Final Environmental Impact Statement

Corporate Average Fuel Economy Standards for Passenger Cars and Light Trucks, Model Years 2027 and Beyond, and Fuel Efficiency Standards for Heavy-Duty Pickup Trucks and Vans, Model Years 2030 and Beyond

Summary **June 2024**

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

NHTSA

SUMMARY

Foreword

The National Highway Traffic Safety Administration (NHTSA) prepared this environmental impact statement (EIS) to analyze and disclose (1) the potential environmental impacts of the Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks for model years (MYs) 2027 to 2031, (2) the potential environmental impacts of the fuel efficiency (FE) standards for heavy-duty (HD) pickup trucks and vans (HDPUVs) for MYs 2030 to 2035, and (3) the cumulative impacts of the Proposed Action and alternatives[1] that reflect the cumulative or combined impact of the two sets of standards that are being issued by NHTSA in its final rule, including MY 2032 augural standards.[2] NHTSA prepared this document pursuant to the Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) implementing regulations, U.S. Department of Transportation (DOT) Order 5610.1C, and NHTSA regulations.[3]

This EIS compares the potential environmental impacts of the No-Action Alternative and five action alternatives for setting fuel economy standards for MY 2027–2031 passenger cars and light trucks and the No-Action Alternative and four action alternatives for setting FE standards for MYs 2030–2035 for HDPUVs. This EIS analyzes the direct, indirect, and cumulative impacts of each CAFE and HDPUV action alternative relative to the impacts of each relevant No-Action Alternative.

This Summary references pertinent data from the analysis in the EIS. Sources of such data are appropriately cited and referenced in those chapters. The Summary was prepared in accordance with NEPA, which requires that "Each environmental impact statement shall contain a summary that adequately and accurately summarizes the statement. The summary shall stress the major conclusions,

---

[1] The term "Proposed Action and alternatives" is used throughout this Final EIS to reflect the fact that the Final EIS is the document that informs the decisionmaker and, thus, the Record of Decision (ROD). 40 CFR 1505.2. For a given set of standards (CAFE or HDPUV FE), the "Proposed Action and alternatives" constitute the entire range of alternatives evaluated by NHTSA and include the agency's Preferred Alternative. In NEPA practice, the EIS can indicate the agency's preferred alternative, but the decision is made and communicated in the ROD. NHTSA's final rule, which states and explains NHTSA's decision and describes NHTSA's consideration of applicable environmental laws and policies, is the ROD. 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.

[2] Because in any single rulemaking under the EPCA, CAFE standards may be established for not more than 5 model years, NHTSA is setting forth conditional (or augural) CAFE standards for MY 2032. The MY 2032 standards for passenger cars and light trucks are "augural," in that they fall beyond the statutory 5-model-year period set out in 49 U.S.C. 32902 and, thus, represent what CAFE standards the agency *would* issue, based on current information, but NHTSA will not be finalizing those standards as part of this rulemaking effort. The CAFE standards for MY 2032 will be determined with finality in a subsequent, *de novo* notice-and-comment rulemaking conducted in full compliance with 49 U.S.C. 32902 and other applicable law. Therefore, NHTSA does not include the MY 2032 CAFE standards in the analysis of direct and indirect impacts of this rulemaking.

[3] The CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations [CFR] Parts 1500–1508; DOT Order 5610.1C, 44 FR 56420 (Oct. 1, 1979), as amended, is 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.

areas of disputed issues raised by agencies and the public, and the issues to be resolved (including the choice among alternatives). The summary normally will not exceed 15 pages."[4]

Background

The Energy Policy and Conservation Act of 1975 (EPCA) mandates 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.[5]

To inform its development of the new CAFE standards and HDPUV FE standards and pursuant to NEPA,[6] NHTSA prepared this EIS to evaluate the potential environmental impacts of a reasonable range of alternatives the agency is considering for MY 2027–2031 CAFE standards and a reasonable range of alternatives NHTSA is considering for MY 2030–2035 HDPUV FE standards. NEPA directs that Federal agencies proposing "major federal actions significantly affecting the quality of the human environment" must prepare a detailed statement on the environmental impacts of the proposed action (including alternatives to the proposed action).[7] This EIS analyzes, discloses, and compares the potential environmental impacts of a reasonable range of alternatives for both CAFE standards and HDPUV FE standards, including a No-Action Alternative and a Preferred Alternative for each set of standards.[8] This EIS analyzes direct, indirect, and cumulative impacts, and discusses impacts in proportion to their significance.

Purpose and Need for the Action

In accordance with EPCA, as amended by EISA, the first purpose of NHTSA's rulemaking is to set fuel economy standards for MY 2027–2031 passenger cars and light trucks to reflect "the maximum feasible average fuel economy level that the Secretary [of Transportation] decides the manufacturers can achieve in that model year."[9] 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,

---

[4] 40 CFR 1502.12.

[5] The Secretary of Transportation has delegated the responsibility for implementing the CAFE program to NHTSA (49 CFR 1.95(a)). Accordingly, the Secretary, DOT, and NHTSA are often used interchangeably in this EIS.

[6] 42 U.S.C. 4321–4347.

[7] 42 U.S.C. 4332.

[8] NHTSA's identification of a Preferred Alternative is consistent with 40 CFR 1502.14(d). The Preferred Alternative is the alternative identified as the favored course of action by the lead agency during the NEPA process. For a given set of standards (CAFE or HDPUV FE), the "Proposed Action and alternatives" constitute the entire range of alternatives evaluated by NHTSA and include the agency's Preferred Alternative. Consistent with 40 CFR 1502.14, this EIS presents the environmental impacts of the Proposed Action and alternatives in comparative form so that reviewers may evaluate their comparative merits.

[9] 49 U.S.C. 32902(a).

when determining the maximum feasible levels, the agency considers relevant safety and environmental factors.

NHTSA must establish separate average fuel economy standards for passenger cars and light trucks for each model year.[10] Standards must be "based on [one] or more vehicle attributes related to fuel economy" and "express[ed]…in the form of a mathematical function."[11]

In accordance with EPCA, as amended by EISA, the second purpose of this rulemaking is to set MY 2030–2035 HDPUV FE standards that are "designed to achieve the maximum feasible improvement."[12] These new HDPUV FE standards will build on the success of the Phase 1 and Phase 2 HD Fuel Efficiency Improvement Programs in furtherance of EPCA's goals of energy independence and security, as well as improving environmental outcomes and national security.

When establishing standards to improve the fuel efficiency of HD vehicles, EISA requires that NHTSA "adopt and implement appropriate test methods, measurement metrics, fuel economy standards,[13] and compliance and enforcement protocols that are appropriate, cost-effective, and technologically feasible for [HD vehicles]."[14]

Proposed Action and Alternatives

NHTSA's action is a rulemaking to set fuel economy standards for passenger cars and light trucks and FE standards for HDPUVs in accordance with EPCA, as amended by EISA. NHTSA has selected a reasonable range of alternatives within which to set CAFE standards and HDPUV FE standards and to evaluate the potential environmental impacts of the CAFE standards and alternatives and HDPUV FE standards and alternatives under NEPA. NHTSA is establishing CAFE standards for MY 2027–2031 passenger cars and light trucks and FE standards for MY 2030–2035 HDPUVs. NHTSA also includes analysis of MY 2032 augural standards as part of the analysis of cumulative environmental impacts considered in this EIS, as described above.

CAFE No-Action and Action Alternatives

The CAFE No-Action Alternative for MY 2027 and beyond assumes that the national CAFE and greenhouse gas (GHG) MY 2026 standards finalized in 2022 continue in perpetuity. In addition, the No-Action Alternative assumes that vehicle manufacturers will, regardless of the existence or non-existence of a legal requirement, produce additional electric vehicles (EVs) consistent with the levels that would be required under California and other Section 177 states' Advanced Clean Cars II program, if it were to

---

[10] 49 U.S.C. 32902(b)(1)-(2).

[11] 49 U.S.C. 32902(b)(3)(A).

[12] 49 U.S.C. 32902(k)(2).

[13] In the *Phase 1 HD Fuel Efficiency Improvement Program* rulemaking, NHTSA, aided by the National Academies of Sciences report, assessed potential metrics for evaluating fuel efficiency. NHTSA found that fuel economy would not be an appropriate metric for HD vehicles. Instead, NHTSA chose a metric that considers the amount of fuel consumed when moving a ton of freight (i.e., performing work). As explained in the Phase 2 HD Fuel Efficiency Improvement Program Final Rule, this metric, delegated by Congress to NHTSA to formulate, is not precluded by the text of the statute. The agency concluded that it is a reasonable way by which to measure fuel efficiency for a program designed to reduce fuel consumption. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles – Phase 2; Final Rule, 81 FR 73478, 73520 (Oct. 25, 2016).

[14] 49 U.S.C. 32902(k)(2).

be granted a Clean Air Act (CAA) preemption waiver, in addition to including assumptions about manufacturer behavior in response to market demand for fuel economy and recently passed tax credits for battery-based vehicle technologies. NHTSA believes that the agency's modeling methodology is the most reasonable approach available to the agency at present. However, NHTSA extensively discusses a No zero-emission vehicle (ZEV) alternative baseline case in the preamble and Final Regulatory Impact Analysis (FRIA) that does not assume manufacturers will produce additional EVs consistent with the levels that would be required under California and other Section 177 states' Advanced Clean Cars II program, and compares the results of that analysis to the reference baseline, which uses the same assumptions about manufacturer commitments to deploy EVs consistent with levels required by California's Advanced Clean Cars II program as those described in this Final EIS. This No ZEV alternative baseline case is discussed in more detail in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and at length in the preamble and FRIA.

The No-Action Alternative represents a lower bound of CAFE stringency that NHTSA can consider and provides an analytical reference baseline against which to compare the environmental impacts of the other alternatives presented in the EIS.

NHTSA has analyzed a range of CAFE action alternatives with fuel economy stringencies that increase annually, on average, 1 percent to 6 percent from the MY 2026 standards for passenger cars and increase, on average, 0 percent to 8 percent for light trucks. This range of the No-Action Alternative and action alternatives 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.

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

Alt. PC2LT002[15]	2 percent increase per year, year over year for MY 2027–2031 passenger cars, 0 percent increase per year, year over year for MY 2027–2028 light trucks, and 2 percent increase per year, year over year for MY 2029–2031 light trucks (Alternative PC2LT002 is NHTSA's Preferred Alternative for CAFE standards)
Alt. PC1LT3	1 percent increase per year, year over year for MY 2027–2031 passenger cars, and 3 percent per year, year over year for MY 2027–2031 light trucks
Alt. PC2LT4	2 percent increase per year, year over year for MY 2027–2031 passenger cars, and 4 percent per year, year over year for MY 2027–2031 light trucks
Alt. PC3LT5	3 percent increase per year, year over year for MY 2027–2031 passenger cars, and 5 percent per year, year over year for MY 2027–2031 light trucks
Alt. PC6LT8	6 percent increase per year, year over year for MY 2027–2031 passenger cars, and 8 percent per year, year over year for MY 2027–2031 light trucks

Table S-1 shows the estimated average required fleet-wide fuel economy forecasts by model year for each alternative.

---

[15] The abbreviation PC2LT002 is meant to reflect a 2 percent increase for passenger cars, a 0 percent increase for light trucks for MY 2027–2028, and a 2 percent increase for light trucks, including SUVs, for MY 2029–2031. PC2LT002 is formatted differently than the other CAFE alternatives because the rate of stringency increase changes across years, whereas in the other alternatives there is a constant year over year rate of increase.

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	No-Action	PC2LT002	PC1LT3	PC2LT4	PC3LT5	PC6LT8
2027	47.0	47.3	48.2	48.7	49.2	50.8
2028	46.9	47.5	49.4	50.4	51.4	54.8
2029	46.9	48.4	50.6	52.2	53.8	59.2
2030	46.9	49.4	51.8	54.0	56.3	64.0
2031	46.9	50.4	53.1	55.9	58.9	69.1

Notes:
mpg = miles per gallon

The range of alternatives under consideration encompasses a spectrum of possible standards that NHTSA could select based on how it weighs EPCA's four statutory factors. These alternatives reflect differences in the degree of technology adoption across the fleet, costs to manufacturers and consumers, and conservation of oil and related reductions in GHG emissions. 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 the ability to select from a wide range of alternatives that begin with the No-Action Alternative and increase up to 6 percent for passenger cars and up to 8 percent for light trucks. Within this range, stringencies could remain the same or differ year to year between and among regulatory classes.

As noted in the preamble to the final rule, NHTSA has determined that Alternative PC2LT002 is technologically feasible, economically practicable, supports the need of the United States to conserve energy, and is complementary to other motor vehicle standards of the government that are simultaneously applicable. NHTSA has determined that Alternative PC2LT002 is maximum feasible for MYs 2027–2031 and is the Preferred Alternative.

HDPUV No-Action and Action Alternatives

The HDPUV No-Action Alternative assumes that the MY 2027 HDPUV FE standards finalized in the Phase 2 program continue in perpetuity. The No-Action Alternative represents a lower bound of fuel efficiency stringency that NHTSA can consider and provides an analytical reference baseline against which to compare the environmental impacts of the other alternatives presented in the EIS.

NHTSA has analyzed a range of HDPUV FE action alternatives with FE stringencies that increase annually, on average, 4 percent to 14 percent from the MY 2027 HDPUV FE standards finalized in the Phase 2 program. This range of No-Action Alternative and action alternatives encompasses a spectrum of possible standards that, based on the different ways the agency could weigh EISA's requirements, encompasses the maximum feasible improvement of FE stringency.

Throughout this EIS, potential impacts are shown for four HDPUV FE standard action alternatives that illustrate the following range of estimated average annual percentage increases in fuel efficiency for HDPUVs.

Alt. HDPUV4[16]	4 percent increase per year, year over year for MY 2030–2035 HDPUVs
Alt. HDPUV108	10 percent increase per year, year over year for MY 2030–2032 and 8 percent increase per year, year over year for MY 2033–2035 HDPUVs (Alternative HDPUV108 is NHTSA's Preferred Alternative for HDPUV FE standards)
Alt. HDPUV10	10 percent increase per year, year over year for MY 2030–2035 HDPUVs
Alt. HDPUV14	14 percent increase per year, year over year for MY 2030–2035 HDPUVs

Table S-2 shows the estimated average required fleet-wide fuel efficiency forecasts by model year for each alternative.

Table S-2. Projected Average Required Fleet-Wide Fuel Efficiency (gallons per 100 miles) for Heavy-Duty Pickup Trucks and Vans by Model Year and Alternative

Model Year	No-Action	HDPUV4	HDPUV108	HDPUV10	HDPUV14
2030	5.00	4.80	4.50	4.50	4.29
2031	5.03	4.63	4.07	4.07	3.71
2032	5.03	4.45	3.67	3.67	3.19
2033	5.03	4.27	3.37	3.29	2.72
2034	5.03	4.10	3.10	2.96	2.34
2035	5.02	3.93	2.85	2.66	2.01

NHTSA reasonably believes the maximum feasible improvement falls within the range of alternatives presented in this EIS. This range encompasses a spectrum of possible standards that NHTSA could select that would satisfy EISA's requirements of increasing the fuel efficiency of HDPUVs. 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 provide decision-makers with the ability to select from a wide range of potential alternatives that begin with the No-Action Alternative and that increase up to 14 percent for HDPUVs. Within this range, stringency could remain the same or differ year to year.

As noted in the preamble to the final rule, NHTSA has determined that Alternative HDPUV108 is appropriate, cost-effective, and technologically feasible. NHTSA has determined that Alternative HDPUV108 is maximum feasible for MYs 2030–2035 and is the Preferred Alternative.

Environmental Consequences

This section describes how the CAFE and HDPUV FE standard No-Action Alternatives and action 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 (LD) vehicle fleet (passenger cars and light trucks combined) and the entire HDPUV fleet; results are reported separately for passenger cars and light trucks in Appendix A, *Modeling Results Reported Separately by Vehicle Class*. No quantifiable, alternative-specific impacts were identified for the other resource areas discussed in Chapter 6, *Life-Cycle Assessment Implications of Vehicle Materials*, Chapter 7, *Environmental Justice*, and

---

[16] The abbreviation HDPUV4 is meant to reflect a 4 percent increase for HDPUVs. The abbreviation for each HDPUV action alternative uses the same naming convention.

Chapter 8, *Historic and Cultural Resources;* however, these resource areas are summarized at a high level here and not included in the detailed discussion of impacts below.

Chapter 6, *Life-Cycle Assessment Implications of Vehicle Materials,* describes the life-cycle environmental implications related to the vehicle cycle phase considering the materials and technologies (e.g., batteries) that NHTSA forecasts vehicle manufacturers might use to comply with the CAFE and HDPUV FE standards. The chapter discusses the impacts related to raw material extraction for materials used for vehicle manufacture, material processing for materials used for vehicle manufacture, component manufacture and vehicle assembly, and vehicle end of life (i.e., disposal and recycling). It also discusses potential opportunities for reductions in environmental impacts in the production and end-of-life vehicle life-cycle phases. NHTSA concludes that manufacturers can choose how to respond to the proposed standards and, depending on vehicle manufacturers' responses in using the various materials or technologies, impacts would vary. As discussed in Chapter 6, Section 6.1, *Introduction,* NHTSA does not know how manufacturers will rely on the different materials or technologies assessed in Chapter 6 and fuel sources assessed in Chapter 3, *Energy*, and as a result, cannot quantitatively distinguish between action alternatives. Chapter 6 further concludes that the magnitude of life-cycle GHG impacts associated with materials and technologies is smaller in comparison with the emissions reductions from avoided fuel consumption during vehicle use.

Chapter 7, *Environmental Justice,* qualitatively describes potential disproportionate impacts on low-income and minority populations. 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 rule would set nationwide standards, and although minority and low-income populations may experience some disproportionate effects or face inequities in receiving some benefits, impacts of the Proposed Action and alternatives on human health and the environment would not be disproportionately high or adverse. Indeed, the reduction of air pollutants and GHGs resulting from the Proposed Action could result in improvements in air quality, decreases in total health effects, and a reduction in the number and severity of outbreaks of vector-borne illnesses for minority and low-income communities.

Chapter 8, *Historic and Cultural Resources*, qualitatively describes potential impacts on historic and cultural resources. The Proposed Action and alternatives would not result in significant impacts on historic and cultural resources. 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 historic buildings and structures and the varying impact of a specific geographic location on any particular historic property or sacred site or object. Metals critical to energy transition from gas-powered vehicles to EVs including copper, nickel, cobalt, and lithium may be located within or near areas of cultural and environmental importance to Native Americans. To the extent that other Federal agencies are involved in permitting mining actions, those agencies would be required to follow laws and procedures outlined in Chapter 8, Section 8.1, *Affected Environment*, which requires steps for Native American voices and perspectives to be solicited and considered during decision-making and planning for mining projects.

Direct, Indirect, and Cumulative Impacts

The potential impacts on energy use, air quality, and climate include *direct*, *indirect*, and *cumulative impacts.*[17] Direct impacts occur at the same time and place as the action. Indirect impacts occur later in

---

[17] 40 CFR 1508.1(g).

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.

To derive the direct and indirect impacts of the action alternatives, NHTSA compares each CAFE and HDPUV FE action alternative to the relevant No-Action Alternative, which reflects trends that would be expected in the absence of any regulatory action by NHTSA as discussed above. Because EPCA, as amended by EISA, requires NHTSA to set CAFE standards and FE standards for each model year, environmental impacts would also depend on future standards established by NHTSA but cannot be quantified at this time.

Cumulative impacts are effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable 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. The other actions that contribute to cumulative impacts can vary by resource and are noted accordingly 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 reference baseline.

The analyses of cumulative impacts of the Proposed Action and alternatives presented in this EIS reflect the cumulative or combined impact of the two sets of standards that are being issued by NHTSA in its final rule and the augural MY 2032 CAFE standards that NHTSA is setting forth in the final rule. Four CAFE and HDPUV FE alternative combinations were considered for the cumulative impacts analysis: CAFE No-Action Alternative and HDPUV No-Action Alternative (No-Action Alternatives), Alternatives PC2LT002 and HDPUV4 (the lowest stringency CAFE and HDPUV FE alternatives), Alternatives PC2LT002 and HDPUV108 (the Preferred CAFE and HDPUV FE alternatives), and Alternatives PC6LT8 and HDPUV14 (the highest stringency CAFE and HDPUV FE alternatives). The specific combinations were chosen to present the full range of cumulative impacts of the two sets of standards that NHTSA is issuing in this rulemaking. The impacts of CAFE and HDPUV FE standards are integrated for the cumulative impacts analysis as their enforcement periods would concurrently intersect, resulting in a cumulative effect.

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 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, and transportation accounts for the largest share of total U.S. petroleum consumption. In 2022, the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) 2023 shows that the transportation sector accounted for 72.2 percent of total U.S. petroleum consumption. In 2050, transportation is expected to account for 66.4 percent of total U.S. petroleum consumption.[18]

With transportation expected to account for 66.4 percent of total petroleum consumption, U.S. net petroleum imports in 2050 are expected to be primarily attributed to fuel consumption by LD and HD vehicles. The United States became a net energy exporter in 2019[19] for the first time in 67 years because improvements in vehicle fuel economy, combined with increases in U.S. petroleum production, have substantially reduced U.S. oil imports, resulting in declining net petroleum imports.

In the future, the transportation sector would continue to be the largest consumer of U.S. petroleum and the second-largest consumer of total U.S. energy, after the industrial sector according to AEO 2023. AEO projects that the fuel consumed by LD vehicles would consist predominantly of gasoline derived from petroleum for the foreseeable future due to conventional gasoline cars continuing to make up over 70 percent of LD vehicle stock through 2050; however, this value (and petroleum use) would likely be lower after considering NHTSA's and EPA's final standards, which are not incorporated in AEO 2023.[20] Similarly, an analysis of fuel consumption for HDPUVs projects that fuel consumed by HDPUVs would consist predominantly of gasoline and diesel derived from petroleum for the foreseeable future. Detailed discussion of this information can be found in the relevant sections of Chapter 3, *Energy*.

Other sources of energy used in the transportation sector include electricity, diesel and biofuels, natural gas, and hydrogen.

- **Electricity.** Electricity currently makes up 0.2 percent of LD vehicle and commercial light truck fuel consumption, but the CAFE Model projects this proportion to increase to 35.0 percent across all LD vehicles by 2050, representing the largest share of fuel consumption outside of gasoline. For HDPUVs, electricity currently makes up 0 percent of fuel consumption and is projected to increase to 19.1 percent by 2050.
- **Diesel.** Diesel currently makes up 0.5 percent of fuel consumption for LD vehicles and commercial light trucks and the CAFE Model projects this proportion to decrease to less than 0.1 percent by 2050. For HDPUVs, diesel makes up 46.9 percent of current fuel consumption but is expected to decrease to 4.7 percent by 2050.
- **Natural gas.** Natural gas currently makes up 0.02 percent of fuel consumption for LD vehicles and commercial light trucks. For freight trucks, natural gas accounts for 0.8 percent of fuel consumption. Natural gas as a transportation fuel is expected to grow an average of 3.9 percent annually by 2050.
- **Hydrogen.** LD fuel cell vehicle hydrogen consumption is less than 0.01 percent of total LD and HDPUV fuel consumption. According to AEO (2023), hydrogen is projected to grow 3.1 percent as a transportation fuel by 2050.

Direct and Indirect Impacts

To calculate the impacts on fuel consumption for each action alternative, NHTSA subtracted projected fuel consumption under the relevant No-Action Alternative from the level under each action alternative. As

---

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

[19] https://www.eia.gov/energyexplained/us-energy-facts/imports-and-exports.php.

[20] Discussions about national energy consumption within this EIS are generally based on data from AEO 2023, while reference to vehicle type-specific energy consumption is generally based on the CAFE Model.

the alternatives increase in stringency, total fuel consumption decreases. Table S-3 and Table S-4 show total 2022 to 2050 fuel consumption for each alternative and the direct and indirect fuel consumption impacts for each action alternative compared with the relevant No-Action Alternative through 2050. NHTSA used 2050 as the end year for its analysis because it is the year by which nearly the entire U.S. vehicle fleet will be composed of MY 2027–2031 or later LD vehicles and MY 2030–2035 HDPUV vehicles. These tables report total 2022 to 2050 fuel consumption in gasoline gallon equivalents (GGE) for diesel, gasoline, electricity, hydrogen, and biofuel for cars, light trucks, and HDPUVs. Gasoline is expected to account for 66.9 percent of energy consumption by passenger cars, light trucks, and HDPUVs in 2050.

Table S-3. Fuel Consumption and Decrease in Fuel Consumption by CAFE Standards Alternative (billion gasoline gallon equivalent total for calendar years 2022–2050)

	No-Action	PC2LT002	PC1LT3	PC2LT4	PC3LT5	PC6LT8
Fuel Consumption						
Cars	821	817	826	821	817	804
Light trucks	1,953	1,943	1,909	1,907	1,877	1,792
All light-duty vehicles	2,774	2,760	2,736	2,729	2,695	2,596
Decrease in Fuel Use Compared to the No-Action Alternative						
Cars	--	-4 (-1%)	+5 (+1%)	+0.2 (0%)	-4 (-1%)	-18 (-2%)
Light trucks	--	-10 (-1%)	-44 (-2%)	-46 (-2%)	-76 (-4%)	-161 (-8%)
All light-duty vehicles	--	-14 (-1%)	-39 (-1%)	-46 (-2%)	-80 (-3%)	-179 (-6%)

Note:
CAFE = Corporate Average Fuel Economy

Total LD vehicle fuel consumption from 2022 to 2050 under the CAFE No-Action Alternative is projected to be 2,774 billion GGE. LD vehicle fuel consumption from 2022 to 2050 under the Proposed Action and alternatives is projected to range from 2,760 billion GGE under Alternative PC2LT002 to 2,596 billion GGE under Alternative PC6LT8. All of the action alternatives would decrease fuel consumption compared to the No-Action Alternative, with fuel consumption decreases that range from 14 billion GGE under Alternative PC2LT002 to 179 billion GGE under Alternative PC6LT8.

Table S-4. Fuel Consumption and Decrease in Fuel Consumption by HDPUV FE Standards Alternative (billion gasoline gallon equivalent total for calendar years 2022–2050)

	No-Action	HDPUV4	HDPUV108	HDPUV10	HDPUV14
Fuel Consumption					
HD Pickup Trucks and Vans	419	419	415	412	402
Decrease in Fuel Use Compared to the No-Action Alternative					
HD Pickup Trucks and Vans	--	-0.3 (0%)	-4 (-1%)	-7 (-2%)	-17 (-4%)

Notes:
FE = fuel efficiency; HD = heavy-duty; HDPUV = heavy-duty pickup trucks and vans

Total HDPUV fuel consumption from 2022 to 2050 under the HDPUV No-Action Alternative is projected to be 418.9 billion GGE. HDPUV fuel consumption from 2022 to 2050 under the action alternatives is projected to range from 418.6 billion GGE under Alternative HDPUV4 to 401.9 billion GGE under Alternative HDPUV14. All of the action alternatives would decrease fuel consumption compared to the No-Action Alternative, with decreases ranging from 0.3 billion GGE under Alternative HDPUV4 to 17.0 billion GGE under Alternative HDPUV14.

Cumulative Impacts

Changes in passenger travel, oil and gas exploration, global EV market projections, and EV charging infrastructure, as well as changes in the electric grid mix may affect U.S. energy use over the long term. In addition to U.S. energy policy, manufacturer investments in plug-in electric vehicles (PEV) technologies and manufacturing in response to government policies (including foreign PEV quotas) may affect market trends and energy use.

Changing CAFE and HDPUV FE standards are expected to reduce gasoline and diesel fuel consumption in the transportation sector but are not expected to have any discernable effect on energy consumption by other sectors of the U.S. economy because petroleum products account for a very small share of energy use in other sectors that are not regulated by the CAFE and HDPUV FE standards. Depending on how manufacturers respond to CAFE standards and HDPUV FE standards, cumulative effects could occur in other energy source sectors, such as the electricity sector. For example, the flexibility in timing of EV charging can affect the use and lower the cost of renewable energy source integration.

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 CAA and its amendments, the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for six relatively common air pollutants known as *criteria pollutants*: carbon monoxide (CO), nitrogen dioxide, 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 CAA 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. As noted in Chapter 4, *Air Quality*, in 2022, on-road mobile sources were responsible for emitting 14.409 million tons[21] per year of CO (23 percent of total U.S. emissions), 79,729 tons per year (1 percent) of PM2.5, and 211,015 tons per year (1 percent) of PM10. In 2023, passenger cars and light trucks are estimated to contribute 86 percent of U.S. highway emissions of CO, 57 percent of highway emissions of PM2.5, and 65 percent of highway emissions of PM10. In 2023, HDPUVs are estimated to contribute 11 percent of highway emissions of CO, 8 percent of highway emissions of PM2.5, and 8 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. In 2022, on-road mobile sources also emitted 971,713 tons per year (6 percent of total U.S. emissions) of VOCs and 2.112 million tons per year (28 percent) of NO_X, which are chemical precursors of ozone. In 2023, passenger cars and light trucks are estimated to emit 81 percent of U.S. highway emissions of VOCs and 49 percent of NO_X, and HDPUVs are estimated to contribute 11 percent of U.S. highway emissions of VOCs and 9 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 are important because they contribute to the formation of PM2.5 in the atmosphere; however, on-road mobile sources account for less than 1 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

NHTSA uses the CAFE Compliance and Effects Modeling System (the CAFE Model) to estimate manufacturers' potential responses to new CAFE, carbon dioxide (CO_2), and HDPUV FE standards and to estimate various impacts of those responses. DOT's Volpe National Transportation Systems Center develops, maintains, and applies the model for NHTSA. The basic design of the CAFE Model is as follows: the system first estimates how vehicle manufacturers might respond to a given regulatory scenario, and from that potential compliance solution, the system estimates what impact that response will have on fuel consumption, emissions, and economic externalities. NHTSA also uses EPA's Motor Vehicle Emissions Simulator (MOVES) model to estimate "downstream" (tailpipe exhaust) emission factors, and uses Argonne National Laboratory's Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model to estimate emissions rates from fuel production and distribution processes ("upstream emissions").

To analyze air quality and human health impacts, NHTSA used the CAFE Model to calculate the emissions of criteria pollutants and MSATs from passenger cars, light trucks, and HDPUVs 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.

---

[21] The term *ton(s)* as used in this chapter refers to U.S. tons (2,000 pounds).

Key Findings for Air Quality

This EIS provides findings for air quality impacts for 2035 and 2050. In 2035, emissions of SO_2 increase, and emissions of CO, NO_X, PM2.5, and VOCs decrease, under all CAFE standard action alternatives compared to the CAFE No-Action Alternative. In 2050, emissions of SO_2 increase under some CAFE standard action alternatives and decrease under others, while emissions of CO, NO_X, PM2.5, and VOCs decrease under all CAFE standard action alternatives, compared to the CAFE No-Action Alternative. In 2035, emissions of SO_2 increase under the HDPUV FE standard action alternatives compared to the HDPUV No-Action Alternative, while emissions of CO, NO_X, PM2.5, and VOCs decrease. In 2050, emissions of SO_2 increase, and emissions of CO, NO_X, PM2.5, and VOCs decrease, under all HDPUV FE standard action alternatives compared to the HDPUV No-Action Alternative.

The changes in emissions are small in relation to total criteria pollutant emissions levels during this period and, overall, the health outcomes due to changes in criteria pollutant emissions through 2050 are projected to be beneficial. The directions and magnitudes of the changes in total emissions are not consistent across all pollutants. This 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 (which also reflect the assumption of increased adoption of PEVs after 2035); the relative proportions of gasoline, diesel, and other fuels in total fuel consumption changes; and changes in vehicle miles traveled (VMT) from the rebound effect. Other CAFE Model inputs and assumptions, which are discussed in Chapter 2, *Proposed Action and Alternatives and Analysis Methods*, and at length in Section III of the final rule preamble, Chapter 2 of the Technical Support Document, and Chapter 3 of the FRIA issued concurrently with the EIS, including the rate at which new vehicles are sold, will also affect these air quality impact estimates. It is important to stress that changes in these assumptions would alter the air pollution estimates. For example, if NHTSA has overestimated the rebound effect,[22] then emissions would be lower; if NHTSA has underestimated the rebound effect, then emissions would be higher. In addition, in 2035 and 2050, the CAFE standard action alternatives would result in decreased incidence of PM2.5-related adverse health impacts, and the HDPUV FE standard action alternatives would result in unchanged or decreased incidence of those impacts. Decreases in adverse health impacts include decreased incidences of premature mortality, acute bronchitis, respiratory emergency room visits, and work-loss days, due to decreases in downstream emissions particularly for PM2.5.

Direct and Indirect Impacts

Criteria Pollutants

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

- In 2035, emissions of CO, NO_X, PM2.5, and VOCs decrease under all CAFE standard action alternatives compared to the CAFE No-Action Alternative, while emissions of SO_2 increase. Relative to the No-Action Alternative, the modeling results suggest CO, NO_X, PM2.5, and VOC emissions decreases in 2035 that get larger from Alternative PC2LT002 through Alternative PC6LT8 (the most stringent alternative in terms of estimated required miles per gallon). The increases in SO_2 emissions reflect the projected increase in EV use in the later years. Further, modeled increases

---

[22] The increase in vehicle use that results from improved fuel economy.

were very small relative to reductions from the historical levels represented in the current CAFE standard.

- In 2050, emissions of CO, NO_X, PM2.5, and VOCs decrease under all CAFE standard action alternatives compared to the CAFE No-Action Alternative. Relative to the No-Action Alternative, the modeling results suggest CO, NO_X, PM2.5, and VOC emissions decreases in 2050 that get larger from Alternative PC2LT002 to Alternative PC1LT3, and from Alternative PC2LT4 through Alternative PC6LT8, but the decreases get smaller from Alternative PC1LT3 to PC2LT4. Emissions of SO_2 increase under all CAFE standard action alternatives, except for Alternative PC2LT4, compared to the CAFE No-Action Alternative, and the increases get larger from Alternative PC2LT002 to Alternative PC1LT3 and from Alternative PC3LT5 to Alternative PC6LT8. In 2050, as in 2035, the increases in SO_2 emissions reflect the projected increase in EV use in the later years. Further, any modeled increases were very small relative to reductions from the historical levels represented in the current CAFE standard.
- Under each CAFE standard action alternative compared to the CAFE No-Action Alternative, the largest relative increases in emissions among the criteria pollutants would occur for SO_2, for which emissions would increase by as much as 3.0 percent under Alternative PC6LT8 in 2050 compared to the No-Action Alternative. The largest relative decreases in emissions would occur for CO, for which emissions would decrease by as much as 18.3 percent under Alternative PC6LT8 in 2050 compared to the No-Action Alternative. Percentage increases and decreases in emissions of NO_X, PM2.5, and VOCs would be less. 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.
- In 2035 and 2050, emissions of SO_2 increase under the HDPUV FE standard action alternatives compared to the HDPUV No-Action Alternative, while emissions of CO, NO_X, PM2.5, and VOCs decrease. Relative to the No-Action Alternative, the modeling results suggest SO_2 emissions increases get larger from Alternative HDPUV4 through Alternative HDPUV14 (the most stringent alternative in terms of the estimated required fuel consumption metric [gallons of fuel per 100 ton-mile]). The increases in SO_2 emissions reflect the projected increase in EV use in the later years. Further, any modeled increases were very small relative to reductions from the historical levels represented in the current HDPUV FE standard. For CO, NO_X, PM2.5, and VOCs, the emissions decreases get larger from Alternative HDPUV4 through Alternative HDPUV14 relative to the No-Action Alternative.
- Under each HDPUV FE standard action alternative compared to the HDPUV No-Action Alternative, the largest relative increases in emissions among the criteria pollutants would occur for SO_2, for which emissions would increase by as much as 6.7 percent under Alternative HDPUV14 in 2050 compared to the No-Action Alternative. The largest relative decreases in emissions would occur for CO, for which emissions would decrease by as much as 13.5 percent under Alternative HDPUV14 in 2050 compared to the No-Action Alternative. Percentage reductions in emissions of NO_X, PM2.5, and VOCs would be less, though the reductions in VOCs in 2035 (by as much as 3.3 percent under Alternative HDPUV14) would be greater than those of CO in 2035 (by as much as 1.7 percent under Alternative HDPUV14). 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.

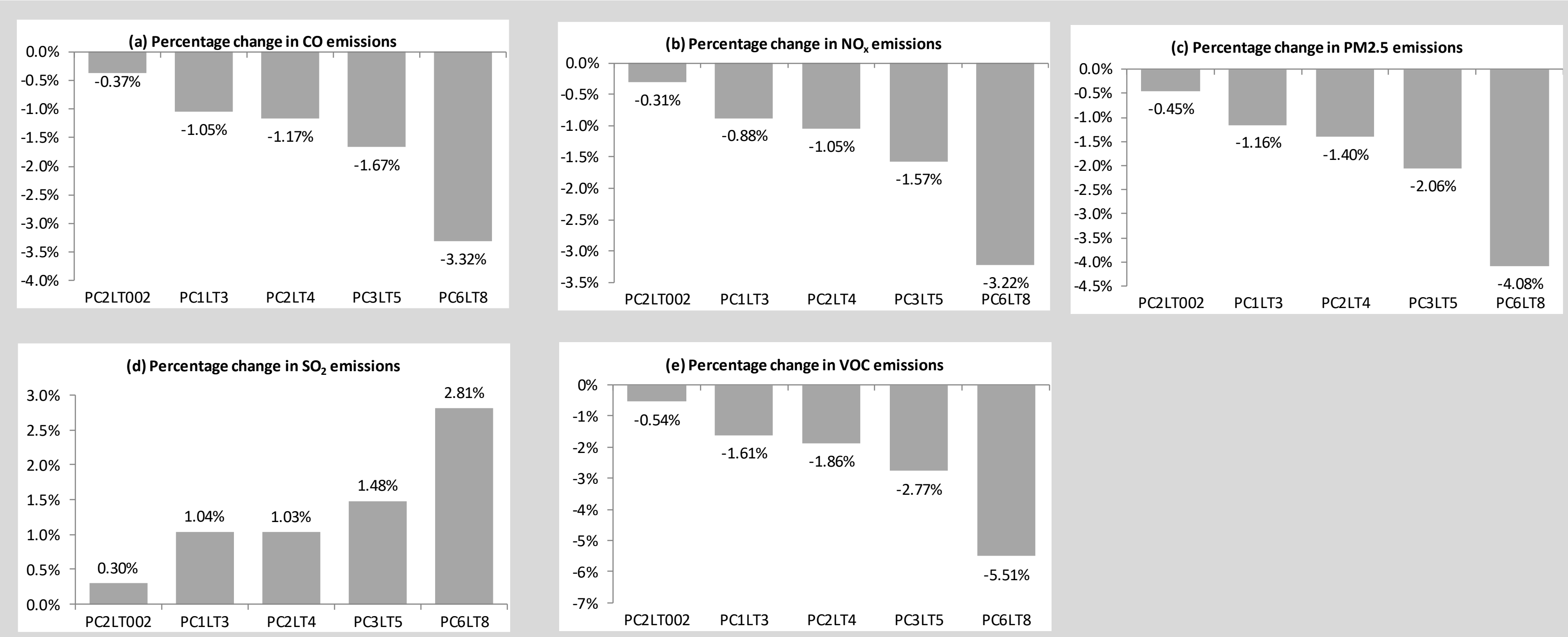
Toxic Air Pollutants

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

- Toxic air pollutant emissions across the CAFE standard action alternatives remain the same or decrease in 2035 and 2050 relative to the CAFE No-Action Alternative. The decreases stay the same or get larger from Alternative PC2LT002 through Alternative PC6LT8, except that for acetaldehyde, acrolein, 1,3-butadiene, benzene, and formaldehyde in 2050 the decrease from Alternative PC1LT3 to Alternative PC2LT4 is smaller.
- The largest relative decreases in emissions generally would occur for acetaldehyde, acrolein, 1,3-butadiene, and formaldehyde for which emissions would decrease by as much as 23 percent under Alternative PC6LT8 in 2050 compared to the CAFE No-Action Alternative. Percentage decreases in emissions of benzene and DPM would be less. 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.
- Toxic air pollutant emissions across the HDPUV FE standard action alternatives remain the same or decrease in 2035 and 2050 relative to the HDPUV No-Action Alternative. The decreases get larger from Alternative HDPUV4 through Alternative HDPUV14.
- The largest relative decreases in emissions generally would occur for 1,3-butadiene and formaldehyde for which emissions would decrease by as much as 14.5 percent under Alternative HDPUV14 in 2050 compared to the HDPUV No-Action Alternative. The largest percentage decreases in emissions of acetaldehyde, acrolein, and benzene would be similar, decreasing as much as 13.6 to 14.2 percent under Alternative HDPUV14 in 2050 compared to the No-Action Alternative. Percentage decreases in emissions of DPM would be less, in some cases less than 1 percent. 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.

Changes in criteria pollutant emissions in 2035 are shown by alternative in Figure S-1 for CAFE standard action alternatives and in Figure S-2 for HDPUV FE standard action alternatives. Changes in toxic air pollutant emissions in 2035 are shown by alternative in Figure S-3 for CAFE standard action alternatives and in Figure S-4 for HDPUV FE standard action alternatives.

Figure S-1. Nationwide Percentage Changes in Criteria Pollutant Emissions from U.S. Passenger Cars and Light Trucks for 2035 by CAFE Alternative Compared to the CAFE No-Action Alternative, Direct and Indirect Impacts



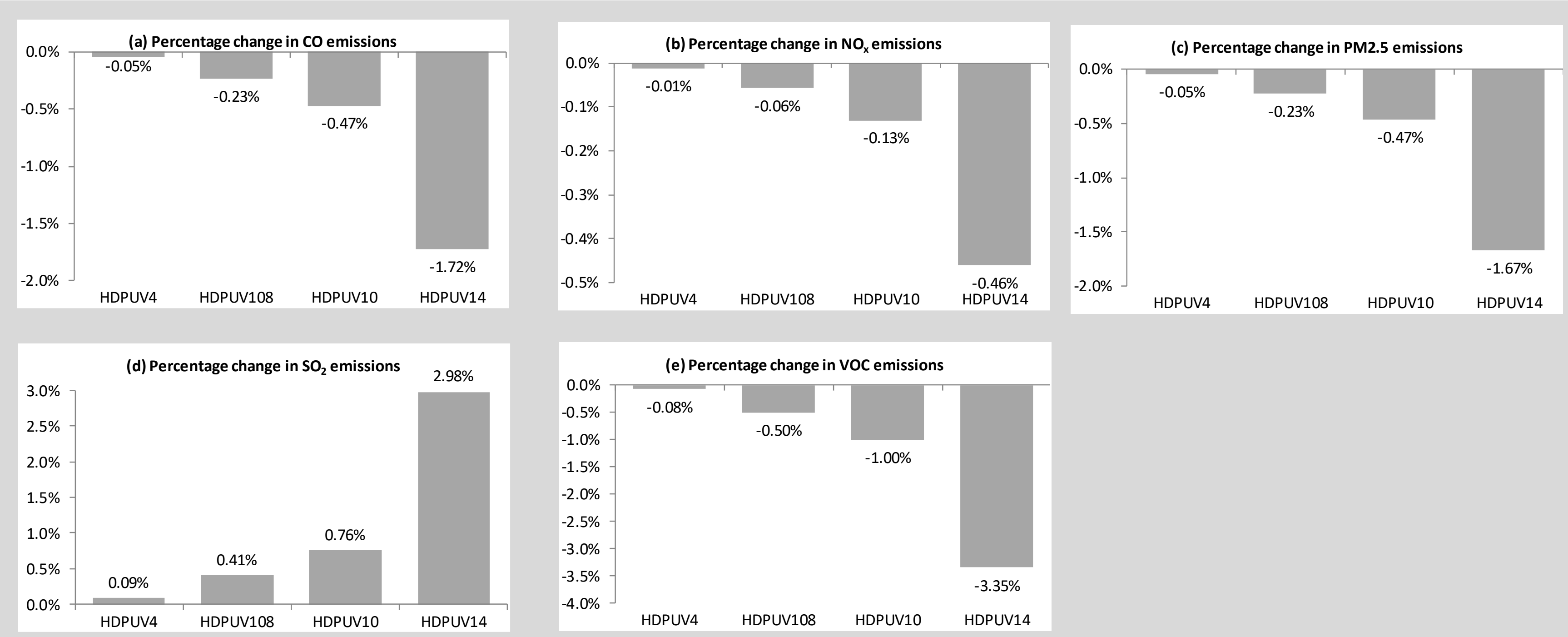
Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

CAFE = Corporate Average Fuel Economy; CO = carbon monoxide; NO$_X$ = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; SO$_2$ = sulfur dioxide; VOC = volatile organic compounds.

Figure S-2. Nationwide Percentage Changes in Criteria Pollutant Emissions from U.S. HDPUVs for 2035 by HDPUV FE Standard Alternative Compared to the HDPUV No-Action Alternative, Direct and Indirect Impacts



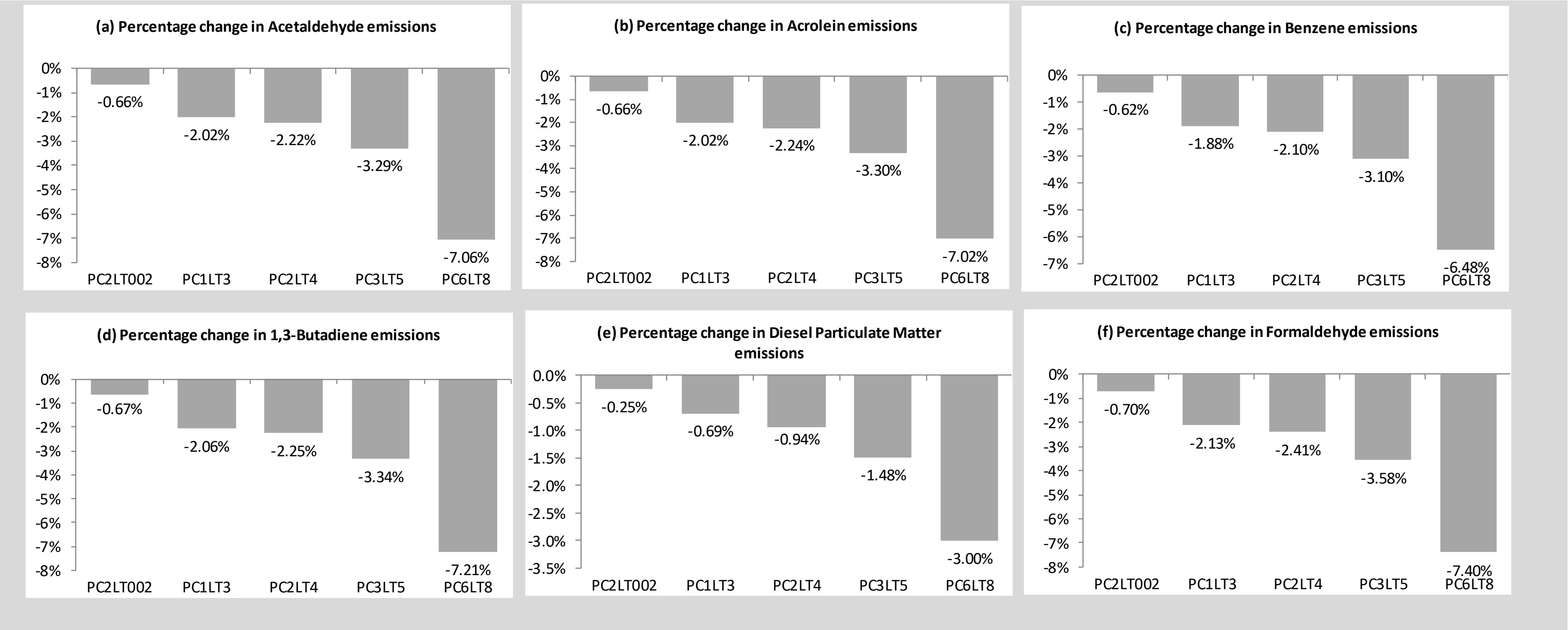
Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

CO = carbon monoxide; FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

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



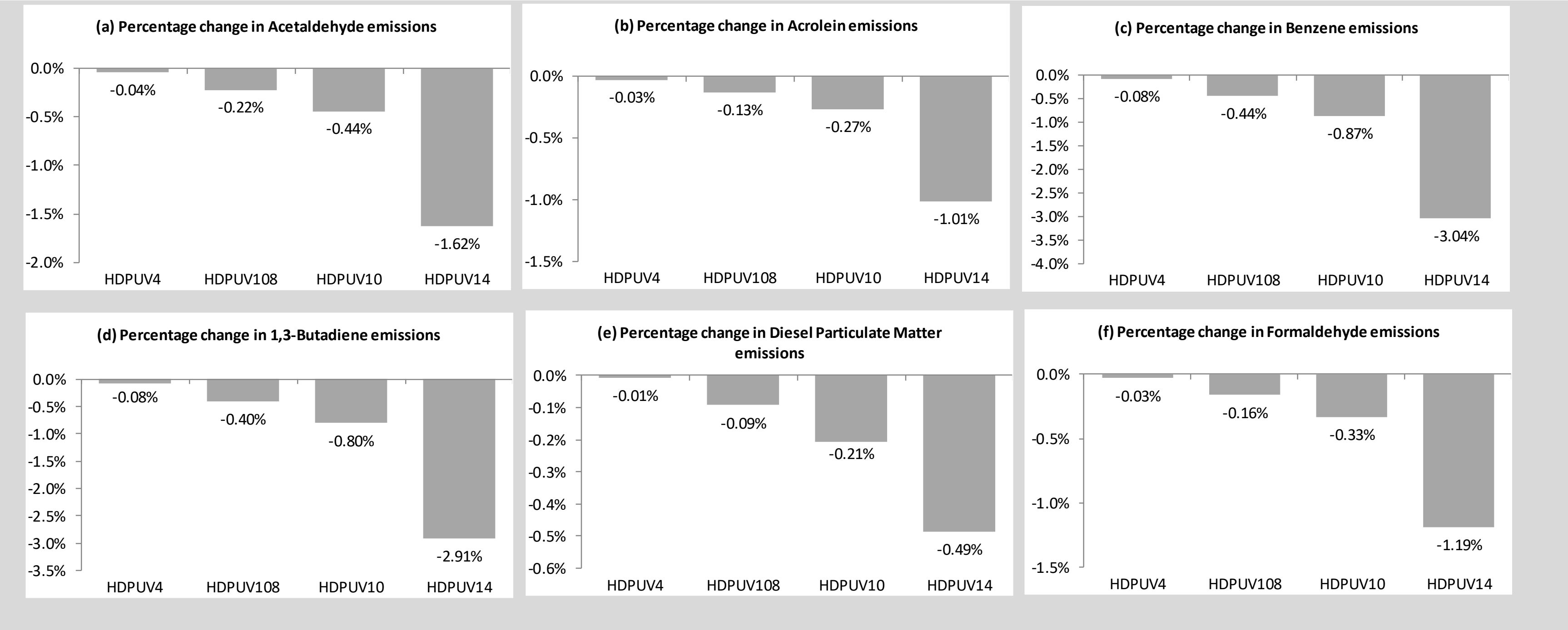
Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

CAFE = Corporate Average Fuel Economy.

Figure S-4. Nationwide Percentage Changes in Toxic Air Pollutant Emissions from U.S. HDPUVs for 2035 by HDPUV FE Standard Alternative Compared to the HDPUV No-Action Alternative, Direct and Indirect Impacts



Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans.

Health Impacts

The air quality analysis identified the following health impacts.

- Adverse health impacts (mortality, acute bronchitis, respiratory emergency room visits, and other health effects) from criteria pollution emissions are projected to decrease nationwide in 2035 and 2050 under all CAFE standard action alternatives, relative to the CAFE No-Action Alternative, due to decreases in downstream emissions, particularly of PM2.5. The improvements to health impacts (or decreases in health incidences) would stay the same or get larger from Alternative PC2LT002 to Alternative PC6LT8 in 2035 and 2050, except that in 2050 the decrease from Alternative PC1LT3 to Alternative PC2LT4 is smaller. These decreases reflect the generally increasing stringency of the action alternatives as they become implemented.
- Adverse health impacts from criteria pollutant emissions are projected to decrease nationwide in 2035 and 2050 under all HDPUV FE standard action alternatives, relative to the HDPUV No-Action Alternative, due to decreases in downstream emissions, particularly of PM2.5. The improvements to health impacts (or decreases in health incidences) would get larger from Alternative HDPUV4 to Alternative HDPUV14 in 2035 and 2050.
- As mentioned above, changes in assumptions about modeled technology adoption; the relative proportions of gasoline, diesel, and other fuels in total fuel consumption changes; and changes in VMT from the rebound effect would alter these health impact results. However, NHTSA believes that these assumptions are reasonable.

Cumulative Impacts

Criteria Pollutants

The air quality analysis identified the following cumulative impacts on criteria air pollutants from the CAFE and HDPUV FE alternative combinations.

- In 2035 and 2050, emissions of SO_2 increase under the CAFE and HDPUV FE alternative combinations compared to the No-Action Alternatives, while emissions of CO, NO_X, PM2.5, and VOCs decrease. Further, any modeled increases were very small relative to reductions from the historical levels represented in the current CAFE and HDPUV FE standards. Relative to the No-Action Alternatives, the modeling results suggest SO_2 emissions increases that get larger with increasing stringency of alternative combinations compared to the No-Action Alternatives. For CO, NO_X, PM2.5, and VOCs, the emissions decreases get larger with increasing stringency of alternative combinations compared to the No-Action Alternatives.
- Under each CAFE and HDPUV FE alternative combination compared to the No-Action Alternatives, the largest relative increases in emissions among the criteria pollutants would occur for SO_2, for which emissions would increase by as much as 5.2 percent under Alternatives PC6LT8 and HDPUV14 in 2050 compared to the No-Action Alternatives. The largest relative decreases in emissions would occur for CO, for which emissions would decrease by as much as 24 percent under Alternatives PC6LT8 and HDPUV14 in 2050 compared to the No-Action Alternatives. Percentage decreases in emissions of NO_X, PM2.5, and VOCs would be less, though reductions in PM2.5 in 2035 (by as much as 4.1 percent under Alternatives PC6LT8 and HDPUV14) and VOCs in 2035 (by as much as 6.1 percent under Alternatives PC6LT8 and HDPUV14) would be greater than those of CO in 2035 (by as much as 3.7 percent under Alternatives PC6LT8 and HDPUV14). 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.

Toxic Air Pollutants

The air quality analysis identified the following cumulative impacts on toxic air pollutants from the CAFE and HDPUV FE alternative combinations.

- Toxic air pollutant emissions across the CAFE and HDPUV FE alternative combinations decrease in 2035 and 2050 relative to the No-Action Alternatives for the same reasons as for criteria pollutants. The decreases remain the same or get larger with increasing stringency of alternative combinations.
- The largest relative decreases in emissions generally would occur for 1,3-butadiene and formaldehyde for which emissions would decrease by as much as 28 percent under Alternatives PC6LT8 and HDPUV14 in 2050, compared to the No-Action Alternatives. The largest percentage decreases in emissions of acetaldehyde, acrolein, and benzene would be similar, decreasing as much as 26 to 27 percent under Alternatives PC6LT8 and HDPUV14 in 2050 compared to the No-Action Alternative. Percentage decreases in emissions of DPM would be less.

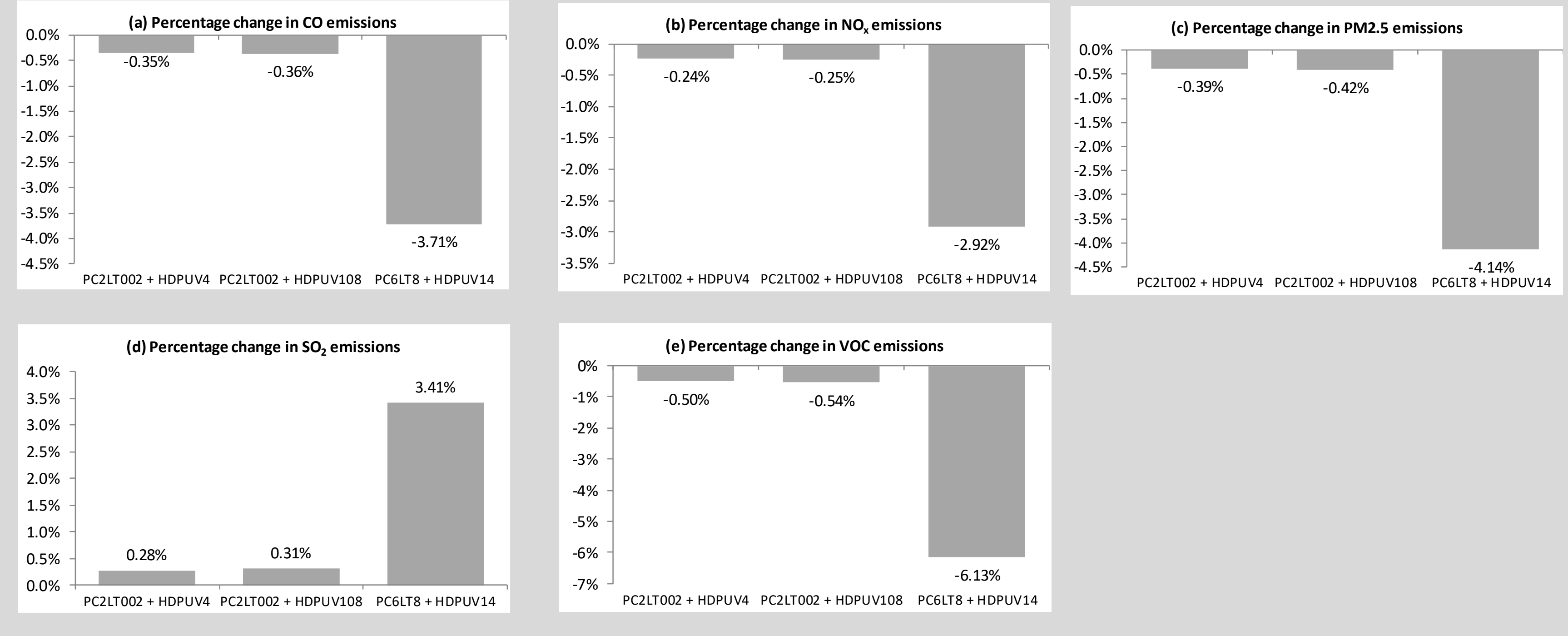
Changes in criteria pollutant emissions in 2035 are shown by alternative in Figure S-5, and changes in toxic air pollutant emissions in 2035 are shown by alternative in Figure S-6, for CAFE and HDPUV FE alternative combinations.

Health Impacts

The air quality analysis identified the following cumulative health impacts from the CAFE and HDPUV FE alternative combinations.

- Adverse health impacts (mortality, acute bronchitis, respiratory emergency room visits, and other health effects) from criteria pollutant emissions would decrease nationwide in 2035 and 2050 under all CAFE and HDPUV FE alternative combinations, relative to the No-Action Alternatives, due to decreases in downstream emissions, particularly of PM2.5. The improvements to health impacts (or decreases in health incidences) in 2035 and 2050 would stay the same or get larger from Alternatives PC2LT002 and HDPUV4 to Alternatives PC6LT8 and HDPUV14. These decreases reflect the generally increasing stringency of the CAFE and HDPUV FE standard action alternatives as they become implemented.
- As mentioned above, changes in assumptions about modeled technology adoption; the relative proportions of gasoline, diesel, and other fuels in total fuel consumption changes; and changes in VMT from the rebound effect would alter these health impact results; however, NHTSA believes that these assumptions are reasonable.

Figure S-5. Nationwide Percentage Changes in Criteria Pollutant Emissions from U.S. Combined Passenger Cars, Light Trucks, and HDPUVs for 2035 by CAFE and HDPUV FE Alternative Combination Compared to the No-Action Alternatives, Cumulative Impacts



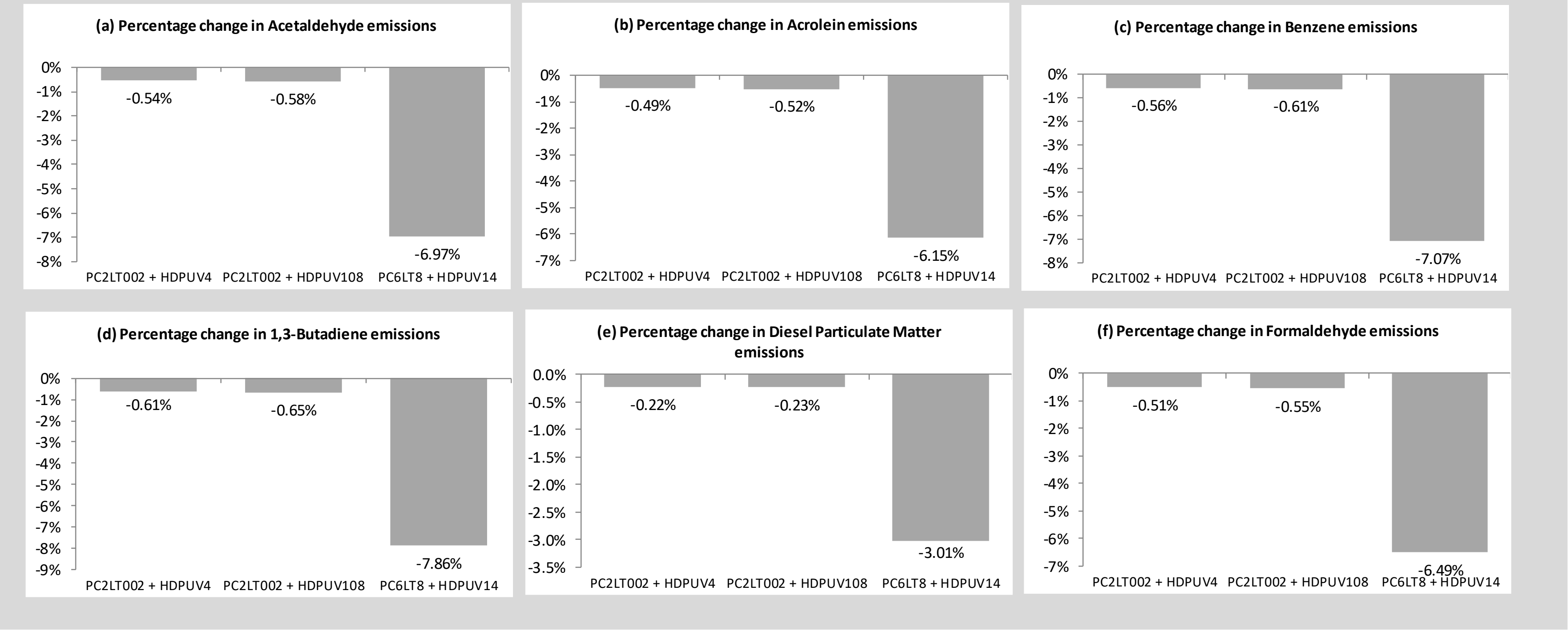
Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

CAFE = Corporate Average Fuel Economy; CO = carbon monoxide; FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Figure S-6. Nationwide Percentage Changes in Toxic Air Pollutant Emissions from U.S. Combined Passenger Cars, Light Trucks, and HDPUVs for 2035 by CAFE and HDPUV FE Alternative Combination Compared to the No-Action Alternatives, Cumulative Impacts



Notes:

The vertical (percentage) scale differs by pollutant.

Negative values indicate emissions decreases; positive values are emissions increases.

CAFE = Corporate Average Fuel Economy; FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans.

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 direct and indirect impacts of climate change focuses on impacts associated with decreases in GHG emissions from the Proposed Action and alternatives as compared to projected GHG emissions under the relevant No-Action Alternative, including impacts on atmospheric 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) by absorbing heat energy emitted by Earth's surface and lower atmosphere, and reradiating much of it back to Earth's surface, 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 as primarily responsible for increasing the concentrations of GHGs in the atmosphere, and this buildup of GHGs is changing the Earth's energy balance. According to the Intergovernmental Panel on Climate Change (IPCC), the warming experienced over the past century is due to a combination of natural climate forcers (e.g., natural GHGs, solar activity), as well as human-made climate forcers (IPCC 2021a).

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.

IPCC, the U.S. Global Change Research Program (GCRP), and other leading groups focused on global climate change have independently concluded that human activity is the main driver for recent observed climatic changes (IPCC 2021a; GCRP 2023). Other observed changes include melting glaciers, diminishing snow cover, shrinking sea ice, ocean acidification, increasing atmospheric water vapor content, changing precipitation intensities, shifting seasons, and many more (IPCC 2021a; GCRP 2023).

This EIS draws primarily on panel-reviewed synthesis and assessment reports from IPCC and 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, methane (CH_4), and nitrous oxide (N_2O) account for approximately 97 percent of global annual anthropogenic GHG emissions (World Resources Institute [WRI] 2023). 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.

In 2020, the United States was the second largest emitter of GHGs, accounting for approximately 12 percent of total global emissions, excluding emissions and sinks from land-use change (WRI 2023).[23] EPA's National Greenhouse Gas Inventory for 1990 to 2021 indicates that, in 2021, the U.S. transportation sector was the single leading source of CO_2 emissions from fossil fuels, contributing over one-third of total U.S. CO_2 emissions from fossil fuels, with passenger cars and light trucks accounting for 58 percent of total U.S. CO_2 emissions from transportation (EPA 2023a).[24] From 1990 to 2021, CO_2 emissions from passenger cars and light trucks increased by 1211 percent, which is attributed to a 44.4 percent increase in VMT by LD motor vehicles (passenger cars and light trucks) driven by population increase, economic growth, and low fuel prices (EPA 2023a).

The coronavirus disease of 2019 (COVID-19) pandemic resulted in a 9 percent decrease in gross U.S. GHG emissions from 2019 to 2020, with contributions by sector remaining relatively consistent (EPA 2023a). Travel restrictions and behavior across the country resulted in decreased VMT by personal vehicles and lightweight trucks by 11 percent from 2019 to 2020 (EPA 2023a). However, due to the increased demand for e-commerce goods, VMT for HD vehicles increased from 2019 to 2020 (DOT 2023a). Recent data show that this decrease in overall transportation emissions was temporary (Bhanumati et al. 2022). Indicators of emissions such as VMT have significantly increased since the end of 2020 as travel restrictions eased and economic activity increased (Liu et al. 2020). VMT increased by 11 percent from 2020 to 2021 (DOT 2021a), despite shifts in travel and behavior compared to before the pandemic (e.g., increases in Americans working from home or hybrid working). Furthermore, between 2020 and 2021, CO_2 emissions from passenger cars and light trucks increased 10 percent; CO_2 emissions from transportation increased 11 percent (EPA 2023a). In 2022, nationwide cumulative travel increased by 0.9 percent from 2021, amounting to an estimated 3,169 billion vehicle miles of travel (FHWA 2023a).

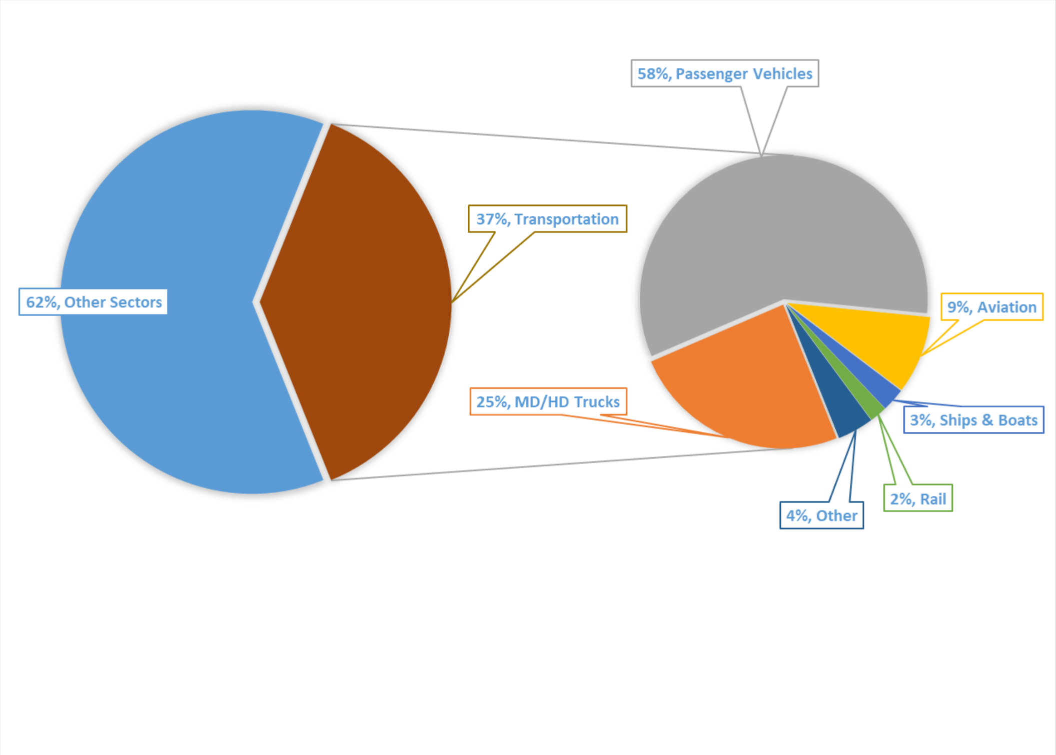
Figure S-7 shows the proportion of U.S. CO_2 emissions attributable to the transportation sector and the contribution of each mode of transportation to those emissions.

---

[23] These numbers are based on global and U.S. estimates for 2020, the most recent year for which a global estimate is available. Excluding emissions and sinks from land-use change and forestry.

[24] This EIS was updated with EPA's 2023 National Greenhouse Gas Inventory report. EPA released a new National Greenhouse Gas Inventory report on April 11, 2024. The results from the 2024 report have not been incorporated into this EIS because they were not available at the time the EIS analysis was being conducted.

Figure S-7. Contribution of Transportation to U.S. Carbon Dioxide Emissions by Mode (2021)



Source: EPA 2023a
MD/HD = Medium-Duty and Heavy-Duty

Key Findings for Climate

The Proposed Action and alternatives would decrease both U.S. passenger car and light truck and HDPUV fuel consumption and CO_2 emissions compared with the relevant No-Action Alternative, reducing the anticipated increases in global CO_2 concentrations, temperature, precipitation, sea level, and ocean acidification that would otherwise occur.

Estimates of GHG emissions and decreases are presented for each of the action alternatives for both CAFE standards and HDPUV FE standards. 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 small in relation to global emissions trajectories. Although these effects are small, they occur on a global scale and are long lasting; therefore, in aggregate, they can have large consequences for health and welfare and can make an important contribution to reducing the risks associated with climate change.

Direct and Indirect Impacts

For the analysis of direct and indirect impacts, NHTSA used the Shared Socioeconomic Pathway (SSP) 3-7.0 scenario to represent the Reference case emissions scenarios. SSP3-7.0 is a high emissions scenario that assumes no additional global cooperation on mitigation efforts resulting in limited mitigation of GHG emissions. NHTSA selected the SSP3-7.0 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. This scenario yields a radiative forcing of approximately 7.0 watts per square meter in the year 2100. More information on global emissions scenarios used in this analysis can be found in Appendix F, *Greenhouse Gas Emissions and Climate Change*.

Greenhouse Gas Emissions

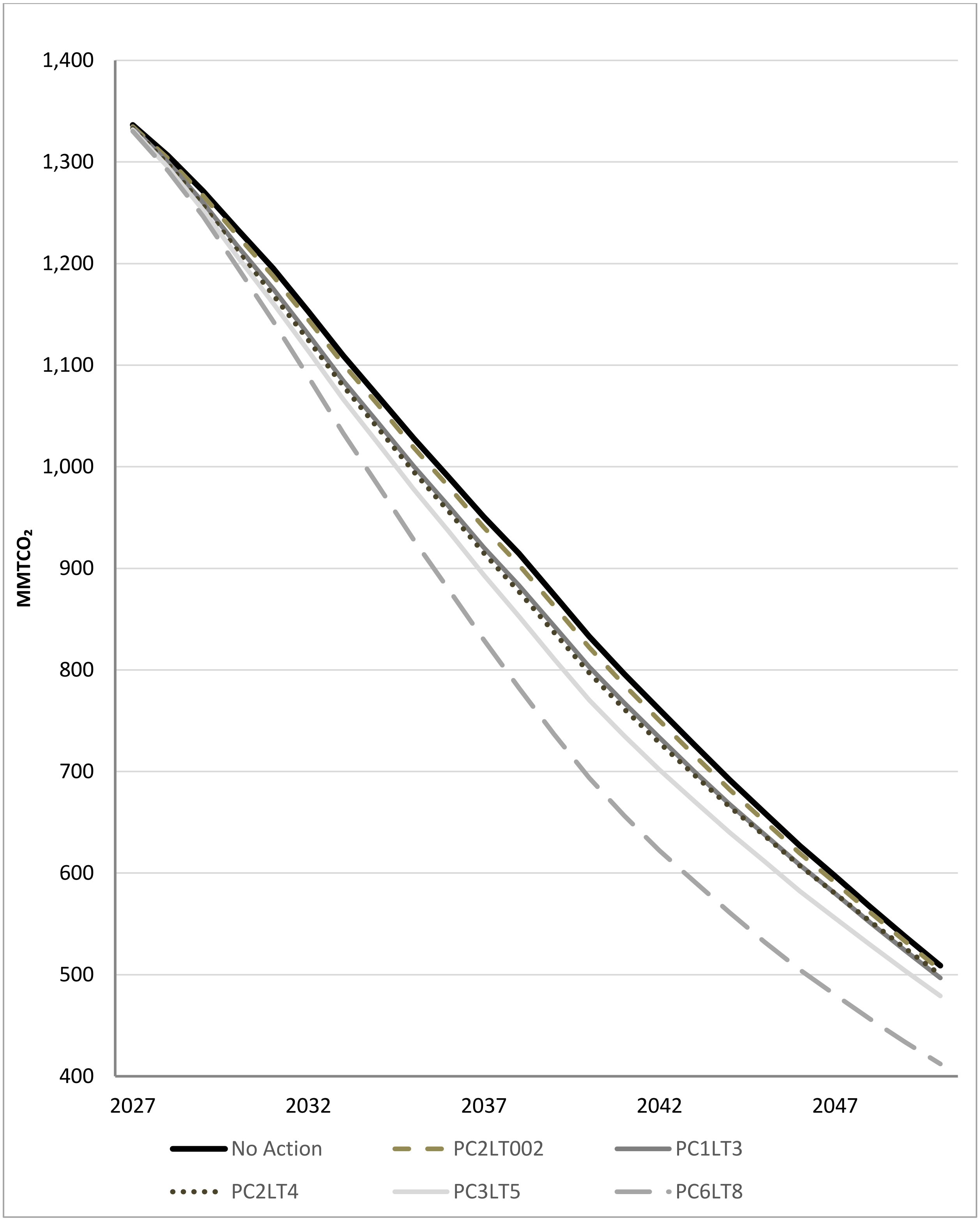
The alternatives would have the following impacts related to GHG emissions.

- Figure S-8 shows projected annual CO_2 emissions from passenger cars and light trucks under all CAFE standard action alternatives. Passenger cars and light trucks are projected to emit 46,500 million metric tons of carbon dioxide ($MMTCO_2$) from 2027 through 2100 under the CAFE No-Action Alternative. Alternative PC2LT002, the preferred alternative, would decrease these emissions by less than 1 percent through 2100. Alternative PC1LT3 and Alternative PC2LT4 would each decrease these emissions by 2 percent through 2100, while Alternative PC3LT5 would decrease these emissions by 5 percent. Alternative PC6LT8 would decrease these emissions by 15 percent through 2100. Emissions would be highest under the No-Action Alternative. All CO_2 emissions estimates associated with the CAFE standard action alternatives include upstream emissions.
- Figure S-9 shows projected annual CO_2 emissions from HDPUV under all HDPUV FE standard action alternatives. HDPUVs are projected to emit 9,700 $MMTCO_2$ from 2027 through 2100 under the HDPUV No-Action Alternative. The action alternatives would decrease these emissions by a range of less than 0.01 percent under HDPUV4 to 11 percent under HDPUV14 through 2100. Alternative HDPUV108, the preferred alternative, would decrease these emissions by 3 percent over the same period. All CO_2 emissions estimates associated with the HDPUV FE standard action alternatives include upstream emissions.
- Compared with total projected CO_2 emissions of 468 $MMTCO_2$ from all passenger cars and light trucks under the CAFE No-Action Alternative in the year 2100, the CAFE standard action alternatives are expected to reduce CO_2 emissions from passenger cars and light trucks in the year 2100 by 2 percent under Alternative PC1LT3, less than 2 percent under Alternative PC2LT4, 6 percent under PC3LT5, and 19 percent under Alternative PC6LT8. Under Alternative PC2LT002, the 2100 total projected CO_2 emissions for all passenger cars and light trucks are 464 $MMTCO_2$, reflecting a 1 percent decrease.
- Compared with total projected CO_2 emissions of 116 $MMTCO_2$ from all HDPUVs under the HDPUV No-Action Alternative in the year 2100, the HDPUV FE standard action alternatives are expected to decrease CO_2 emissions from HDPUVs in the year 2100 by a range of less than 1 percent under Alternative HDPUV4 to 13 percent under Alternative HDPUV14. Under Alternative HDPUV108, the 2100 total projected CO_2 emissions for all HDPUVs are 112 $MMTCO_2$, reflecting a 4 percent decrease.
- Compared to SSP3-7.0 total global CO_2 emissions projection of 4,991,547 $MMTCO_2$ under the CAFE No-Action Alternative from 2027 through 2100, the CAFE standard action alternatives are expected to reduce global CO_2 by 0.02 percent under Alternative PC1LT3, 0.02 percent under Alternative PC2LT4, 0.05 percent under Alternative PC3LT5, and 0.14 percent under Alternative PC6LT8 by 2100. Alternative PC2LT002 is expected to reduce global CO_2 by 0.01 percent by 2100.
- Compared to SSP3-7.0 total global CO_2 emissions projection of 4,991,547 $MMTCO_2$ under the HDPUV No-Action Alternative from 2027 through 2100, the HDPUV action alternatives are expected to

reduce global CO_2 by less than 0.01 percent under Alternatives HDPUV4, 0.01 percent under Alternative HDPUV108, 0.01 percent under Alternative HDPUV10, and 0.02 percent under HDPUV14 by 2100.

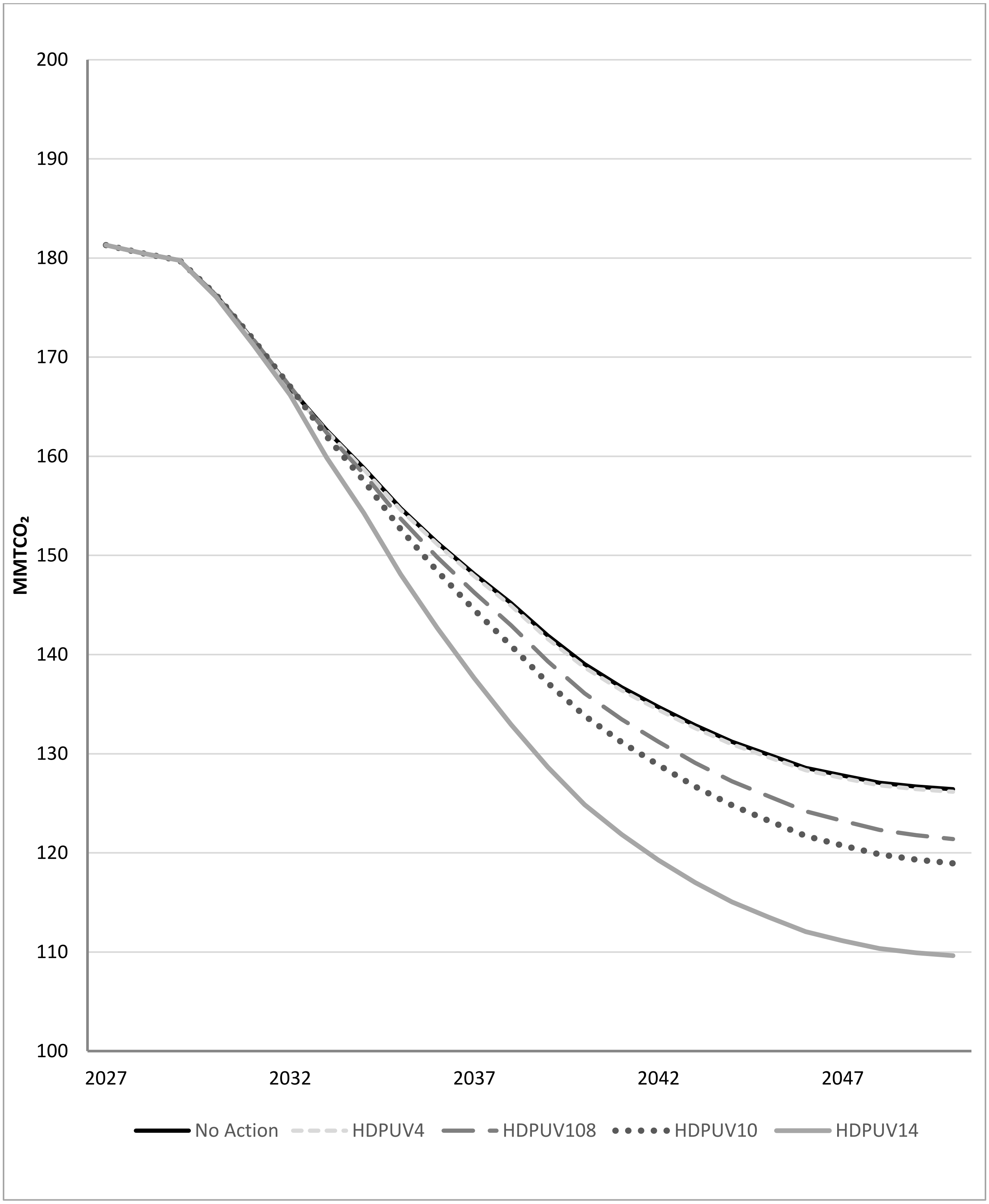
- The emissions reductions from all passenger cars and light trucks in 2035 compared with emissions under the CAFE No-Action Alternative are approximately equivalent to the annual emissions from 2,282,379 vehicles under Alternative PC2LT002, 6,967,595 vehicles under Alternative PC1LT3, 8,343,818 vehicles under Alternative PC2LT4, 12,720,713 vehicles under Alternative PC3LT5, and 25,343,679 vehicles under Alternative PC6LT8. (A total of 260,932,626 passenger cars and light trucks are projected to be on the road in 2035 under the No-Action Alternative.)
- The emissions reductions from HDPUVs in 2035 compared with emissions under the HDPUV No-Action Alternative are approximately equivalent to the annual emissions from 16,180 vehicles under Alternative HDPUV4, 123,506 vehicles under Alternative HDPUV108, 247,467 vehicles under Alternative HDPUV10, and 785,474 vehicles under Alternative HDPUV14. (A total of 18,299,639 HDPUVs are projected to be on the road in 2035 under the No-Action Alternative.)

Figure S-8. 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

Figure S-9. Projected Annual Carbon Dioxide Emissions (MMTCO$_2$) from All HDPUVs by Alternative



FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans; MMTCO$_2$ = million metric tons of carbon dioxide

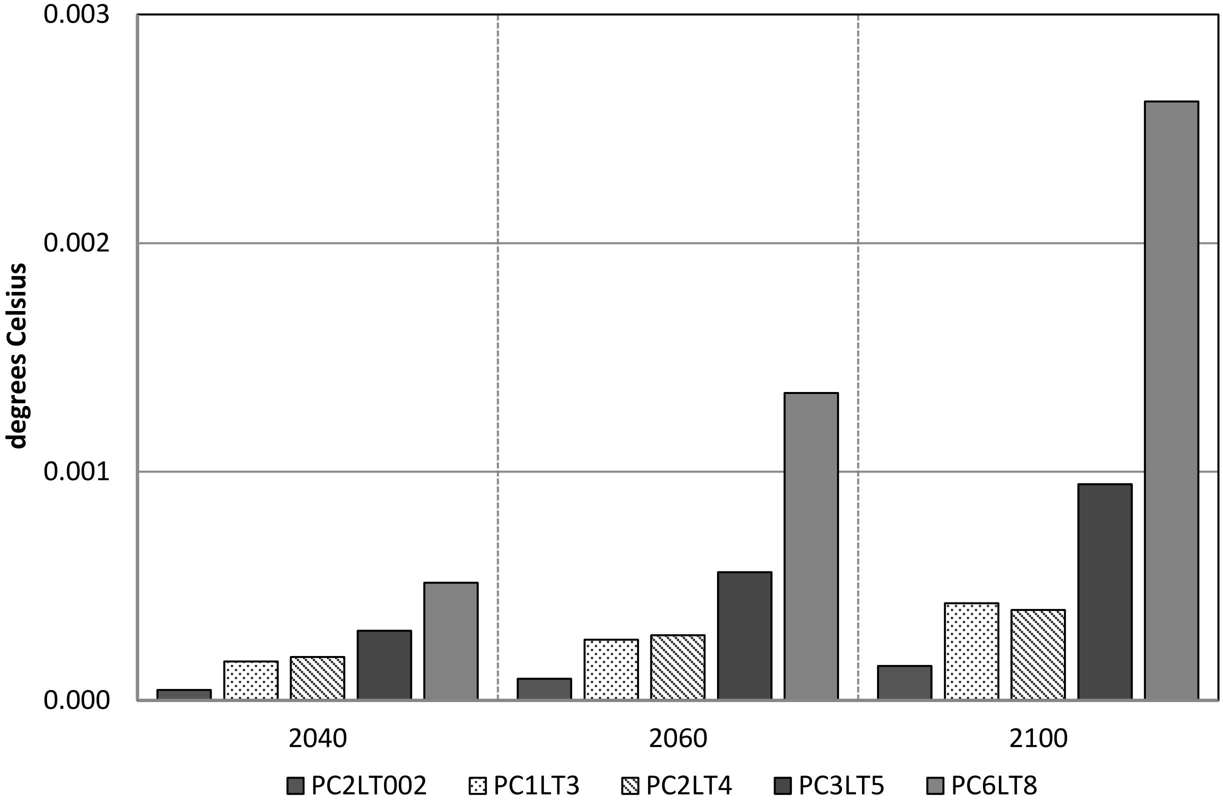
Climate Change Indicators

CO_2 emissions affect the concentration of CO_2 in the atmosphere, which in turn affects global temperature, sea level, precipitation, and ocean pH.

- Estimated CO_2 concentrations in the atmosphere for 2100 are estimated to be 838.31 parts per million (ppm) under the CAFE No-Action Alternative. CO_2 concentrations under the CAFE standard action alternatives could reach 837.65 ppm under Alternative PC6LT8, indicating a maximum atmospheric CO_2 decrease of approximately 0.67 ppm compared to the No-Action Alternative. Atmospheric CO_2 concentrations under Alternative PC2LT002 would decrease by 0.04 ppm compared with the No-Action Alternative.
- Under the HDPUV FE standard action alternatives CO_2 concentrations in the atmosphere could decrease to 838.21 ppm under Alternative HDPUV14, indicating a maximum atmospheric CO_2 decrease of approximately 0.10 ppm compared to the HDPUV No-Action Alternative. Atmospheric CO_2 concentration under Alternative HDPUV108 would decrease by 0.03 ppm compared with the No-Action Alternative.
- Global mean surface temperature is projected to increase by approximately 4.34 degrees Celsius (°C) (7.81 degrees Fahrenheit [°F]) under the CAFE No-Action Alternative by 2100. The most stringent CAFE standard action alternative (Alternative PC6LT8) would decrease this projected temperature rise by 0.003°C (0.005°F), while Alternative PC2LT002 would decrease projected temperature rise by less than 0.001°C (0.002°F). Figure S-10 shows the increase in projected global mean surface temperature under each action alternative compared with temperatures under the CAFE No-Action Alternative.
- Global mean surface temperature is projected to increase by approximately 4.34°C (7.81°F) under the HDPUV No-Action Alternative by 2100. The range of temperature increases under the HDPUV FE standard action alternatives would decrease this projected temperature rise by a range of less than 0.0001°C (0.0002°F) under Alternative HDPUV4 to 0.0042°C (0.0076°F) under Alternative HDPUV14. Figure S-11 shows the increase in projected global mean surface temperature under each HDPUV action alternative compared with temperatures under the No-Action Alternative.
- Projected sea-level rise in 2100 ranges from a high of 83.24 centimeters (32.77 inches) under the CAFE No-Action Alternative to a low of 83.19 centimeters (32.75 inches) under Alternative PC6LT8. Alternative PC6LT8 would result in a decrease in sea-level rise equal to 0.06 centimeter (0.02 inch) by 2100 compared with the level projected under the No-Action Alternative. Alternative PC2LT002 would result in a decrease of less than 0.01 centimeter (0.004 inch) compared with the No-Action Alternative.
- Under the HDPUV FE standard action alternatives, projected sea-level rise in 2100 under the SSP3-7.0 scenario varies less than 0.01 centimeter (0.004 inch) from a high of 83.24 centimeters (32.77 inches) under the HDPUV No-Action Alternative.
- Global mean precipitation is anticipated to increase by 7.42 percent by 2100 under the CAFE No-Action Alternative. Under the CAFE standard action alternatives, this increase in precipitation would be reduced by less than 0.01 percent.
- Global mean precipitation is anticipated to increase by 7.42 percent by 2100 under the HDPUV No-Action Alternative. HDPUV FE standard action alternatives would see a reduction in precipitation of less than 0.01 percent.

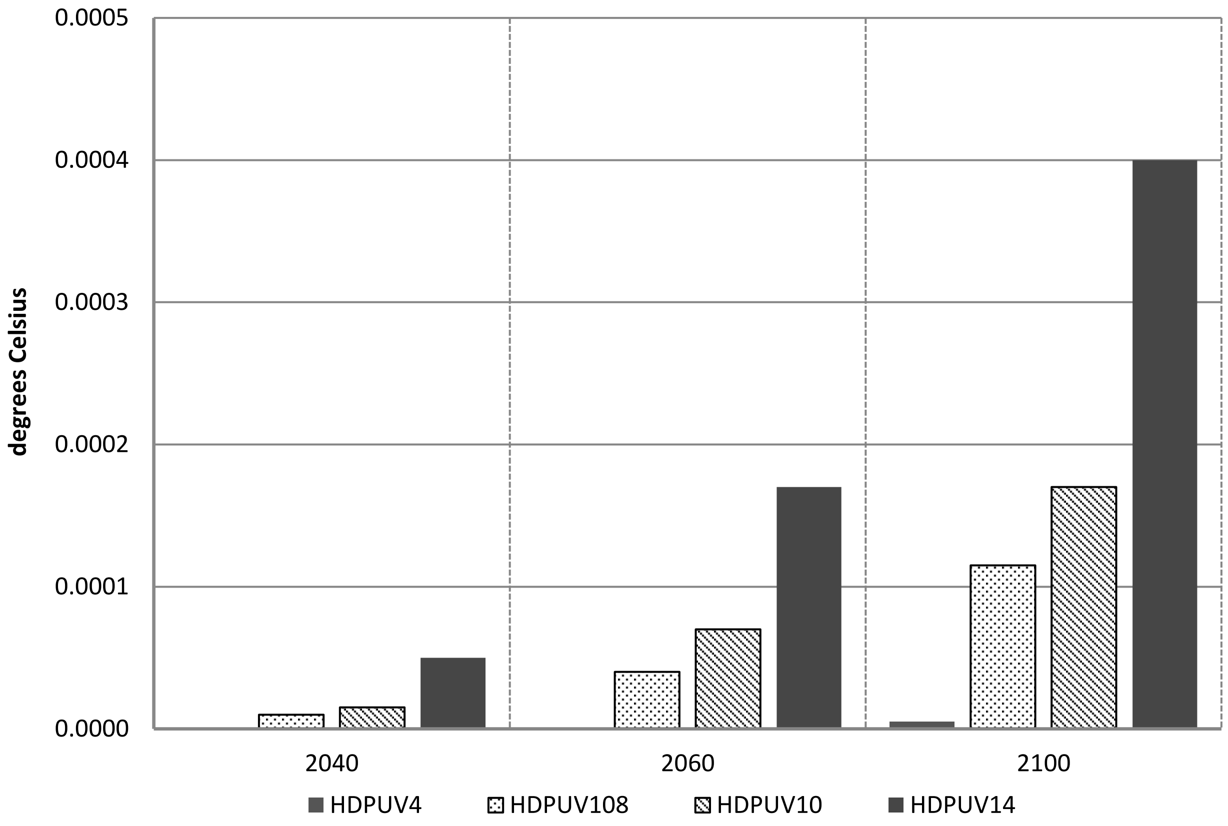
- Ocean pH in 2100 is anticipated to be 8.1936 under Alternative PC6LT8, about 0.0003 more than the CAFE No-Action Alternative. Under Alternative PC2LT002, ocean pH in 2100 would be 8.1933, or less than 0.0001 more than the CAFE No-Action Alternative.
- For HDPUV FE standard action alternatives, ocean pH in 2100 is anticipated to be 8.1933 under Alternative HDPUV108, or less than 0.0001 more than the HDPUV No-Action Alternative.

Figure S-10. Reductions in Global Mean Surface Temperature Compared to the CAFE No-Action Alternative



CAFE = Corporate Average Fuel Economy

Figure S-11. Reductions in Global Mean Surface Temperature Compared to the HDPUV No-Action Alternative



FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans

Cumulative Impacts

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 is SSP2-4.5, which is an intermediate global emissions scenario. It reflects reasonably foreseeable actions in global climate change policy, yielding a moderate level of global GHG reductions from the baseline global emissions scenario used in the direct and indirect analysis. 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, coastal ecosystems).

Greenhouse Gas Emissions

The following cumulative impacts related to GHG emissions are anticipated.

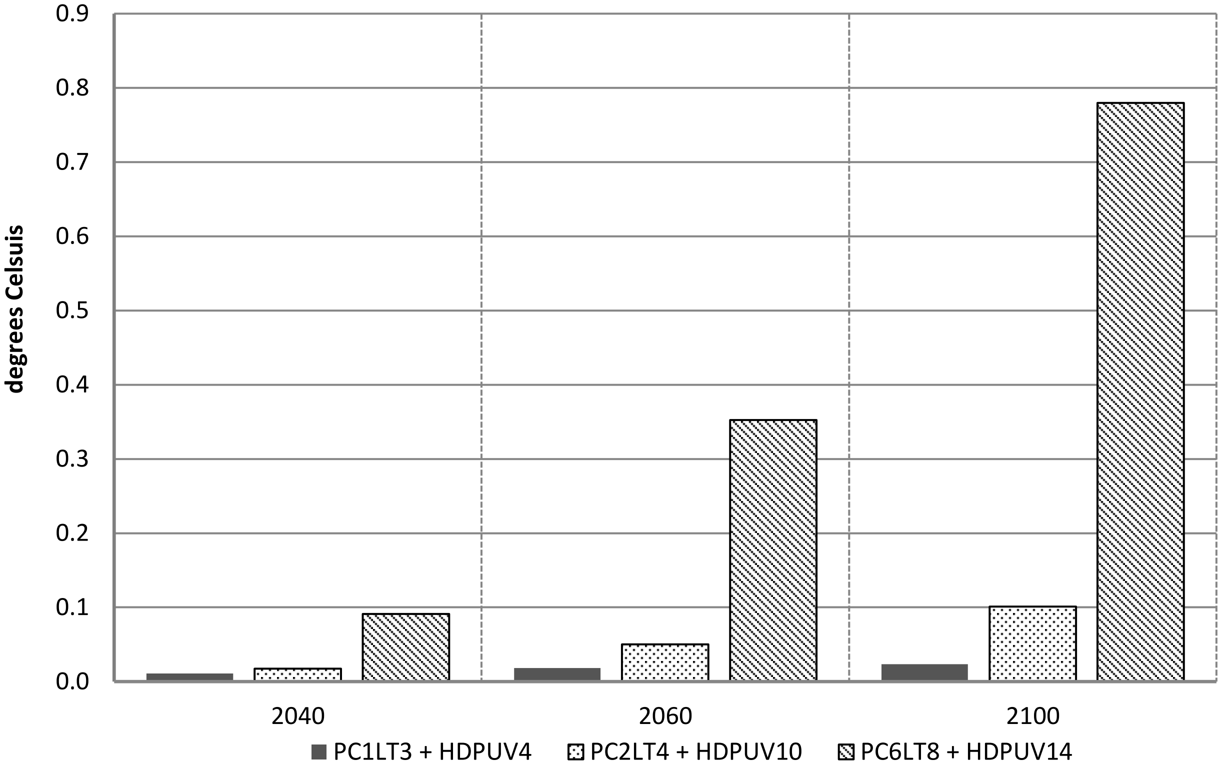
- Projections of total emissions reductions from 2027 to 2100 under the CAFE and HDPUV alternative combinations and other reasonably foreseeable future actions compared with the No-Action Alternatives ranges from 500 $MMTCO_2$ under Alternatives PC2LT002 and HDPUV4 to 10,500 $MMTCO_2$ under Alternatives PC6LT8 and HDPUV14. The Proposed Action and alternatives would decrease total vehicle emissions by between 0.9 percent under Alternatives PC2LT002 and HDPUV4 and 19 percent under Alternatives PC6LT8 and HDPUV14 by 2100.
- Compared with projected total global CO_2 emissions of 2,484,191 $MMTCO_2$ from all sources from 2027 to 2100 using the moderate climate scenario, the incremental impact of this rulemaking is expected to reduce global CO_2 emissions between 0.01 percent under Alternatives PC2LT002 and HDPUV4 and 0.21 percent under Alternatives PC6LT8 and HDPUV14 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 587.78 ppm under the No-Action Alternatives to 586.89 ppm under Alternatives PC6LT8 and HDPUV14 (the combination of the most stringent CAFE and HDPUV FE standard alternatives). This is a decrease of 0.89 ppm compared with the No-Action Alternatives.
- Global mean surface temperature decreases for the CAFE and HDPUV FE alternative combinations compared with the No-Action Alternatives in 2100 range from a low of less than 0.001°C (0.002°F) under Alternatives PC2LT002 and HDPUV4 to a high of 0.004°C (0.007°F) under Alternatives PC6LT8 and HDPUV14. Figure S-12 illustrates the reductions in the rate at which global mean temperature would increase under each CAFE and HDPUV FE alternative combination compared with the No-Action Alternatives.
- Global mean precipitation is anticipated to increase 6.11 percent under the No-Action Alternatives, with the CAFE and HDPUV FE alternative combinations reducing this effect up to 0.01 percent.
- Projected sea-level rise in 2100 ranges from a high of 67.12 centimeters (26.42 inches) under the No-Action Alternatives to a low of 67.03 centimeters (26.39 inches) under Alternatives PC6LT8 and HDPUV14, indicating a maximum decrease in projected sea-level rise of 0.08 centimeter (0.03 inch) by 2100.
- Ocean pH in 2100 is anticipated to be 8.3334 under Alternatives PC6LT8 and HDPUV14, about 0.0006 more than the No-Action Alternatives.

Figure S-12. Reductions in Global Mean Surface Temperature Compared with the No-Action Alternatives, Combined Impacts



Health, Societal, and Environmental Impacts of Climate Change

The Proposed Action and alternatives for both CAFE and HDPUV FE standards would reduce the impacts of climate change that would otherwise occur under the No-Action Alternatives. The largest magnitude of changes in climate effects would be produced by the most stringent action alternatives combination, which are Alternatives PC6LT8 and HDPUV14. Using the three-degree sensitivity analysis, by the year 2100 the following would result.

- A 0.89 ppm lower concentration of CO_2.
- A four-thousandths-of-a-degree decrease in projected temperature rise.
- A small percentage change in precipitation increase.
- A 0.08 centimeter (0.03 inch) decrease in projected sea-level rise.
- An increase of 0.0006 in ocean pH.

Although the projected reductions in CO_2 and climate effects are small compared with total projected future climate change, they are quantifiable and directionally consistent and would represent an important contribution to reducing the risks associated with climate change.

Many specific impacts of climate change on health, society, and the environment cannot be estimated quantitatively. Therefore, in Chapter 5, *Greenhouse Gas Emissions and Climate Change*, NHTSA provides a qualitative discussion of projected impacts by presenting the findings of peer-reviewed panel reports including those from the IPCC, GCRP, CCSP, the National Research Council, and the Arctic Council, among others. While the action alternatives would decrease growth in GHG emissions and reduce the impact of climate change across resources relative to the No-Action Alternatives, they would not entirely prevent climate change and associated impacts. It is difficult to attribute any particular impact to emissions resulting from this rulemaking; however, NHTSA's assumption is that overall impacts are likely to be beneficial due to the reduced emissions resulting from the action alternatives. A detailed discussion of sectoral and regional impacts of climate change is provided in Chapter 5, Section 5.4.3, *Health, Societal, and Environmental Impacts of Climate Change.*

Comparison of Alternatives

Direct and Indirect Impacts

Table S-5 summarizes the direct and indirect effects of the CAFE standard action alternatives on each resource. Table S-6 summarizes the direct and indirect effects of the HDPUV FE standard action alternatives on each resource. Climate results are based on a climate analysis utilizing the SSP 3-7.0 global emissions reference scenario where noted.

Cumulative Impacts

Table S-7 summarizes the cumulative impacts of the CAFE and HDPUV FE standard action alternatives on energy, air quality, and climate, as presented in Chapter 3, Section 3.3.2, *Cumulative Impacts,* Chapter 4, Section 4.2.2, *Cumulative Impacts,* and Chapter 5, Section 5.4.2*, Cumulative Impacts on Greenhouse Gas Emissions and Climate Change*. These cumulative impacts are presented as the impacts of three specific combinations of CAFE standard and HDPUV FE standard action alternatives, which represent the full range of cumulative impacts of the two sets of standards that NHTSA is proposing in its rulemaking. Climate results are based on a climate analysis utilizing the SSP 2-4.5 global emissions reference scenario where noted.

Table S-5. Direct and Indirect Impacts of CAFE Standards

No-Action	PC2LT002	PC1LT3	PC2LT4	PC3LT5	PC6LT8
Energy: Combined U.S. Passenger Car and Light Truck Fuel Consumption for 2022–2050 (billion gasoline gallon equivalent)					
2,774	2,760	2,736	2,729	2,695	2,596
Energy: Combined U.S. Passenger Car and Light Truck Decrease in Fuel Consumption for 2022–2050 (billion gallons)					
--	-14 (-1%)	-39 (-1%)	-46 (-2%)	-80 (-3%)	-179 (-6%)
Air Quality: Criteria Air Pollutant Emissions Changes in 2035 (tons per year)					
--	Decrease: CO (-22,111), NO_X (-842), PM2.5 (-90), and VOCs (-4,032). Increase: SO_2 (135).	Decrease: CO (-63,024), NO_X (-2,378), PM2.5 (-228), and VOCs (-12,096), emissions smaller than Alt. PC2LT002. Increase: SO_2 (473), emissions larger than Alt. PC2LT002.	Decrease: CO (-70,190), NO_X (-2,847), PM2.5 (-277), and VOCs (-14,014), emissions smaller than Alts. PC2LT002 and PC1LT3. Increase: SO_2 (471), emissions larger than Alt. PC2LT002 and smaller than Alt. PC1LT3.	Decrease: CO (-99.891), NO_X (-4,249), PM2.5 (-406), and VOCs (-20,799), emissions smaller than Alts. PC2LT002, PC1LT3, and PC2LT4. Increase: SO_2 (674), emissions larger than Alts. PC2LT002, PC1LT3, and PC2LT4.	Decrease: CO (-198,722), NO_X (-8,731), PM2.5 (-806), and VOCs (-41,370), emissions smaller than Alts. PC2LT002, PC1LT3, PC2LT4, and PC3LT5. Increase: SO_2 (1,279), emissions larger than Alts. PC2LT002, PC1LT3, PC2LT4, and PC3LT5.
Air Quality: Toxic Air Pollutant Emissions Changes in 2035 (tons per year)					
--	Decrease: Acetaldehyde (-14), acrolein (-1), benzene (-49), 1,3-butadiene (-5), DPM (-89), and formaldehyde (-12). Increase: None.	Decrease: Acetaldehyde (-42), acrolein (-3), benzene (-149), 1,3-butadiene (-17), DPM (-247), and formaldehyde (-36), emissions smaller than Alt. PC2LT002. Increase: None.	Decrease: Acetaldehyde (-46), acrolein (-3), benzene (-167), 1,3-butadiene (-18), DPM (-337), and formaldehyde (-40), emissions the same or smaller than Alts. PC2LT002 and PC1LT3. Increase: None.	Decrease: Acetaldehyde (-69), acrolein (-4), benzene (-246), 1,3-butadiene (-27), DPM (-534), and formaldehyde (-60), emissions smaller than Alts. PC2LT002, PC1LT3, and PC2LT4. Increase: None.	Decrease: Acetaldehyde (-147), acrolein (-10), benzene (-514), 1,3-butadiene (-59), DPM (-1,080), and formaldehyde (-124), emissions smaller than Alts. PC2LT002, PC1LT3, PC2LT4, and PC3LT5. Increase: None.

No-Action	PC2LT002	PC1LT3	PC2LT4	PC3LT5	PC6LT8
Air Quality: Changes in Premature Mortality Cases and Work-Loss Days in 2035					
--	Premature mortality: -10 cases Work loss: -1,366 days	Premature mortality: -32 cases Work loss: -4,517 days	Premature mortality: -35 cases Work loss: -5,029 days	Premature mortality: -53 cases Work loss: -7,545 days	Premature mortality: -115 cases Work loss: -16,254 days
Climate: Total Carbon Dioxide Emissions from U.S. Passenger Cars and Light Trucks for 2027–2100 ($MMTCO_2$)					
46,500	46,100	45,400	45,500	44,000	39,500
Climate: Atmospheric Carbon Dioxide Concentrations in 2100 (ppm)[a]					
838.31	838.27	838.21	838.22	838.08	837.65
Climate: Increase in Global Mean Surface Temperature by 2100 in °C (°F)[a]					
4.3395°C (7.8111°F)	4.3394°C (7.8109°F)	4.3391°C (7.8104°F)	4.3391°C (7.8104°F)	4.3386°C (7.8095°F)	4.3369°C (7.8064°F)
Climate: Global Sea-Level Rise by 2100 in centimeters (inches)[a]					
83.24 (32.77)	83.24 (32.77)	83.23 (32.77)	83.23 (32.77)	83.22 (32.76)	83.19 (32.75)
Climate: Global Mean Precipitation Increase by 2100[a]					
7.42%	7.42%	7.42%	7.42%	7.42%	7.42%
Climate: Ocean Acidification in 2100 (pH)[a]					
8.1933	8.1933	8.1933	8.1933	8.1934	8.1936

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.

[a] Results based on a climate analysis utilizing the SSP 3-7.0 global emissions reference scenario.

°C = degrees Celsius; °F = degrees Fahrenheit; CAFE = Corporate Average Fuel Economy; CO = carbon monoxide; DPM = diesel particulate matter; $MMTCO_2$ = million metric tons of carbon dioxide; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; ppm = parts per million; SO_2 = sulfur dioxide; VOCs = volatile organic compounds

Table S-6. Direct and Indirect Impacts of HDPUV FE Standards

No-Action	HDPUV4	HDPUV108	HDPUV10	HDPUV14
Energy: HDPUV Fuel Consumption for 2022–2050 (billion gasoline gallon equivalent)				
419	419	415	412	402
Energy: HDPUV Decrease in Fuel Consumption for 2022–2050 (billion gallons)				
--	-0.3 (0%)	-4 (-1%)	-7 (-2%)	-17 (-4%)
Air Quality: Criteria Air Pollutant Emissions Changes in 2035 (tons per year)				
--	Decrease: CO (-249), NO_x (-11), PM2.5 (-2), and VOCs (-68). Increase: SO_2 (5).	Decrease: CO (-1,223), NO_x (-53), PM2.5 (-10), and VOCs (-445), emissions smaller than Alt. HDPUV4. Increase: SO_2 (23), emissions larger than Alt. HDPUV4.	Decrease: CO (-2,454), NO_x (-119), PM2.5 (-21), and VOCs (-890), emissions smaller than Alts. HDPUV4 and HDPUV108. Increase: SO_2 (43), emissions larger than Alts. HDPUV4 and HDPUV108.	Decrease: CO (-9,031), NO_x (-423), PM2.5 (-75), and VOCs (-2,968), emissions smaller than Alts. HDPUV4, HDPUV108, and HDPUV10. Increase: SO_2 (169), emissions larger than Alts. HDPUV4, HDPUV108, and HDPUV10.
Air Quality: Toxic Air Pollutant Emissions Changes in 2035 (tons per year)				
--	No change: Acetaldehyde (0), acrolein (0), 1,3-butadiene (0), DPM (0), and formaldehyde (0). Decrease: Benzene (-1). Increase: None.	No change: Acrolein (0) and 1,3-butadiene (0). Decrease: Acetaldehyde (-1), benzene (-5), DPM (-6), and formaldehyde (-1), emissions smaller than HDPUV4. Increase: None.	No change: Acrolein (0). Decrease: Acetaldehyde (-2), benzene (-10), 1,3-butadiene (-1), DPM (-13), and formaldehyde (-2), emissions the same or smaller than Alts. HDPUV4 and HDPUV108. Increase: None.	Decrease: Acetaldehyde (-9), acrolein (-1), benzene (-36), 1,3-butadiene (-4), DPM (-29), and formaldehyde (-8), emissions the same or smaller than Alts. HDPUV4, HDPUV108, and HDPUV10. Increase: None.
Air Quality: Changes in Premature Mortality Cases and Work-Loss Days in 2035				
--	Premature mortality: No change Work loss: -31 days	Premature mortality: -1 cases Work loss: -173 days	Premature mortality: -2 cases Work loss: -349 days	Premature mortality: -9 cases Work loss: -1,218 days
Climate: Total Carbon Dioxide Emissions from All HDPUVs for 2027–2100 ($MMTCO_2$)				
9,700	9,700	9,400	9,300	8,700
Climate: Atmospheric Carbon Dioxide Concentrations in 2100 (ppm)[a]				
838.31	838.31	838.28	838.27	838.21

No-Action	HDPUV4	HDPUV108	HDPUV10	HDPUV14
Climate Increase in Global Mean Surface Temperature by 2100 in °C (°F)[a]				
4.3395°C (7.8111°F)	4.3395°C (7.8111°F)	4.3394°C (7.8109°F)	4.3394°C (7.8109°F)	4.3391°C (7.8104°F)
Climate: Global Sea-Level Rise by 2100 in centimeters (inches)[a]				
83.24 (32.77)	83.24 (32.77)	83.24 (32.77)	83.24 (32.77)	83.24 (32.77)
Climate: Global Mean Precipitation Increase by 2100[a]				
7.42%	7.42%	7.42%	7.42%	7.42%
Climate: Ocean Acidification in 2100 (pH)[a]				
8.1933	8.1933	8.1933	8.1933	8.1933

Notes:

[a] Results based on a climate analysis utilizing the SSP 3-7.0 global emissions reference scenario.

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; CAFE = Corporate Average Fuel Economy; CO = carbon monoxide; DPM = diesel particulate matter; ppm = parts per million; FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans; MMTCO$_2$ = million metric tons of carbon dioxide; NO$_X$ = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; ppm = parts per million; SO$_2$ = sulfur dioxide; VOCs = volatile organic compounds

Table S-7. Cumulative Impacts of MY 2027–2032 CAFE Standards and MY 2030–2035 HDPUV FE Standards

No-Action	PC2LT002 + HDPUV4	PC2LT002 + HDPUV108	PC6LT8 + HDPUV14
Energy: Fuel Consumption of LD Vehicles and HDPUVs (billion gasoline gallon equivalent total for calendar years 2022–2050)			
3,193	3,178	3,174	2,955
Energy: Decrease in Fuel Consumption of LD Vehicles and HDPUVs (billion gasoline gallon equivalent total for calendar years 2022–2050)			
--	-15 (0%)	-19 (-1%)	-238 (-7%)
Air Quality: Criteria Air Pollutant Emissions Changes in 2035 (tons per year)			
--	Decrease: CO (-22,814), NO_X (-873), PM2.5 (-94), and VOCs (-4,186). Increase: SO_2 (142).	Decrease: CO (-23,788), NO_X (-915), PM2.5 (-102), and VOCs (-4,563), emissions smaller than Alts. PC2LT002 + HDPUV4. Increase: SO_2 (160), emissions larger than Alt. PC2LT002 + HDPUV4.	Decrease: CO (-242,062), NO_X (-10,581), PM2.5 (-1,003), and VOCs (-51,528), emissions smaller than Alts. PC2LT002 + HDPUV4 and PC2LT002 + HDPUV108. Increase: SO_2 (1,745), emissions larger than Alts. PC2LT002 + HDPUV4 and PC2LT002 + HDPUV108.
Air Quality: Toxic Air Pollutant Emissions Changes in 2035 (tons per year)			
--	Decrease: Acetaldehyde (-14), acrolein (-1), benzene (-51), 1,3-butadiene (-6), DPM (-92), and formaldehyde (-12). Increase: None.	Decrease: Acetaldehyde (-15), acrolein (-1), benzene (-56), 1,3-butadiene (-6), DPM (-97), and formaldehyde (-13), emissions the same or smaller than Alt. PC2LT002 + HDPUV4. Increase: None.	Decrease: Acetaldehyde (-184), acrolein (-12), benzene (-644), 1,3-butadiene (-74), DPM (-1,268), and formaldehyde (-155), emissions smaller than Alts. PC2LT002 + HDPUV4 and PC2LT002 + HDPUV108. Increase: None.
Air Quality: Changes in Premature Mortality Cases and Work-Loss Days in 2035			
--	Premature mortality: -10 cases Work loss: -1,404 days	Premature mortality: -10 cases Work loss: -1,404 days	Premature mortality: -136 cases Work loss: -19,315 days
Climate: Total Carbon Dioxide Emissions from All LD Vehicles and HDPUVs for 2027–2100 ($MMTCO_2$)[a]			
56,200	55,700	55,400	45,700
Climate: Atmospheric Carbon Dioxide Concentrations in 2100 (ppm) [b]			
587.78	587.74	587.71	586.89

No-Action	PC2LT002 + HDPUV4	PC2LT002 + HDPUV108	PC6LT8 + HDPUV14
Climate Increase in Global Mean Surface Temperature by 2100 in °C (°F)[b]			
2.8264°C (5.0876°F)	2.8262°C (5.0872°F)	2.8261°C (5.0870°F)	2.8222°C (5.0800°F)
Climate: Global Sea-Level Rise by 2100 in centimeters (inches)[b]			
67.12 (26.43)	67.11 (26.42)	67.11 (26.42)	67.03 (26.39)
Climate: Global Mean Precipitation Increase by 2100[b]			
6.11%	6.10%	6.10%	6.10%
Climate: Ocean pH in 2100[b]			
8.3328	8.3328	8.3329	8.3334

Notes:

[a] Total greenhouse gas emissions from the combined impacts of all LD vehicles and HDPUVs are the same as the additive sum presented 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 an intermediate global emissions scenario (SSP2-4.5) as opposed to the high emissions scenario (SSP3-7.0) used in the direct and indirect effects analysis. NHTSA chose the SSP2-4.5 scenario as plausible global emissions baseline for the cumulative analysis because this scenario is more aligned with reasonably foreseeable global actions that will result in a moderate level of emissions reductions (although it does not explicitly include any particular policy or program).

[b] Results based on a climate analysis utilizing the SSP 2-4.5 global emissions reference scenario.

°C = degrees Celsius; °F = degrees Fahrenheit; CAFE = Corporate Average Fuel Economy; CO = carbon monoxide; DPM = diesel particulate matter; EV = electric vehicle; FE = fuel efficiency; HDPUV = heavy-duty pickup trucks and vans; MMTCO$_2$ = million metric tons of carbon dioxide; NO_X = nitrogen oxides; PM2.5 = particulate matter 2.5 microns or less in diameter; ppm = parts per million; SO_2 = sulfur dioxide; VOCs = volatile organic compounds