (the ash borer will cause almost 100% mortality in trees with diameters greater than 1 inch). New research shows that temperatures below (-) 30 degrees F are needed to kill EAB larvae and that the mortality rate for the larvae decreases exponentially with every degree of warming above (-) 30. Ash Is very important to the Band as it has traditionally been used to make snowshoes, lacrosse sticks, baskets, and some ceremonial items.

Docket Number: EPA-HQ-OAR-2018-0283-5471
Organization: Community Action to Promote Healthy Environments
Commenter: Stuart Batterman, PhD

The transport sector's emissions affect large numbers of individuals who live close to major roads and who are disproportionately exposed to traffic related air pollutants. This means that for conventional and toxic pollutants, emissions from the transportation sector have a larger impact than emissions from other sectors on a ton-for-ton basis. This results since in most other sectors, emissions occur from tall stacks or occur in more remote or less populated areas. The DEIS and others estimate that roughly 20% of the nation's population or about 60 million individuals live within 500 m or major roads, a zone in which numerous adverse health effects associated with traffic-related air pollutants have been documented. The NHTSA assessment is flawed as it does not recognize that individuals living in transportation corridors and adjacent areas are more vulnerable to adverse health effects and will suffer adverse health effects. The assessment does not account for the increased susceptibility of this population. A growing body of peer-reviewed scientific literature documents the increased susceptibility of this population. In Detroit alone, we estimate the air pollution health burden that is attributable to ambient PM2.5, O_3, SO_2 and NO_X is responsible for 560 death annually, 13,000 disability-adjusted life years (DALYs), with a financial valuation of $5.5 billion annually; much of this is due to vehicular sources. As noted above, approximately 60 million individuals live near major roads, many of whom will have enhanced susceptibility to traffic-related air pollutants. The approach used in the NHTSA analysis severely underestimates health impacts associated with traffic-related pollutants.

Docket Number: EPA-HQ-OAR-2018-0283-5765
Organization: Fresh Energy
Commenter: Ben Passer

The Environmental Protection Agency asserts that the proposed SAFE rule "would not result in 'disproportionately high and adverse' human health or environmental effects regarding these pollutants on minority and/or low-income populations." For the reasons discussed below, we strongly disagree.

The Environmental Protection Agency itself recognizes that low-income and minority populations are disproportionately impacted by transportation pollution. As the Environmental Protection Agency stated:

> Publications that address EJ issues generally report that populations living near major roadways (and other types of transportation infrastructure) tend to be composed of larger fractions of nonwhite residents. People living in neighborhoods near such sources of air pollution also tend to be lower in income than people living elsewhere. Numerous studies evaluating the demographics and socioeconomic status of populations or schools near roadways have found that they include a greater percentage of minority residents, as well as lower SES.

The Environmental Protection Agency continued: "several studies find stronger associations between air pollution and health in locations with such chronic neighborhood stress, suggesting that populations in these areas may be more susceptible to the effects of air pollution." Rolling back emissions standards would increase air pollution along motorways, disproportionately impacting minority and low-income communities in violation of Executive Order 12898. Burning gasoline and diesel produces harmful emissions like carbon monoxide, particulate matter, and nitrogen oxides, which contribute to serious respiratory diseases and can even cause premature death. It is estimated that road transportation emissions cause 53,000 premature deaths per year nationally, making transportation the largest single contributor to premature deaths from air pollution. In the Twin Cities alone, particulate matter and ozone pollution contribute to 2,000 deaths, 400 hospitalizations, and 600 emergency room visits per year.

Most troublingly, the costs of this pollution are not distributed equally; they fall disproportionately on children, the elderly, economically disadvantaged communities, and communities of color. The Minnesota Pollution Control Agency's and Department of Health's 2015 Life and Breath report took an in-depth look at the effects of air pollution in the Twin Cities by zip code. The results (at pp. 36 – 38) are staggering:

- Rates of premature death due to air pollution are 45 percent higher in economically disadvantaged neighborhoods and 33 percent higher in neighborhoods in which the majority of residents are people of color;
- Rates of respiratory hospitalizations due to air pollution are 68 percent higher in economically disadvantaged neighborhoods and 66 percent higher in neighborhoods in which the majority of residents are people of color; and
- Rates of asthma-related ER visits due to air pollution are 5 times higher in economically disadvantaged neighborhoods and 4 times higher in neighborhoods in which the majority of residents are people of color.

Several independent national reports find that the likely health impacts from this proposed rule will disproportionately accrue to low-income communities and communities of color. The Environmental Protection Agency itself acknowledges that the transportation sector is responsible for numerous pollutants that contribute to poor air quality, including PM2.5. According to research from Yale University, Hispanics and African-Americans experience disproportionately higher exposure to components of PM2.5, and low-income people have much higher exposure to PM2.5 and its components. This particulate matter is linked to serious health threats including cardiovascular and respiratory conditions, reproductive and developmental harm, and premature death.

These likely impacts are directly opposed to the Environmental Protection Agency's own stated objectives. The Environmental Protection Agency's Office of Environmental Justice, for example, has a goal that everyone has "the same degree of protection from environmental and health hazards…" The EJ 2020 Action Plan also commits the Environmental Protection Agency to make demonstrable progress on significant environmental justice challenges, including air quality in vulnerable communities. We urge the Environmental Protection Agency to recommit to these objectives and ensure that any proposed rule mitigates the effects of air pollution in these communities, rather than worsen them.
It is also critical to note that the negative health effects related to the proposed rule are likely to affect communities that already suffer disproportionate impacts due to the siting of hazardous waste sites, such as chemical plants and landfills, in or near their neighborhoods.

The Environmental Protection Agency's EJSCREEN tool is helpful to identify these areas. While we recognize that the proposed SAFE rule is not intended to regulate such facilities, it is important to recognize that low-income communities and communities of color are already facing disproportionate exposure to air pollution, safety issues, and health concerns. The proposed SAFE rule would only serve to compound those impacts.

In addition to the disproportionate health impacts discussed above, the proposed SAFE rule further harms low-income communities and communities of color which are already disempowered from combatting high levels of air pollution in and near their communities. A case study in Minnesota found that despite driving less, communities living nearer to the urban core had higher exposures to traffic pollution, and were at higher risk for adverse health outcomes. Further, low-income communities and communities of color have historically borne the burden of highway development in the United States. The proposed SAFE rule would roll back fuel efficiency standards purportedly in the name of public safety while perpetuating the harms facing these communities, keeping dirtier cars in under-resourced communities longer and exacerbating the negative health impacts discussed above.

Response

The two major policies guiding NHTSA's environmental justice analysis are Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*,[98] and DOT Order 5610.2(a), *Department of Transportation Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*.[99] These policies require agencies to identify and consider any disproportionately high and adverse human health or environmental effects of a proposed action. NHTSA appreciates the many comments it received on its environmental justice analysis, and the agency has carefully considered all of the information and studies provided. As discussed in the revised Final EIS Section 7.5, *Environmental Justice*, (which has been updated to reflect new information provided by commenters), while there are likely to be some disproportionate adverse effects on low income and minority populations resulting from the Proposed Action, these impacts would be minor and are not considered "high" as defined by the Executive Order and DOT Order. NHTSA's conclusions regarding environmental justice also appear in Section X.E.11 of the preamble to the final rule.

In the Draft EIS, NHTSA wrote that there is mixed evidence as to whether there is a higher proportion of minority and low-income populations living close to refineries. Many commenters asserted that the evidence is far more conclusive than the Draft EIS acknowledged. NHTSA has reviewed the additional studies these commenters cited, and incorporated the findings of scientific journal articles that were directly relevant to environmental justice into the Final EIS. Based on a new review of the material, NHTSA has revised the language in the Final EIS to reflect that, although results of individual studies may vary, overall, the body of scientific literature points to disproportionate representation of minority and low-income populations in proximity to a range of industrial, manufacturing, and hazardous waste facilities that are stationary sources of air pollution. While the scientific literature specific to oil refineries is limited, disproportionate exposure of minority and low-income populations to air pollution from oil refineries is suggested by other broader studies of racial and socioeconomic disparities in proximity to industrial facilities generally.

Minority and low-income populations are, in many cases, disproportionately affected by changes in criteria and air toxic pollutant emissions, as noted by numerous commenters. NHTSA's analysis, echoed by the commenters, addressed the two major sources from which air pollutant emissions might disproportionately affect minority and low income populations: oil refineries (upstream emissions) and roadways (downstream emissions). A higher prevalence of minority and low-income populations in close proximity to these sources may result in disproportionate impacts on these communities. However, as described in NHTSA's environmental justice analysis, the change in emissions relative to the No Action

[98] 59 FR 7629 (Feb. 16, 1994).
[99] 77 FR 27534 (May 10, 2012).

Alternative would be minor, so these impacts would not be characterized as "high." NHTSA addresses comments related to its modeling methodology in Section VI of the preamble to the final rule.

Some commenters noted that climate change is likely to disproportionately affect tribal communities because of their deeper reliance on the natural environment. In addition to its discussion in Section 7.5, *Environmental Justice,* NHTSA discusses the impacts of climate change on Native American Tribes in Section 8.6.5.2, *Human Security.* In response to these comments, NHTSA has added additional details on the impacts of climate change on Native American Tribes to that section. Several commenters also documented that climate change is likely to disproportionately affect low-income and minority populations that do not have access to the adequate resources for dealing with natural disasters or urban impacts related to the heat island effect. NHTSA acknowledges that the impacts of climate change on minority and low-income populations are likely to be disproportionately high and adverse. Yet the Proposed Action is projected to have a very small contribution to overall climate dynamics, representing a small fraction of total global GHG emissions. (See Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, for discussions about the impacts of the Proposed Action and alternatives on certain climate values, the impacts of global climate change throughout the United States, and how these impacts may be exacerbated by existing socioeconomic disparities and other inequalities.) Any impacts on low-income and minority communities would be attenuated by a lengthy causal chain; but if one could attempt to draw those links, the climate impacts on minority and low-income populations resulting from the Proposed Action—while disproportionate and potentially adverse—would be marginal and could not be considered "high."

CARB asserted that this EIS "fails to acknowledge the significant impact social and economic disparities have on exposure disparities." Its comment emphasizes that socioeconomic circumstances and histories of discrimination and inequity interact with health and environmental impacts to exacerbate negative outcomes. NHTSA acknowledges this and has augmented the discussion of these interactions in the Final EIS. CARB also commented on the environmental justice impacts of the preemption of California's Zero Emission Vehicle regulation. NHTSA addressed issues associated with preemption in the Safer Affordable Fuel-Efficient Vehicles Rule Part One: One National Program final rulemaking.[100]

New York State Department of Environmental Conservation asserted that NHTSA has not adequately included minority and low-income populations within the NEPA process. NHTSA held three public meetings across three cities to solicit comments on the Proposed Action and provided a lengthy comment period on the Draft EIS. Comments were solicited from all members of the public, including minority and low-income populations. NHTSA believes these consultations comply with public consultation requirements under NEPA and Executive Order 12898.

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[100] 84 FR 51310 (Sep. 27, 2019).

10.8 Cumulative Impacts

Comment

Docket Number: NHTSA-2018-0067-11154
Organization: International Mosaic
Commenter: Andrew Yamamoto et al.

The cumulative effects of the Proposed Repeal when coupled with other known major federal actions was not disclosed in the DEIS and must be. Such other actions include, but are not limited to, the EPA's plan to allow drillers to release much more methane (a potent climate changing chemical) and the Proposal to Limit Use of Scientific Evidence in Rulemakings, 83 Fed. Reg. 18,768 (April 30, 2018) - Docket ID No. EPA-HQ-OA-2018-0259.

Response

Chapter 8, *Cumulative Impacts*, of this EIS discusses the impacts of the Proposed Action and alternatives in combination with other past, present, and reasonably foreseeable future actions that affect the same resources. The range of actions considered includes other actions that have impacts that add to, or offset, the anticipated impacts of the proposed fuel economy standards on resources analyzed in this EIS. The other actions that contribute to cumulative impacts can vary by resource and are defined independently for each resource. Other past, present, and reasonably foreseeable future actions for each resource area are addressed in Section 8.3, *Energy*, Section 8.4, *Air Quality*, Section 8.5, *Other Impacts*, and Section 8.6, *Greenhouse Gas Emissions and Climate Change*.

For energy, air quality, and other impacts, the other actions considered in their respective cumulative impact analyses are predictable actions where meaningful conclusions on impacts or trends relative to impacts of the Proposed Action and alternatives can be discerned. The cumulative impact analysis for GHG emissions and climate impacts is based on a global-scale emissions scenario because it is not possible to individually identify and define the incremental impact of each action during the analysis period (2020 through 2100) that could contribute to global GHG emissions and climate change. Instead, examples of some known actions that contribute to the underlying emissions scenario provide a national and an international perspective. One such known action that NHTSA discusses in Section 8.6.3.2, *United States: Federal Actions*, is noted by the commenter: EPA's 2018 proposal to revise the methane new sources performance standards.

The EIS does not discuss EPA's April 2018 proposal, Strengthening Transparency in Regulatory Science (83 FR 18768), because that rule, if finalized, would not have reasonably foreseeable impacts that would directly add to, or offset, the anticipated impacts of the proposed fuel economy standards on resources analyzed in this EIS.

Comment

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 4. The scoping analysis of the draft EIS has so clearly ignored the basic principles of cumulative effects analysis required by NEPA that it seems instructive to include here the complete table of these principles given in the CEQ handbook [page 8]. The revised EIS should outline how the scope of the cumulative impacts analysis conforms with each one of these principles.

[See original comment for table titled Table 1-2. Principles of cumulative effects analysis.]

Response

NHTSA believes its cumulative impacts analysis in this EIS is consistent with all applicable regulations, policies, and case law regarding cumulative impacts analyses in NEPA documents. Neither the CEQ regulations and policies nor the DOT and NHTSA NEPA implementing procedures require the agency to outline the ways in which its EIS conforms with the table provided by the commenter, nor does NHTSA believe such an outline is necessary to allow a reasoned choice among alternatives.

10.8.1 Air Quality

Comment

Docket Number: NHTSA-2017-0069-0523
Organization: Arkansas Department of Environmental Quality
Commenter: Stuart Spencer

On July 26, 2017, the NHTSA published a Notice of Intent to prepare an Environmental Impact Statement for new Corporate Average Fuel Economy (CAFE) standards. On August 3, 2018 the NHTSA published the *Draft Environmental Impact Statement*, which compares the potential environmental impacts, including on Air Quality, of nine (eight action alternatives and the No Action Alternative) fuel economy standards for Model Year 2021-2026 passenger cars and light trucks. The *Draft Environmental Impact Statement* found that "For NO_X (in 2050), PM2.5, SO_2, and VOCs (in 2035 and 2050), emissions would generally increase across action alternatives (compared to the No Action Alternative), with the largest increases occurring under Alternative 1 and emissions increases getting smaller from Alternative 1 through Alternative 7." and "By 2050, these increases would range from 2.1 percent for NO_X to 9.1 percent for SO_2...". The *Draft Environmental Impact Statement* also states that Alternative 1 is the "Preferred Alternative" by the NHTSA.

Automotive emissions comprise a significant share (estimated at 3.6 million tons per year or 34 percent) of the United States' nitrogen oxide (NO_X) emissions, a precursor of ozone (O_3). As illustrated in Figure A, on-road vehicles in Arkansas emitted an estimated 73,324 tons of NO_X (36% of the total anthropogenic NO_X emissions in Arkansas), which is equivalent to the percentage of NO_X emissions from Arkansas' point sources. ADEQ has broad authority to effect Arkansas' point source emissions through permitting and state planning activities, but only a limited ability to influence emissions from on-road sources and therefore, relies on federal efficiency programs to help reduce on-road NO_X emissions.

[See original comment for Figure A titled 2014 Relative Contribution of Anthropogenic NO_X Emissions in Arkansas by Data Category]

On May 21, 2012, Crittenden County, Arkansas, Shelby County, Tennessee, and a portion of DeSoto County, Mississippi, were classified as a marginal nonattainment area under the U.S. Environmental Protection Agency's (EPA) 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS). Then on April 25, 2016, Crittenden County, AR reattained the 2008 ozone NAAQS due to continued improvements in air quality and is currently designated as a Maintenance Area for the 2008 ozone NAAQS. As a part of Arkansas' Attainment Redesignation Request and Maintenance Plan (effective May 1, 2015 through January 31, 2027), ADEQ presented data that indicated that less than 1% of the NO_X emissions in Crittenden County were from industrial stationary "Point Sources," and 38.6% of the NO_X emissions for Crittenden County were from "On-Road Mobile Sources."

Crittenden County is host to a major transportation corridor and is, therefore, dependent upon federal regulations pertaining to mobile source emissions reductions in order to maintain air quality. The lack of industrial NO_X sources of and a considerable emissions contribution from mobile sources places a heavy dependency on Crittenden County's ozone NAAQS attainment/nonattainment on federal programs related to On-Road Mobile Sources and the Gasoline Sulfur Standard. Using EPA's mobile source emissions model, Motor Vehicle Emissions Simulator (MOVES), ADEQ was required to quantify mobile source emissions and determine specific transformation conformity emissions budgets for the On-Road Mobile Sources portion of the Crittenden County emission inventory. These MOVES analyses were based partially on Tier 2 and Tier 3 federal Motor Vehicle Emissions (affected by gallons of fuel used per miles traveled efficiency) and Gasoline Sulfur Standards. The Tier 2 standard was phased in between 2004 and 2009 and required a 75% emissions reduction from the previous standard. When fully implemented, the Tier 2 standards are expected to reduce NO_X emissions by about 74% by 2030. Future year NO_X reduction will also be realized from EPA's Tier 3 Motor Vehicle Emissions and Fuel Standards, which began being phased in in 2017. From 2017 levels, the Tier 3 standard is predicted to further reduce NO_X emissions from on-road mobile sources by 31% by 2050, when Tier 3 vehicles comprise most of the on-road vehicles.

As a result of these Motor Vehicle Emissions Standards that have already and will continue to reduce NO_X emissions, concentrations of ozone have dropped in Crittenden County and across all of Arkansas over the past ten years (Figure 1).

[See original comment for Figure 1 titled Ozone Monitor Design Value Trends for Arkansas]

However, also over the last 21 years, the 8-hour ozone NAAQS has been revised downward twice from 0.08 parts per million (ppm) in 1997 to 0.075 ppm in 2008 then to 0.070 ppm in 2015. Lower ozone levels benefit the health of Arkansas's citizens and visitors to our state, particularly children, the elderly, and those with respiratory diseases. Additionally, the ability to maintain full NAAQS attainment status for all criteria pollutants makes our state more attractive to potential businesses and industries due to the less restrictive permitting requirements in an attainment versus a non-attainment area. Likewise, an attainment designation is of key interest to developers and transportation planners as they determine where to invest time and money. The required continued improvement in air quality to meet the continual reduction in the ozone NAAQS will only be realized with collaborative federal and state efforts. Therefore, when evaluating any potential environmental impacts as a result of revisions to the CAFE standards, please consider the federal requirement for Arkansas, and other states, to maintain attainment with the ozone NAAQS, which is partially dependent on Motor Vehicle Emissions and Fuel Standards.

Response

NHTSA recognizes the challenges that attainment and maintenance areas face in reducing ozone precursor (NO_X and VOC) emissions to assure continued attainment. The photochemical modeling analysis in Final EIS Appendix E, *Air Quality Modeling and Health Impacts Assessment*, shows the estimated changes in regional ozone concentrations by alternative. NHTSA has considered the impact of the Proposed Action and alternatives on criteria pollutant emissions as part of its decision-making process.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The DEIS has an exceptionally cursory and superficial analysis of the cumulative impacts to air quality from the proposed action and other alternatives especially when compared to the same analysis in the 2012 Final EIS. Notably, the air quality cumulative impacts analysis in the DEIS spans less than three pages while the same analysis in the 2012 Final EIS covers more than thirty pages, featuring a robust and informative evaluation of cumulative impacts to air quality, including various comparative analyses of criteria and toxic air pollutant emissions by alternatives, clear tables and figures, and a discussion of the health effects and monetized health benefits of each alternative, followed by individual analyses of emissions for the proposed action and other alternatives. For example, in its air quality cumulative impact analysis, the 2012 Final EIS includes tables showing decreases in negative health outcomes, including mortality, chronic bronchitis, emergency room visits for asthma, and work-loss days, as well as increases in the monetized values of the same by alternative and year. NHTSA's current analysis certainly fails NEPA's "hard look" requirement, by comparison with the 2012 Final EIS or otherwise.

Response

The "hard look" requirement under NEPA does not require that the same analytical methodology or level of detail used in one EIS be followed in a subsequent EIS for a similar rulemaking. In its 2012 Final EIS, NHTSA distinguished its analysis of cumulative impacts from its analysis of direct and indirect impacts by including over-compliance by certain manufacturers and ongoing fuel economy improvements after the model years regulated by the standards. In other words, NHTSA determined that these market forces constituted the only "reasonably foreseeable" future actions for purposes of determining cumulative impacts. However, these market forces are indistinguishable from other assumptions NHTSA must make about the future light duty fleet (e.g., manufacturer product plans and sales). Therefore, for this EIS, NHTSA has factored these assumptions into the CAFE model for purposes of the analysis of direct and indirect impacts in this EIS (see Chapter 4, *Air Quality*, for the information discussed by the commenter). Chapter 4 includes extensive discussion of the air quality impacts of the Proposed Action and alternatives. NHTSA believes providing an additional analysis excluding these factors would have resulted in excessive paperwork without providing additional analytical detail. For these reasons, NHTSA continues to believe that this analytical approach is reasonable and provides for a "hard look" at the potential environmental impacts of its rulemaking.

10.8.2 Greenhouse Gas Emissions and Climate Change

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

In the context of setting fuel economy standards, the need to take a hard look at the cumulative impacts of a proposed rule and its alternatives is well settled: "The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct. Any given rule setting a CAFE standard might have an 'individually minor' effect on the environment, but these rules are 'collectively significant actions taking place over a period of time.'" *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1217 (9th Cir. 2008) (quoting 40 C.F.R. § 1508.7). The DEIS fails this test in numerous ways.

The Joint Commenters are submitting to this docket a separate comment letter on the effects of climate change, both those already observed and those reasonably foreseeable through 2100 under various scenarios. Here we incorporate those comments by reference. Below we discuss the many ways in which NHTSA's discussion and treatment of the cumulative effects of climate change are unlawful, arbitrary or capricious.

* * * * *

Second, also as discussed above, NHTSA's analysis of its Proposal's cumulative effects is scientifically flawed because it omits highly pertinent data, artificially minimizes the significance of the alternatives' differences, and is erroneous in other respects. The cumulative effects analysis fails to use available, peer-reviewed and highly pertinent studies and thus lacks professional and scientific integrity.

Response

This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions. The impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, reflect the best available science regarding climate change and its impacts on health, society, and the environment. NHTSA relied primarily on existing expert panel- and peer-reviewed climate change studies and reports when preparing the Draft and Final EIS. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from the IPCC and GCRP, supplemented with additional peer-reviewed literature.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA compares the cumulative effects in 2100 of the No Action Alternative to its Preferred Alternative as follows: atmospheric CO_2 would rise by 0.6 ppm, from 687.3 ppm to 687.9 ppm; temperatures would increase by 0.003°C; precipitation would increase by less than 0.01 percent; sea levels would rise by 0.06 centimeters from 70.22 centimeters to 70.28 centimeters; and ocean pH would increase by 0.0004 to 8.2719. NHTSA then claims that because the projected climate effects "are extremely small compared with total projected future climate change, they would only marginally increase the potential risks associated with climate change." Though NHTSA's discussion in the Proposal about why it proposes to freeze the standards from 2021 to 2026 even though they increase greenhouse gases lacks any overall rationale, here NHTSA effectively writes off their effects as immaterial ("extremely small") by comparing them to total worldwide emissions by 2100.

In *Massachusetts v. EPA*, 549 U.S. 497, 523 (2007), the Supreme Court rejected this very same argument (there made to rebut petitioners' standing)--that incremental greenhouse gas emission reductions make no difference. The Supreme Court had this to say about EPA's claims:

> EPA ... maintains that its decision not to regulate greenhouse gas emissions from new motor vehicles contributes so insignificantly to petitioners' injuries that the Agency cannot be haled into federal court to answer for them. For the same reason, EPA does not believe that any realistic possibility exists that the relief petitioners seek would mitigate global climate change and remedy their injuries. That is especially so because predicted increases in greenhouse gas emissions from developing nations, particularly China and India, are likely to offset any marginal domestic decrease. [¶] But EPA overstates its case. Its argument rests on the erroneous assumption that a small incremental step, because it is incremental, can never be attacked in a federal judicial forum. Yet accepting that premise would doom most challenges to regulatory action ... [¶¶] ... Nor is it dispositive that developing countries such as China and India are poised to increase greenhouse gas emissions substantially over the next century: A reduction in domestic emissions would slow the pace of global emissions increases, no matter what happens elsewhere.

Id. at 523-24, 525-26. See also *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1217 (9th Cir. 2008) ("[a]ny given rule setting a CAFE standard might have an 'individually minor' effect on the environment, but these rules are 'collectively significant actions taking place over a period of time'" (quoting 40 C.F.R. § 1508.7)).

While in 2007 EPA announced its reasoning clearly, NHTSA in 2018 does all it can to hide it; but the assertion that the Proposal and its alternatives make no difference to climate change, human suffering and death is the same and must be rejected for the same reasons. And certainly, characterizing these emissions as immaterial does not take the requisite "hard look."

NHTSA's approach to evaluating the significance of the climate impacts of its decision is precisely the kind of limited analysis that CEQ specifically directed agencies *not* to do:

> Therefore, a statement that emissions from a proposed Federal action represent only a small fraction of global emissions is essentially a statement about the nature of the climate change challenge, and *is not an*

> *appropriate basis* for deciding whether or to what extent to consider climate change impacts under NEPA. *Moreover, these comparisons are also not an appropriate method for characterizing the potential impacts associated with a proposed action and its alternatives* and mitigations because this approach does not reveal anything beyond the nature of the climate change challenge itself: the fact that diverse individual sources of emissions each make a relatively small addition to global atmospheric GHG concentrations that collectively have a large impact.

CEQ Climate Guidance at 11 (emphasis added); see also *Massachusetts v. EPA*, 549 U.S. at 525-526.

Likewise, EPA has cautioned, in its 2009 motor vehicle endangerment finding under §202(a)(1):

> ...[N]o single greenhouse gas source category dominates on the global scale, and many (if not all) individual greenhouse gas source categories could appear small in comparison to the total, when, in fact, they could be very important contributors in terms of both absolute emissions or in comparison to other source categories, globally or within the United States. If the United States and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues. The commenters' approach, if used globally, would effectively lead to a tragedy of the commons, whereby no country or source category would be accountable for contributing to the global problem of climate change, and nobody would take action as the problem persists and worsens.

74 Fed. Reg. at 66,543 (Dec. 15, 2009).

NHTSA's emissions disappearance act is even less credible than was EPA's 2007 (unlawful) position, as the proposed rule here would roll back already existing, protective regulations that reduce greenhouse gas emissions and instead take a regulatory step to *increase* them over the status quo. If regulations that by themselves would implement relatively small incremental emissions decreases cannot be written off under *Massachusetts v. EPA*, regulations that actively increase emissions certainly cannot be either.

NHTSA's failure in this regard is all the more egregious because the nation's vehicle fleet is the single largest source of greenhouse gases in the U.S. and larger than many major nations' *entire* emissions inventories. *See* 549 U.S. at 524-25. The notion that the U.S. can simply throw up its hands and decline to tackle this huge emissions category would lead to the conclusion–irrational, for reasons pointed out by *Massachusetts* and by EPA's 2009 endangerment finding–that no source category is worth taking on.

*   *   *   *   *

NHTSA must explain the basis for its conclusion that the incremental additional GHG emissions resulting from each alternative are immaterial. It must disclose whether, in NHTSA's view, this is so because (a) it believes that the consequences of climate change cannot be meaningfully addressed, and thus the world will inevitably suffer the outcome it describes for 2100 regardless of its actions now; or (b) it has concluded that atmospheric carbon concentrations in the neighborhood of 800 ppm and a 3.6°C increase in warming simply are not worrisome in any event because they do no or only insignificant harm to the environment and human health, and that incremental increases like those caused by the Proposal (.0003) do not change that benign outcome (a conclusion contradicted by the overwhelming scientific consensus); (c) it believes that someone other than NHTSA is responsible for reducing greenhouse gases; or (d) it has any other justification for proposing an alternative that increases carbon emissions even while the planet becomes ever hotter. NHTSA must disclose the rationale behind its projections and choices so the reader can understand and comment on NHTSA's justification.

Response

NHTSA recognizes the point made by the Supreme Court in *Massachusetts v. EPA*, 549 U.S. 497 (2007), and cited here by the commenters. However, as the commenters recognize, this was with regard to the question of the petitioner's standing. The Court's ultimate conclusion in that case was, "We hold only that EPA must ground its reasons for action or inaction in the statute." *Mass. v. EPA*, 549 U.S. at 535. NHTSA believes it is justified to view fractional changes in temperature, precipitation, sea-level rise, and ocean pH as "small." NHTSA does not dismiss such changes as "immaterial," as the commenters allege. Rather, in Section VIII of the preamble to the final rule, the agency weighs these fractional changes in climate attributes against the other EPCA statutory factors, such as economic practicability. While NHTSA recognizes that these small increases may contribute to climate change,[101] NHTSA must consider the other statutory factors, as the statute commands.

NHTSA also finds the commenters' reference to the CEQ's *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews* (dated August 1, 2016) unavailing. First, that document was withdrawn by CEQ.[102] Second, the document went on to recommend that agencies consider more than a proposed action's emissions as a percentage of sector, nationwide, or global emissions in deciding whether, or to what extent, to consider climate change impacts under NEPA. In fact, NHTSA *has* considered climate change impacts under NEPA by quantifying potential impacts of alternatives (under both its direct and indirect impacts analysis and its cumulative impacts analysis), discussing climate change science, and reporting potential impacts of climate change on key natural and human resources. NHTSA weighs all of this information in Section VIII of the preamble to the final rule. Finally, NHTSA notes that CEQ issued draft guidance on the consideration of GHG emissions in NEPA reviews in mid-2019.[103] According to that guidance:

- "Agencies should attempt to quantify a proposed action's projected direct and reasonably foreseeable indirect GHG emissions when the amount of those emissions is substantial enough to warrant quantification, and when it is practicable to quantify them using available data and GHG quantification tools."—NHTSA has quantified these impacts in Chapter 5, *Greenhouse Gas Emissions and Climate Change.*
- "Where GHG inventory information is available, an agency may also reference local, regional, national, or sector-wide emission estimates to provide context for understanding the relative magnitude of a proposed action's GHG emissions."—NHTSA has done so in Chapter 5 and Chapter 8, *Cumulative Impacts*, by comparing the affected emissions to total passenger car and light truck emissions, U.S. emissions, and global emissions.
- "This approach, together with a qualitative summary discussion of the effects of GHG emissions based on an appropriate literature review, allows an agency to present the environmental impacts of a proposed action in clear terms and with sufficient information to make a reasoned choice

[101] NHTSA notes that the final rule concludes that the maximum feasible standards for MYs 2021-2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. This results in year-over-year improvements to fuel economy and reductions in GHG emissions compared to NHTSA having no standards for those MYs (which is the case for MYs 2022-2026). By requiring year-over-year improvements in fuel economy, NHTSA is not "throw[ing] up its hands," as the commenter claims.

[102] CEQ, *Withdrawal of Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*, 82 FR 16576 (Apr. 5, 2017).

[103] CEQ, *Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions*, 84 FR 30097 (June 26, 2019).

> among the alternatives. Such a discussion satisfies NEPA's requirement that agencies analyze the cumulative effects of a proposed action because the potential effects of GHG emissions are inherently a global cumulative effect. Therefore, a separate cumulative effects analysis is not required."—NHTSA provides such a literature in Chapter 5 and Chapter 8. In fact, NHTSA goes above and beyond what is recommended by CEQ in the draft guidance by providing a quantitative cumulative impacts analysis.

While NHTSA recognizes that the draft guidance has not been finalized, it is instructive that NHTSA's approach, which the agency has used in all of its recent EISs, is reasonable.

Finally, the commenters quote the 2009 motor vehicle endangerment finding and mischaracterize potential explanations for NHTSA's Proposed Action and alternatives. NHTSA does not state that the consequences of climate change are inevitable or that they are "not worrisome." Regardless of the question of whether the country "must do [its] part" to address climate change, NHTSA's authority to regulate fuel economy requires it to consider all of the EPCA statutory factors. The relative weight of each factor is addressed in Section VIII of the preamble to the final rule.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Lastly, NHTSA does not sufficiently describe how it arrived at the fractional temperature and ppm increases and other fractional climate change indicators other than to state that it used a climate model called GCAM 6.0, as discussed below. NHTSA states that GCAM 6.0 is "based on a set of assumptions about drivers such as population, technology, socioeconomic changes, and global climate policies that correspond to stabilization, by 2100, … [at] CO_2 concentrations at roughly 678" ppm. It adds that, "[a]lthough GCAM 6.0 does not explicitly include specific climate change mitigation policies, it does represent a plausible future pathway of global emissions in response to substantial global action to mitigate climate change. … [It] represents a reasonable proxy for the past, present, and reasonably foreseeable GHG emissions through 2100." But such general assumptions, particularly assumptions that do not account even for all current, and much less all reasonably foreseeable, actions by third parties to reduce emissions, cannot take the place of the requisite "hard look" or the agency's obligation to "[r]igorously explore and objectively evaluate all reasonable alternatives ... so that reviewers may evaluate their comparative merits." 40 C.F.R. §§ 1502.14(a)-(b).

NHTSA does not analyze or explain, for example, how GCAM 6.0's assumptions are affected by the very Proposal and its alternatives under consideration in the DEIS, or whether the model incorporates the new and startling data about automakers' large investments into EV technology and numerous countries' adoption of targets to completely phase out sales of new internal combustion vehicles on or before 2040, a date less than the mid-point of the 2100 time frame that the DEIS purports to analyze. Instead, how NHTSA arrived at its apparently super-precise calculations of such things as fractional degrees of warming and ppm concentrations 82 years from now receives no reasoned explanation, and indeed is entirely impenetrable to the reader. The brief reference to an opaque climate model plainly does not meet NEPA's requirements.

Response

NHTSA uses the GCAM6.0 scenario and the MAGICC model for its cumulative impact analysis. Contrary to the commenters' assertion, NHTSA provides extensive explanation about the GCAM6.0 scenario and the MAGICC model in Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact Analysis*, and Section 5.3.3.1, *MAGICC Modeling.*

As the commenters have acknowledged, climate change is driven by GHG emissions that occur globally. NHTSA is not aware of any practical means by which to model every action undertaken by every party globally to reduce emissions. Instead, NHTSA relies on the GCAM scenarios, which are commonly accepted in the scientific community for this purpose. GCAM6.0 does not include specific climate change mitigation policies, but it does assume a moderate level of global GHG reductions compared to current emissions forecasts. Atmospheric CO_2 concentrations in 2100 are estimated to be 687 parts per million (ppm) under the GCAM6.0 scenario. NHTSA believes the use of this scenario alongside others ensures that a full range of consequences of the Proposed Action and alternatives is considered within the context of other likely actions. For example, NHTSA also modelled the RCP 4.5 scenario, a more aggressive emissions stabilization scenario, in a sensitivity analysis. Atmospheric CO_2 concentrations in 2100 are estimated to be 544 ppm under this scenario. This approach ensures that a range of consequences of the Proposed Action and alternatives is considered within the context of other actions.

The commenters allege that NHTSA does not analyze how GCAM's assumptions are affected by the very proposal under consideration. On the contrary, that is the very purpose of the analysis conducted in Chapter 8, *Cumulative Impacts*. NHTSA explains its methodology in Section 5.3, *Analysis Methods*, to see how future forecasts would change when substituting the emissions outputs from the CAFE model. As explained in Section 8.6.3, *Other Past, Present, and Reasonably Foreseeable Future Actions,* while the GCAM scenarios do not explicitly model specific actions undertaken globally, they can be used as proxies for different levels of action undertaken. For example, it is reasonable to assume that the level of GHG emissions mitigation assumed by GCAM6.0 is representative of global efforts akin to the manufacturer investments cited by the commenters. NHTSA continues to believe this is a reasonable approach to apply the best available science and data.

Comment

Docket Number: NHTSA-2017-0069-0550
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Commenter: Alejandra Núñez et al.

The cumulative impacts analysis must pay particular attention to the actions of EPA, which is statutorily charged with reducing greenhouse gases from vehicles. EPA has tackled this mandate since 2009, but NHTSA now ignores EPA's mission, and failed to correct most of the errors and modeling faults pointed out to it by senior EPA staff before the Proposal was published. Instead, NHTSA proposes that that EPA will jettison credits, established under Clean Air Act authority, for actions such as using less polluting air conditioner refrigerants, leakage prevention, and reductions in nitrous oxide and methane emissions, all to "[t]o better align the programs." That explanation bears no scrutiny, as a joint program has operated for years with these credits intact.

Response

NHTSA discusses the assumptions and methodologies of the CAFE model in Section VI of the preamble to the final rule. NHTSA's EIS reflects the Proposed Action and alternatives considered by EPA and NHTSA, who are partner agencies in this rulemaking and have worked to harmonize their programs to the maximum extent practicable and reasonable. NHTSA does not propose that EPA will undertake any particular action; rather, the Draft EIS reflected the actions proposed by EPA with regard to that agency's program as part of the joint rulemaking. NHTSA recognizes the role that EPA plays in regulating CO_2 emissions from motor vehicles, and that is reflected in the discussion of EPA's program in the EIS.

Comment

Docket Number: NHTSA-2017-0069-0550
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Commenter: Alejandra Núñez et al.

The IPCC Special Report concludes that pathways to limit warming to 1.5°C with little or no overshoot require "a rapid phase out of CO_2 emissions and deep emissions reductions in other GHGs and climate forcers." In pathways consistent with a 1.5°C temperature increase, global net anthropogenic CO_2 emissions must decline *by about 45% from 2010 levels by 2030*, reaching net zero around 2050 *(high confidence*). For a two-thirds chance for limiting warming to 1.5°C, CO_2 emissions must reach carbon neutrality in 25 years *(high confidence)*. The IPCC Special Report lays out in stark terms that a mere one-half of a degree Celsius of additional global warming makes a vast difference in avoiding immense damages: loss of food and water security, loss of coastal land and properties, loss of biodiversity, more and more extreme heat waves, droughts and flooding, population migrations, poverty, devastating health outcomes and innumerable lives lost. And it leaves no doubt that emission reductions within *just the next decade* will make that difference. The DEIS' attempt to minimize these devastating consequences while the agencies are actively putting a blowtorch to our already overheating planet during the next critical decade by reversing emissions reduction regulations is directly contrary to what the best available science makes clear must be done to avoid them. And, even if the GCAM 6.0 assumptions—which do not include the administration's rules and proposals to eviscerate emission reduction regulations—were a reasonable projection of cumulative impacts, and even if the IPCC Special Report did not demonstrate the immense importance of acting now to reduce emissions, NHTSA must *explain* why it believes the differences among its alternatives are too small to matter. NHTSA does not do so.

Response

In the Final EIS, NHTSA has integrated the findings of consensus reports and peer-reviewed literature published since the release of the Draft EIS, including the IPCC *Special Report: Global Warming 1.5°C* and the GCRP *Fourth National Climate Assessment.* NHTSA is obligated to balance the four statutory factors and other relevant considerations in setting maximum feasible fuel economy standards. NHTSA considered the environmental impacts of this rulemaking, including the contents of this Final EIS, as it developed its final rule. For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards, and that the maximum feasible standards for MYs 2021-2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. While CO_2 emissions (and other environmental impacts) will be higher under this final rule than if NHTSA had determined that the augural standards were maximum feasible, they will be lower than they would have been under the proposal. NHTSA does not state that the differences among its alternatives are "too small to matter;" on the contrary, NHTSA's final rule will still accomplish reductions in GHG emissions over time.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Moreover, relying on a temperature increase as set by GCAM 6.0 as a result of *all* human-caused emissions is not the same as analyzing NHTSA's own contribution when combined with that of other policies of the current administration. When temperatures have already risen by 3°C or more, even fractional increases in temperature degrees (and less than one additional ppm of carbon in the atmosphere) may have significant effects. For example, NHTSA has undertaken no evaluation of whether the risk of the occurrence of tipping points would be affected under circumstances like these. The Fourth National Climate Assessment concluded with very high confidence that large-scale shifts in the climate system, also known as tipping points, and the compound effects of simultaneous extreme climate events have the potential to create unanticipated, and potentially abrupt and irreversible, "surprises" that become more likely as warming increases. The IPCC Fifth Assessment Report similarly concluded that "[t]he risks of abrupt or irreversible changes increase as the magnitude of the warming increases." The disastrous effects of compound extreme events are, in fact, already occurring, such as during Hurricane Sandy when sea level rise, abnormally high ocean temperatures, and high tides combined to intensify the storm and associated storm surge, and an atmospheric pressure field over Greenland steered the hurricane inland to an "exceptionally high-exposure location."

In contrast to the DEIS' downplaying of the matter, in its 2012 Final EIS, NHTSA disclosed and discussed the interrelationship between the likelihood of reaching tipping points and temperature increases. The 2012 Final EIS noted that, based on

> "'growing evidence that even modest increases in [global mean temperature] could commit the climate system to the risk of very large impacts on multiple-century time scales,' the risks of large-scale discontinuities [tipping points] were expertly judged to begin being a source of substantial risk around 1°C (around 2°F). Smith *et al.* (2008) projected 2.5 °C (4.5°F) ... to be the 'possible trigger for commitment to large-scale global impacts over multiple-century time scales.'"

In addition, the 2012 Final EIS noted that, "[t]emperature increases above 3°C increase the risk of triggering large-scale discontinuities, and there is general agreement among recent studies ... that these risks, although difficult to quantify, grow with greater anthropogenic warming." The IPCC Fifth Assessment Report warned that increasing warming increases risk of abrupt and irreversible changes:

> With increasing warming, some physical and ecological systems are at risk of abrupt and/or irreversible changes. Risks associated with such tipping points are moderate between 0 and 1°C additional warming, since there are signs that both warm-water coral reefs and Arctic ecosystems are already experiencing irreversible regime shifts (*medium confidence*). Risks increase at a steepening rate under an additional warming of 1 to 2°C and become high above 3°C, due to the potential for large and irreversible sea level rise from ice sheet loss. For sustained warming above some threshold greater than ~0.5°C additional warming (*low confidence*) but less than ~3.5°C (*medium confidence*), near-complete loss of the Greenland ice sheet would occur over a millennium or more, eventually contributing up to 7 m to global mean sea level rise.

For example, research indicates that a critical tipping point important to the stability of the West Antarctic Ice Sheet has been crossed, and that rapid and irreversible collapse of the ice sheet is likely in the next 200 to 900 years. As stated by the Fourth National Climate Assessment:

> "Observational evidence suggests that ice dynamics already in progress have committed the planet to as much as 3.9 feet (1.2 m) worth of sea level rise from the West Antarctic Ice Sheet alone, although that amount is projected to occur over the course of many centuries. Plausible physical modeling indicates that, under the higher RCP8.5 scenario, Antarctic ice could contribute 3.3 feet (1 m) or more to global mean sea level over the remainder of this century, with some authors arguing that rates of change could be even faster."

Moreover, despite the clear danger posed by and likelihood of tripping climate tipping points, NHTSA states that "the current state of science does not allow for quantifying how increased emissions from a specific policy or action might affect the probability and timing of abrupt climate change." This statement is incorrect, and highly questionable in light of the fact that NHTSA is attempting to freeze all efforts to control the very largest source of greenhouse gas pollution in the United States. The Fourth National Climate Assessment states that there is *"very high confidence"* that "[s]ome feedbacks and potential state shifts can be modeled and quantified." And NHTSA's justification cannot withstand scrutiny for another reason: under the cumulative impacts analysis, NHTSA is not tasked with quantifying how its Proposal to decrease U.S. mileage standards alone would affect tipping points; instead, it must assess the damages likely to arise from crossing them as a result of cumulative impacts from actions by others.

Response

As noted in this EIS, given the difficulty of simulating the large-scale processes involved in these tipping points, or inferring their characteristics from paleoclimatology, considerable uncertainties remain on tipping points and the rate of change. Despite the lack of a precise quantitative methodological approach (including an approach to "assess the damages likely to arise from crossing [tipping points]), NHTSA has provided a qualitative and comparative analysis of tipping points and abrupt climate change in Section 8.6.5.2, *Tipping Points and Abrupt Climate Change*. This discussion does not "downplay" the matter, but rather engages with a reasonable literature review of the available science. NHTSA has supplemented this discussion in the Final EIS to include additional material, including some of the information provided by the commenter. While the National Climate Assessment may recognize that some of these feedbacks and processes may be capable of being modeled, NHTSA has neither the expertise nor the responsibility to do so. NHTSA's EIS need not be the authoritative compendium of climate science, but rather must provide a "hard look" at the relevant environmental impacts. NHTSA also need not perform a "worst-case scenario" analysis of crossing tipping points, nor would such an approach be justifiable as there is no way to conclude that this action is singularly responsible for the crossing of any such tipping point. NHTSA believes that the discussion of tipping points and abrupt climate change in Section 8.6.5.2 is thorough and reasonable for this action.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA also errs by using as its only assumptions about cumulative actions to stem climate change those scenarios that leave the world with such untenable results as temperature increases of up to 3.6°C or ppm up to nearly 800, without portraying what such a world will actually look like. There are numerous tools available now to do so, including tools showing the amount of land that will vanish when sea levels rise as projected, the crops that will fail when temperatures reach those projected, the size of the human migration that will occur when land becomes uninhabitable, and the premature mortality rate that will increase within predictable ranges when temperatures exceed 3.6°C above pre-industrial levels. NHTSA's failure to describe the real-world consequences of the alternatives in ways a reader can understand fails the requirements of NEPA and above-cited provisions of the CEQ regulations.

Response

NHTSA has reviewed and incorporated the cited resources provided, as appropriate. For example, Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, includes a discussion of such impacts of climate change, including information on the number of people that live in the coastal zone and that may be affected by sea-level rise, and a link to the National Oceanic Atmospheric Administration (NOAA) sea-level rise viewer mapping tool (Section 8.6.5.2, *Ocean Systems, Coasts, and Low Lying Areas)*; the impacts of climate change on crops (Section 8.6.5.2, *Ocean Systems, Coasts, and Low-Lying Areas;* Chuang Zhao et al. reference was added to the Final EIS*)*; the impact of climate change on human migration (Section 8.6.5.2, *Human Security*); and the impact of climate change on premature mortality (Section, 8.6.5.2, *Human Health*). Section 8.6.5 does not distinguish between the alternatives under consideration; however, it does provide a review of projected real world impacts from increases in GHG emissions. Section 5.2.2.1, *Climate Change Attributes*, also discusses current climate attributes and projects impacts. NHTSA believes that this provides adequate context for the reader to understand the magnitude of the climate effects associated with the action under consideration.

Comment

Docket Number: NHTSA-2017-0069-0608
Organization: New York State Department of Environmental Conservation
Commenter: Basil Seggos

The NHTSA and EPA proposed rule and "supporting" DEIS have failed to take a hard look at the weighing of supposed costs and benefits. The analysis is completely inconsistent with the United States' international commitments and with the actions of many state and local governments to address climate change on behalf of their citizens. In the DEIS, NHTSA states that U.S. GHG emissions are equal to 14% of current worldwide emissions and that transportation is the "single leading source." But the DEIS ignores actions to lower GHG emissions, including the National Program that the proposal seeks to undermine. It would significantly affect global GHG emission rates, resulting concentrations of GHG in the atmosphere, and thereby the projected impacts from climate change. The harms caused to states, including New York, because of these impacts are actual and imminent, as acknowledged by the U.S. Supreme Court in Massachusetts.

NHTSA indicates in the DEIS that it lacks technical and scientific expertise to draw its own conclusions regarding climate change, and instead relied on governmental, or peer-reviewed, reports including EPA's 2009 Endangerment Finding and the IPCC's 2013 5th Assessment Report. But the agencies' proposal indicates that, because new information was available, a 'de novo' analysis was needed to evaluate the need for GHG standards. The ironic result is that NHTSA appears to rely on authoritative reports when discussing the impacts of climate change, but on new unverified analyses or statements to suggest that the impact of this rule on climate change is minimal. These new 'analyses' do not allow for a reasoned reconsideration of the standards.

The background information on GHGs in the DEIS does not reference the set of 6 GHGs that EPA assessed as part of the Endangerment Finding, or even the full list of over 100 GHG assessed by the Intergovernmental Panel on Climate Change (IPCC). It instead paraphrases from a different section of the IPCC that is not directly relevant to the explanation of GHGs, explaining for example, the relative role of ozone and clouds. The DEIS refers interchangeably to the U.S. Energy Information Administration's (EIA) outlooks for 2017 and 2018, which are intentionally conservative and may not reflect transformative trends. Finally, although NHTSA states that it uses either governmental or peer reviewed sources in its assessment of climate change, 'WRI 2018' is cited extensively in 5.2.1 and is neither an authoritative source nor a peer-reviewed report.

Despite its limitations, even the flawed DEIS demonstrates that the impacts of marginal GHG emissions are reasonably foreseeable and impose severe risks on the public. Yet, NHTSA concludes that the GHG emission increases associated with all alternatives - along with the lack of any other meaningful regulatory action by EPA to mitigate GHG emissions from the same sources -will have minimal impacts on the public. The minimization of impacts and the federal government's willingness to leave the public unprotected from the worst effects of climate change is completely unacceptable and at odds with the scientific consensus in multiple scientific reports including the most recent IPCC report.

The most obvious issue is that the agencies refer to a baseline atmospheric concentration of CO_2 that can only align with the worst-case scenario for global climate change (i.e. more than 700ppm; van Vuuren et al 2011). They then claim that the additional contribution of GHG emissions from this proposal will have a minimal impact on these extremely high GHG levels. That error is compounded by the unreasonable base case assumption that 2025 standards **will** remain flat in future years, rather than becoming more stringent year after year, in accordance with EPA's obligation to address the endangerment of climate change. In truth, transportation emissions are the largest source of GHG emissions in the United States, which is second only to China in total GHG emissions. Reducing emissions from the transportation system in the United States is therefore one of the most substantial ways of addressing climate change, and preventing the global catastrophe that would accompany a global GHG concentration of more than 700 ppm.

Under the high-emissions scenario referenced in the DEIS, the United States and New York State would have significant adverse impacts. For example, this scenario is likely to result in more than 6 feet of sea-level rise in Manhattan and elsewhere along the State's tidal coast. These and other impacts would unquestionably impose unacceptable economic and environmental burdens on New York and surrounding states. The use of this apocalyptic scenario as a future baseline is unacceptable and this scenario should primarily be used to illustrate the need for GHG emission reductions. A more refined assessment would focus on identifying how this decision fits into long term needs to reduce GHG emissions from transportation and other sectors over time, and would include a description of the limitations of the 5-year policy decision. Instead, the DEIS seems to surrender to the hopeless inevitability of severe climate change through 2100 and beyond.

While the global emission scenarios are useful in identifying the global scale and worldwide impacts, the global level analysis is not the best method to evaluate an individual action such as the proposed alternative. The comparison of a portion of one country's emissions to global emissions over the next 80 years is not an effective method of protecting the environment. The DEIS could articulate short term policy decisions with long term goals by showing how the decisions conform to a pathway or step down to reach long term goals generally considered to be solutions to climate change. This for example could be part of efforts for the national government to reduce GHGs in line with pledges made by every other country in the world or by coalitions of states. The technology exists and it will be economical during MY 2021 through MY 2026 to make meaningful emissions reductions in the transportation sector of the United States.

The overall approach to minimize the importance of the GHG emission standards for vehicles with regards to the impacts of climate change is inconsistent with basic, publicly available data on the sources of GHG emissions in the U.S. The EPA has publicly reported an annual GHG emission inventory since 1990, per the U.S. obligation as a signatory to the United Nations Framework Convention on Climate Change. In 2016, the most recent year of reporting, U.S. emissions were equal to 38% of all emissions from developed countries. Transportation is the second largest source of emissions in the U.S. after electricity — and road transportation alone is responsible for 23% of all US emissions. Furthermore, not only are U.S. emissions not declining, U.S. emissions are higher today than they were in 1990 and transportation sector emissions have increased 20%.

The existing NHTSA and EPA regulatory programs addressed in the proposed rule have as their clear purposes to reduce fuel combustion and GHG emissions. But the proposed rule makes clear that the federal government now puts unbalanced emphasis on supposed short term costs, rather than overall long-term benefits. If the NHTSA had referenced appropriate authoritative literature regarding cost-benefit analysis as it relates to delayed action on greenhouse gas emissions, it would have found that any short-term costs of action to address climate change are much less than the significant long-term costs of inaction. A good place to start is the IPCC 5th Assessment Report cited in the DEIS.

Response

NHTSA's analysis in this EIS constitutes a "hard look" as required under NEPA. This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions and does not minimize the impact of the current action. The impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, reflect the best available science regarding climate change and its impacts on health, society, and the environment. NHTSA relied primarily on existing expert panel- and peer-reviewed climate change studies and reports when preparing the EIS. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and GCRP, supplemented with additional peer-reviewed literature. In addition, NHTSA has cited a few sources that are not panel- or peer-reviewed, such as WRI 2018 (now updated to WRI 2020), when such sources are widely used and accepted by the scientific community. In this instance, WRI 2020 is widely recognized and cited as a leading, comprehensive, and up-to-date source of global GHG emissions. NHTSA relies on the entirety of the record in the EIS in making its decision, as described in Section VIII of the preamble to the final rule.

NHTSA recognizes there are many contributors to global climate change, including many GHGs. As described in Chapter 5, NHTSA's analysis focuses on the primary drivers of climate change, especially as it pertains to the Proposed Action and alternatives, rather than focusing on factors that are less significant. This is consistent with the requirements of the CEQ regulations (40 CFR § 1502.1 ["Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data."]).

NHTSA disagrees with the commenter's assertion that it is unreasonable to assume that 2025 standards would remain flat in future years, rather than becoming more stringent year after year. NHTSA recognizes that both agencies involved in this action have ongoing responsibilities to regulate fuel economy and CO_2 emissions, respectively. However, the level of future stringency increases are unknowable at this time, since NHTSA is not setting those standards as part of this rulemaking. Further, incorporating such increases into the baseline would give the erroneous impression that the alternatives under consideration in this action were already planned or underway. However, NHTSA's modeling does assume fuel economy increases in the future based on anticipated manufacturer actions (e.g., incorporating additional fuel economy technology if the payback period warrants it), as described in the preamble to the final rule and the Final EIS.

NHTSA considered the environmental impacts of this rulemaking, including the contents of this Final EIS, as it developed its final rule. NHTSA does not frame its analysis as an "apocalyptic scenario," but rather considers a variety of GCAM scenarios to best understand the potential impacts of the Proposed Action and alternatives regardless of the level of global effort to address climate change. NHTSA believes this provides sufficient information and context to understand the potential impacts of its action.

For the reasons discussed in Section VIII of the preamble to the final rule, based on the information before the agencies and considering carefully the comments received, NHTSA determined that the preferred alternative identified in the proposal—amending the MY 2021 standards to match MY 2020, and holding those standards flat through MY 2026—does not represent the maximum feasible standards, and that the maximum feasible standards for MYs 2021–2026 passenger cars and light trucks increase in stringency by 1.5 percent per year from the MY 2020 standards. While CO_2 emissions (and other environmental impacts) will be higher under this final rule than if NHTSA had determined that the augural standards were maximum feasible, they will be lower than they would have been under the proposal. The preamble to the final rule (like the NPRM before it) includes lengthy discussions of how environmental impacts, including climate change, factored into the agency's balancing of the EPCA statutory factors. NHTSA must adhere to its statutory authority and consider environmental impacts as one of several factors it must balance.

10.8.2.1 Emissions Scenarios Used for the Quantitative Cumulative Impacts Analysis

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

As in its discussion of the direct and indirect effects of the greenhouse gas emission increases caused by its Proposal and alternatives, NHTSA fails to take the requisite "hard look" at their cumulative effects. Notably, missing from the DEIS are key data tables that were presented in the 2012 Final EIS accompanying the MY2017-2025 standards:

- Tables showing total greenhouse gas emissions from new cars through 2100 in $MMTCO_2$ by alternative and as compared to the No Action Alternative, in meaningful time increments;
- Tables showing the cumulative impacts of each action alternative as compared to the No Action Alternative in terms of monetized damages as measured by the social cost of carbon, in meaningful time increments.

Here again, the absence of these crucial tables from the DEIS itself falls short of the requirement that NHTSA "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public." 40 C.F.R. § 1502.14.

Response

As discussed in Section 10.5, *Greenhouse Gas Emissions and Climate Change,* NHTSA addressed an issue in the Final EIS in which some tables and figures were inadvertently omitted from the Draft EIS, including a table showing total GHG emissions from new cars through 2100 in million metric tons of carbon dioxide ($MMTCO_2$) by alternative and as compared to the No Action Alternative, in meaningful time increments. Table 5.4.1-2, Emissions of Greenhouse Gases ($MMTCO_2e$ per year) from All Passenger Cars and Light Trucks by Alternative, has been added back to Section 5.4, *Environmental Consequences*. For the reasons explained in that section, this information was available elsewhere in the Draft EIS or could be easily calculated from information reported elsewhere in the Draft EIS. Therefore, NHTSA took a "hard look" in the Draft EIS at this material.

NHTSA also responds to several comments in Section 10.5.2, *Social Cost of Carbon*, regarding its decision to present its social cost of carbon analysis in the preamble to the final rule and FRIA rather than in the EIS. Those responses are incorporated by reference here.

Comment

Docket Number: NHTSA-2017-0069-0688
Organization: National Tribal Air Association
Commenter: Wilford Nabahe

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

The proposed rule also fails to adequately address the new petroleum demand and additional increases in other GHG emissions, including CH_4 and N_2O, which are released by stationary sources and mobile sources during oil extraction, production, refining, transportation, and distribution.

Response

As discussed in Section 10.5, *Greenhouse Gas Emissions and Climate Change,* NHTSA addressed an issue in the Final EIS in which some tables and figures were inadvertently omitted from the Draft EIS. Table 5.4.1-2, Emissions of Greenhouse Gases ($MMTCO_2e$ per year) from All Passenger Cars and Light Trucks by Alternative, has been added back to Section 5.4, *Environmental Consequences*. For the reasons explained in that section, this information was available elsewhere in the Draft EIS or could be easily calculated from information reported elsewhere in the Draft EIS.

As documented in Section 5.3.1, *Methods for Modeling Greenhouse Gas Emissions*, and further detailed in Section VI of the preamble to the final rule, the GREET model developed by the U.S. Department of Energy Argonne National Laboratory is used to estimate upstream emissions associated with recovery, extraction, and transportation, as well as during the refining, storage, and distribution of transportation of fuels. This upstream emissions information is included in the values reported in Table 5.4.1-2.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA provides information about strong surges in sales of electric vehicles. It notes that China, the largest vehicle market in the world, has quotas for plug-in electric and fuel cell vehicles of at least 10 percent of each automaker's sales in China in 2019, rising to 12 percent in 2020, with higher annual targets expected thereafter; in fact, China is expected to phase out sales of internal combustion vehicles altogether by 2040. NHTSA also states that Norway, the Netherlands, France, Austria, Denmark, Ireland, Japan, Portugal, Korea, Spain and Britain have also adopted zero-emission vehicle targets or pledged to end sales of new internal combustion vehicles between 2025 and 2040, and that the European Union and India are considering such phase-out targets by 2030. And it notes that ten U.S. states have also adopted zero-emission vehicle targets that rise by 2 percent per year to 16 percent in 2025. NHTSA also notes automakers' investments of many billions of dollars into EV models and the planned introduction of numerous new such models into the market after 2019. Despite all of this information, NHTSA does *not* factor these developments into its projections of the future vehicle fleet or its emissions of greenhouse gases, traditional pollutants, or toxics. Nor does it consider whether a freeze in vehicle standards will hamper technological innovation and development, including EV development, not only in the U.S. but also around the world, and what impact such retrenchment would have world-wide. Instead, NHTSA simply calls the impact of increasing EV sales and targets "too complex" for quantification and does not factor them into its models. In light of the abundant evidence of a surge in EV sales in the near future, NHTSA's failure to account for it is turning a blind eye to the obvious—the opposite of a "hard look."

Response

NHTSA presents the information cited by the commenters in the acknowledgement that EV sales and production targets in other nations could reduce the cost of EVs and thereby increase EV demand in the United States over time, but the uncertainties associated with this possibility are too complex to support specific quantified forecasts of associated impacts. NHTSA cannot feasibly model the light duty sector on a global scale, nor can it predict how manufacturers and purchases in other countries will respond to the alternatives considered by NHTSA for the U.S. light duty sector. In Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, NHTSA presents the potential climate change impacts of the Proposed Action and alternatives using several GCAM scenarios, thereby taking a "hard look" at the alternatives in the context of various potential levels of global effort to mitigate climate change.

In fact, attempting to incorporate these assumptions directly into NHTSA's modeling would appear to conflict with the commenters' position that more stringent standards are necessary to ensure improvements in fuel economy. While automaker investments and public announcements are informative of future product plans, as discussed in Section VI of the preamble to the final rule, NHTSA considers a wide range and complex set of factors in modeling a feasible compliance scenario with the CAFE model.

10.8.2.2 Other Past, Present, and Reasonably Foreseeable Future Actions

Comments

Docket Number: NHTSA-2017-0069-0492
Commenter: Andrew Yamamoto

The EPA plans to allow well owners to increase their release of methane, a potent climate change chemical. See EPA Announces Proposal to Roll Back Obama-Era Rules on Methane Emissions, Wall Street Journal, September 15, 2018. Given that the methane decision will impact the climate in a manner similar to vehicle emissions, the new DEIS must consider the cumulative effects of the vehicle emission and methane rules. Truth be told, the DEIS, and the EIS for every major federal action that will increase the production or release of climate changing elements or compounds, must fully analyze and disclose the cumulative effect of the action when aggregated with the effect of all other human activities

Docket Number: NHTSA-2017-0069-0706
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto

Moreover, even assuming that the DEIS and EIS adequately analyzed the climate change issue with respect to the mileage regulation, they failed to properly analyze the regulation's cumulative impacts when one considers other pending proposals that have adverse climate impacts. For example, the EPA is considering Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Reconsideration ID: EPA-HQ-OAR-2017-0483-0005. The proposed emission standards will allow the increased release of methane (a greenhouse gas). There is a wealth of published scientific evidence that methane leaks associated with oil and natural gas production present a major climate change danger. For example, one UN article states in part:

> "The Problem with Methane
>
> "Methane is a greenhouse gas as is carbon dioxide. Human activity has increased the amount of methane in the atmosphere, contributing to climate change. Methane is particularly problematic as its impact is 34 times greater than CO_2 over a 100-year period, according to the latest IPCC Assessment Report. A significant source of human-made methane emissions is fossil fuel production. For example, methane is a key by-product of the rapidly rising global extraction and processing of natural gas. Other top sources of methane come from the digestive process of livestock and from landfills, which emit it as waste decomposes.

"The Growing Response to Climate Change

> "The current level of response remains inadequate to keep the average global temperature rise below two degrees Celsius, beyond which expected climate change impacts become significantly worse. But action to curb human-generated greenhouse gas emissions is rapidly increasing at every level of government, business, cities and civil society as the many economic, social and environmental benefits of taking climate action become clear."

UN Article, "Why Methane Matters", Aug. 7, 2014.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

The agency also omits consideration of the effects of the current administration's overall deregulatory agenda, which seeks an across-the-board rollback of rulemakings designed to curb greenhouse gas emissions. Chief among those are EPA's proposals to rescind or amend the Clean Power Plan, which, if implemented, would significantly reduce emissions from power plants; efforts to weaken, delay, or eliminate rules and regulations that limit greenhouse gas emissions from the oil and gas sector; the Department of Interior's decision to end the moratorium on federal coal leasing; and the administration's decision to exit the Paris Agreement. A "hard look" cumulative impact analysis requires discussion of these other actions and a disclosure of the effect of taking them, or not taking them.

NHTSA must disclose and analyze the cumulative impacts of the current administration's numerous actions to roll back existing environmental regulations that reduce greenhouse gases in light of the special report recently issued by the IPCC. The report makes abundantly clear that emissions must be reduced dramatically *within the next decade* if we are to avoid massive additional damages by overshooting the target of limiting additional warming to no more than 1.5° C. The six years of emissions the Proposal would affect (2021-2026) are the very years for which the agencies plan to *reverse* the progress in emission reductions from the vehicle fleet.

Docket Number: NHTSA-2017-0069-0573
Organization: Environmental Law & Policy Center
Commenter: Ann Mesnikoff

NHTSA's cumulative impacts analysis is flawed because it fails to account for other actions the administration is taking that will increase climate pollution. No single policy, including CAFE standards, is a solution to reducing the threats of climate change. Each policy that reduces emissions, however, is a critical component to essential domestic climate pollution reductions and contributes to global reductions and commitments.

According to NHTSA, this "EIS analyzes the potential direct, indirect, and cumulative impacts of the Proposed Action and alternatives. Cumulative impacts are the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." NHTSA claims it has considered the best available information and includes extensive analyses of the potential impacts of the Proposed Action and alternatives in the RIA and this EIS.

Yet NHTSA fails to consider and assess the cumulative impacts of other actions the administration is taking to *increase* climate pollution. These actions include the rollback of the Clean Power Plan, methane standards, and addressing HFCs.

Clean Power Plan: EPA's rollback of the Clean Power Plan should be factored into the EIS as a present action of the administration. When proposing to rescind the Clean Power Plan (CPP), EPA estimated that the energy sector would have cumulatively produced 384 MMT more CO_2 by 2030 without the CPP than it would have if the plan remained in place. Calculations conducted by independent researchers suggest that this estimate may substantially understate the emissions reductions which would have occurred under the CPP. One recent study, for example, calculated that the CPP would have reduced emissions by up to 72 MMT each year, assuming that states chose to implement the cap and trade system.

NHTSA should include these increased emissions in the same context it considers emission increases from freezing standards for MY2021-2016 so as to ensure the public and decision makers understand the consequences of the action on CAFE standards in a more complete and accurate context. Further, the CPP rollback could increase emissions associated with charging electric vehicles including in the Midwest which remains heavily reliant on dirty coal fired power plants. These added climate and air quality impacts must be assessed in a valid DEIS.

Methane Rules: The administration is actively weakening methane emissions standards for the oil and gas industry. These weaker standards will drive up emissions of methane, a powerful greenhouse gas, but specifically drive up methane emissions associated with the 500,000 barrels per day of additional oil consumption that result NHTSA and EPA calculate will result from the preferred alternative.

EPA has issued a proposal to roll back standards to limit methane emissions from new or modified oil and gas facilities. According to EPA, this proposal will increase emissions by between 344,730 to 435,448 metric tons of methane between 2019 through 2025. This is the equivalent of between 8.5 and 11 MMT of CO_2.

In addition, the Bureau of Land Management has issued a final rule that replaces its standards for reducing waste from the oil and gas industry on public lands. When it promulgated the final rule in 2016, the Bureau of Land Management projected that the rule would reduce methane emissions by between

175,000 and 180,000 tons per year. The agency calculated that this would have reduced methane emissions by approximately 35% from its 2014 levels.

Both the BLM and EPA actions are "reasonably foreseeable future actions" that should have been considered in the cumulative impacts analysis. These methane rollbacks and how they will directly, indirectly and cumulatively impact both the climate and the emissions associated with the additional 500,000 barrels of oil consumption per day that results from adoption of the preferred freeze of standards should have been considered in the DEIS. Absent this update, the DEIS deceives the reader and decision makers as to the full impacts of driving up oil consumption.

Hydrofluorocarbons: On November 18, 2016, EPA finalized a rule that regulated the use of hydrofluorocarbons, an extremely potent, ozone-depleting, greenhouse gas found primarily in certain kinds of refrigerants. Depending upon their precise chemical composition, hydrofluorocarbons have several thousands of times more global warming potential than carbon dioxide. On Sept. 18, 2018, EPA unveiled a proposed rule to substantially weaken regulations of hydrofluorocarbons, which, by the agency's own calculations would increase greenhouse gas emissions by the equivalent of 3 MMT of CO_2 per year.

Although EPA's proposal to reduce regulations of hydrofluorocarbons was released after the DEIS was issued, the final EIS must assess the combined impact of EPA's proposed action alongside NHTSA's proposed revisions to the light-duty fuel efficiency standards.

NHTSA's failure to account for the full impacts of this administration's rollbacks limits the utility of the climate (and air quality) analysis in the DEIS. NHTSA should reevaluate the climate impacts of the NPRM and in the DEIS to ensure the public and decision makers are fully informed on the climate impacts of the proposal in context of other administrative actions.

Docket Number: EPA-HQ-OAR-2018-0283-1414
Commenter: Ron Lindsay

Comment 3. The EIS for this policy change must address the climate impacts of the entire US Government fossil fuel policy, including Presidential Executive Order #13783.

The Draft EIS states there will be a 3.48C increase in global mean temperature by 2100 and an increase in the global sea level of 76 cm (page s-15). These are astonishing and scary projections that will have major health and economic impacts on the American public and since this rule change will contribute to the changes, however small if only five years are considered, it is incumbent for the EIS to address the entire governments approach for mitigating such a large and detrimental change in our national environment.

As the NEPA lead agency for this proposal, the NHTSA is responsible for ensuring the respective federal environmental rules and regulations are followed thoroughly and without bias during the NEPA process. The EPA states that under NEPA all of the actions that may contribute to cumulative impacts must be considered along with the project direct effects:

> Geographic boundaries and time periods used in cumulative impact analysis should be based on all resources of concern and all of the actions that may contribute, along with the project effects, to cumulative impacts. ***Generally, the scope of analysis will be broader than the scope of analysis used in assessing direct or indirect effects.*** To avoid extending data and analytical

> requirements beyond those relevant to decision making, a practical delineation of the spatial and temporal scales is needed. ***The selection of geographic boundaries and time period should be, whenever possible, based on the natural boundaries of resources of concern and the period of time that the proposed action's impacts will persist, even beyond the project life.*** EPA reviewers should determine whether the NEPA analysis has used geographic and time boundaries large enough to include all potentially significant effects on the resources of concern. The NEPA document should delineate appropriate geographic areas including natural ecological boundaries, whenever possible, and should evaluate the time period of the project's effects. [Consideration of Cumulative Impacts In EPA Review of NEPA Documents, U.S. Environmental Protection Agency, Office of Federal Activities (2252A) EPA 315-R- 99-002/May 1999. Italics added for emphasis.]

As the lead agency the NHTSA is required to analyze the entire policy. There is a key concept articulated by the Council on Environmental Quality (CEQ) in the handbook entitled *Considering Cumulative Effects under the National Environmental Policy Act* (1997)

> The Council on Environmental Quality's (CEQ) regulations (40 CFR $$ 1500 - 1508) implementing the procedural provisions of the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. $$ 4321 et seq.), define cumulative effects as
>
>> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions ***regardless of what agency*** (Federal or non- Federal) or person undertakes such other actions (40 CFR ~ 1508.7). [italics added for emphasis]

Thus the claim that the EIS need not consider the cumulative impact of the entire US Government energy policy is incorrect. Furthermore the CEQ Handbook states

> Specifically, NEPA requires that ***all related actions be addressed in the same analysis***. For example, the expansion of an airport runway that will increase the number of passengers traveling must address not only the effects of the runway itself, but also the expansion of the terminal and the extension of roadways to provide access to the expanded terminal. If there are similar actions planned in the area that will also add traffic or require roadway extensions (even though they are nonfederal), they must be addressed in the same analysis. [page 1, italics added for emphasis]

and

> The purpose of cumulative effects analysis, therefore, is to ensure that ***federal decisions consider the full range of consequences of actions***. [page 3, italics added for emphasis]

and

> Many times there is a mismatch between the scale at which environmental effects occur and the level at which decisions are made. Such mismatches present an obstacle to cumulative effects analysis. ... ***Cumulative effects analysis should be the tool for federal agencies to evaluate the implications of even project-level environmental assessments (EAs) on regional resources*.** [page 4, italics added for emphasis]

According to CFR-2012-title33-vol3-part230, page 317

> The initial broad or programmatic EIS must present sufficient information regarding ***overall impacts*** of the proposed action so that the decision-makers can make a reasoned judgment on the merits of the action ...[italics added for emphasis]

Response

NHTSA assesses the impact of the action in the context of several global emissions scenarios in this EIS. The GCAM Reference scenario is used by NHTSA for the direct and indirect analysis, which does not assume comprehensive global actions to mitigate GHG emissions. The GCAM6.0 scenario is used in the cumulative analysis. GCAM6.0 does not include specific climate change mitigation policies; it does, however, represent a plausible future pathway of global emissions in response to a moderate global action to mitigate climate change. For further discussion, see Final EIS Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact Analysis*. As NHTSA is unable to quantify the emissions impacts of every federal action (as such calculations are complex and federal agency reports may not rely on the same assumptions), the agency believes the GCAM6.0 scenario serves as a reasonable proxy for a moderate level of global action.

Section 8.6.3, *Other Past, Present, and Reasonably Foreseeable Future Actions*, documents and, to the extent possible, quantifies U.S. and international actions that will increase or decrease GHG emissions. NHTSA recognizes that an additional discussion of administrative actions would provide further context for its cumulative analysis and, in response to this comment, has added a discussion of federal actions that are already underway or reasonably foreseeable that will increase GHG emissions in Section 8.6.3.2, *United States: Federal Actions*. However, other domestic and global actions indicate that a moderate reduction in the growth rate of global GHG emissions is reasonably foreseeable in the future. Therefore, NHTSA believes the GCAM6.0 scenario is still representative of broader global emissions trends and should be used for the cumulative impacts analysis in this EIS. (To the degree to which commenters believe such moderate reductions are implausible in light of the administration's actions, such commenters can consult the direct and indirect analysis, which uses the GCAM Reference scenario.)

To conduct a sensitivity analysis, NHTSA also models the RCP4.5 scenario, a more aggressive emissions stabilization scenario. This approach ensures that a range of consequences of the Proposed Action and alternatives is considered in the context of other global actions. Ultimately, regardless of which scenario is used, the impact of the Proposed Action and alternatives on climate attributes would be small.

NHTSA disagrees with the comment saying that NHTSA's EIS must analyze the climate impacts of the entire U.S. government's fossil fuel policy, including the entire government's approach for mitigating climate change. NHTSA's responsibility under NEPA is to analyze the potential environmental impacts of its Proposed Action and alternatives to allow for a reasoned choice among those alternatives, not to formulate climate policy for the entire federal government. If every agency were responsible for conducting a similar analysis, it would lead to burdensome and duplicative analyses. NHTSA has considered the potential impacts of various levels of global effort to mitigate GHG emissions by using a variety of scenarios in the EIS. This is a reasonable approach to assess the cumulative impacts of the agency's action.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NHTSA's artificial minimization of the Proposal's effects is amplified by its use of "GCAM 6.0" modeling, which assumes a "moderate" response to climate change that results in 678 ppm of atmospheric CO_2 concentrations by 2100. At those concentrations, climate change would have already advanced to such an extent that overall worldwide emission increases would overwhelm what by themselves are highly significant differences among the action alternatives chosen now.

NHTSA uses two other scenarios in its sensitivity analysis, but both also assume very high increases in emissions (resulting in 544 ppm and 789 ppm in 2100, respectively). NHTSA does not present any scenario that assumes aggressive global action holding increases in ppm to 450 ppm (or returning to that level once emissions have peaked), even though such a response is clearly among the reasonably foreseeable actions by third parties in light of the catastrophic changes that inevitably accompany ppm and temperature ranges as high as those assumed. Forgoing this necessary comparison also ignores the Paris Climate Agreement, to which the U.S. remains a party and in which 195 nations pledged to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels and pursu[e] efforts to limit the temperature increase to 1.5°C above pre-industrial levels." It also violates NHTSA's obligation to "inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." 40 C.F.R.§ 1502.1. *See also Friends of Se.'s Future v. Morrison*, 153 F.3d 1059, 1065 (9th Cir. 1998) ("The existence of reasonable but unexamined alternatives renders an EIS inadequate"). As NHTSA describes only those among many alternative responses to the global climate threat that worsen the environmental and health impacts of carbon emissions beyond the breaking point, it has failed to comply with 40 C.F.R. § 1502.1.

Moreover, NEPA and its implementing regulations direct federal agencies to "[u]se the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment," and "[u]se all practicable means ... to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment." 40 C.F.R. §§ 1500.2(e) and (f). Plainly, the proposed action and alternatives artificially force exactly the opposite outcome, and do not model a scenario where emission reductions from the light duty vehicle fleet would contribute to the avoidance or minimization of environmental harm. In sum, because NHTSA's analysis describes only massive worldwide failure to act in the face of enormous risks and masks the actual effects of actions taken, or not taken, during 2021-2026, while failing to disclose and discuss reasonable alternatives avoiding or minimizing those outcomes, the DEIS fails its purpose and must be withdrawn.

Response

This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions. The GCAM Reference scenario is used by NHTSA for the direct and indirect analysis, which does not assume comprehensive global actions to mitigate GHG emissions. The cumulative impacts analysis uses the

GCAM6.0 scenario, which does not include specific climate change mitigation policies but does represent a plausible future pathway of global emissions in response to a moderate global action to mitigate climate change. For further discussion, see the revised Final EIS Section 8.6.2.1, *Global Emissions Scenarios Used for the Cumulative Impact Analysis*. To conduct a sensitivity analysis, NHTSA also models the RCP4.5 scenario, a more aggressive emissions stabilization scenario. NHTSA believes that this approach reasonably ensures that it has considered a full range of consequences of the Final Action and alternatives within the context of other reasonably foreseeable future actions, as required under the NEPA regulations.

NHTSA did consider the RCP2.6 scenario when developing its analysis. The RCP2.6 scenario represents an even more aggressive emission stabilization scenario than the RCP4.5 scenario. The RCP2.6 scenario yields a radiative forcing of approximately 2.6 watts per square meter and an atmospheric CO_2 concentration of roughly 426 ppm in the year 2100. RCP2.6 assumes that global emissions peak around 2020 and that significant global emission reductions begin to occur before 2020. Under RCP2.6, cumulative emissions of greenhouse gases from 2010 to 2100 are reduced by 70 percent compared to the baseline scenario, requiring substantial changes in energy use and emissions of non-CO_2 gases. RCP2.6 was not included in the EIS analysis because it is not reasonably foreseeable, given the current trajectory of global emissions. Nevertheless, the table below shows NHTSA's modeling results using the RCP2.6 scenario for the commenter's reference.

Under the RCP2.6 scenario, CO_2 concentrations under the No Action Alternative are 425.5 ppm in 2100, and range from 425.6 under Alternative 7 to 426.0 ppm under Alternative 1 in 2100. For 2040 and 2060, the corresponding range of ppm differences across alternatives is even smaller. Because CO_2 concentrations are the key determinant of other climate effects (which, in turn, drive the resource impacts discussed in Section 8.6, *Cumulative Impacts—Greenhouse Gas Emissions and Climate Change*), this leads to very small differences in these effects.

Under the No Action Alternative, using the RCP2.6 scenario, global surface air temperature is projected to increase from 1986 to 2005 average levels by 0.893 °C by 2040, 1.060°C by 2060, and 1.109 by 2100. The differences among the increases in baseline temperature projected to result from the various action alternatives are very small compared to total projected temperature increases. For example, under RCP2.6, in 2100 the increase in temperature rise compared to the No Action Alternative ranges from 0.001°C under Alternative 7 to 0.003°C under Alternative 1. As noted in this EIS, each of the alternatives represents a different level of stringency NHTSA considered in balancing policies and considerations in setting the standards.

GCAMs dynamically couple climate and water systems with human systems, such as representations of the energy sector, economy, and land use. As a result, an alternative action applied to different emissions scenarios (e.g., GCAM Reference versus RCP2.6) will inevitably result in different amounts of future atmospheric CO_2 and, in turn, climate change impacts due to both natural (i.e., carbon cycle) and anthropogenic (i.e., energy demand) feedbacks simulated within the model. Ultimately, however, the conclusion is the same: regardless of the GCAM scenario assumed, the impacts of the Proposed Action and alternatives on climate attributes would be small. The purpose of the EIS is to allow NHTSA to meaningfully distinguish among the alternatives, not to consider the appropriate level of other actions unrelated to the agency's action that need be undertaken to address climate change. In fact, presenting this analysis as the primary analysis in the EIS could give the false impression that the issue of climate change has already been "solved," and that further reductions in GHG emissions are, therefore, irrelevant. NHTSA believes its choice of GCAM scenarios to present in the EIS are reasonable and appropriate to provide a "hard look" at the potential impacts of the Proposed Action and alternatives.

CO_2 Concentrations and Global Mean Surface Temperature Increase (RCP2.6) by Alternative[a]

	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C) [b, c]		
	2040	2060	2100	2040	2060	2100
Totals by Alternative						
Alt. 0[d]	438.1	441.6	425.5	0.893	1.060	1.109
Alt. 1	438.2	441.9	426.1	0.893	1.062	1.114
Alt. 2	438.2	441.9	426.1	0.893	1.062	1.114
Alt. 3	438.2	441.9	426.0	0.893	1.062	1.113
Alt. 4	438.2	441.9	426.0	0.893	1.061	1.113
Alt. 5	438.2	441.8	425.9	0.893	1.061	1.112
Alt. 6	438.2	441.8	425.8	0.893	1.061	1.112
Alt. 7	438.2	441.7	425.7	0.893	1.060	1.111
Increases Under Alternatives						
Alt. 1	0.11	0.31	0.61	0.001	0.002	0.004
Alt. 2	0.11	0.30	0.58	0.001	0.002	0.004
Alt. 3	0.10	0.27	0.54	0.001	0.002	0.004
Alt. 4	0.09	0.25	0.50	0.000	0.002	0.004
Alt. 5	0.07	0.19	0.38	0.000	0.001	0.003
Alt. 6	0.06	0.16	0.31	0.000	0.001	0.002
Alt. 7	0.04	0.11	0.21	0.000	0.001	0.002

Notes:
[a] The numbers in this table have been rounded for presentation purposes. As a result, the reductions might not reflect the exact difference of the values in all cases.
[b] The values for global mean surface temperature are relative to the average of the years 1986–2005.
[c] Temperature changes reported as 0.000 are more than zero but less than 0.0005.
[d] No Action Alternative
°C = degrees Celsius; ppm = parts per million

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

Also missing is a description, let alone quantification, of climate change damage that has already occurred during the last several years, an assessment which is now possible because of advances in attribution studies. As summarized by the Fourth National Climate Assessment, "[i]n addition to warming, many other aspects of global climate are changing, primarily in response to human activities.

Thousands of studies conducted by researchers around the world have documented changes in surface, atmospheric, and oceanic temperatures; melting glaciers; diminishing snow cover; shrinking sea ice; rising sea levels; ocean acidification; and increasing atmospheric water vapor." For example, recent studies of Hurricane Harvey and the 2016 flood in south Louisiana concluded that climate warming made the record rainfall totals of both disasters more likely and intense. In 2016, the intense marine heat wave off Alaska—which drove oyster farm failures, harmful algal blooms, mass seabird die offs, and failed subsistence harvest—was found to be up to fifty times more likely due to anthropogenic warming. In the continental western U.S., human-caused climate change accounted for more than half of observed increases in forest fuel aridity from 1979 to 2015. One model suggests that anthropogenic climate change may have quintupled the risk of extreme vapor pressure deficit (a measure of atmospheric moisture) in the western U.S. and Canada in 2016, increasing the risk of wildfire. In addition to warming Earth's climate, CO_2 emissions have made the surface of global oceans about 30 percent more acidic over the last 150 years. Studies show hundreds of billions in climate change damage suffered *annually* in recent years. For example, research shows that the cost of U.S. hurricane damage has increased because of human-caused climate change, estimated as adding between $2 and $14 billion of losses in 2005. In 2017, there were 16 separate extreme weather and climate disaster events in the U.S. with damages exceeding $1 billion each, totaling $312 billion and making 2017 by far the costliest year on record in terms of climate harms.

Response

In response to this comment, NHTSA has revised Final EIS Section 5.2.2.1, *Climate Change Attributes,* to provide a more comprehensive summary of the observed and anticipated trends in climate change. In Final EIS Section 5.2.2.2, *Increased Incidence of Extreme Weather Events,* NHTSA has added information on the attribution of Hurricane Harvey to climate change. In Final EIS Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change,* NHTSA has updated the overview of the recent findings regarding both observed and projected impacts of climate change on a number of resource areas to account for sources that were published after the release of the Draft EIS. These sections focus on global and regional trends in impacts rather than on the attribution of specific extreme weather events.

This EIS reflects NHTSA's careful consideration of the environmental impacts of its action and a reasonable range of alternatives. NHTSA need not document every single impact of climate change in its EIS to provide a "hard look" at the potential impacts of the Proposed Action and alternatives. NHTSA believes the information presented in the Final EIS provides sufficient context to make a reasoned choice among alternatives.

Comment

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

No dispute remains that meaningful consideration of the environmental damage caused by greenhouse gas emissions is required as part of any NEPA review of direct, indirect and cumulative impacts of agency action. See, e.g., *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1217 (9th Cir. 2008) ("The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."); *Sierra Club v. FERC*, 867 F.3d 1357, 1371 (D.C. Cir. 2017) (NEPA review must consider the direct and indirect effects of greenhouse gas emissions of the alternatives). In 2016, the Department of Transportation published for comment DOT Order 5610.1D, setting forth procedures to address climate change when conducting a NEPA analysis of its proposed actions. DOT Order 5610.1D(2)(a) (establishing procedures for consideration of environmental impacts as part of the decision-making process for Department of Transportation actions) and (c)(6) (stating that DOT will strive to create an environmental review process that considers climate change). The Council on Environmental Quality issued a Final Climate Guidance, 81 Fed. Reg. 51,866 (Aug. 5, 2016),[104] which states the following:

> If the direct and indirect GHG emissions can be quantified based on available information, including reasonable projections and assumptions, agencies should consider and disclose the reasonably foreseeable direct and indirect emissions when analyzing the direct and indirect effects of the proposed action. Agencies should disclose the information and any assumptions used in the analysis and explain any uncertainties. To compare a project's estimated direct and indirect emissions with GHG emissions from the no-action alternative, agencies should draw on existing, timely, objective, and authoritative analyses, such as those by the Energy Information Administration, the Federal Energy Management Program, or Office of Fossil Energy of the Department of Energy. In the absence of such analyses, agencies should use other available information.

NHTSA's disclosure and discussion of the greenhouse gas effects of its Proposal and its alternatives fails NEPA's "hard look" test for numerous reasons.

Response

NHTSA's analysis in this EIS constitutes a "hard look" as required under NEPA. This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions. In Chapter 5, *Greenhouse Gas Emissions and Climate Change*, NHTSA quantifies the direct and indirect GHG emissions based on available information, as previously required by the withdrawn CEQ guidance. NHTSA also presents a cumulative impacts analysis in Chapter 8, *Cumulative Impacts*, which includes a qualitative discussion of the impacts of climate change on key natural and human resources (Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*).

Comments

Docket Number: NHTSA-2017-0069-0526
Organization: Oregon Department of Environmental Quality
Commenter: Richard Whitman

Oregon has an aggressive long-term GHG emission reduction goal: 75% below 1990 levels by 2050 (Figure 1). While emissions from all other sectors are declining, emissions from motor vehicles are climbing. The transportation sector is the single largest source of GHG emissions in Oregon comprising nearly 40% of statewide emissions.

[See original comment for Figure 1 titled Oregon's Greenhouse Gas Inventory]

[104] Although this guidance was withdrawn on April 5, 2017, Withdrawal of Final Guidance for Federal Departments and Agencies on Consideration of GHG Emissions and the Effects of Climate Change in NEPA Reviews, 82 Fed. Reg. 16,576 (Apr. 5, 2017), it was withdrawn for political, not legal or technical reasons and has not been replaced; at a minimum, it continues to have persuasive value.

*   *   *   *   *

To meet our state GHG targets, the Oregon transportation sector must transition to cleaner fuels, reduce the number of miles driven, and convert to cleaner vehicles. In 2017, Governor Kate Brown issued an Executive Order (17-21) establishing a goal of 50,000 registered and operating electric vehicles in Oregon by 2020, and outlining policies designed to achieve that goal. Oregon's programs to reduce transportation sector emissions include:

- A strong vehicle inspection program;
- A clean fuels program that imposes a declining limit on the carbon intensity of transportation fuels and provides incentives to electric vehicle charger owners and electric utilities to support Oregon's transition to electric vehicles;
- A state cash rebate for the purchase or lease of an electric vehicle of between $2,500 and $5,000 per vehicle;
- Leveraging up to 15 percent of the Volkswagen Mitigation Fund to develop and maintain EV charging stations with a focus on connecting rural communities, low-income communities, and Oregonians living in multi-family homes;
- Conversion of the state light duty vehicle fleet to electric and hybrid cars, and the aggressive installation of vehicle charging stations at state facilities; and
- Requirements for Oregon's electric utilities to make investments in transportation electrification to encourage more rapid EV adoption.

In sum, Oregon has invested heavily in decarbonizing the transportation sector. The proposed action by EPA and NHTSA threatens to devalue and undercut these investments, and to place a greater regulatory burden on industry and consumers to meet other state and federal emissions requirements.

*   *   *   *   *

We have adopted state programs to lower the carbon intensity of our transportation fuels, integrate land use and transportation planning to reduce vehicle miles traveled per capita and decarbonize our electricity, but we must continue to have the cleanest and most efficient passenger cars and trucks available in Oregon to avoid emissions that will result in the worst effects of climate change. Weakening requirements for vehicles will place a greater burden on future consumers to address greenhouse gas emissions, and shift the shorter-term burden from automobile manufacturers to fuel suppliers and other sectors of our economy.

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

Mobile sources – cars, trucks, and myriad off-road equipment – and the fossil fuels that power them, are a big source, if not the biggest source, of the emissions that are hurting public health and changing the climate.

In 2016, greenhouse gas emissions from the transportation sector accounted for about 28 percent of total U.S. greenhouse gas emissions, making it the largest contributor of U.S. greenhouse gas emissions. In terms of the overall trend, from 1990 to 2016 total transportation emissions increased due, in large part, to increased demand for travel. The number of vehicle miles traveled (VMT) by light-duty motor vehicles (passenger cars and light-duty trucks) increased by approximately 45 percent from 1990 to 2016 as a result of a confluence of factors including population growth, economic growth, urban sprawl, and periods of low fuel prices.

Mobile sources are also the largest contributors to the formation of ozone, PM2.5, toxic diesel particulate matter, and greenhouse gas (GHG) emissions in California. Because of this, vehicular emissions must be significantly cut to achieve the NAAQS for ozone in 2023 and 2031, and to reduce GHG emissions by over 40 percent below 1990 levels by 2030. The interconnected strategies necessary to meet these goals has led California to develop an integrated planning approach to control vehicular emissions over the next 15 years that includes a comprehensive transformation to cleaner vehicle technologies, fuels, and energy sources.

Response

The cumulative impacts analysis in Chapter 8, *Cumulative Impacts*, uses the GCAM6.0 scenario, which does not include specific climate change mitigation policies but does represent a plausible future pathway of global emissions in response to a moderate global action to mitigate climate change. NHTSA recognizes the efforts undertaken by many state and local governments to reduce GHG emissions. NHTSA believes the GCAM6.0 scenario represents a reasonable proxy for such efforts, to the degree to which they are not preempted by EPCA.

Comment

Docket Number: NHTSA-2017-0069-0527
Commenter: Lynn Carroll

The analysis of alternatives you have outlined states that the 2012 assumption that gas prices would rise was in error and led to expectation of higher benefit to consumers from higher gas mileage that hasn't been realized. Gas prices would have risen if the cost to society from carbon dioxide emissions had been included in the price. Such carbon pricing would be a strong incentive to drive less or buy more efficient cars, and I expect to see this happen within a few years.

Response

NHTSA mentions carbon pricing as a potential program to encourage reduction in VMT in Section 9.2, *Mitigation Measures.* NHTSA discusses the relevance of gas prices to the Proposed Action and alternatives in the preamble to the final rule and the FRIA.

10.8.2.3 Health, Societal, and Environmental Impacts of Climate Change

Comment

Docket Number: EPA-HQ-OAR-2018-0283-5471
Organization: Community Action to Promote Healthy Environments

8. The NHTSA analysis is incomplete as it does not perform a quantitative analysis of the impacts of greenhouse gas emissions, a significant omission. These emissions have many broadly accepted environmental, health, and welfare impacts that are substantial and quantifiable. For example, the analysis does not quantify effects from heat stress or any other impact associated with increased greenhouse gas emissions and climate change.

Response

As described in Section 5.4, *Environmental Consequences*, and Section 8.6.4, *Cumulative Impacts on Greenhouse Gas Emissions and Climate Change,* ongoing emissions of GHGs from many sectors, including transportation, affect global CO_2 concentrations, temperature, precipitation, sea level, and ocean pH. Sections 5.4 and 8.6.4 use the best-available peer-reviewed literature and panel-reviewed assessments to review potential impacts from GHGs on these and other indicators, as well as human health. While the action alternatives would affect growth in GHG emissions, they alone would neither cause nor prevent these impacts. Instead, they would result in marginal increases in global CO_2 concentrations beyond those anticipated and would thus similarly affect impacts that are otherwise projected to occur under the No Action Alternative.

NHTSA's assumption is that increases in these climate effects would increase impacts on key natural and human resources. However, these impacts would be too small and too uncertain to address quantitatively for specific human and natural resources. Additionally, it is inappropriate to identify GHG emissions associated with a single source or group of sources as the single cause of any particular impact given climate-related impacts and events result from globally integrated GHG emissions.

This EIS, therefore, provides a qualitative discussion of the potential impacts of climate change on key natural and human resources in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.* The discussion of resource impacts in this section does not distinguish between the alternatives; rather, it provides a qualitative review of projected impacts (where the potential incremental increases in GHG emissions would result in incremental increases in these impacts). This provides adequate context for the reader to understand the magnitude and type of impacts that may be associated with increasing GHG emissions.

Comment

Docket Number: NHTSA-2017-0069-0498
Organization: InternationalMosaic.com
Commenter: Andrew Yamamoto et al.

The DEIS systematically understates the risks of the Proposed Repeal. At a minimum, the DEIS should concede that the action will increase emissions of climate changing gases and cumulative effect of the repeal may be the increase in catastrophic weather events like Hurricanes, Florence, Harvey and Maria. With respect to Harvey, Wikipedia says: "Warmer air can hold more water vapor, in accordance with the Clausius–Clapeyron relation, and there has been a global increase of daily rainfall records. Regional sea surface temperatures around Houston have risen around 0.5 °C (0.9 °F) in recent decades, which caused a 3–5% increase in moisture in the atmosphere. This had the effect of allowing Harvey to strengthen more than expected. The water temperature of the Gulf of Mexico was above average for this time of the year, and likely to be a factor in Harvey's impact. Within a week of Harvey, Hurricane Irma formed in the eastern Atlantic, due to the similar conditions involving unusually warm seawater. Some scientists fear this may be becoming a 'new normal'. Also higher sea-water temperatures can make hurricanes more devastating.

"The slow movement of Harvey over Texas allowed the storm to drop prolonged heavy rains on the state, as has also happened with earlier storms. Harvey's stalled position was due to weak prevailing winds linked to a greatly expanded subtropical high pressure system over much of the US at the time, which had pushed the jet stream to the north. Research and model simulations have indicated an association between this pattern and human-caused climate change (internal links omitted).” https://en.wikipedia.org/wiki/Hurricane_Harvey#Climate_change

*   *   *   *   *

The ongoing Hurricane (now storm) Florence also provides new evidence that must be considered in a new draft EIS. On September 13, 2018, the Washington Post reported: “In the case of Hurricane Florence and the Carolinas, some six inches of the coming storm surge is attributable to climate change because sea levels have risen in the past 100 years or so.”

Response

This EIS reflects NHTSA’s careful consideration of the rule’s effect on global climate conditions. Section 5.4, *Environmental Consequences*, discloses the GHG emissions associated with each alternative, and Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change,* includes a discussion of the impacts of climate change on key natural and human resources. In response to this comment and others, NHTSA has added additional information on extreme weather event attribution to climate change to Final EIS Section 5.2.2.2, *Increased Incidence of Extreme Weather Events.*

Comment

Docket Number: NHTSA-2017-0069-0547
Organization: Academy of Integrative Health & Medicine et al.

Many different vulnerable groups and disadvantaged communities, including seniors, children and those with disabilities, will have a harder time responding to the threats, especially if electricity is lost or relocation or evacuation is required. Hurricane Katrina demonstrated that many people in these groups had difficulty evacuating and relocating after a major weather event. Native American and other tribal communities may face threats to food supplies and difficulty relocating due to tribal land locations.

Response

In Section 8.6.5.2, *Human Security*, NHTSA reviews the threats and disproportionate impacts of climate change on vulnerable populations and Native American tribes.

Comment

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

The rollback’s significant impacts from air pollution and climate change will lead to increased flooding, inundation of wetlands, and harm wildlife, fish, and migratory birds. This action is contrary to multiple statutes and requirements, including:

- The Fish and Wildlife Conservation Act
- Floodplain Management Executive Order 11988 and DOT Order 5650.2
- Wetlands Preservation Executive Order 11990 and DOT Order 5660.1a
- The Migratory Bird Treaty Act.

Response

NHTSA addresses its obligations under the statutes, Executive Orders, and DOT Orders referenced by the commenter in the Regulatory Notices and Analyses section of the preamble to the final rule (Section X.E).

Comment

Docket Number: NHTSA-2017-0069-0722
Organization: Environmental Defense Fund et al.

The undersigned organizations hereby submit this supplemental comment in the above dockets. Because the information herein is of central relevance to the rulemaking we are submitting this letter and the referenced documents in EPA's rulemaking docket. We are also submitting them in NHTSA's dockets for the Proposal and the Draft Environmental Impact Statement. The documents, which became available only after the close of the comment period, provide compelling evidence of the urgent need to reduce ongoing harm and grave danger to public health and welfare caused by greenhouse gas emissions. The agencies have a duty to consider this new evidence demonstrating that the climate crisis caused by anthropogenic emissions of carbon dioxide and other greenhouse gases is already upon us and will lead to catastrophic consequences unless emissions are steeply reduced within the next decade.

Since the close of the comment period, greenhouse gas concentrations have continued to increase. Events during the last few months graphically illustrate that climate change is causing extreme weather, including heatwaves, to become both more frequent and more severe. June 2019 was the warmest June on record, with extreme heat waves experienced throughout Northern latitudes. Early July 2019 brought an extreme heat wave to Alaska, which "re-wrote the record books for multiple cities and communities across the state." Later in July, another extreme heatwave in Europe shattered temperature records – breaking the all-time record for Paris by nearly four degrees Fahrenheit, with a temperature of 108.68 degrees (42.6°C).

July 2019 appears to have been the Earth's hottest month on record. Extreme heat has blanketed much of the continental United States and caused significant harm, including to the crops of farmers already suffering from this year's extensive and disruptive flooding. The heatwaves caused serious health hazards, disrupted economies, and exacerbated other adverse impacts associated with climate change. In late July, the extreme heatwave that struck Europe moved northwest, causing massive melting of Greenland's ice-sheet, adding an estimated nearly two hundred billion tons of water into the Atlantic and causing a projected half-millimeter rise of the global sea level in a single month. Exceptionally warm temperatures in Siberia and Alaska are causing dramatic, destabilizing and climate change-accelerating melting of permafrost. These are only some of the facets of a global environmental and social disaster currently unfolding as greenhouse gas concentrations continue to climb. Countless others are documented in the record.

We are also submitting the following centrally relevant information which became available after the deadline for public comment. First, we draw the agencies' attention to a study recently reported in the journal NATURE finding that:

> the warmest period of the past two millennia occurred during the twentieth century for more than 98 per cent of the globe. This provides strong evidence that anthropogenic global warming is not only unparalleled in terms of absolute temperatures, but also unprecedented in spatial consistency within the

> context of the past 2,000 years. The study of past climate provides an essential baseline from which to understand and contextualize changes in the contemporary climate.

Additionally, we submit the Government Accountability Office's June 2019 written testimony submitted to the House Budget Committee, which concludes that "the effects of climate change have already and will continue to cause fiscal exposure across the federal government and that exposure will continue to increase."

Also attached is a research brief prepared by Climate Central which documents the connection between a warming climate and increased numbers of "stagnation events" in urban areas, creating conditions for high levels of harmful ground-level ozone pollution.

In August 2019, the Intergovernmental Panel on Climate Change released in summary form a Special Report on the impact of climate change on land, agriculture, and food supplies.

Reflecting the work of more than 100 experts, the Special Report concludes that climate change is causing and exacerbating a wide variety of harms to land – including desertification of very large areas, water scarcity, and widespread loss of soils – thereby threatening the world's food supply. Among the Report's findings are that:

> "Climate change, including increases in frequency and intensity of extremes, has adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions (high confidence)." Special Report, Summary for Policymakers (Approved Draft) at 5.
>
> "Climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems (high confidence)." *Id.* at 15.
>
> "Deferral of GHG emissions reductions from all sectors implies tradeoffs including irreversible loss in land ecosystem functions and services required for food, health, habitable settlements and production, leading to increasingly significant economic impacts on many countries in many regions of the world (high confidence)." *Id*. at 41.

The unfolding climate crisis is undeniable. The agencies cannot continue to ignore these events and must abandon their indefensible proposal to freeze or weaken the current light-duty vehicle standards. Finalizing this proposal would ignore the facts before us and would exacerbate the ongoing disaster, experienced most severely by those least able to protect themselves. That would be a historic blunder and an unconscionable betrayal of the public.

Response

This EIS reflects NHTSA's careful consideration of the rule's effect on global climate conditions. NHTSA acknowledges the scientific consensus that human emissions of GHGs have been the dominant cause of global warming throughout the 20th century (Section 5.1.2, C*limate Change and Its Causes*) and that the majority of CO_2 emissions in the United States are from the combustion of fossil fuels (Section 5.2.1.2*, U.S. Greenhouse Gas Emissions*).

The climate change impacts reported in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, and Chapter 8, *Cumulative Impacts*, reflect the best available science regarding climate change and its impacts on health, society, and the environment. NHTSA relied primarily on existing expert panel- and peer-reviewed climate change studies and reports when preparing this EIS, including several of the resources cited by the commenter. In particular, this EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and GCRP, supplemented with additional peer-reviewed literature. In the Final EIS, NHTSA has integrated the findings of consensus reports and peer-reviewed literature that have been published since the release of the Draft EIS, including the IPCC *Special Report: Global Warming 1.5°C* and the GCRP *Fourth National Climate* Assessment. In response to the comment, NHTSA has reviewed the provided references and added additional information to Final EIS Chapters 5 and 8, including additional references on extreme weather attribution, climate tipping points, wildfire risks, and human migration due to climate change. NHTSA has considered this information as part of its decision-making.

Comment

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

Anthropogenic climate change is already affecting public health, and will pose even more severe threats without action to greatly limit GHGs. The 2012 joint rulemaking recognized and accounted for these threats. For instance, the 2012 preamble explained that climate change-induced “extreme weather events, changes in air quality, increases in food- and water-borne pathogens, and increases in temperatures are likely to have adverse health effects.” Evidence gathered since the 2012 Final Rule shows the threats to human health have only multiplied and become more severe. The current proposal, however, does not discuss any specific health-related impacts from climate change anywhere in the preamble or its RIA, in contravention of the agencies’ duty to “examine all relevant factors and record evidence, and to articulate a reasoned explanation for [their] decision.” Further, the Draft EIS also improperly shortchanges the discussion of climate change impacts on human health.

Heat is the most direct health threat from climate change, particularly for older adults and young children, outdoor workers, low-income communities, communities of color, and people with chronic illnesses (*very high confidence*). A recent review found evidence for 27 different ways in which extreme heat leads to deadly organ failure, including (but not limited to) such pathologies as ischemia (inadequate blood supply), heat cytotoxicity, and inflammatory response—conditions that can affect the brain, heart, intestines, kidneys, and liver. It is very likely that the United States will see thousands to tens of thousands more premature heat-related deaths in the summer under business as usual. The increase in heat deaths will likely be larger than a concomitant decrease in cold-related deaths.

Extreme heat can exacerbate or cause a range of illnesses such as respiratory diseases or pre-term births that often require expensive emergency treatment. More than 73,000 U.S. patients hospitalized for heat-related illnesses in the U.S. from 2001 to 2010 had a median stay of two days, at a median cost of nearly $9,000 per stay. Costs were highest among adults over 65 years, African-Americans, Asians/Pacific Islanders, and women.

By one estimate, nearly one-third of the world’s population is currently exposed to a deadly combination of heat and humidity for at least 20 days a year; without deep cuts in global GHG emissions, that percentage is projected to rise to nearly three-quarters of the world’s population by the end of the century, with particular harms to the southeastern United States. Although air conditioning and other response measures can help limit heat-related deaths and illnesses, future increases in heat could “recurrently ‘imprison people’ indoors and may turn infrastructure failures (e.g., power outages) into catastrophic events." Florida suffered such harms after Hurricane Irma knocked out electricity at a nursing home and at least 14 residents tragically lost their lives due to heat.

Climate change also is likely to worsen air quality by accelerating the formation of ground-level ozone pollution (*high confidence*), increasing fine particle pollution and ozone pollution from wildfires (*high confidence*), and making pollen and mold allergy seasons longer and more severe (*high confidence*).

Research indicates that faster reductions in carbon pollution will prevent millions of premature deaths. Compared with a 2°C pathway, a 1.5°C pathway is projected to result in 153 ± 43 million fewer premature deaths worldwide (with ~40% of those deaths avoided during the next 40 years) due to reduced PM 2.5 stemming from fossil fuel combustion and ozone exposure, including 130,000 fewer premature deaths in Los Angeles and 120,000 in the New York metropolitan area. For example, there is consistent evidence that wildfire smoke exacerbates existing respiratory health problems, including asthma and chronic obstructive pulmonary disease. Growing evidence also suggests that wildfire smoke exposure is associated with increased risk of respiratory infections. The severe wildfires in summer and fall of 2017 sent people across Washington and California to triage centers, hospitals, and doctors' offices with breathing problems. Communities already suffer a considerable economic burden from the illnesses and deaths related to wildfire smoke. A study that modeled wildfire smoke exposures over the continental U.S. from 2008 to 2012 found that health costs from short-term smoke exposures totaled $63 billion in net present value over the study period, and $450 billion for long-term exposure effects.

Young children, older adults, those active outdoors, and people with asthma are among the populations most vulnerable to climate-related increases in air pollution. Estimates show that the annual costs that asthma imposes on U.S. states range from $60.7 million (Wyoming) to $3.4 billion (California) due to medical expenditures, and $4.4 million (Wyoming) to $345 million (California) from missed work and school days.

The USGCRP has also determined with *high confidence* that climate change will alter the geographical extent and seasonal timing of tick- and mosquito-borne diseases like Lyme disease and West Nile Virus. The two species of ticks capable of spreading Lyme disease — the most common vector-borne illness in the U.S.— have already expanded to new regions of the U.S. partly because of rising temperatures. In 2015, *Ixodes scapularis* and *I. pacificus* were found in more than 49 percent of counties in the continental U.S., a nearly 45 percent increase since 1998. Globally, climate change has also increased the capacity of mosquitoes to generate new infections of dengue fever, and the number of dengue cases each year has doubled every decade since 1990.

Rising temperatures, more extreme rainfall, and coastal storm surges are expected with medium confidence to increase the risk of water and food-borne illnesses. For example, vibriosis is an infection contracted through contaminated shellfish or seawater that can lead to diarrhea, skin infections, or even death. The bacteria that cause vibriosis grow more quickly in warmer waters and are restricted to warmer months of the year along much of the eastern U.S. coast. Reported cases of vibriosis have tripled in the U.S. since 1996.

In addition, climate-related disasters like inland flooding, wildfires, and hurricanes are associated with myriad health threats including injuries, skin infections, mental health conditions, and deaths (*high confidence*).

Response

NHTSA has added additional information on the health impacts of climate change to Final EIS Section 8.6.5.2, *Human Health*, including information on heat-related hospital admissions, human exposure to heat and humidity, and the impacts of wildfire smoke. Several other citations and key points provided by the commenter were already included in the EIS, such as the GCRP *The Impacts of Climate Change on Human Health in the United States* report. The analysis of environmental impacts contained in an EIS is part of the rulemaking record of evidence before the agency and the decision-maker, and this EIS addresses health-related impacts of climate change in Section 8.6.5.2.

Comment

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

Species can respond to climate change in three ways: they can cope through temporary changes or evolutionary adaptation, relocate to new habitats, or go extinct. Both geographic shifts and extinctions will have dramatic consequences for biodiversity and the ecosystem functions on which humans depend. EPA and NHTSA recognized these threats in the joint 2012 Final Rule and mid-term evaluation. Among many examples, in the 2012 Final Rule preamble, the agencies discussed the NRC's *Advancing the Science of Climate Change* report, which noted the potential for "broad, catastrophic impacts on marine ecosystems." The agencies' Draft TAR reviewed the NRC's *Abrupt Impacts* report, which found "similarities between the projections for future acidification and warming and the extinction at the end of the Permian[,] which resulted in the loss of an estimated 90 percent of known species." In the current Proposal, on the other hand, the agencies include no discussion or analysis of such impacts, even though the evidence of these harms has become even more alarming.

Because attempting to shift its range is often a species' first response to new environmental pressures, climate change is already "impelling a universal redistribution of life on Earth." In fact, many species have experienced local extinctions at the warm edge of their range as they have shifted to cooler latitudes or elevations. A recent review of 976 plant and animal species around the world found that 47 percent have experienced climate-related local extinctions, with the highest extinction rates occurring in tropical species, animals, and freshwater habitats. The redistribution of species has been linked to reduced terrestrial productivity, alterations in ecological networks in marine habitats, and the development of toxic algal blooms.

Many species will be unable to move quickly enough—or to move at all—due to geographical barriers such as oceans or mountains, characteristics of their life histories, a lack of suitable new habitat, or the rapid pace of local changes in climate. For instance, high temperatures, ocean acidification, and non-climate stressors are already causing significant losses of shallow coral reefs in the U.S. Under continued high emissions of GHGs, shallow coral cover in Hawaii is expected to decline from 38 percent in 2010 to 11 percent in 2050. Shallow corals are projected to nearly disappear from south Florida by the late 2030s and from Puerto Rico by the 2070s. In the Arctic's Eastern Bering Sea, reduced ocean productivity linked to higher temperatures is expected to reduce catches of walleye pollock, one of the largest fisheries in the world. At the same time, however, continuing winter sea ice cover may limit the ability of pollock to shift northward to cooler, more productive waters. By one estimate, 4.3?C of additional global warming caused by continued high levels of GHGs could lead to the extinction of 1 in 6 of the world's species, while a temperature rise of 3°C could lead to the extinction of 1 in 12 species.

Both population declines and species extinctions can disrupt the structure and function of ecological networks, which in turn can harm or eliminate ecosystem functions such as pollination. Oyster reefs, for example, provide a wide array of ecosystem services including food production, water filtration, shoreline stabilization, and cultural heritage. Ocean acidification threatens those services by stunting oyster growth, causing developmental abnormalities in larval oysters, and increasing mortality. One recent review of nearly 120 scientific studies found negative effects of climate change on ecosystem services in 59 percent of the analyses. Regulating services (e.g., biological control of pests) and cultural services (e.g., tourism) were strongly harmed by climate change. Another meta-analysis reported that climate change is already adversely affecting 82 percent of 94 key ecological processes that form the foundation of healthy ecosystems.

America's national parks are bellwethers for many of these changes. In 2014, the National Park Service published a study that examined the extent to which 289 parks are experiencing extreme climate changes when compared to the historical records from 1901 to 2012. Results show that our national parks are overwhelmingly at the extreme warm end of the historical temperatures. For example, rising sea levels in Florida's Everglades National Park threaten the mangrove ecosystem that filters saltwater, thereby preserving freshwater wetlands. Rising temperatures and drought in New Mexico's Bandelier National Monument have driven bark beetles to higher elevations, causing high mortality rates to the Piñon pines. Rising temperatures in Yellowstone National Park are also killing whitebark pine trees; loss of whitebark pine translates to reduced grizzly bear survival in Yellowstone because grizzlies rely heavily on whitebark pine seeds as a critical source of nutrition. Warmer temperatures in Great Smoky Mountains National Park could increase ozone levels, further damaging critical tree and plant species. Our national parks are living emblems of our nation's heritage, and they warrant regulations and policies that promote ecosystem resilience, enhance restoration and conservation of the system's essential resources, and preserve America's natural and cultural legacy.

Response

NHTSA has added additional information to Final EIS Section 8.6.5.2, *Sectoral Impacts of Climate Change*, such as information on climate-related extinctions, the impact of species redistribution on humans, and climate change impacts on ecological functions and ecosystem health. The EIS already contained information on several other impacts identified by the commenter, including the impact of climate change on coral reefs in Section 8.6.5.2, *Sectoral Impacts of Climate Change*. The analysis of environmental impacts contained in an EIS is part of the rulemaking record of evidence before the agency and the decision-maker, and this EIS addresses impacts on biodiversity, ecosystem services, and public lands in Section 8.6.5.2.

Comment

Docket Number: NHTSA-2017-0069-0613
Organization: Environmental Defense Fund et al.
Commenter: Erin Murphy

Climate- and weather-related disasters are already harming the U.S. economy. There have been 219 such disasters since 1980 that cost the country at least $1 billion each, for a total cost of more than $1.5 trillion. One recent study estimated that the increased cost of U.S. hurricane damage due to human-caused climate change added between $2 and $14 billion of losses in 2005. In 2017, there were 16 separate weather and climate disaster events in the U.S. with damages exceeding $1 billion each, *totaling $306 billion in just one year*—a new U.S. record.

In the 2012 Final Rule, EPA and NHTSA provided both a macro-level discussion of the economic consequences of climate change and also noted the many specific phenomena that will have negative economic repercussions. With regard to the former, the agencies discussed in detail their use of the Interagency Working Group's social cost of carbon metric to quantify the negative economic impacts resulting from each marginal ton of CO_2 pollution and the corresponding economic benefits resulting from each marginal ton of emission *reduction*. With regard to the latter, the agency noted many specific impacts from climate change that will have economic consequences, such as changes in "net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services."

In stark contrast, the Proposal and PRIA discuss *no* specific economic impacts from climate change, nor do they assess how the proposed repeal may exacerbate these impacts. The Draft EIS' discussion of climate change's economic impacts is similarly inadequate. This is a basic violation of the agencies' duties to "consider [the] important aspect[s] of the problem" in front of it and to "examine all relevant factors and record evidence." The Proposal and PRIA's only discussion of climate change's economic consequences is an unlawfully skewed and fundamentally erroneous assessment that drastically undervalues the estimated net climate benefits that would be lost if the repeal were finalized. As discussed in detail in other comments submitted by the Organizations and others to the docket, the Proposal applies a deeply flawed social cost of carbon metric to quantify these net climate benefits. Recent data, however, demonstrate that the economic harm attributable to climate change is *at least* as devastating as the estimate reflected in the 2012 Final Rule. According to a 2017 technical assessment by EPA's Climate Change Impacts and Risk Analysis ("CIRA") project, climate change will cost the U.S. economy *hundreds of billions of dollars each year under conservative estimates*. Projected damages are significantly larger under a high-emissions scenario. Damages also increase over time, but not necessarily gradually; abrupt changes in climate may lead to abrupt increases in economic harm. Some of the major climate-related economic impacts examined include:

- **Labor losses ($160 billion per year).** Changes in extreme temperature, particularly heat, are expected to reduce the number of suitable working hours in the contiguous U.S. by 1.9 billion hours in 2090. Globally, heat has already reduced outdoor labor capacity in rural areas by approximately 5.3 percent from 2000 to 2016. In 2013, 16,320 U.S. workers missed work because of heat-related illnesses.
- **Heat-related deaths ($140 billion per year).** By 2090, 49 U.S. cities will see an estimated 9,300 additional premature deaths due to heat.
- **Damage to coastal property ($120 billion per year).** The combination of sea level rise and storm surge will put energy infrastructure and residential, commercial, industrial, and government properties at significant risk by 2090. This damage estimate is extremely conservative, as it does not include transportation or telecommunication infrastructure or ecological resources. The credit-rating agency Moody's already incorporates the severe financial risks of sea level rise and hurricane damage in its assessment of state and local credit-worthiness.
- **Damage to roads ($20 billion per year).** Extreme heat, heavy rain and flooding, and changes in freeze-thaw cycles are expected to significantly increase costs for road maintenance, repair, and replacement by 2090. A more recent analysis suggests that costs associated with heat alone could exceed $35 billion per year in 2070.

- **Need for increased electricity generation ($9.2 billion per year).** Electricity demand is expected to increase in every region of the U.S. as temperatures rise, increasing the costs of power generation in 2090.

Other national-scale studies have confirmed the CIRA report's finding that unmitigated climate change will have extremely damaging economic impacts on the United States. For example, a September 2017 report by the Government Accountability Office highlighted a 2014 study by the Rhodium Group, entitled the "American Climate Prospectus," that assessed the impacts of climate change on coastal property, health, agriculture, the energy sector, labor productivity, and crime. According to the Rhodium study, the likely combined impacts of climate change would reduce United States gross domestic product by 1 to 3 percent each year by the end of this century. According to this study, the *annual* health-related impacts alone could reach as high as $161 billion over the 2040-2059 period and surpass $500 billion by the 2080- 2099 period. Losses in labor productivity could be as high as $150 billion per year by 2080- 2099, and storm-related losses and sea level rise could cause an additional $190 billion per year in property damage from 2080-2099.

Response

The economic costs associated with climate change-related impacts are captured by SC-CO_2. The comparison of the potential impacts of the Proposed Action and alternatives using the SC-CO_2 appears in the preamble to the final rule and FRIA. NHTSA recognizes the limitations and uncertainties associated with the SC-CO_2 as a metric. The EIS, therefore, provides a qualitative discussion of the potential impacts of climate change on key natural and human resources in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.*

Comment

Docket Number: NHTSA-2017-0069-0188
Commenter: Ryan Scott

Where the document reads "NHTSA provides a qualitative discussion of these impacts by presenting the findings of peer-reviewed panel reports including those from IPCC, GCRP, the CCSP, the National Research Council, and the Arctic Council, among others", this indicates that these elements cannot be quantified. Until these full costs and benefits both to economics and human health are calculated, however uncertain, I do not see how the rule can be implemented. Essentially, there is uncertainty in all estimates, and, based on the EIS it does not appear the EPA did an adequate job of calculating the potential for impacts to health based on this change. Even putting uncertainty bounds on this estimate would be advisable.

Response

Page S-20 of the Draft EIS stated,

> Although NHTSA does quantify the increases in monetized damages that can be attributable to each action alternative (see CO_2 Damage Reduction Benefit metric in the Preliminary Regulatory Impact Analysis (PRIA) benefits and net impacts tables), many specific impacts of climate change on health, society, and the environment cannot be estimated quantitatively. Therefore, NHTSA provides a qualitative discussion of these impacts by presenting the findings of peer-reviewed panel reports including those from IPCC, GCRP, the CCSP, the National Research Council, and the Arctic Council, among others.

NEPA recognizes that available information may be limited and uncertain, and does not require that all impacts be quantified. The EIS discusses the approach to scientific uncertainty and incomplete information available in Section 2.3.5, *Approach to Scientific Uncertainty and Incomplete Information*.

Comment

Docket Number: NHTSA-2017-0069-0693
Commenter: Rafael Pagan and Madeleine Green

The Trump Administration is stating that only the domestic cost should be concerned despite the large global presence the United State has gained over the years. The global impacts of climate change could cause us to lose trading partnerships, needing to send more aid to countries, and it is possible that an environmental disaster can result in an influx in the number of refugees needing asylum. The United States should be responsible because our nation has been for a long time the number one contributor to greenhouse gas emissions. Right now, we sit at number three behind India and China who will experience greater social costs of carbon emissions. Compound events, consisting of two or more extreme weather events occurring simultaneously or in sequence, may also occur more frequently under the proposed revisions. (DEIS S-22)

Response

NHTSA addresses the potential impacts of GHG emissions and climate change on human security and compound events, including the impacts described by the commenter, in Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change.*

Comments

Docket Number: NHTSA-2017-0069-0575
Organization: California Air Resources Board
Commenter: Richard Corey

California is one of the most geographically and ecologically diverse regions in the world, with landscapes ranging from sandy beaches to coastal redwood rainforests to snow-covered alpine mountains to dry desert valleys. California suffers from compelling and extraordinary circumstances in part because it is highly vulnerable to climate change. It contains multiple climate zones, and each region could experience a combination of impacts from climate change unique to that area. These include drought, prolonged and extreme heat waves, proliferating wildfires, and rising seas. Climate change poses an immediate and escalating threat to California's environment, public health, and economic vitality.

CARB's estimates indicate that the Agencies proposal can increase the CO_2 emissions in California by almost 12 million metric tons in 2030[105] accounting for both vehicle and fuel production emissions. This is equivalent to about half of the projected annual GHG benefits from the Advanced Clean Cars and represent 9 percent of the GHG reductions needed to meet the targets set by the California Global Warming Solutions Act of 2006.

[105] Calculated using data from the EMFAC model.

[See original comment for Figure VII-3 titled Carbon Pollution in California Increases under Cleaner Cars Rollback]

California is already experiencing the effects of climate change, and projections show that these effects will continue and worsen over the coming centuries. Changes in weather patterns can influence the frequency of meteorological conditions conducive to the development of high pollutant levels. Some of the key air pollutants (ozone, secondary particulate matter) depend strongly on temperature. Increases in atmospheric GHGs since the Industrial Revolution are well-known to warm global near- surface and tropospheric air temperatures. Some of the other broad range of effects of higher temperatures on air quality could include increases in emissions of biogenic gases year-around, in electric power and vehicle-fuel emissions in summer, in the temperature-dependent rates of photochemical reactions, and vaporization of volatile particle components. Higher temperatures will also impact meteorology by increasing atmospheric stability due to enhanced cloudiness but decreasing in stability due to warmer near-surface temperatures.

The impacts of climate change disproportionately impact the state's most vulnerable populations. The magnitude and rate of climate change in this century will likely exceed that experienced by California's native peoples over past millennia. California is committed to accelerating efforts to incorporate climate science and adaptation into its planning activities. California's leadership in climate change program is built on a strong foundation of scientific research addressing the impacts of climate change on the state. The ability for all Californians to withstand impacts to climate change is dependent on considering climate change impacts in scientific discussions and coordinating public agencies efforts to address these issues. Hence, as climate change exacerbates inland and coastal flooding, wildfires, droughts, extreme heat and other hazards, Californians and their public agencies are working alongside to prioritize long-term safety and resilience. This year two major reports prepared by the Office of Environmental Health Hazard Assessment and California Energy Commission, provide the scientific foundation for understanding climate-related impacts at the local scale that serves the growing needs of state and local-level decision-makers from a variety of sectors.

2018 Report: Indicators of Climate Change in California: The impacts of climate change have been compiled by the California Office of Environmental Health Hazard Assessment (OEHHA) in the Indicators of Climate Change Report, which details a number of already occurring changes. The report documents the growing number of extreme weather-related events in recent years, such as the devastating 2017 wildfires and the record-setting 2012-2016 drought. Some of the long-term warming trends underlying these events, including the rise in average temperatures and the number of extremely hot days and nights, have accelerated in recent decades. The report also tracks a variety of other climate change indicators: the declining snowpack and dramatic retreat of glaciers in the Sierra Nevada, unprecedented tree mortality in California forests, a rise in ocean temperatures off the California coast, and the shifting ranges of many species of California plants and animals. These impacts are similar to those that are occurring globally. The following highlight the report findings:

- Atmospheric concentrations of CO_2 continue to increase. Measurements at California coastal sites are consistent with those at Mauna Loa, Hawaii, where the first and longest continuous measurements of global atmospheric CO_2 concentrations have been taken.
- As atmospheric concentrations of CO_2 increase, so do levels in the ocean, part of a process known as "ocean acidification". The net result of adding CO_2 to seawater is to increase seawater acidity, a fundamental 'building block' for organisms forming shells of calcium carbonate.

- Since 1895, annual average air temperatures have increased throughout the state, with temperatures rising at a faster rate beginning in the 1980s. The last four years were notably warm, with 2014 being the warmest on record, followed by 2015, 2017, and 2016.
- California has become drier over time. Five of the eight years of severe to extreme drought occurred between 2007 and 2016, with unprecedented dry years in 2014 and 2015.
- Since 1950, the area burned by wildfires each year has been increasing, and five of the largest fire years have occurred since 2006. The largest recorded wildfire in the state (Thomas Fire) occurred in December 2017.
- The amount of water stored in the state's snowpack — referred to as snow-water content — ranges from a high in 1952 of about 240 percent to a record low of 5 percent in 2015. With less spring runoff, less water is available during summer months to meet the state's domestic and agricultural water demands.
- Compared to the 1930s, today's forests have more small trees and fewer large trees. Pines occupy less area statewide and, in certain parts of the state, oaks cover larger areas. The decline in large trees and increased abundance of oaks are associated with statewide increases in climatic water deficit.
- Along the California coast, sea levels have generally risen. Since 1900, mean sea level has increased by about 180 millimeters (7 inches) at San Francisco.
- Climate change poses a threat to public health. Warming temperatures and changes in precipitation can affect vector-borne pathogen transmission and disease patterns in California. West Nile Virus currently poses the greatest mosquito-borne disease threat. Heat-related deaths and illnesses, which are severely underreported, vary from year to year. In 2006, they were much higher than any other year because of a prolonged heat wave.

California's Fourth Climate Change Assessment (Fourth Assessment): California is committed to further supporting new research on ways to mitigate climate change and to understand its ongoing and projected impacts. California's Fourth Climate Change Assessment further updates our understanding of the impacts from climate change in a way that directly informs State agencies' efforts to safeguard the State's people, economy, and environment. The Fourth Assessment report also includes new climate projections with higher spatial resolution to better simulate and project extreme events. These updated projections reinforce past findings about temperature and precipitation extremes. The key findings from the Fourth Assessment are summarized below:

- *Economic Impacts:* Emerging findings for California show that costs associated with direct climate impacts by 2050 are dominated by human mortality, damages to coastal properties, and the potential for droughts and mega-floods. The costs are in the order of tens of billions of dollars. If global greenhouse gas emissions are reduced substantially from the current business-as-usual trajectory, the economic impacts could be greatly reduced.
- *Wildfire Projections:* By 2100, if greenhouse gas emissions continue to rise, one study found that the frequency of extreme wildfires burning over approximately 25,000 acres would increase by nearly 50 percent, and that average area burned statewide would increase by 77 percent by the end of the century. In the areas that have the highest fire risk, wildfire insurance is estimated to see costs rise by 18 percent by 2055 and the fraction of property insured would decrease.
- *Sea Level Rise Projections:* A new study estimates that, under mid-to high-sea- level rise scenarios, 30 to 70 percent of Southern California beaches may completely erode by 2100 without large-scale human interventions. Statewide damages could reach nearly $17.9 billion from inundation of residential and commercial buildings under 50 cm (around 20 inches) of sea-level rise, which is close

to the 95th percentile of potential sea-level rise by the middle of this century. A 100-year coastal flood, on top of this level of sea-level rise, would almost double the costs.

- *Public Health Impact:* Heat-Health Events (HHEs), which better predict risk to populations vulnerable to heat, will worsen drastically throughout the State: by midcentury, the Central Valley is projected to experience average HHEs that are two weeks longer, and HHEs could occur four to ten times more often in the Northern Sierra region.
- *Water Supply Impact:* Current management practices for water supply and flood management in California may need to be revised for a changing climate. As one example, the reduction in the Sierra Nevada snowpack, which provides natural water storage, will have implications throughout California's water management system.
- *Delta Levees and Infrastructure Impact:* New measurements found mean subsidence rates for some of the levees in the Sacramento-San Joaquin Delta of about 0.4 to 0.8 inches per year. This subsidence compounds the risk that sea- level rise and storms could cause overtopping or failure of the levees, exposing natural gas pipelines and other infrastructure to damage or structural failure. At this rate of subsidence, the levees may fail to meet the federal levee height standard (1.5 feet of freeboard above 100-year flood level) between 2050 and 2080, depending on the rate of sea-level rise.
- *Agriculture Impact:* Many of California's important crops, including fruit and nut trees, are particularly vulnerable to climate change impacts like changing temperature regimes and water-induced stress. A Fourth Assessment study indicates that adaptive decision-making and technological advancement may maintain the viability of California agriculture. However, additional studies show that viability of the sector overall may be at the expense of agricultural jobs and the dairy sector.
- *Oceans Impact:* There is increasing evidence that climate change is transforming and degrading California's coastal and marine ecosystems due to impacts including sea-level rise, ocean acidification, and ocean warming. Continued climate-driven changes to the ocean and coast will have significant consequences for California's coastal ecosystems, economy, communities, culture, and heritage. Together, historical data, current conditions, and future projections provide a picture of California's changing climate. Sea level rise, droughts, floods, and forest impacts are just some of the impacts affected by climate change, and as GHG emissions continue to accumulate, such destructive events will become more prevalent. The historical record, which has long provided the basis for our expectations for the traditional range of weather and other natural events, is becoming an increasingly unreliable predictor of the conditions we will face in the future. Climate disruption can drive extreme weather events such as coastal storm surges, drought, wildfires, floods, and heat waves. Thus, California's efforts are vital steps toward minimizing risks to public health, safety, and the economy and maximizing equity and protection of the most vulnerable so that they do not simply survive climate-related events, but thrive despite and after these events.

Recognizing the facts, the California Legislature has acted to reduce GHG emissions in California. In 2006, the California Legislature passed, and the Governor signed, Assembly Bill 32, the California Global Warming Solutions Act of 2006. Assembly Bill 32 requires CARB to enact regulations to achieve the level of statewide GHG emissions in 1990 by 2020, authorizes and directs CARB to monitor and regulate sources of GHG emissions, and specifically directs CARB to "adopt rules and regulations … to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources … subject to the criteria and schedules set forth in this part."

In 2016 California's Legislature passed, and California's Governor Brown signed Senate Bill 32, which requires CARB to ensure that California's statewide emissions of GHG emissions are reduced to at least 40 percent below the level of statewide GHG emissions in 1990, no later than December 31, 2030.

In addition to its directional shift in 2012 based on the 2009 Vision modeling mentioned above, CARB has reconfirmed it needs to obtain significant reductions in GHG emissions from the transportation sector (which includes mobile sources) in order to comply with the above mentioned statutory mandates, especially since the transportation sector is largest source of GHG emissions in California. CARB has identified strategies to obtain GHG emissions from mobile sources that include policies to move toward a goal of achieving 100 percent ZEV sales in the light-duty vehicle sector and reductions in vehicle miles travelled, and accelerating the use of clean vehicle and equipment technologies and fuels through the targeted introduction of zero emission and near-zero emission technologies in other sectors.

These analyses maintain the need for strong GHG fleet-wide standards in congruence with meaningful ZEV requirements. As mentioned above, the ZEV regulation acted as an incubator for hybrid technology, and hybrid technology (once commercialized) was used to help set the 2012 LEV III GHG emission standards for all cars. Now, the aforementioned analyses show ZEV technology is imperative for meeting long-term emission reduction goals. Manufacturers would not likely make a more expensive technology to reduce GHG emissions (like a BEV) if there were other technologies that could still help achieve GHG standards at less cost. The ZEV regulation can help set a floor to ensure manufacturers are developing technologies that can be used to set meaningful GHG fleet-wide standards in the future.

Docket Number: NHTSA-2017-0069-0715
Organization: California Air Resources Board
Commenter: Wesley Dyer

The California Air Resources Board (CARB) submits this supplemental comment concerning additional studies to the federal dockets on the proposed Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks (Proposal). Specifically, CARB is submitting Northcott et al. (2019), which contains new information on the uptake and emission of carbon dioxide (CO_2) by coastal waters, and Gleason et al. (2019), which contains new information on the feedback between wildfires and snowpack melt. These studies were released after the closing of the period for public comment on the Proposal. Because these studies contain material "of central relevance to the rulemaking," CARB is submitting this letter and both studies to all three Proposal dockets.

CARB noted in its initial comments on the Proposal that the United States Environmental Protection Agency (U.S. EPA) and the National Highway Traffic and Safety Administration (NHTSA) (collectively, the Agencies) have failed to analyze properly the climate impacts of the Proposal. Instead, the Agencies have claimed that the impacts of climate change will be so severe that the Proposal's increase in greenhouse gas emissions (and, by extension, the long-term effects of stalling emissions progress in the auto industry) are insignificant. The Agencies' position represents an abdication of their statutory duties and responsibilities and is contrary to law. The Agencies were required to analyze and consider the expected results.

The attached studies further demonstrate the need for thorough, careful analysis of the Proposal's climate impacts, as well as the compelling and extraordinary conditions California faces from climate change and increased greenhouse gas emissions. In Northcott et al. (2019), the authors collected data on CO_2 concentrations over Monterey Bay (which is home to a national marine sanctuary, significant fisheries, and globally important ecosystems) using moorings and surface robots. The data document, for the first time, that CO_2 concentrations over ocean waters ebb and flow throughout the day, often peaking in the early morning - showing that a previously common scientific assumption that CO_2 concentrations over ocean waters do not vary much over time and space does not always hold true. For Monterey Bay particularly, high morning CO_2 concentrations are likely an issue because of the nearby dense, urban Santa Clara Valley and the agricultural Salinas Valley. Given the unique topography surrounding Monterey Bay, the area's winds and other atmospheric conditions in the early morning appear to concentrate CO_2 from both Valleys over the Bay. The study concludes that this previously undocumented process could increase the amount of CO_2 that coastal waters are absorbing by about 20 percent.

The higher amount of CO_2 being absorbed by Monterey Bay and likely other coastal waters than was previously understood has important ramifications for climate impacts. The more CO_2 dissolved in the oceans, the more acidic the ocean becomes. The harmful impacts of ocean acidification have already been extensively studied and are already being seen. Northcott et al. (2019) indicates these impacts are likely to accrue faster than and not be as evenly distributed as previously anticipated. Coastal waters, particularly off urban or agricultural areas like Monterey Bay, may be harmed by ocean acidification to greater degrees.

Gleason et al. (2019) documents a unique feedback loop in western forests that exacerbates climate-driven water impacts and wildfire risk. Increased wildfires in the western U.S. in recent decades has contributed to widespread forest mortality, carbon emissions, periods of severely degraded air quality, and substantial fire suppression expenditures; climate change will continue to chronically enhance the potential for western U.S. wildfire activity. And as colleagues and I have previously reported, the deposition and accumulation of black carbon in Sierra Nevada snowpack accelerates snowmelt and has negative impacts on California's water supply. Gleason et al. (2019) provides new insight into the magnitude and persistence of wildfire disturbance on snowpack and water resources via black carbon and other impurities - and the melting snowpack's feedback on wildfires. In studying the albedo of snow in several areas between 1 and 15 years after a wildfire, the authors found that, over the last 20 years, there has been more than a four-fold increase in the amount of energy absorbed by snowpack because of fires across the western U.S. As a result, more than 11 percent of western forests are already experiencing earlier snowmelt because of increased wildfires. For western states that rely on snowpack and its runoff into local streams and reservoirs, earlier snowmelt is a major concern, as the volume of snowpack and the timing of snowmelt are the dominant drivers of how much water there is and when that water is available downstream - and, thus, the presence and magnitude of summer drought. The presence and magnitude of drought itself influences the frequency and degree of wildfires.

This feedback loop - wildfires expediting snowmelt, which then amplifies the frequency and magnitude of wildfires - will only be magnified as the climate continues to change. An increasingly warmer and drier climate in the western U.S. has already been documented to yield increased frequency, duration, and severity of both wildfires and droughts. In California, the forest mortality rate has been rising over the past two decades, posing an increasingly higher risk of wildfire in the Sierra Nevada. Climate change is already melting snowpack and increasing wildfires on its own; now, as shown in Gleason et al. (2019), the wildfire-snowpack feedback loop further amplifies the climate impacts.

As the Agencies acknowledge, the Proposal will result in a notable increase in CO_2 emissions, and yet, in the face of ample evidence of an already changing climate from unprecedented greenhouse gas emissions, the Agencies are pursing the Proposal and did not analyze how the Proposal will affect the already changing climate. The attached studies, Northcott et al. (2019) and Gleason et al. (2019), further illustrate the climate impacts already underway and that finalizing the Proposal would be arbitrary and capricious.

Docket Number: NHTSA-2017-0069-0723-1
Organization: California Air Resources Board

The California Air Resources Board (CARB) submits this supplemental comment concerning an additional study to the federal dockets on the proposed Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks (Proposal). Specifically, CARB is submitting Williams et al. (2019), which contains new information on the relationship between greenhouse gas emissions and California wildfires. This study was recently published, well after the closing of the period for public comment on the Proposal. Because this study contains material "of central relevance to the rulemaking," CARB is submitting this letter and the study to all three Proposal dockets.

* * * * *

The attached study further demonstrates the need for thorough, careful analysis of the Proposal's climate impacts, as well as the compelling and extraordinary conditions California faces from climate change and increased greenhouse gas emissions. In Williams et al. (2019), the authors compiled records of almost 40,000 wildfires larger than 0.1 hectares in California between 1972 and 2018, and used various datasets for precipitation, temperature, humidity, wind speed, solar radiation, moisture content in dead vegetation, and fire potential. The authors also distinguished between forest and non-forest fires, as well as by season.

Williams et al. (2019) found that annual burned area in California increased by 405 percent during 1972-2018. This was significantly driven by increases in burned area in the North Coast and Sierra Nevada forest regions, which respectively saw increases of 630 percent and 618 percent. The increases in burned area also mainly occurred in the summer, though the fall also saw higher burned area averages. In analyzing the data and past trends, the authors conclude: "*The large increase in California's annual forest-fire area over the past several decades is very likely linked to anthropogenic warming*" (emphasis in original). Specifically, the authors found that the increasing vapor pressure deficit, a climate variable that measures the air's dryness and is a function of temperature and specific humidity, has mainly driven the increase in summer burned areas in California, particularly in the North Coast and Sierra Nevada regions. Higher vapor pressure deficits mean drier air and drier vegetation, and this is expected to increase with a changing climate. The authors warn that if greenhouse gas emissions are not curbed, the damage from wildfires in California will continue to magnify exponentially:

Response

NHTSA recognizes the global and regional impacts of climate change. A summary of these impacts, primarily drawn from panel-reviewed synthesis and assessment reports from the IPCC and the GCRP with other supplemental resources, is provided in Section 5.2.2, *Climate Change Trends*, Section 5.4, *Environmental Consequences,* and Section 8.6, *Greenhouse Gas Emissions and Climate Change*. More specifically, information on the impacts of climate change on air quality and vulnerable populations is provided in Section 8.6.5.2, *Human Health*, and Section 8.6.5.2, *Human Security*. Section 8.6.5, *Health, Societal, and Environmental Impacts of Climate Change*, does not distinguish between the alternatives under consideration or differences in regional impacts; however, it does provide a review of projected impacts from increases in GHG emissions. NHTSA believes that this provides adequate context for the reader to understand the magnitude of the climate effects associated with the action under consideration.

With regard to regional impacts, in response to these comments, NHTSA has added an acknowledgement of detailed state-level assessments, such as California's, to Section 8.6.5.3, *Regional Impacts of Climate Change.* More generally, NHTSA complements panel-reviewed synthesis and assessment reports with novel peer-reviewed research to better address regional climate change and associated impacts in Section 5.2.2, *Climate Change Trends*, Section 5.4, *Environmental Consequences,* and Section 8.6, *Greenhouse Gas Emissions and Climate Change*. Regionally focused studies are broadly consistent with findings already reported in the analysis. NHTSA has included a reference to Williams et al. (2019) in Section 8.6.5.2, not because the study fundamentally changes the results of NHTSA's analysis, but because the study offers regional granularity to already established results. In the hypothetical case that regional studies were not included, the fundamental finding that climate change will exacerbate impacts would still hold true.

For more information on regional impacts, in Section 8.6.5.3 NHTSA refers readers to Section 5.5.2 of the MY 2017–2025 CAFE Standards Final EIS (NHTSA 2012), Section 5.5.2 of the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c), and the *Fourth National Climate Assessment* (GCRP 2017, 2018). In the NEPA context, there are limits to the utility of drawing from assessments to characterize the regional climate impacts of the Proposed Action and alternatives. The existing assessment reports do not have the resolution necessary to illustrate the effects of this action, because they typically assess climate change impacts associated with emissions scenarios that have much larger differences in emissions—generally between one and two orders of magnitude greater than the difference between the No Action Alternative in 2100, and the emissions increases associated with all the action alternatives in 2100. The differences between the climate change impacts of the Proposed Action and alternatives are far too small to address quantitatively in terms of their impacts on the specific resources of each region. Attempting to do so may introduce uncertainties at the same magnitude or more than the projected change itself (i.e., the projected change in regional impacts would be within the noise of the model). Agencies' responsibilities under NEPA involve presenting impacts information that would be useful, relevant to the decision, and meaningful to decision-makers and the public.

With regard to CARB's discussion of the state's Zero Emission Vehicle (ZEV) program, the issues of Clean Air Act waivers of preemption under Section 209 and EPCA/EISA preemption under 49 U.S.C. § 32919 are not addressed in this Final EIS, as they were the subject of a separate final action and rulemaking by EPA and NHTSA in September 2019. The joint action is available at 84 FR 51310, and comments on these issues have been addressed and responded to in that action and rulemaking process. In that action, EPA withdrew aspects of a Clean Air Act Preemption waiver previously granted to California, and NHTSA concluded that EPCA expressly and impliedly preempted state laws or regulations having the direct or substantial effect of regulating or prohibiting tailpipe CO_2 emissions from automobiles or automobile fuel economy.

Comment

Docket Number: NHTSA-2017-0069-0499
Organization: Boulder County Public Health
Commenter: Jeffrey Zayach

Increasing scientific evidence demonstrates that carbon dioxide and other greenhouse gases released into the atmosphere are exerting a profound effect on the earth's climate, such as increasing extreme weather events, changing rainfall and crop productivity patterns, and fueling the migration of infectious diseases. Since 1983, average temperatures in Colorado have risen 2° F and continue to rise. Many Colorado communities are already experiencing the impacts of a warming climate in the form of reduced snowpack, earlier snowmelt, increased risk of high-intensity wildfires and their associated air pollution, extreme weather events, and an increased number of "high heat" days. Climate change will continue to impact the health of those who live, work, and play in Colorado if we fail to minimize greenhouse gas emissions.

There are a myriad of ways in which Coloradans are being impacted now by the health effects of climate change. Poor air quality aggravates cardiovascular, respiratory, and allergy-related illness and leads to: 1) more doctor or hospital visits for asthma caused by more frequent wildfires, 2) increased length and severity of allergy seasons, and 3) higher temperatures, leading to more high ozone days when air quality is poor. Climate change also increases the risk of death, physical injury, and exposure, which can result from: 1) increased frequency and intensity of flooding and precipitation events, 2) more intense wildfires that can destroy more homes, and 3) increased frequency and duration of droughts. Rising temperatures and recent droughts in the region have killed many trees by drying out soils and enabling outbreaks of forest insects. Dry forest conditions have increased the risk of forest fires.

In the coming decades, the changing climate is also likely to decrease water availability and agricultural yields in Colorado, impacting residents and farmers. Children, the elderly, people with weakened immune systems, and residents living in poverty are more vulnerable to heat-related illness. In the Denver area, the annual frequency of 100 degree days increased by more than 250% on average between 1967 and 1999. With continued high levels of greenhouse gas emissions, Denver could experience extreme heat, similar to Tucson, Arizona. Climate change is also associated with increased transmission and severity of waterborne and vector-borne diseases, including West Nile virus, Hantavirus, and tick-related diseases.

In 2017, the Colorado Department of Local Affairs and Denver Public Health and Environment funded analyses of the likely future temperature extremes in Larimer County, Boulder County and Denver. The study found that if emissions continue to rise, by mid-century, the temperatures will rise from the historical average of 1-2 days per year over 100 degrees to 7 days per year. By the end of the century, the study estimated that a typical year would have 34 days over 100 degree temperatures, while unusually hot years could have over 70 days of these temperature extremes.

Response

NHTSA includes a discussion of the impacts of climate change on air quality, human health, natural resources, crops, and vulnerable populations in Section 8.6.5 *Health, Societal, and Environmental Impacts of Climate Change*. In Section 8.6.5.3, *Regional Impacts of Climate Change*, NHTSA recognizes the public's interest in understanding the potential regional impacts of climate change. For more information on the projected impacts of climate change on regions of the United States, NHTSA refers readers to Section 5.5.2 of the *MY 2017–2025 CAFE Standards Final EIS* (NHTSA 2012), Section 5.5.2 of the *Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Final EIS* (NHTSA 2016c), and the *Fourth National Climate Assessment* (GCRP 2017, 2018).

10.8.2.4 Other Comments on Cumulative Impacts of GHG Emissions and Climate Change

Comment

Docket Number: NHTSA-2017-0069-0688
Organization: National Tribal Air Association
Commenter: Wilford Nabahe

Docket Number: NHTSA-2017-0069-0521
Organization: Sac and Fox Nation
Commenter: Kay Rhoads

According to NHTSA's EIS draft, the proposed SAFE Vehicles rule will increase domestic petroleum consumption by 116 billion gasoline gallons equivalent total for total calendar years 2020-2050, increasing upstream greenhouse gas emissions. Less stringent standards will increase oil production to meet the new petroleum demand that would have decreased compared to retaining the existing standards. Upstream carbon dioxide emissions from oil production, transportation, refining, and distribution would increase cumulatively by 159 million metric tons for MY 2021 - 2026. The additional emissions in non-attainment areas would impact current emissions levels and would shift more of the burden of compliance to stationary sources like refineries and power plants' ability to meet standards. It could also cause areas currently in attainment to slide into nonattainment.

Response

NHTSA recognizes that changes in emissions that may result from revisions to the CAFE standards could lead to states reviewing their own emissions reduction programs to meet self-imposed statewide emissions targets. NHTSA recognizes the challenges that nonattainment and attainment areas face in reducing ozone precursor (NO_X and VOC) and PM2.5 emissions to achieve attainment or assure continued attainment. Chapter 4, *Air Quality*, and Chapter 5, *Greenhouse Gas Emissions and Climate Change*, discuss the emissions impacts of the alternatives under consideration, and Appendix A, *Air Quality Nonattainment Area Results*, provides estimated emissions changes by nonattainment area. The photochemical modeling analysis in Final EIS Appendix E, *Air Quality Modeling and Health Impacts Assessment*, shows the estimated changes in air pollutant concentrations by alternative.

Comment

Docket Number: NHTSA-2017-0069-0544
Commenter: David Bella

We are **locked in** on a course that could lead to emissions that exceed the No Action Alternative in the EIS. Why?

Our institutions are **locked in** to a course of expanding car-dependent infrastructure. Once built, this infrastructure **locks in** urban form and its carbon dioxide emissions for many decades to come.

Year after year, we expand **lock in** as shown below for my home town, Corvallis, Oregon.

> [See original comment for figure titled Lock In Expands in Corvallis, OR 2018]

A literature review on carbon **lock in** describes our long-lived problem.

> "Some of the longest-lived infrastructures are not CO_2-emiting power plants – which last on the order of decades – but buildings, transportation infrastructure and other spatial arrangements of urban settlements. The fundamental building blocks that make up the physical features of urban settlements, such as the layout of the street network and the size of the city blocks, can affect lock in energy demand for long time periods."

This review then states "*Only a handful of studies have examined locked in energy demand from urban form*." Given the vast sums of money spent on maintaining and expanding car-dependent infrastructure that **locks in** urban form and energy demand, <u>why are there "only a handful of studies"?</u>

If **locked in** energy demand grows year after year as car-dependent infrastructure expands year after year, we face two troubling outcomes: (1) suffer the consequences of continuing CO_2 emissions and/or (2) employ technological fixes that are costly, not currently feasible, and portend catastrophic failure. We can and should do better than this!

Response

NHTSA recognizes that other policy options, such as alternative transportation infrastructure, could mitigate the impacts of climate change. NHTSA discusses some of these options in Chapter 9, *Mitigation*. Ultimately, however, these options are beyond the scope of this rulemaking.

10.9 Mitigation

Comments

Docket Number: NHTSA-2017-0069-0511
Commenter: Harold Draper

The EIS analyses describe in detail how all action alternatives would result in increased adverse health impacts compared to No Action. In addition, all action alternatives would result in increases in certain air pollutants regulated by the NAAQS and all alternatives would increase GHG emissions. As a result of these considerations, the EIS is obligated to propose mitigation measures that can be considered by NHTSA, EPA, and DOE in preparing a Record of Decision.

Instead, the EIS does not propose any mitigation measures, asserting that any measures are outside of the jurisdiction of NHTSA but that other agencies could propose mitigation measures. Two of these agencies are cooperating agencies in this EIS and should therefore propose what mitigation actions they propose to take. NHTSA should be in coordination with other federal agencies such as the Department of the Interior and describe what actions they propose to take. It should be noted that this action also proposes to rescind California's waiver for greenhouse gases. Allowing states to set stricter standards is a possible mitigation measure that is not discussed in the EIS and is within the power of NHTSA, EPA, and DOE.

Docket Number: NHTSA-2017-0069-0550
Organization: Center for Biological Diversity, Earthjustice, Environmental Law and Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Safe Climate Campaign, Sierra Club, Southern Environmental Law Center, and Union of Concerned Scientists
Commenter: Alejandra Núñez et al.

NEPA requires agencies to describe mitigation measures in detail. 40 C.F.R. § 1502.16(h); 1502.14(f). "All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency or the cooperating agencies …" Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026, 18,031 (Mar. 23, 1981). In addressing the duty to discuss mitigation measures, courts have held that the "omission of a reasonably complete discussion of possible mitigation measures would undermine the 'action-forcing' function of NEPA. Without such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects." *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). A "perfunctory description" of mitigation measures, without supporting analytical data analyzing their efficacy, is inadequate to satisfy NEPA's requirements that an agency take a "hard look" at possible mitigating measures. *Neighbors of Cuddy Mountain v. U.S. Forest Serv.*, 137 F.3d 1372, 1380 (9th Cir. 1998). And an agency's "broad generalizations and vague references to mitigation measures ... do not constitute the detail as to mitigation measures that would be undertaken, and their effectiveness, that the [agency] is required to provide." *Id.* at 1380-81.

NHTSA's proposal to undo its augural standards for MY2022-2025 and weaken its final standards for MY2021 light duty vehicles—standards that it reaffirmed less than two years ago—and to join with EPA in rescinding the currently effective greenhouse gas emission standards for that fleet is unprecedented. NHTSA is embarking on this at-all-costs deregulatory agenda even though vehicles constitute the nation's largest source of greenhouse gas emissions, and though it admits that even under its own skewed assumptions, its proposal and alternatives will increase fuel consumption, greenhouse gas and criteria pollutants, and the attendant adverse health effects. Nonetheless, NHTSA spends just three desultory pages on vague "mitigation" measures, none of which, it proclaims, lie within its own power.

The agency rests its get-out-of-jail-free-card approach entirely on the assertion, without analysis or discussion, that it "does not have the jurisdiction to regulate the specified pollutants that are projected to increase as a result of the Proposed Action and alternatives." But that assertion is beside the point. NHTSA is the very agency that has not only the authority, but the duty to set fuel efficiency standards for vehicles, and the direct result of the choice it proposes to make is the increase of the pollutants in question, as NHTSA admits throughout the DEIS and even in the paragraph directly preceding its claim of lack of ability to do anything about the problem. It is axiomatic that fuel efficiency standards set at levels of the No Action Alternative or at more stringent levels would eliminate the additional pollution created by the proposed freeze.

Mitigation, therefore, is directly in NHTSA's hands, and its attempt to pin responsibility for cleaning up the environmental harms flowing from its decision onto other agencies is unavailing. NHTSA cannot shield itself from its duty to disclose and discuss the obvious mitigating measures under its control—setting "maximum feasible" fuel efficiency standards though 2025 instead of freezing at either 2020 or 2021 levels. Similar to the agency in *Sierra Club v. FERC*, 867 F.3d 1357 (D.C. Cir. 2017), NHTSA here is the "'legally relevant cause' of the direct and indirect environmental effects" at issue, *id.* at 1373, and is not excused from complying fully with NEPA. See also *DOT v. Public Citizen*, 541 U.S. 752, 753 (2004) (agency excused from NEPA obligations only where agency had no ability to take actions that could lessen the environmental impacts).

Docket Number: NHTSA-2017-0069-0625
Organization: California Office of the Attorney General et al.
Commenter: Kavita Lesser

Compounding its lack of transparency in air quality modeling, NHTSA proposes to essentially eviscerate one of the significant federal climate measures, without adequately disclosing the magnitude of that change to the public, and without providing any mitigation for the increased greenhouse gas emissions it would cause.

* * * * *

Further, NHTSA dedicates a mere four sentences in the 500-page DEIS to mitigation measures, perfunctorily claiming its hands are jurisdictionally tied. At a minimum, NHTSA must include a thorough discussion of all reasonable mitigation measures and detail the appropriate agencies that could implement such measures. One obvious mitigation measure that NHTSA can identify is recommending that EPA— a cooperating agency in the drafting of the DEIS—not act to weaken its greenhouse gas emission standards for vehicles.

* * * * *

NHTSA dedicates only four sentences in the DEIS to mitigation measures, claiming it does not need to include mitigation measures to minimize adverse environmental impacts in the DEIS since “NHTSA does not have the jurisdiction to regulate the specified pollutants that are projected to increase as a result of the Proposed Action and alternatives.” NHTSA has not met its statutory duty under NEPA to provide a detailed statement on the environmental impacts and reasonable alternatives to a proposed project, including alternatives and mitigation measures outside the scope of the agency’s authority. See 40 C.F.R. § 1502.14(c) (stating agencies shall “[i]nclude reasonable alternatives not within the jurisdiction of the lead agency”). A “hard look” review of mitigation measures under NEPA must account for “all foreseeable direct and indirect impacts,” discuss adverse impacts without “improperly minimiz[ing] negative side effects,” and not rely on “[g]eneral statements about possible effects.” *League of Wilderness Defenders-Blue Mountains Biodiversity Project v. U.S. Forest Serv.*, 689 F.3d 1060, 1075 (9th Cir. 2012). Thus, NHTSA must do more than merely list examples of mitigation concepts, but rather discuss measures it may implement “in detail and explain the effectiveness of the measures.” *Nw. Indian Cemetery Protective Ass’n v. Peterson*, 795 F.2d 688, 697 (9th Cir. 1986), *rev’d on other grounds*, 108 S.Ct. 1319 (1988).

At a minimum, NHTSA must include a thorough discussion of all reasonable mitigation measures and detail the appropriate agencies that could implement such measures. NHTSA admits that mitigation measures to the proposed action include “further EPA emissions standards for passenger cars and light trucks.” At the same time, EPA—a cooperating agency for the DEIS—is jointly proposing to weaken its GHG emission standards for vehicles. NHTSA’s claim that its “hands are tied” is thus contrary to NEPA and inherently inconsistent with the proposed rulemaking. NHTSA further states that “mechanisms to encourage the reduction of VMT” may mitigate the adverse environmental impacts of the proposed action and alternatives. NHTSA must include a detailed discussion of these “mechanisms” in the DEIS, which may include such federal actions as creating tax breaks for transit and biking, expanding transportation demand management programs for federal employees, implementing a social marketing campaign regarding VMT reduction, increasing dedicated funding for transit and active modes, requiring VMT as a performance measure for federal funding, and providing NEPA guidance on evaluating VMT impacts of federal projects.

Response

Compared to the No Action Alternative, the Preferred Alternative is anticipated to result in adverse impacts such as increased GHG emissions and increases in certain criteria and air toxic emissions. However, because the Preferred Alternative increases the stringency of CAFE standards on a year-by-year basis, NHTSA expects that GHG emissions and some criteria and air toxic emissions would decrease over time.

CEQ regulations implementing NEPA require NHTSA and other federal agencies to include in an EIS a discussion of appropriate mitigation measures.[106] Most of the commenters asserted that the list of mitigation measures provided in the Draft EIS was inadequate to fulfill the requirements of NEPA. As noted in Chapter 9, *Mitigation*; however, NHTSA does not have jurisdiction to regulate the GHG emissions and the criteria and toxic air pollutant emissions projected to result from the Proposed Action. NHTSA also cannot regulate other factors affecting emissions, such as VMT, consumer purchasing behavior, and other consumer behaviors that are primarily driven by market forces and are beyond NHTSA's statutory authority. In short, NHTSA does not have the statutory authority to set specific limits on the relevant emissions. Consequently, any mitigation measures proposed are necessarily vague, as it is only within the authority of other agencies to implement them. Similarly, commenters requested supporting analytical data and a full-scale analysis of the potential efficacy of each mitigation measure. Again, because it is not within NHTSA's jurisdiction to implement these measures, it lacks the expertise to conduct a full-scale analysis of their efficacy (which would necessarily include the specifics of how they were implemented and with what effect). Moreover, given the diffuse and indeterminate nature of the potential impacts—they are nationwide and, in the case of climate impacts, global—a large range of measures may serve to mitigate adverse impacts, but determining with what certainty and to what effect would require an analysis that only the authorizing agency would be capable of undertaking.

Commenters also asserted that NHTSA does indeed have authority to mitigate GHG and criteria and toxic pollutant emissions, albeit indirectly, through the agency's authority to set fuel economy standards or by encouraging EPA to set more stringent CO_2 emissions standards. A mitigation measure, however, is by definition a measure intended to reduce or counter the potential impacts of the Proposed Action. Because setting fuel economy standards is the basis of the Proposed Action, it cannot also be considered a mitigation measure. Furthermore, NHTSA considers environmental impacts as part of its balancing of EPCA factors and other considerations (see Section VIII.B.4 of the preamble to the final rule). NHTSA has necessarily considered the benefits of setting more stringent fuel economy standards on the environment, but must balance those benefits against other statutory criteria, such as economic practicability, when setting CAFE standards. NHTSA must set "maximum feasible" standards under EPCA by considering the statutory factors; it cannot then increase the stringency of the maximum feasible standards for the sole purpose of mitigating any adverse impacts it identifies.

California Office of the Attorney General et al. requested that NHTSA include a detailed discussion of potential mechanisms to promote the reduction of VMT—a mitigation measure that was included in the

[106] 40 CFR § 1502.14(f).

Draft EIS. In response to this comment, NHTSA has revised the Final EIS to include a discussion of specific possible mechanisms that could be used to reduce VMT and how a reduction in VMT would generally affect the impacts reported in the EIS. However, as previously stated, because such mitigation measures would be outside of NHTSA's jurisdiction, the agency cannot provide more specific details about the projected efficacy of these measures.

Commenter Harold Draper suggested allowing states to set stricter fuel economy standards as a potential mitigation measure. However, such a mitigation measure is contrary to EPCA, which preempts state laws or regulations related to fuel economy standards or average fuel economy standards (s*ee* 49 U.S.C. § 32919). Consequently, it is not included in the Final EIS.

CHAPTER 11 LIST OF PREPARERS AND REVIEWERS

11.1 U.S. Department of Transportation

Table 11-1 identifies the preparers, contributors, and reviewers in the U.S. Department of Transportation.

Table 11-1. U.S. Department of Transportation Preparers and Reviewers

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11.2 Consultant Team

ICF supported NHTSA in preparing its environmental analyses and this environmental impact statement. Table 11-2 identifies the consultant team and their contributions.

Table 11-2. Consultant Team

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Nicole Vetter, Librarian	
	M.L.S., Library Science, Simmons College B.A., Women's Studies, University of Minnesota 8 years of experience in consulting, education, and library settings
Hannah Wagner, Climate Change Team	
	B.A., Geosciences and Mathematics, Hamilton College 3 years of experience in climate adaptation and resilience
Matia Whiting, Climate Change Team	
	B.A., Environmental Studies and Biology, Middlebury College 1 year of experience in climate data interpretation and resilience report writing

CHAPTER 12 DISTRIBUTION LIST

The CEQ NEPA implementing regulations (40 CFR § 1501.19) specify requirements for circulating an EIS. In accordance with those requirements, NHTSA is mailing notification of the availability of this EIS, as well as instructions on how to access it to the agencies, officials, and other stakeholders listed in this chapter.

12.1 Federal Agencies

- Advisory Council on Historic Preservation, Office of Federal Agency Programs
- Appalachian Regional Commission, Office of the General Counsel
- Argonne National Laboratory
- Armed Forces Retirement Home, Campus Operations
- Board of Governors of the Federal Reserve System, Engineering and Facilities
- Central Intelligence Agency, Headquarters Environmental Safety Staff
- Committee for Purchase From People Who Are Blind or Severely Disabled, Office of the General Counsel
- Consumer Product Safety Commission, Directorate for Economic Analysis
- Defense Nuclear Facilities Safety Board
- Delaware River Basin Commission
- Denali Commission
- Executive Office of the President, Council on Environmental Quality
- Executive Office of the President, Office of Science and Technology Policy
- Export-Import Bank of the United States, Office of the Senior Counsel
- Export-Import Bank of the United States, Environmental and Social Policy and Review Program
- Farm Credit Administration, Office of Regulatory Policy
- Federal Communications Commission, Office of General Counsel
- Federal Communications Commission, Wireless Telecommunications Commission, Competition and Infrastructure Policy Division
- Federal Deposit Insurance Corporation, Corporate Services Branch, Administration Division, Health, Safety and Environmental Programs Unit
- Federal Energy Regulatory Commission, Office of Energy Projects, Environmental Review and Permitting
- Federal Energy Regulatory Commission, Office of Energy Projects, Federal Energy Regulatory Commission
- Federal Maritime Commission
- Federal Trade Commission, Litigation
- General Services Administration, Federal Permitting Improvement Steering Council
- General Services Administration, Public Buildings Service, Office of Portfolio Management and Customer Engagement

- International Boundary and Water Commission, U.S. & Mexico, Environmental Management Division
- International Trade Commission
- Marine Mammal Commission, Office of the General Counsel
- Millennium Challenge Corporation, Environmental and Social Assessment
- National Aeronautics and Space Administration, Environmental Management Division, Office of Strategic Infrastructure
- National Capital Planning Commission, Office of Urban Design and Plan Review Division
- National Credit Union Administration, Office of General Counsel, Division of Operations
- National Endowment for the Arts
- National Endowment for the Humanities
- National Indian Gaming Commission, Office of the General Counsel
- National Indian Gaming Commission, Office of the Chief of Staff
- National Science Foundation, Office of the General Counsel
- Nuclear Regulatory Commission, Division of Rulemaking, Environmental, and Financial Support
- Nuclear Regulatory Commission, Division of Fuel Cycle Safety, Safeguards, and Environmental Review
- Nuclear Regulatory Commission, Office of New Reactors, Division of Licensing, Siting, and Environmental Analysis
- Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards
- Oak Ridge National Laboratory
- Overseas Private Investment Corporation, Environmental Group
- Presidio Trust, NEPA Compliance
- Securities and Exchange Commission, Office of Support Operations
- Small Business Administration, Office of the General Counsel, Department of Litigation
- Social Security Administration, Office of Environmental Health and Occupational Safety
- Surface Transportation Board, Office of Environmental Analysis
- Tennessee Valley Authority, Environmental Policy and Planning
- U.S. Access Board (Architectural and Transportation Barriers Compliance Board), Office of the General Counsel
- U.S. Agency for International Development
- U.S. Department of Agriculture, Environmental Review and Permitting
- U.S. Department of Agriculture, Agriculture Research Service, Natural Resources and Sustainable Agricultural Systems
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Environmental Services
- U.S. Department of Agriculture, Farm Service Agency
- U.S. Department of Agriculture, National Institute of Food and Agriculture, Institute of Bioenergy, Climate, and Environment

- U.S. Department of Agriculture, Natural Resources Conservation Service, Ecological Services Division
- U.S. Department of Agriculture, Rural Development, Rural Utilities Service, Engineering and Environmental Staff
- U.S. Department of Agriculture, U.S. Forest Service—Ecosystem Management Coordination
- U.S. Department of Commerce, Office of the Senior Counsel
- U.S. Department of Commerce, Economic Development Administration
- U.S. Department of Commerce, Energy and Environmental Law Division, Office of the General Counsel
- U.S. Department of Commerce, First Responder Network Authority (FirstNet)
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Review and Coordination Section, Office of the General Counsel
- U.S. Department of Defense, Army Corps of Engineers (Civil Works), Operations and Regulatory Division
- U.S. Department of Defense, Army Corps of Engineers (Civil Works), Office of the Assistant Secretary of the Army,
- U.S. Department of Defense, Army Corps of Engineers, Planning and Policy Division, Office of Water Project Review
- U.S. Department of Defense, Defense Logistics Agency; DLA Installation Support, Environmental Management
- U.S. Department of Defense, Defense Threat Reduction Agency, ESOH Department
- U.S. Department of Defense, Department of Air Force, Air Force Civil Engineer, Strategic Plans and Programs Division, DCS/Logistics, Installations, and Mission Support
- U.S. Department of Defense, Department of Army, Office of the Assistant Secretary of the Army for Installations, Energy & Environment
- U.S. Department of Defense, Department of Navy, Office of the Deputy Assistant Secretary of the Navy, Environmental Planning and Terrestrial Resources
- U.S. Department of Defense, Department of the Navy, Office of the Chief of Naval Operations, Energy and Environmental Readiness Division, Operational Environmental Readiness and Planning
- U.S. Department of Defense, Missile Defense Agency, Environmental
- U.S. Department of Defense, National Guard Bureau
- U.S. Department of Defense, National Guard Bureau, Environmental Installations and Environment Division, Military Construction Branch
- U.S. Department of Defense, National Guard Bureau, National Guard Bureau Directorate, Army National Guard Directorate
- U.S. Department of Defense, National Guard Bureau, Environmental Installations and Environment Division
- U.S. Department of Defense, National Security Agency
- U.S. Department of Defense, Office of the Deputy Assistant Secretary of Defense, Environment, Safety, and Occupational Health

- U.S. Department of Defense, U.S. Marine Corps, Headquarters
- U.S. Department of Education, Office of the General Counsel
- U.S. Department of Energy, Office of Electricity
- U.S. Department of Energy, Bonneville Power Administration, Environmental Planning and Analysis
- U.S. Department of Energy, Office of the General Counsel, Office of NEPA Policy and Compliance
- U.S. Department of Energy, Office of Environmental Management
- U.S. Department of Energy, Office of Cybersecurity, Energy Security, and Emergency Response
- U.S. Department of Energy, Western Area Power Administration
- U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Division of Emergency and Environmental Health Services
- U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Environmental Health
- U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Office of Safety, Security, and Asset Management
- U.S. Department of Health and Human Services, Environmental Health and Safety Services Program Support Center
- U.S. Department of Health and Human Services, Food and Drug Administration, Center for Food Safety and Applied Nutrition
- U.S. Department of Health and Human Services, Indian Health Service
- U.S. Department of Health and Human Services, National Institutes of Health, Division of Environmental Protection
- U.S. Department of Homeland Security
- U.S. Department of Homeland Security, Customs and Border Protection
- U.S. Department of Homeland Security, Environmental Planning and Historic Preservation Program
- U.S. Department of Homeland Security, Federal Emergency Management Agency—Office of Environmental Planning and Historic Preservation
- U.S. Department of Homeland Security, Federal Law Enforcement Training Center, Environmental and Safety Division
- U.S. Department of Homeland Security, Immigration and Customs Enforcement, Environmental Program
- U.S. Department of Homeland Security, Sustainability and Environmental Programs
- U.S. Department of Homeland Security, Transportation Security Administration, Office of Occupational Safety, Health and Environment
- U.S. Department of Homeland Security, U.S. Citizenship and Immigration Services, Facilities Management Division, Planning, Programming & Environmental Branch
- U.S. Department of Homeland Security, U.S. Coast Guard, Office of Bridge Programs
- U.S. Department of Homeland Security, U.S. Coast Guard, Office of Environmental Management
- U.S. Department of Housing and Urban Development, Office of Environment and Energy

- U.S. Department of Interior, Bureau of Indian Affairs, Division of Environmental and Cultural Resources Management
- U.S. Department of Interior, Bureau of Land Management, Division of Decision Support, Planning, and NEPA
- U.S. Department of Interior, Bureau of Ocean Energy Management Office of Environmental Programs, Division of Environmental Assessment, Office of Environmental Programs
- U.S. Department of Interior, Bureau of Reclamation
- U.S. Department of Interior, Bureau of Safety and Environmental Enforcement, Environmental Compliance Division
- U.S. Department of Interior, National Park Service, Environmental Planning and Compliance Branch
- U.S. Department of Interior, Office of Environmental Policy and Compliance
- U.S. Department of Interior, Office of the Associate Deputy Secretary
- U.S. Department of Interior, Office of Surface Mining Reclamation and Enforcement
- U.S. Department of Interior, U.S. Fish and Wildlife Service, Ecological Services, Branch of Conservation Planning Assistance
- U.S. Department of Interior, U.S. Geological Survey—Environmental Management Branch
- U.S. Department of Interior, U.S. Geological Survey, Office of Water Program Coordination
- U.S. Department of Justice, Drug Enforcement Administration, Civil Litigation Section
- U.S. Department of Justice, Environment and Natural Resources Division
- U.S. Department of Justice, Federal Bureau of Investigation
- U.S. Department of Justice, Federal Bureau of Investigation, Occupational Safety & Environmental Programs Unit, Environmental Compliance Program
- U.S. Department of Justice, Federal Bureau of Prisons, Environmental Program
- U.S. Department of Justice, Justice Management Division, Environmental and Sustainability Services
- U.S. Department of Justice, U.S. Marshals Service, Office of General Counsel
- U.S. Department of Justice, U.S. Marshals Service, Office of Security, Safety, and Health
- U.S. Department of Labor, Office of the Assistant Secretary for Administration and Management
- U.S. Department of Labor, Office of the Assistant Secretary for Policy
- U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs
- U.S. Department of Transportation, Federal Aviation Administration, Office of Environment and Energy
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Department of Transportation, Federal Highway Administration, Office of Project Development and Environmental Review
- U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Regulatory and Legislative Affairs Division, Office of the Chief Counsel
- U.S. Department of Transportation, Federal Railroad Administration, Environmental and Corridor Planning

- U.S. Department of Transportation, Federal Transit Administration, Office of Environmental Programs
- U.S. Department of Transportation, Maritime Administration, Office of Environment
- U.S. Department of Transportation, Office of the Secretary of Transportation, Office of Policy Development, Strategic Planning, and Performance
- U.S. Department of Transportation, Office of the General Counsel
- U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Hazardous Materials Safety
- U.S. Department of Transportation, Saint Lawrence Seaway Development Corporation, Office of the Chief Counsel
- U.S. Department of Transportation, Surface Transportation Board, Office of Environmental Analysis
- U.S. Department of Transportation, Volpe Center, Environmental Science and Engineering Division
- U.S. Department of Transportation, Volpe Center, Policy Analysis and Strategic Planning Division
- U.S. Department of the Treasury, CDFI Fund
- U.S. Department of the Treasury, Office of Environment, Safety, and Health
- U.S. Department of Veterans Affairs, Green Management Program Service
- U.S. Department of Veterans Affairs, Office of Construction and Facilities Management
- U.S. Department of Veterans Affairs, Veterans Health Administration, Office of General Counsel
- U.S. Environmental Protection Agency
- U.S. Environmental Protection Agency, Office of Federal Activities
- U.S. Postal Service, Environmental Compliance/Risk Management

12.2 State and Local Government Organizations

- American Samoa Office of Grants Policy/Office of the Governor, Department of Commerce, American Samoa Government
- Arizona Department of Environmental Quality
- Arkansas Department of Environmental Quality
- Arkansas Office of Intergovernmental Services, Department of Finance and Administration
- Boulder County Public Health
- California Air Resources Board
- California Department of Justice
- California Office of the Attorney General
- Connecticut Department of Environmental Protection
- Connecticut Department of Transportation
- Connecticut Office of the Attorney General
- Delaware Department of Justice
- District of Columbia Office of the City Administrator

- Florida State Clearinghouse, Florida Department of Environmental Protection
- Grants Coordination, California State Clearinghouse, Office of Planning and Research
- Guam State Clearinghouse, Office of I Segundo na Maga'lahen Guahan, Office of the Governor
- Hawaii Office of the Attorney General
- Hawaii Office of Environmental Quality
- Illinois Department of the Attorney General
- Iowa Department of Management
- Iowa Office of the Attorney General
- Los Angeles City Attorney’s Office
- Los Angeles County, Public Health
- Maine State Planning Office
- Maryland Department of Planning
- Maryland Department of Transportation
- Maryland State Clearinghouse for Intergovernmental Assistance
- Massachusetts Office of the Attorney General
- Michigan Department of Transportation
- Minnesota Department of Commerce, Division of Energy Resources
- Minnesota Department of Environmental Protection
- Minnesota Office of the Attorney General
- Missouri Federal Assistance Clearinghouse, Office of Administration, Commissioner's Office
- Nevada Division of State Lands
- New Hampshire Office of Energy and Planning, Attn: Intergovernmental Review Process
- New Jersey Environmental Practice Group, Division of Law
- New York City Law Department
- New York State Department of Environmental Conservation
- North Carolina Department of Environmental Quality
- North Carolina Department of Justice
- North Dakota Department of Commerce
- Oakland City Attorney
- Oregon Department of Environmental Quality
- Pennsylvania Department of Environmental Protection
- Puerto Rico Highway and Transportation Authority
- Puerto Rico Planning Board, Federal Proposals Review Office
- Regional Air Pollution Control Agency
- Rhode Island Department of the Attorney General
- Rhode Island Division of Planning
- Sacramento Municipal Utility District
- Saint Thomas, VI Office of Management and Budget

- San Francisco Office of the City Attorney
- San Jose Office of the City Attorney
- South Carolina Office of State Budget
- Southeast Michigan Council of Governments
- State of Vermont Agency of Natural Resources
- The Governor of Kentucky's Office for Local Development
- Town of Brookhaven, Planning, Environment, and Land Management
- Town of Brookline
- Utah State Clearinghouse, Governor's Office of Planning and Budget Utah State
- Virginia Office of the Attorney General
- Virgin Islands, Office of Management and Budget
- Washington State Department of Ecology
- West Virginia Development Office

12.3 Elected Officials

- The Honorable Karl Racine, Attorney General of the District of Columbia
- The Honorable Tom Miller, Attorney General of Iowa
- The Honorable Aaron Frey, Attorney General of Maine
- The Honorable Brian Frosh, Attorney General of Maryland
- The Honorable Maura Healey, Attorney General of Massachusetts
- The Honorable Letitia James, Attorney General of New York
- The Honorable Ellen Rosenblum, Attorney General of Oregon
- The Honorable Josh Shapiro, Attorney General of Pennsylvania
- The Honorable Thomas J. Donovan, Attorney General of Vermont
- The Honorable Bob Ferguson, Attorney General of Washington
- The Honorable Kay Ivey, Governor of Alabama
- The Honorable Michael Dunleavy, Governor of Alaska
- The Honorable Lolo Matalasi Moliga, Governor of American Samoa
- The Honorable Doug Ducey, Governor of Arizona
- The Honorable Asa Hutchinson, Governor of Arkansas
- The Honorable Gavin Newsom, Governor of California
- The Honorable Jared Polis, Governor of Colorado
- The Honorable Ned Lamont, Governor of Connecticut
- The Honorable John Carney, Governor of Delaware
- The Honorable Ron DeSantis, Governor of Florida
- The Honorable Brian Kemp, Governor of Georgia
- The Honorable Lourdes Leon Guerrero, Governor of Guam
- The Honorable David Ige, Governor of Hawaii

- The Honorable Brad Little, Governor of Idaho
- The Honorable Jay Pritzker, Governor of Illinois
- The Honorable Eric Holcomb, Governor of Indiana
- The Honorable Kim Reynolds, Governor of Iowa
- The Honorable Laura Kelly, Governor of Kansas
- The Honorable Andy Beshear, Governor of Kentucky
- The Honorable John Bel Edwards, Governor of Louisiana
- The Honorable Janet Mills, Governor of Maine
- The Honorable Larry Hogan, Governor of Maryland
- The Honorable Charles Baker, Governor of Massachusetts
- The Honorable Gretchen Whitmer, Governor of Michigan
- The Honorable Tim Walz, Governor of Minnesota
- The Honorable Tate Reeves, Governor of Mississippi
- The Honorable Michael L. Parson, Governor of Missouri
- The Honorable Steve Bullock, Governor of Montana
- The Honorable Pete Ricketts, Governor of Nebraska
- The Honorable Steve Sisolak, Governor of Nevada
- The Honorable Christopher Sununu, Governor of New Hampshire
- The Honorable Philip Murphy, Governor of New Jersey
- The Honorable Michelle Grisham, Governor of New Mexico
- The Honorable Andrew Cuomo, Governor of New York
- The Honorable Roy Cooper, Governor of North Carolina
- The Honorable Doug Burgum, Governor of North Dakota
- The Honorable Ralph Deleon Guerrero Torres, Governor of the Commonwealth of the Northern Mariana Islands
- The Honorable Richard Michael DeWine, Governor of Ohio
- The Honorable Kevin Stitt, Governor of Oklahoma
- The Honorable Kate Brown, Governor of Oregon
- The Honorable Tom Wolf, Governor of Pennsylvania
- The Honorable Wanda Vazquez, Governor of Puerto Rico
- The Honorable Gina Raimondo, Governor of Rhode Island
- The Honorable Henry McMaster, Governor of South Carolina
- The Honorable Kristi Noem, Governor of South Dakota
- The Honorable Bill Lee, Governor of Tennessee
- The Honorable Greg Abbott, Governor of Texas
- The Honorable Albert Bryan, Governor of the United States Virgin Islands
- The Honorable Gary Herbert, Governor of Utah
- The Honorable Phil Scott, Governor of Vermont

- The Honorable Ralph Northam, Governor of Virginia
- The Honorable Jay Inslee, Governor of Washington
- The Honorable Jim Justice, Governor of West Virginia
- The Honorable Anthony Evers, Governor of Wisconsin
- The Honorable Mark Gordon, Governor of Wyoming
- The Honorable Muriel Bowser, Mayor of the District of Columbia

12.4 Federally Recognized Native American Tribes

- Absentee-Shawnee Tribe of Indians of Oklahoma
- Agdaagux Tribe of King Cove
- Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation, California
- Ak-Chin Indian Community
- Akiachak Native Community
- Akiak Native Community
- Alabama-Coushatta Tribe of Texas
- Alabama-Quassarte Tribal Town
- Alatna Village
- Algaaciq Native Village (St. Mary's)
- Allakaket Village
- Alturas Indian Rancheria, California
- Alutiiq Tribe of Old Harbor
- Angoon Community Association
- Anvik Village
- Apache Tribe of Oklahoma
- Arapaho Tribe of the Wind River Reservation, Wyoming
- Arctic Village
- Aroostook Band of Micmacs
- Asa'carsarmiut Tribe
- Assiniboine & Sioux Tribes of the Fort Peck Indian Reservation, Montana
- Atqasuk Village (Atkasook)
- Augustine Band of Cahuilla Indians, California
- Bad River Band of Lake Superior Tribe of Chippewa Indians of the Bad River Reservation, Wisconsin
- Bay Mills Indian Community, Michigan
- Bear River Band of the Rohnerville Rancheria, California
- Beaver Village
- Berry Creek Rancheria of Maidu Indians of California
- Big Lagoon Rancheria, California

- Big Pine Paiute Tribe of the Owens Valley
- Big Sandy Rancheria of Western Mono Indians of California
- Big Valley Band of Pomo Indians of the Big Valley Rancheria, California
- Birch Creek Tribe
- Bishop Paiute Tribe
- Blackfeet Tribe of the Blackfeet Indian Reservation of Montana
- Blue Lake Rancheria, California
- Bridgeport Indian Colony
- Buena Vista Rancheria of Me-wuk Indians of California
- Burns Paiute Tribe
- Cabazon Band of Mission Indians, California
- Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, California
- Caddo Nation of Oklahoma
- Cahto Tribe of the Laytonville Rancheria
- Cahuilla Band of Indians
- California Valley Miwok Tribe, California
- Campo Band of Diegueno Mission Indians of the Campo Indian Reservation, California
- Capitan Grande Band of Diegueno Mission Indians of California (Barona Group of Capitan Grande Band of Mission Indians of the Barona Reservation, California)
- Capitan Grande Band of Diegueno Mission Indians of California: Viejas (Barona Long) Group of Capitan Grande Band of Mission Indians of the Viejas Reservation, California
- Catawba Indian Nation
- Cayuga Nation
- Cedarville Rancheria, California
- Central Council of the Tlingit & Haida Indian Tribes of Alaska
- Chalkyitsik Village
- Cheesh-Na Tribe
- Chemehuevi Indian Tribe of the Chemehuevi Reservation, California
- Cher-Ae Heights Indian Community of the Trinidad Rancheria, California
- Cherokee Nation
- Chevak Native Village
- Cheyenne and Arapaho Tribes, Oklahoma
- Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
- Chickahominy Indian Tribe
- Chickahominy Indian Tribe—Eastern Division
- Chickaloon Native Village
- Chicken Ranch Rancheria of Me-wuk Indians of California

- Chignik Bay Tribal Council
- Chignik Lake Village
- Chilkat Indian Village (Klukwan)
- Chilkoot Indian Association (Haines)
- Chinik Eskimo Community (Golovin)
- Chippewa Cree Indians of the Rocky Boy's Reservation, Montana
- Chitimacha Tribe of Louisiana
- Chuloonawick Native Village
- Circle Native Community
- Citizen Potawatomi Nation (Oklahoma)
- Cloverdale Rancheria of Pomo Indians of California
- Cocopah Tribe of Arizona
- Coeur D'Alene Tribe
- Cold Springs Rancheria of Mono Indians of California
- Colorado River Indian Tribes of the Colorado Indian Reservation, Arizona and California
- Comanche Nation, Oklahoma
- Confederated Salish and Kootenai Tribes of the Flathead Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians
- Confederated Tribes of Siletz Indians of Oregon
- Confederated Tribes of the Chehalis Reservation
- Confederated Tribes of the Colville Reservation
- Confederated Tribes of the Goshute Reservation, Nevada and Utah
- Confederated Tribes of the Grand Ronde Community of Oregon
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Coquille Indian Tribe
- Coushatta Tribe of Louisiana
- Cow Creek Band of Umpqua Tribe of Indians
- Cowlitz Indian Tribe
- Coyote Valley Band of Pomo Indians of California
- Craig Tribal Association
- Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
- Crow Tribe of Montana
- Curyung Tribal Council
- Delaware Nation, Oklahoma
- Delaware Tribe of Indians
- Douglas Indian Association

- Dry Creek Rancheria Band of Pomo Indians, California
- Duckwater Shoshone Tribe of the Duckwater Reservation, Nevada
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Eastern Shoshone Tribe of the Wind River Reservation, Wyoming
- Egegik Village
- Eklutna Native Village
- Elem Indian Colony of Pomo Indians of the Sulphur Bank Rancheria, California
- Elk Valley Rancheria, California
- Ely Shoshone Tribe of Nevada
- Emmonak Village
- Enterprise Rancheria of Maidu Indians of California
- Evansville Village (aka Bettles Field)
- Ewiiaapaayp Band of Kumeyaay Indians, California
- Federated Indians of Graton Rancheria, California
- Flandreau Santee Sioux Tribe of South Dakota
- Forest County Potawatomi Community, Wisconsin
- Fort Belknap Indian Community
- Fort Bidwell Indian Community of the Fort Bidwell Reservation of California
- Fort Independence Indian Community of Paiute Indians of the Fort Independence Reservation, California
- Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation, Nevada and Oregon
- Fort McDowell Yavapai Nation, Arizona
- Fort Mojave Indian Tribe of Arizona, California and Nevada
- Fort Sill Apache Tribe of Oklahoma
- Galena Village (aka Louden Village)
- Gila River Indian Community of the Gila River Indian Reservation, Arizona
- Grand Traverse Band of Ottawa and Chippewa Indians, Michigan
- Greenville Rancheria
- Grindstone Indian Rancheria of Wintun-Wailaki Indians of California
- Guidiville Rancheria of California
- Gulkana Village
- Habematolel Pomo of Upper Lake, California
- Hannahville Indian Community, Michigan
- Havasupai Tribe of the Havasupai Reservation, Arizona
- Healy Lake Village
- Ho-Chunk Nation of Wisconsin

- Hoh Indian Tribe
- Holy Cross Village
- Hoonah Indian Association
- Hoopa Valley Tribe, California
- Hopi Tribe of Arizona
- Hopland Band of Pomo Indians, California
- Houlton Band of Maliseet Indians
- Hualapai Indian Tribe of the Hualapai Indian Reservation, Arizona
- Hughes Village
- Huslia Village
- Hydaburg Cooperative Association
- Igiugig Village
- Iipay Nation of Santa Ysabel, California
- Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation, California
- Inupiat Community of the Arctic Slope
- Ione Band of Miwok Indians of California
- Iowa Tribe of Kansas and Nebraska
- Iowa Tribe of Oklahoma
- Iqurmuit Traditional Council
- Ivanof Bay Tribe
- Jackson Band of Miwuk Indians
- Jamestown S'Klallam Tribe
- Jamul Indian Village of California
- Jena Band of Choctaw Indians
- Jicarilla Apache Nation, New Mexico
- Kaguyak Village
- Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, Arizona
- Kaktovik Village (aka Barter Island)
- Kalispel Indian Community of the Kalispel Reservation
- Karuk Tribe
- Kashia Band of Pomo Indians of the Stewarts Point Rancheria, California
- Kasigluk Traditional Elders Council
- Kaw Nation, Oklahoma
- Kenaitze Indian Tribe
- Ketchikan Indian Corporation
- Kewa Pueblo, New Mexico
- Keweenaw Bay Indian Community, Michigan
- Kialegee Tribal Town

- Kickapoo Traditional Tribe of Texas
- Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas
- Kickapoo Tribe of Oklahoma
- King Island Native Community
- King Salmon Tribe
- Kiowa Indian Tribe of Oklahoma
- Klamath Tribes
- Klawock Cooperative Association
- Kletsel Dehe Band of Wintun Indians
- Knik Tribe
- Koi Nation of Northern California
- Kokhanok Village
- Kootenai Tribe of Idaho
- Koyukuk Native Village
- La Jolla Band of Luiseno Indians, California
- La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation, California
- Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin
- Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin
- Lac Vieux Desert Band of Lake Superior Chippewa Indians of Michigan
- Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony, Nevada
- Levelock Village
- Lime Village
- Little River Band of Ottawa Indians, Michigan
- Little Shell Tribe of Chippewa Indians
- of Montana
- Little Traverse Bay Bands of Odawa Indians, Michigan
- Lone Pine Paiute-Shoshone Tribe
- Los Coyotes Band of Cahuilla and Cupeno Indians, California
- Lovelock Paiute Tribe of the Lovelock Indian Colony, Nevada
- Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
- Lower Elwha Tribal Community
- Lower Sioux Indian Community in the State of Minnesota
- Lummi Tribe of the Lummi Reservation
- Lytton Rancheria of California
- Makah Indian Tribe of the Makah Indian Reservation
- Manchester Band of Pomo Indians of the Manchester Rancheria, California
- Manley Hot Springs Village
- Manokotak Village

- Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation, California
- Mashantucket Pequot Indian Tribe
- Mashpee Wampanoag Tribe
- Match-e-be-nash-she-wish Band of Pottawatomi Indians of Michigan
- McGrath Native Village
- Mechoopda Indian Tribe of Chico Rancheria, California
- Menominee Indian Tribe of Wisconsin
- Mentasta Traditional Council
- Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation, California
- Mescalero Apache Tribe of the Mescalero Reservation, New Mexico
- Metlakatla Indian Community, Annette Island Reserve
- Miami Tribe of Oklahoma
- Miccosukee Tribe of Indians
- Middletown Rancheria of Pomo Indians of California
- Minnesota Chippewa Tribe
- Minnesota Chippewa Tribe—Bois Forte Band (Nett Lake)
- Minnesota Chippewa Tribe—Fond du Lac Band
- Minnesota Chippewa Tribe—Grand Portage Band
- Minnesota Chippewa Tribe—Leech Lake Band
- Minnesota Chippewa Tribe—Mille Lacs Band
- Minnesota Chippewa Tribe—White Earth Band
- Mississippi Band of Choctaw Indians
- Moapa Band of Paiute Indians of the Moapa River Indian Reservation, Nevada
- Mohegan Tribe of Indians of Connecticut
- Modoc Nation
- Monacan Indian Nation
- Mooretown Rancheria of Maidu Indians of California
- Morongo Band of Mission Indians, California
- Muckleshoot Indian Tribe
- Naknek Native Village
- Nansemond Indian Nation
- Narragansett Indian Tribe
- Native Village of Afognak
- Native Village of Akhiok
- Native Village of Akutan
- Native Village of Aleknagik
- Native Village of Ambler
- Native Village of Atka

- Native Village of Barrow Inupiat Traditional Government
- Native Village of Belkofski
- Native Village of Brevig Mission
- Native Village of Buckland
- Native Village of Cantwell
- Native Village of Chenega (aka Chanega)
- Native Village of Chignik Lagoon
- Native Village of Chitina
- Native Village of Chuathbaluk (Russian Mission, Kuskokwim)
- Native Village of Council
- Native Village of Deering
- Native Village of Diomede (aka Inalik)
- Native Village of Eagle
- Native Village of Eek
- Native Village of Ekuk
- Native Village of Ekwok
- Native Village of Elim
- Native Village of Eyak (Cordova)
- Native Village of False Pass
- Native Village of Fort Yukon
- Native Village of Gakona
- Native Village of Gambell
- Native Village of Georgetown
- Native Village of Goodnews Bay
- Native Village of Hamilton
- Native Village of Hooper Bay
- Native Village of Kanatak
- Native Village of Karluk
- Native Village of Kiana
- Native Village of Kipnuk
- Native Village of Kivalina
- Native Village of Kluti-Kaah (aka Copper Center)
- Native Village of Kobuk
- Native Village of Kongiganak
- Native Village of Kotzebue
- Native Village of Koyuk
- Native Village of Kwigillingok
- Native Village of Kwinhagak (aka Quinhagak)

- Native Village of Larsen Bay
- Native Village of Marshall (aka Fortuna Ledge)
- Native Village of Mary's Igloo
- Native Village of Mekoryuk
- Native Village of Minto
- Native Village of Nanwalek (aka English Bay)
- Native Village of Napaimute
- Native Village of Napakiak
- Native Village of Napaskiak
- Native Village of Nelson Lagoon
- Native Village of Nightmute
- Native Village of Nikolski
- Native Village of Noatak
- Native Village of Nuiqsut (aka Nooiksut)
- Native Village of Nunam Iqua
- Native Village of Nunapitchuk
- Native Village of Ouzinkie
- Native Village of Paimiut
- Native Village of Perryville
- Native Village of Pilot Point
- Native Village of Point Hope
- Native Village of Point Lay
- Native Village of Port Graham
- Native Village of Port Heiden
- Native Village of Port Lions
- Native Village of Ruby
- Native Village of Saint Michael
- Native Village of Savoonga
- Native Village of Scammon Bay
- Native Village of Selawik
- Native Village of Shaktoolik
- Native Village of Shishmaref
- Native Village of Shungnak
- Native Village of Stevens
- Native Village of Tanacross
- Native Village of Tanana
- Native Village of Tatitlek
- Native Village of Tazlina

- Native Village of Teller
- Native Village of Tetlin
- Native Village of Tuntutuliak
- Native Village of Tununak
- Native Village of Tyonek
- Native Village of Unalakleet
- Native Village of Unga
- Native Village of Venetie Tribal Government
- Native Village of Wales
- Native Village of White Mountain
- Navajo Nation, Arizona, New Mexico and Utah
- Nenana Native Association
- New Koliganek Village Council
- New Stuyahok Village
- Newhalen Village
- Newtok Village
- Nez Perce Tribe
- Nikolai Village
- Ninilchik Village
- Nisqually Indian Tribe
- Nome Eskimo Community
- Nondalton Village
- Nooksack Indian Tribe
- Noorvik Native Community
- Northern Arapaho Tribe of the Wind River Reservation, Wyoming
- Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation, Montana
- Northfork Rancheria of Mono Indians of California
- Northway Village
- Northwestern Band of Shoshone Nation
- Nottawaseppi Huron Band of the Potawatomi, Michigan
- Nulato Village
- Nunakauyarmiut Tribe
- Oglala Sioux Tribe
- Ohkay Owingeh, New Mexico
- Omaha Tribe of Nebraska
- Oneida Indian Nation
- Oneida Nation
- Onondaga Nation

- Organized Village of Grayling (aka Holikachuk)
- Organized Village of Kake
- Organized Village of Kasaan
- Organized Village of Kwethluk
- Organized Village of Saxman
- Orutsararmiut Traditional Native Council
- Oscarville Traditional Village
- Otoe-Missouria Tribe of Indians, Oklahoma
- Ottawa Tribe of Oklahoma
- Paiute Indian Tribe of Utah (Cedar Band of Paiutes, Kanosh Band of Paiutes, Koosharem Band of Paiutes, Indian Peaks Band of Paiutes, and Shivwits Band of Paiutes)
- Paiute-Shoshone Tribe of the Fallon Reservation and Colony, Nevada
- Pala Band of Mission Indians
- Pamunkey Indian Tribe
- Pascua Yaqui Tribe of Arizona
- Paskenta Band of Nomlaki Indians of California
- Passamaquoddy Tribe—Indian Township
- Passamaquoddy Tribe—Pleasant Point
- Pauloff Harbor Village
- Pauma Band of Luiseno Mission Indians of the Pauma & Yuima Reservation, California
- Pawnee Nation of Oklahoma
- Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation, California
- Pedro Bay Village
- Penobscot Nation
- Peoria Tribe of Indians of Oklahoma
- Petersburg Indian Association
- Picayune Rancheria of Chukchansi Indians of California
- Pilot Station Traditional Village
- Pinoleville Pomo Nation, California
- Pit River Tribe, California
- Pitka's Point Traditional Council
- Platinum Traditional Village
- Poarch Band of Creeks
- Pokagon Band of Potawatomi Indians, Michigan & Indiana
- Ponca Tribe of Indians of Oklahoma
- Ponca Tribe of Nebraska
- Port Gamble S'Klallam Tribe
- Portage Creek Village (aka Ohgsenakale)

- Potter Valley Tribe, California
- Prairie Band of Potawatomi Nation
- Prairie Island Indian Community in the State of Minnesota
- Pribilof Islands Aleut Communities of St. Paul and St. George Islands
- Pueblo of Acoma, New Mexico
- Pueblo of Cochiti, New Mexico
- Pueblo of Isleta, New Mexico
- Pueblo of Jemez, New Mexico
- Pueblo of Laguna, New Mexico
- Pueblo of Nambe, New Mexico
- Pueblo of Picuris, New Mexico
- Pueblo of Pojoaque, New Mexico
- Pueblo of San Felipe, New Mexico
- Pueblo of San Ildefonso, New Mexico
- Pueblo of Sandia, New Mexico
- Pueblo of Santa Ana, New Mexico
- Pueblo of Santa Clara, New Mexico
- Pueblo of Taos, New Mexico
- Pueblo of Tesuque, New Mexico
- Pueblo of Zia, New Mexico
- Puyallup Tribe of the Puyallup Reservation
- Pyramid Lake Paiute Tribe of the Pyramid Lake Reservation, Nevada
- Quapaw Nation
- Qagan Tayagungin Tribe of Sand Point
- Qawalangin Tribe of Unalaska
- Quartz Valley Indian Community of the Quartz Valley Reservation of California
- Quechan Tribe of the Fort Yuma Indian Reservation, California and Arizona
- Quileute Tribe of the Quileute Reservation
- Quinault Indian Nation
- Ramah Navajo Chapter
- Ramona Band of Cahuilla, California
- Rampart Village
- Rappahannock Tribe, Inc.
- Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
- Red Lake Band of Chippewa Indians, Minnesota
- Redding Rancheria, California
- Redwood Valley or Little River Band of Pomo Indians of the Redwood Valley Rancheria California
- Reno-Sparks Indian Colony, Nevada

- Resighini Rancheria, California
- Rincon Band of Luiseno Mission Indians of the Rincon Reservation, California
- Robinson Rancheria, California
- Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
- Round Valley Indian Tribes, Round Valley Reservation, California
- Sac & Fox Tribe of the Mississippi in Iowa
- Sac and Fox Nation of Missouri in Kansas and Nebraska
- Sac and Fox Nation, Oklahoma
- Saginaw Chippewa Indian Tribe of Michigan
- Saint George Island (Pribilof Islands Aleut Communities of St. Paul and St. George Islands)
- Saint Paul Island (Pribilof Islands Aleut Communities of St. Paul and St. George Islands)
- Saint Regis Mohawk Tribe
- Salamatof Tribe
- Salt River Pima-Maricopa Indian Community of the Salt River Reservation, Arizona
- Samish Indian Nation
- San Carlos Apache Tribe of the San Carlos Reservation, Arizona
- San Juan Southern Paiute Tribe of Arizona
- San Manuel Band of Mission Indians, California
- San Pasqual Band of Diegueno Mission Indians of California
- Santa Rosa Band of Cahuilla Indians, California
- Santa Rosa Indian Community of the Santa Rosa Rancheria, California
- Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation, California
- Santee Sioux Nation, Nebraska
- Sauk-Suiattle Indian Tribe
- Sault Ste. Marie Tribe of Chippewa Indians, Michigan
- Scotts Valley Band of Pomo Indians of California
- Seldovia Village Tribe
- Seminole Tribe of Florida
- Seneca Nation of Indians
- Seneca-Cayuga Nation
- Shageluk Native Village
- Shakopee Mdewakanton Sioux Community of Minnesota
- Shawnee Tribe
- Sherwood Valley Rancheria of Pomo Indians of California
- Shingle Springs Band of Miwok Indians, Shingle Springs Rancheria (Verona Tract), California
- Shinnecock Indian Nation
- Shoalwater Bay Indian Tribe of the Shoalwater Bay Indian Reservation
- Shoshone-Bannock Tribes of the Fort Hall Reservation

- Shoshone-Paiute Tribes of the Duck Valley Reservation, Nevada
- Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
- Sitka Tribe of Alaska
- Skagway Village
- Skokomish Indian Tribe
- Skull Valley Band of Goshute Indians of Utah
- Snoqualmie Indian Tribe
- Soboba Band of Luiseno Indians, California
- Sokaogon Chippewa Community, Wisconsin
- South Naknek Village
- Southern Ute Indian Tribe of the Southern Ute Reservation, Colorado
- Spirit Lake Tribe, North Dakota
- Spokane Tribe of the Spokane Reservation
- Squaxin Island Tribe of the Squaxin Island Reservation
- St. Croix Chippewa Indians of Wisconsin
- Standing Rock Sioux Tribe of North and South Dakota
- Stebbins Community Association
- Stillaguamish Tribe of Indians of Washington
- Stockbridge Munsee Community, Wisconsin
- Summit Lake Paiute Tribe of Nevada
- Sun'aq Tribe of Kodiak
- Suquamish Indian Tribe of the Port Madison Reservation
- Susanville Indian Rancheria, California
- Swinomish Indian Tribal Community
- Sycuan Band of the Kumeyaay Nation
- Table Mountain Rancheria of California
- Takotna Village
- Tangirnaq Native Village (aka Woody Island)
- Tejon Indian Tribe
- Telida Village
- Te-Moak Tribe of Western Shoshone Indians of Nevada (four constituent bands: Battle Mountain Band, Elko Band, South Fork Band, and Wells Band)
- The Chickasaw Nation
- The Choctaw Nation of Oklahoma
- The Muscogee (Creek) Nation
- The Osage Nation
- The Seminole Nation of Oklahoma
- Thlopthlocco Tribal Town

- Three Affiliated Tribes of the Fort Berthold Reservation, North Dakota
- Timbisha Shoshone Tribe
- Tohono O'odham Nation of Arizona
- Tolowa Dee-Ni' Nation
- Tonawanda Band of Seneca
- Tonkawa Tribe of Indians of Oklahoma
- Tonto Apache Tribe of Arizona
- Torres Martinez Desert Cahuilla Indians, California
- Traditional Village of Togiak
- Tulalip Tribes of Washington
- Tule River Indian Tribe of the Tule River Reservation, California
- Tuluksak Native Community
- Tunica-Biloxi Indian Tribe
- Tuolumne Band of Me-Wuk Indians of the Tuolumne Rancheria of California
- Turtle Mountain Band of Chippewa Indians of North Dakota
- Tuscarora Nation
- Twenty-Nine Palms Band of Mission Indians of California
- Twin Hills Village
- Ugashik Village
- Umkumiut Native Village
- United Auburn Indian Community of the Auburn Rancheria of California
- United Keetoowah Band of Cherokee Indians in Oklahoma
- Upper Mattaponi Tribe
- Upper Sioux Community, Minnesota
- Upper Skagit Indian Tribe
- Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
- Ute Mountain Ute Tribe
- Utu Utu Gwaitu Paiute Tribe of the Benton Paiute Reservation, California
- Village of Alakanuk
- Village of Anaktuvuk Pass
- Village of Aniak
- Village of Atmautluak
- Village of Bill Moore's Slough
- Village of Chefornak
- Village of Clarks Point
- Village of Crooked Creek
- Village of Dot Lake
- Village of Iliamna

- Village of Kalskag
- Village of Kaltag
- Village of Kotlik
- Village of Lower Kalskag
- Village of Ohogamiut
- Village of Red Devil
- Village of Sleetmute
- Village of Solomon
- Village of Stony River
- Village of Venetie
- Village of Wainwright
- Walker River Paiute Tribe of the Walker River Reservation, Nevada
- Wampanoag Tribe of Gay Head (Aquinnah)
- Washoe Tribe of Nevada and California (Carson Colony, Dresslerville Colony, Woodfords Community, Stewart Community, and Washoe Ranches)
- White Mountain Apache Tribe of the Fort Apache Reservation, Arizona
- Wichita and Affiliated Tribes
- Wilton Rancheria, California
- Winnebago Tribe of Nebraska
- Winnemucca Indian Colony of Nevada
- Wiyot Tribe, California
- Wrangell Cooperative Association
- Wyandotte Nation
- Yakutat Tlingit Tribe
- Yankton Sioux Tribe of South Dakota
- Yavapai-Apache Nation of the Camp Verde Indian Reservation, Arizona
- Yavapai-Prescott Indian Tribe
- Yerington Paiute Tribe of the Yerington Colony and Campbell Ranch, Nevada
- Yocha Dehe Wintun Nation, California
- Yomba Shoshone Tribe of the Yomba Reservation, Nevada
- Ysleta del Sur Pueblo
- Yupiit of Andreafski
- Yurok Tribe of the Yurok Reservation, California
- Zuni Tribe of the Zuni Reservation

12.5 Manufacturers

- Accubuilt, Inc.
- Adient plc

- Adrian Steel Company
- Advanced Wheels of Technology, Inc.
- Adventurer LP
- Advics North America, Inc.
- AGC Glass Company North America
- Agility Fuel Systems
- Aisin World Corp. of America
- Akron Brass Company
- Alcoa Inc.
- Alliance Tire Americas, Inc.
- Almared, Inc.
- American Grease Stick Company
- American Honda Motor Co.
- American Kenda Rubber Industrial Company
- American Pacific Industries, Inc.
- American Suzuki Motor Corporation
- Aston Martin Laginda
- Aston Martin The Americas
- ATI Performance Products, Inc.
- Auto Pro USA, Inc.
- Autoliv, Inc.
- Automobili Lamborghini
- Automobili Lamborghini America, LLC
- Autotech Accessories, Inc.
- Azure Dynamics Corporation
- B&W Custom Truck Beds, Inc.
- Battery-Biz, Inc.
- Beijing Capital Tyre Co., LTD
- Bentley Motors, Inc.
- BF1 Systems Limited
- Bluecar SAS
- BMW of North America, LLC
- Bombardier Recreational Products, Inc.
- Brake Parts, Inc.
- Brammo, Inc.
- Bridgestone Americas Tire Operations, LLC
- Bugatti
- Buy4easy, Inc.

- Campagna Motors
- Carrier Corporation
- Centric Parts
- Cequent Consumer Products, Inc.
- China Manufacturers Alliance, LLC
- Chrysler (Fiat Chrysler Automobiles US LLC)
- CIRCOR Aerospace, Inc.
- Cleanfuel USA
- Clore Automotive, LLC
- Continental Automotive Systems, Inc.
- Continental Tire the Americas, LLC.
- Cooper Tire & Rubber Co.
- Craftsmen Industries, Inc.
- Daimler AG
- Daimler Trucks North America
- Daimler Vans USA, LLC
- Dana Driveshaft Manufacturing, LLC
- Daystar Products International, Inc.
- Delphi Automotive Systems, LLC
- Discount Tire
- Dometic Corporation
- Dorman Products, Inc.
- Double Coin Holdings, Ltd.
- Ducati North America
- Dynamic Tire Corp.
- Eaton Corporation
- Eldorado Mobility, Inc.
- Emcara Gas Development, Inc.
- e-ride Industries
- EV-Charge America, Ltd
- Federal Coach, LLC
- Federal-Mogul Corporation
- Ferrari North America, Inc.
- Fiat Chrysler Automobiles US LLC
- Flex-a-lite
- Ford Motor Company
- Fram Group Operations, LLC
- Freedom Motors, Inc.

- General Motors, LLC
- GITI Tire (USA) Ltd.
- Goodyear Tire & Rubber Company
- Guardian Industries Corp.
- Hankook Tire America Corp.
- Hercules Tire & Rubber Company
- Holley Performance Products, Inc.
- Honda North America, Inc.
- Hydraulic Supply Co.
- Hyundai Kia America Technical Center, Inc.
- Hyundai Motor America
- ILJIN USA Corporation
- Isuzu Manufacturing Services of America
- Isuzu Motors America, LLC
- Isuzu Technical Center of America, Inc.
- Jaguar Land Rover North America, LLC
- Karma Automotive, LLC
- Kia Motors America
- Koenigsegg Automotive AB
- Kraco Enterprises, LLC
- Kumho Tire U.S.A., Inc.
- Landi Renzo USA
- Lionshead Specialty Tire & Wheel, LLC
- LiquidMetal Motorsports, Inc.
- LiquidSpring, LLC
- Lotus Cars USA, Inc.
- Maserati North America, Inc.
- Maxion Wheels/Hayes Lemmerz
- Mazda Motor Corp.
- Mazda North American Operations
- McLaren Automotive Incorporated
- Mercedes-Benz USA, LLC
- Michelin North America, Inc.
- Midway Specialty Vehicles
- Mitsubishi Motors North America, Inc.
- Mobility Ventures, LLC
- Morgan 3 Wheeler Limited
- Nissan North America, Inc.

- Nissens North America, Inc.
- Nitto Tire U.S.A., Inc.
- Norgren Inc.
- Oreion Motors, LLC
- Pagani Automobili SpA
- Pirelli Tire, LLC
- Polaris Industries, Inc.
- Porsche Cars North America, Inc.
- Prime-Time Specialty Vehicles
- PT Multistrada Arah Sarana, Tbk
- Robert Bosch, LLC
- Rolls-Royce Motor Cars, Ltd.
- Saab Cars North America, Inc.
- Shandong Jinyu Industrial Co., Ltd.
- SKF USA Inc.
- Spartan Motors, Inc.
- Stoneridge, Inc.
- Subaru of America, Inc.
- Sumitomo Rubber Industries, Ltd.
- Sumitomo Rubber USA, LLC
- Suzuki Motor of America, Inc.
- Tesla Motors, Inc.
- TI Group Automotive Systems, LLC
- Timken Company
- Tireco Inc.
- Tishomingo Acquisition, LLC
- Tong Yang Industry Co.
- Toyo Tire Holdings of Americas, Inc.
- Toyota Motor Engineering & Manufacturing
- Toyota Motor North America, Inc.
- Tread Systems, Inc., dba Diamond Back
- Valeo
- Vantage Mobility International, LLC
- Vee Tyre and Rubber Co., Ltd.
- Vision Wheel, Inc.
- Vogue Tyre & Rubber Co.
- Volkswagen Group of America, Inc.
- Volvo Car USA, LLC

- Volvo Group North America
- Wells Vehicle Electronics, L.P.
- Westward Industries
- Wheel Pros, LLC
- Wilson Manifolds, Inc.
- Yokohama Tire Corporation
- ZF North America, Inc.

12.6 Stakeholders

- 1854 Treaty Authority
- 350 Bay Area Transportation Campaign
- AAA Mid-Atlantic
- Advanced Engine Systems Institute
- Alaska Public Interest Research Group
- Alliance of Automobile Manufacturers
- Alliance to Save Energy
- American Association of Blacks in Energy
- American Automotive Policy Council
- American Chemistry Council
- American Council for an Energy-Efficient Economy
- American Council on Renewable Energy
- American Fuel & Petrochemical Manufacturers
- American Gas Association
- American Indian Science and Engineering Society
- American International Automobile Dealers Association
- American Iron and Steel Institute
- American Jewish Committee
- American Lung Association
- American Petroleum Institute
- American Powersports Mfg. Co. Inc.
- American Road & Transportation Builders Association (ARTBA)
- American Security Project
- American Thoracic Society
- Appalachian Mountain Club
- Arizona Public Interest Research Group
- Association of International Automobile Manufacturers, Inc.
- Association of Metropolitan Planning Organizations
- Auto Research Center

- BlueGreen Alliance
- Border Valley Trading LTD
- Boyden Gray & Associates PLLC
- Bridgestone Americas Tire Operations Product Development Group
- California Air Pollution Control Officers Association
- CALPIRG (Public Interest Research Group)
- CALSTART
- Cato Institute
- Center for Auto Safety
- Center for Biological Diversity
- Central States Air Resources Agencies
- Ceres and the Investor Network on Climate Risk (INCR)
- Ceres BICEP Network
- ChargePoint, Inc.
- Citizens' Utility Board of Oregon
- Clean Air Task Force
- Clean Energy
- Clean Fuel Development Coalition
- Climate Institute
- Columbian Justice Peace and Integrity of Creation Office
- Commission for Environmental Cooperation
- Competitive Enterprise Institute
- Conservation Law Foundation
- Consumer Action
- Consumer Assistance Council of Cape Cod
- Consumer Federation of America
- Consumer Federation of the Southeast
- Consumers for Auto Reliability and Safety
- Consumers Union
- Convoy Solutions dba IdleAir
- Con-way Inc
- CoPIRG Foundation
- Coulomb Technologies, Inc.
- Criterion Economics, LLC
- Crowell Moring
- CSRA
- Dale Kardos & Associates, Inc.
- Dallas Clean Energy, LLC

- Dana Holding Corporation
- Defenders of Wildlife
- Delaware Interfaith Power and Light
- Democratic Processes Center
- Ecology Center
- Edison Electric Institute
- Electric Applications Inc.
- Electric Drive Transportation Association
- Electric Power Research Institute
- Emmett Institute on Climate Change and the Environment
- Empire State Consumer Association
- Environment America
- Environment Illinois
- Environmental Defense Fund
- Environmental Law & Policy Center
- Evangelical Environmental Network
- Evangelical Lutheran Church in America
- FedEx Corporation
- Florida Consumer Action Network
- Florida Power & Light Co.
- Florida Public Internet Research Group
- FreedomWorks Foundation
- Friends Committee on National Legislation
- Gibson, Dunn & Crutcher LLP
- Global Automakers
- Greater Washington Interfaith Power and Light
- Growth Energy
- HayDay Farms, Inc.
- Honeywell Transportation Systems
- ICM
- IdleAir
- Illinois Corn Growers Association
- Illinois Trucking Association
- Illinois Public Interest Research Group
- Indiana Corn Growers Association
- Indiana University
- Ingevity
- Insurance Institute for Highway Safety

- International Council on Clean Transportation
- International Mosaic
- Jewish Community Relations Council
- Justice and Witness Ministries
- Kansas Corn Growers Association
- Kirkland & Ellis LLP
- Manufacturers of Emission Controls Association
- Maryknoll Office of Global Concerns
- Maryland Consumer Rights Coalition
- Maryland Public Interest Research Group
- Massachusetts Consumers Council
- Massachusetts Public Interest Research Group
- Mercatus Center, George Mason University
- Metro 4/SESARM
- Meszler Engineering Services
- Michigan Tech University
- Mid-Atlantic Regional Air Management Association, Inc.
- Motor & Equipment Manufacturers Association
- National Alliance of Forest Owners
- National Association of Attorneys General
- National Association of Clean Air Agencies
- National Association of Counties
- National Association of Regional Councils
- National Association of Regulatory Utility Commissioners
- National Association of State Energy Officials
- National Automobile Dealers Association
- National Biodiesel Board
- National Caucus of Environmental Legislators
- National Conference of State Legislatures
- National Corn Growers Association
- National Council of Churches USA
- National Governors Association
- National Groundwater Association
- National League of Cities
- National Propane Gas Association
- National Tribal Air Association
- National Wildlife Federation
- Natural Gas Vehicles (NGV) America

- Natural Resources Canada
- Natural Resources Defense Council
- Nebraska Corn Board
- Nebraska Corn Growers Association
- New Jersey Citizen Action
- New Mexico Public Interest Research Group
- New York Corn & Soybean Growers Association
- Northeast Ohio Areawide Coordination Agency
- Northeast States for Coordinated Air Use Management
- Novation Analytics
- NTEA - The Association for the Work Truck Industry
- NY Public Interest Research Group
- Ohio Corn Wheat Growers Association
- Original United Citizens of Southwest Detroit
- Ozone Transport Commission
- Pew Environment Group
- Pierobon & Partners
- Plastics Industry Association
- Podesta Group
- Pollution Probe
- Presbyterian Church (USA)
- Public Citizen
- Recreation Vehicle Industry Association
- Renewable Fuels Association
- Republicans for Environmental Protection
- Respiratory Health Association
- Resources for the Future
- Road Safe America
- Rocky Mountain Institute
- Rubber Manufacturers Association
- Safe Climate Campaign
- Santa Clara Pueblo
- SAVE EPA
- SaviCorp, Inc.
- Securing America's Future Energy
- Sentech, Inc.
- Sierra Club
- Single Springs Rancheria

- Socially Responsible Investing
- South Coast Air Quality Management District
- Sport Utility Vehicle Owners of America
- SUN DAY Campaign
- Susquehanna River Basin Commission
- Teamsters Joint Council 25
- Tetlin Village Council
- Texas Corn Producers Association (TCPA)
- The Accord Group
- The Aluminum Association, Inc.
- The Consumer Alliance
- The Council of State Governments
- The Environmental Council of the States
- The Episcopal Church
- The Hertz Corporation
- The Lee Auto Malls
- The Pew Charitable Trusts
- The Truman National Security Project
- The United Methodist Church General
- TIAX LLC
- ToChi Technologies Inc
- Trillium Asset Management Corporation
- Truck Manufacturer's Association
- Truman Center for National Policy
- Tufts University
- U.S. Chamber of Commerce
- U.S. Conference of Mayors
- Union for Reform Judaism
- Union of Concerned Scientists
- United Auto Workers
- United Automobile, Aerospace and Agricultural Workers of America (UAW)
- United Church of Christ
- United Steelworkers
- University of Colorado School of Law
- University of Michigan Center for Sustainable Systems
- University of Michigan Transportation Research Institute
- University of Southern California
- U.S. Public Interest Research Group

- Utility Consumers Action Network
- Vermont Public Interest Research Group
- Victims Committee for Recall of Defective Vehicles
- Virginia Citizens Consumer Council
- VNG.co LLC
- Washtenaw Climate Reality
- Wayne Stewart Trucking Company
- West Virginia University
- Western Governors' Association
- Western Regional Air Partnership
- Western States Air Resources Council
- Wisconsin Consumers League
- World Auto Steel
- World Resources Institute

12.7 Individuals

Individual commenters are not named in this distribution list for their privacy. NHTSA is mailing notification of the availability of this EIS to individual commenters who provided a mailing address as part of their comment submission.

CHAPTER 13 REFERENCES

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