Medium- and Heavy-Duty Fuel Efficiency Improvement Program

Final Environmental Impact Statement

Summary

June 2011

NHTSA

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FOREWORD

The National Highway Traffic Safety Administration (NHTSA) prepared this Environmental Impact Statement (EIS) to analyze and disclose the potential environmental impacts of the proposed Fuel Efficiency Improvement Program for commercial medium- and heavy-duty vehicles pursuant to Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA), U.S. Department of Transportation (DOT) Order 5610.1C, and NHTSA regulations. This EIS compares the potential environmental impacts of five alternative approaches that NHTSA is considering, including the Preferred Alternative and the No Action Alternative. It also analyzes direct, indirect, and cumulative impacts in proportion to their significance. The alternatives selected for evaluation by NHTSA encompass a reasonable range to evaluate the potential environmental impacts of the proposed HD Fuel Efficiency Improvement Program and alternatives under NEPA. Note that footnotes and supporting citations are not included in this summary section. Consult the relevant chapters of this EIS for that information.

BACKGROUND

The Energy Policy and Conservation Act of 1975 (EPCA) mandated that NHTSA establish and implement a regulatory program for motor vehicle fuel economy. As codified in Chapter 329 of Title 49 of the U.S. Code, and as amended by the Energy Independence and Security Act of 2007 (EISA), EPCA sets forth extensive requirements concerning the establishment of average fuel economy standards for passenger automobiles and non-passenger automobiles, which are motor vehicles that weigh less than 10,000 pounds. This regulatory program, known as the Corporate Average Fuel Economy Program (CAFE), was established to reduce national energy consumption by increasing the fuel economy of these vehicles.

EISA was enacted in December 2007, providing the U.S. DOT (and by delegation, NHTSA) new authority to implement, via rulemaking and regulations, "a commercial medium- and heavy-duty on-highway vehicle and work truck fuel efficiency improvement program," to regulate the fuel consumption of motor vehicles weighing more than 10,000 pounds. This provision also directs NHTSA to "adopt and implement appropriate test methods, measurement metrics, fuel economy standards, and compliance and enforcement protocols that are appropriate, cost-effective, and technologically feasible for commercial medium- and heavy-duty on-highway vehicles and work trucks." This new authority permits NHTSA to set "separate standards for different classes of vehicles." Commercial medium- and heavy-duty on-highway vehicles and work trucks are hereinafter referred to collectively as HD vehicles. Pursuant to EISA, the HD Fuel Efficiency Improvement Program must provide not less than four full model years of regulatory lead time and three full model years of regulatory stability.

Further guiding the establishment of NHTSA's HD Fuel Efficiency Improvement Program, on May 21, 2010 President Obama issued a memorandum entitled "Improving Energy Security, American Competitiveness and Job Creation, and Environmental Protection through a Transformation of our Nation's Fleet of Cars and Trucks" to the Secretary of Transportation, the Administrator of NHTSA, the Administrator of the U.S. Environmental Protection Agency (EPA), and the Secretary of Energy. The memorandum requested that the Administrators of EPA and NHTSA begin work on a Joint Rulemaking under EISA and the Clean Air Act

and to establish fuel efficiency and greenhouse gas (GHG) emissions standards for HD vehicles beginning with MY 2014, with the aim of issuing a Final Rule by July 30, 2011.

The President requested that, before promulgating a final rule, the Administrators of EPA and NHTSA: "Propose and take comment on strategies, including those designed to increase the use of existing technologies, to achieve substantial annual progress in reducing transportation sector emissions and fossil fuel consumption…" The President also requested that NHTSA implement fuel efficiency standards and EPA implement GHG emissions standards that take into account the market structure of the trucking industry and the unique demands of HD vehicle applications; seek harmonization with applicable State standards; consider the findings and recommendations published in the National Academy of Sciences report on HD truck regulation; strengthen the industry and enhance job creation in the United States; and seek input from all stakeholders, while recognizing the continued leadership role of California and other States.

Consistent with statutory requirements of EPCA/EISA and the President's directive, NHTSA's proposal includes mandatory standards beginning in model year (MY) 2016. Under the proposal, the standards would remain stable for three model years. Although EISA prevents NHTSA from enacting mandatory standards before MY 2016, NHTSA's proposal includes voluntary compliance standards for MYs 2014–2015 prior to the proposed mandatory regulation in MY 2016. As directed by EISA, this rulemaking is being conducted in consultation with EPA and the U.S. Department of Energy (DOE).

Under NEPA, a Federal agency must analyze environmental impacts of an action if the agency implements, funds, or permits or otherwise approves a proposed Federal action. Specifically, NEPA directs that "to the fullest extent possible," 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). To inform its development of the HD Fuel Efficiency Improvement Program required under EISA, NHTSA prepared a Draft EIS (DEIS) to analyze and disclose the potential environmental impacts of a proposed preferred alternative and other proposed alternative actions. This Final EIS (FEIS) updates the analysis presented in the DEIS, comparing the potential environmental impacts among alternatives, including a No Action Alternative. It also analyzes the potential direct, indirect, and cumulative impacts of the alternatives.

Both EPA and the Federal Motor Carrier Safety Administration (FMCSA) have acted as cooperating agencies in the development of this EIS. Under 40 CFR § 1501.6, a Federal agency that has special expertise with respect to any environmental issue that should be addressed in the EIS may be a cooperating agency upon request of the lead agency. EPA has special expertise in the areas of climate change and air quality, and FMCSA has special expertise in HD vehicles. The staff of both agencies also participated in technical discussions and reviewed and commented on draft sections and the draft final version of this EIS.

PURPOSE AND NEED FOR THE PROPOSED ACTION

For this EIS, NHTSA's proposed action is to set HD vehicle fuel consumption standards in accordance with EISA/EPCA. NEPA requires that proposed alternatives be developed based on the action's purpose and need. The purpose and need statement explains why the action is needed, describes the action's intended purpose, and serves as the basis for developing the range of alternatives to be considered in the NEPA analysis. The EISA/EPCA statutory requirements form the purpose and need for

NHTSA's action. In accordance with EISA, NHTSA must establish a fuel efficiency improvement program for HD vehicles "designed to achieve the maximum feasible improvement, and [must] adopt and implement appropriate test methods, measurement metrics, fuel economy standards, and compliance and enforcement protocols that are appropriate, cost-effective, and technologically feasible for commercial medium- and heavy-duty on-highway vehicles and work trucks." The standards adopted under NHTSA's fuel efficiency improvement program must provide not less than four model years of regulatory lead time and three model years of regulatory stability. In considering these various requirements, NHTSA also accounts for relevant environmental and safety requirements. The NEPA analysis presented in this EIS informs the agency's action in setting HD vehicle fuel consumption standards.

ALTERNATIVES

The specific alternatives selected by NHTSA encompass a reasonable range to evaluate the potential environmental impacts of the proposed HD Fuel Efficiency Improvement Program and alternatives under NEPA. At one end of this range is the No Action Alternative (Alternative 1), which assumes no action would occur under the HD National Program. Under this alternative, neither NHTSA nor EPA would issue a rule regarding the HD fuel consumption standards or GHG emissions. The No Action Alternative assumes that average fuel efficiency levels in the absence of an HD Fuel Efficiency Improvement Program would equal the level of fuel efficiency and GHG performance NHTSA believes manufacturers would achieve without regulation. Therefore, the No Action Alternative would only yield additional environmental improvement that might occur from market forces.

In addition to the No Action Alternative, NHTSA also examined four action alternatives. Each of these action alternatives would include standards for engines used in Classes 2b–8 vehicles (except engines in HD pickups and vans, which are regulated as complete vehicles), fuel consumption standards for HD pickups and vans by work factor, overall vehicle fuel consumption standards for Classes 2b–8 vocational vehicles (in gal/1,000 ton-miles), and overall fuel consumption standards for Classes 7 and 8 tractors. Alternatives 2–4 would regulate the same vehicle categories, but at increasing levels of stringency, with Alternative 2 being the least stringent alternative and Alternative 4 being the most stringent. These levels of stringency are based on agency assumptions about the types and penetration rates of technologies manufacturers would apply, taking into account the cost associated with those technologies. More stringent alternatives would require that manufacturers use more technology. Alternative 5 would build on these requirements by adding, in addition to the components regulated under the other action alternatives, a performance standard for the commercial trailers pulled by tractors and by specifying more stringent standards based on accelerated adoption of hybrid powertrains for HD vehicles.

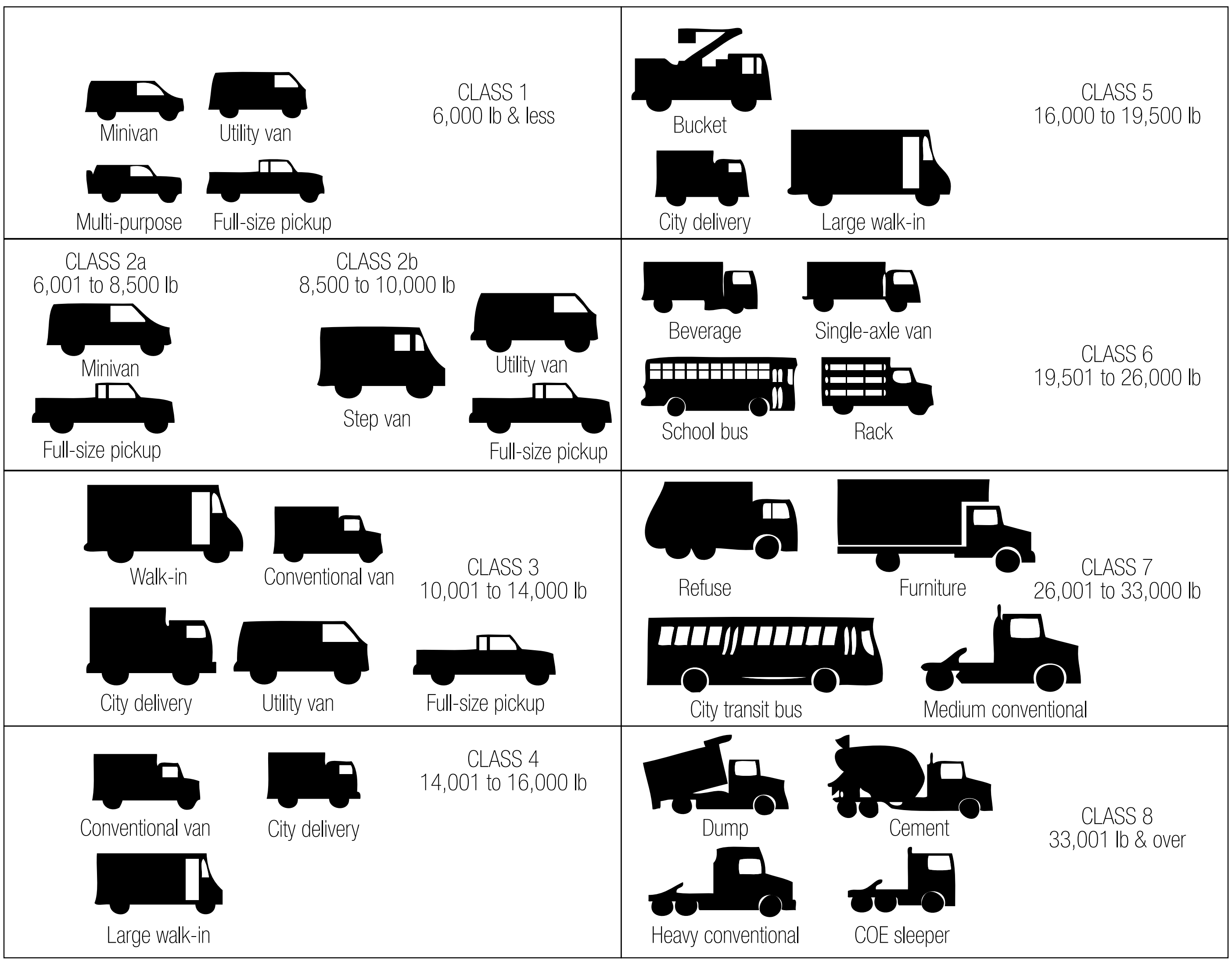
This regulatory approach was selected in view of the complexity of the HD vehicle fleet, the applicability of differing fuel-savings technologies to different portions of that fleet, and the relative degree of homogeneity among vehicles within broad categories (HD pickups and vans, vocational vehicles, and combination tractors).

Table S-1 and Figure S-1 show the vehicle classifications that are the subject of the proposed rule. For more details about these vehicle categories *see* Section 2.3.

Table S-1. HD Vehicle Categories by Gross Vehicle Class Weight Rating (pounds)

Class 2b	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
8,501–10,000 lbs	10,001–14,000 lbs	14,001–16,000 lbs	16,001–19,500 lbs	19,501–26,000 lbs	26,001–33,000 lbs	> 33,001 lbs
HD Pickups and Vans (Work Trucks)						
Vocational Vehicles (e.g., van trucks, utility "bucket" trucks, tank trucks, refuse trucks, buses, fire trucks, flat-bed trucks, and dump trucks)						
					Tractors (for Combination Tractor-Trailers)	

Figure S-1. HD Vehicle Categories



Below is a brief description of the five alternatives. For the proposed standards, *see* Section 2.2 of this EIS. For a detailed explanation of the alternatives, *see* Section 2.3 of this EIS.

- **Alternative 1**, the No Action Alternative, specifies no fuel consumption standards.
- **Alternative 2** specifies a stringency level that is 12 percent less than the Preferred Alternative (Alternative 3). The agencies calculated the stringency level by assuming that manufacturers would incorporate fewer technologies (taking into account their relative costs and benefits), resulting in a 12 percent reduction in the standards.
- **Alternative 3**, the agencies' Preferred Alternative, specifies standards for all Class 2b-8 vehicles and all engines used in those vehicles.
- **Alternative 4** specifies a stringency level that is 20 percent greater than the Preferred Alternative. The agencies calculated the stringency level by assuming that manufacturers would incorporate more technologies (taking into account their relative costs and benefits), resulting in a 20 percent increase in the standards.
- **Alternative 5**, Trailers and Accelerated Hybrid, specifies standards for each vehicle category as set out in the Preferred Alternative, but adds an additional performance standard for commercial trailers pulled by tractors, and also specifies more stringent standards based on accelerated adoption of hybrid powertrains for HD vehicles.

These alternatives reflect differences in the degree of technology adoption across the fleet, in costs to manufacturers and consumers, and in conservation of oil and related reductions in greenhouse gases. For example, the most stringent alternative NHTSA is evaluating (Alternative 5) would require greater adoption of technology across the fleet, including more advanced technology, than the least stringent alternative NHTSA is evaluating. As a result, the most stringent alternative would impose greater costs and achieve greater energy conservation and related reductions in greenhouse gases.

POTENTIAL ENVIRONMENTAL CONSEQUENCES

This section describes how the proposed action and alternatives could affect energy use, air quality, and climate. The EIS also qualitatively describes potential additional impacts on water resources, biological resources, safety, hazardous materials and regulated wastes, noise, and environmental justice.

The effects on energy use, air quality, and climate described in this Summary include *direct, indirect,* and *cumulative impacts*. Direct impacts occur at the same time and place as the action. Indirect impacts occur later in time or are farther removed in distance. Cumulative impacts are the incremental impacts resulting from the action added to those of other past, present, and reasonably foreseeable future actions.

The analysis of the direct and indirect impacts of the proposed standards measures only the impacts of fuel efficiency requirements through 2018, and therefore largely assumes no further increases in average new HD vehicle fuel efficiency after 2018. In contrast, the cumulative analysis includes reasonably foreseeable future actions, consistent with NEPA's requirement to consider such actions as part of the cumulative impacts analysis. These reasonably foreseeable actions include increases in fuel efficiency of new HD vehicles beyond 2018 derived from Annual Energy Outlook (AEO) projections until 2050. The cumulative impacts analysis considers both national and global potential impacts.

Energy Use

Energy intensity in the United States (energy use per dollar of gross domestic product) has improved at an average rate of 2.0 percent per year since 1992. Despite this improvement in economy-wide energy efficiency, transportation fuel consumption has grown steadily on an annual basis and now represents the major use of petroleum in the U.S. economy.

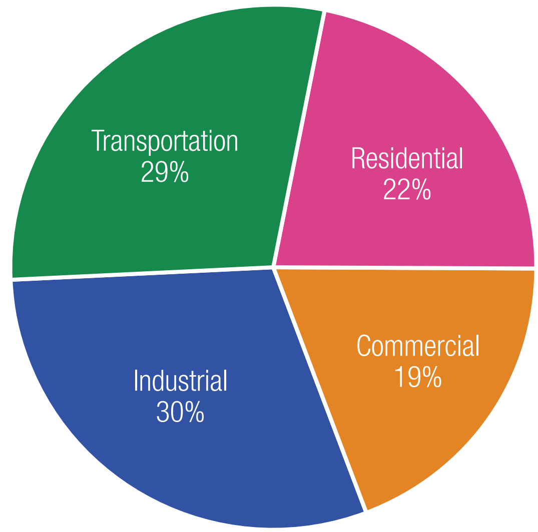
The transportation sector is the second largest consumer of energy in the United States (after the industrial sector) and, as shown in Figure S-2, represents 29 percent of U.S. total energy use. According to the EIA, more than half of U.S. energy consumption in the transportation sector—ranging from 62 percent in 2009 to 50 percent by 2035—can be attributed to petroleum (gasoline and diesel) consumption from light vehicles. Petroleum consumption from HD vehicles made up 18 percent of energy consumption in the U.S. transportation sector in 2009, and is projected to increase to 20 percent of energy consumption in the U.S. transportation sector in 2035. In the future, the transportation sector will continue to be the largest component of total U.S. energy consumption after the industrial sector.

As shown in Figure S-3, 71 percent of the petroleum used in the United States is consumed by the transportation sector. NHTSA's analysis of fuel consumption in this EIS assumes that fuel consumed by HD vehicles will consist predominantly of diesel and gasoline fuel derived from petroleum for the foreseeable future. Petroleum consumption by HD vehicles will continue to grow. In 2009, HD vehicles accounted for 18 percent of total transportation sector petroleum consumption.

Key Findings for Energy Use

To calculate fuel savings for each proposed alternative, NHTSA subtracted fuel consumption under each alternative from the No Action Alternative level. The figures that follow reflect the total fuel savings for all years between 2014

Figure S-2. U.S. Energy Consumption by Sector, 2009



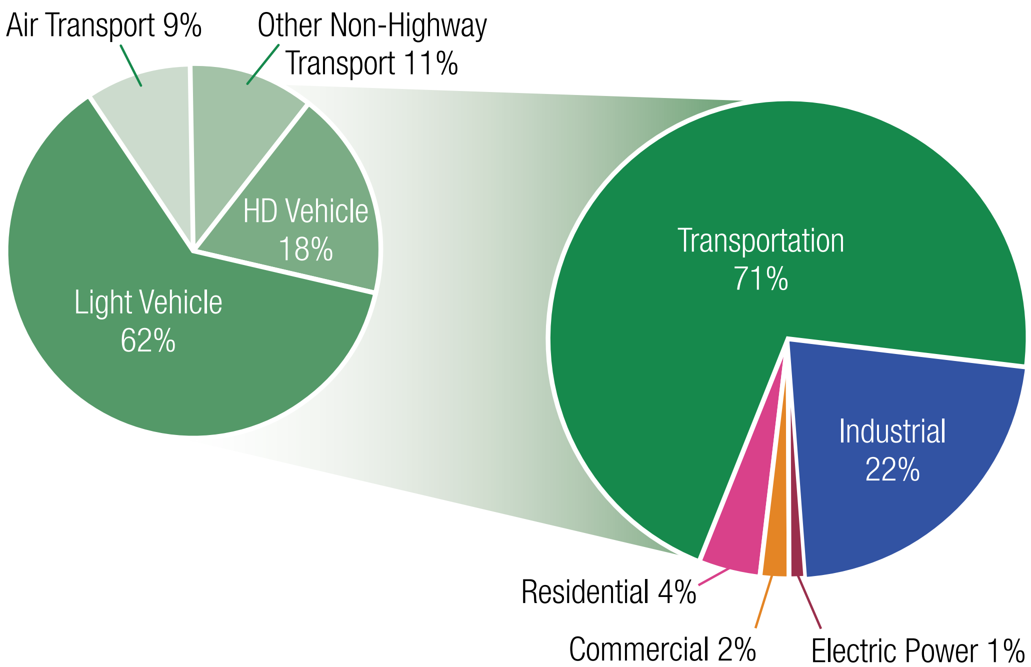
Source: EIA (Energy Information Administration). 2009. Annual Energy Review 2009. Table 2.1a—Energy Consumption by Sector, Selected Years, 1949–2009. DOE/EIA-0384(2009). U.S. Department of Energy. Washington, D.C. Available at: <http://www.eia.doe.gov/emeu/aer/consump.html>. (Accessed: May 26, 2011).

and 2050, when nearly the entire U.S. fleet will likely be comprised of MY 2014–2018 and later vehicles.

Direct and Indirect Impacts

- Under the No Action Alternative, total combined gas and diesel fuel consumption by all U.S. HD vehicles from 2014–2050 would be 2115.3 billion gallons. Total fuel consumption under the action alternatives ranges from 1925.9 billion gallons under Alternative 5 to 2068.6 billion gallons under Alternative 2. Total 2014–2050 fuel consumption under the Preferred Alternative amounts to 2050 billion gallons.
- As compared to the No Action Alternative, total fuel savings from 2014–2050 range from 46.7 billion gallons under Alternative 2 to 189.4 billion gallons under Alternative 5. Total 2014–2050 fuel savings under the Preferred Alternative amounts to 64.4 billion gallons. *See* Figure S-4.

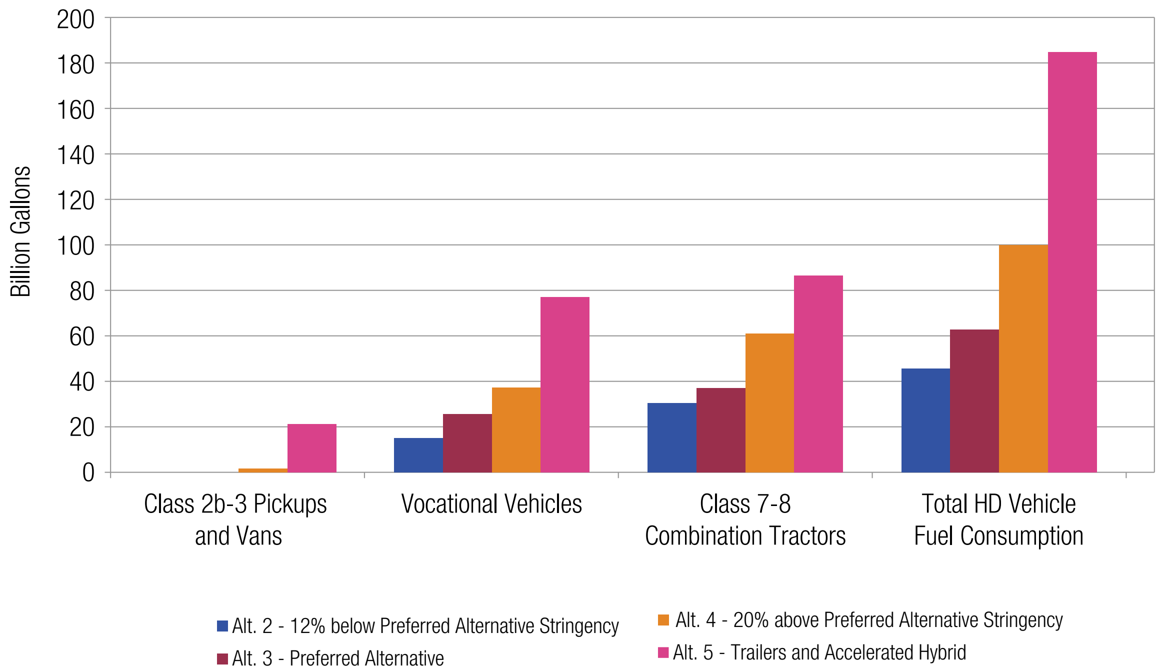
Figure S-3. U.S. Petroleum Consumption by Sector, 2009



Source: EIA. 2011. Annual Energy Outlook 2011. Table 7—Transportation Sector Key Indicators and Delivered Energy Consumption, Reference Case, 2008-2035. DOE/EIA-0383(2011), April. U.S. Department of Energy. Washington, D.C. Available at: <http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=7-AEO2011&region=0-0&cases=ref2011-d020911a>. (Accessed: May 26, 2011).

Source: EIA. 2009. Annual Energy Review 2009. Table 5.13a—Estimated Petroleum Consumption: Residential and Commercial Sectors; Table 5.13b—Estimated Petroleum Consumption: Industrial Sector; Table 5.13c—Estimated Petroleum Consumption: Transportation Sector; Table 5.13d—Estimated Petroleum Consumption: Electric Power Sector. DOE /EIA-0384(2009). U.S. Department of Energy. Washington, D.C. Available at: <http://ei-01.eia.doe.gov/emeu/aer/petro.html>. (Accessed: May 26, 2011).

Figure S-4. HD Vehicle Total 2014–2050 Fuel Savings by Alternative, Direct and Indirect Impacts



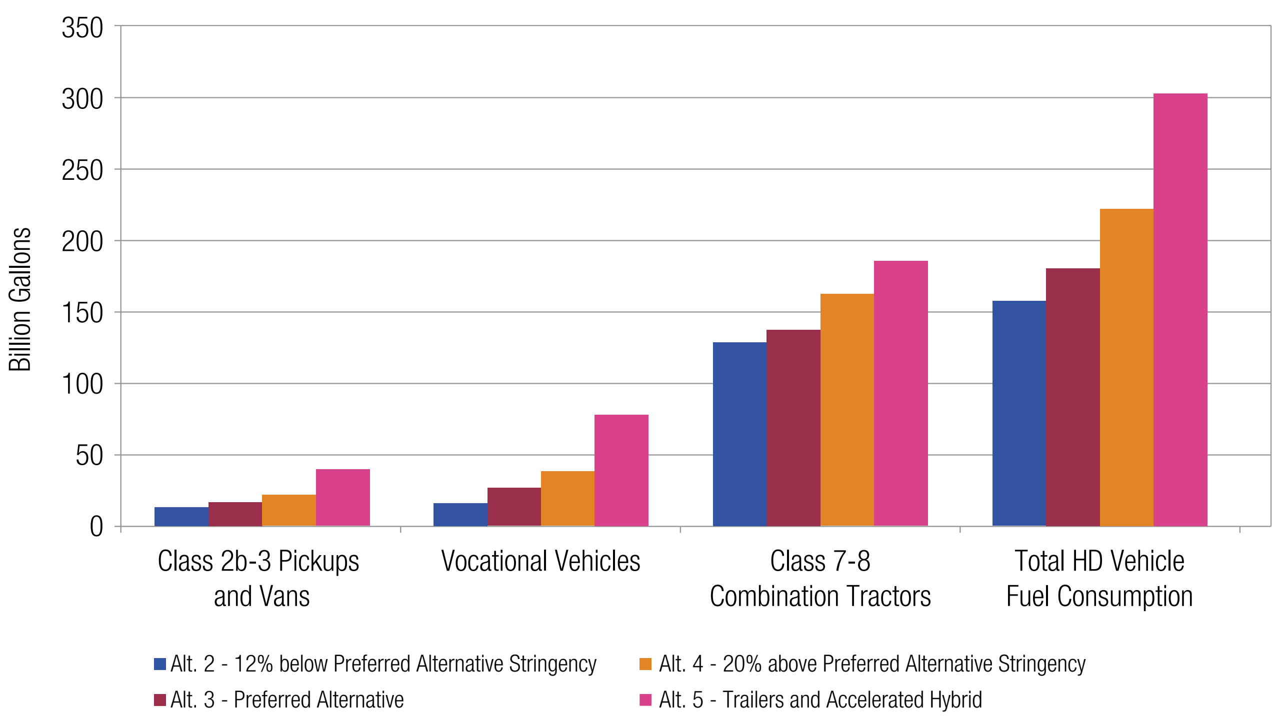
Cumulative Impacts

- Under the No Action Alternative, total combined gas and diesel fuel consumption by all U.S. HD vehicles from 2014–2050 would be 2115.3 billion gallons. Total fuel consumption under the action alternatives ranges from 1811.2 billion gallons under Alternative 5 to 1957.2 billion gallons under Alternative 2. Total 2014–2050 fuel consumption under the Preferred Alternative amounts to 1934.2 billion gallons.
- As compared to the No Action Alternative, total cumulative 2014–2050 fuel savings range from 158.0 billion gallons for Alternative 2 to 304.0 billion gallons for Alternative 5. Total cumulative 2014–2050 fuel savings under the Preferred Alternative is 1 81.1 billion gallons. *See* Figure S-5.

Air Quality

Air pollution and air quality can affect public health, public welfare, and the environment. The alternative HD standards under consideration would affect air pollutant emissions and air quality. The EIS air quality analysis assesses the impacts of the alternatives in relation to emissions of pollutants of concern from mobile sources and the resulting adverse health effects, and the monetized health benefits of emissions reductions. Although the air pollutant emissions generally decline under the action alternatives, the magnitudes of the declines are not consistent across all pollutants (and some air pollutant emissions may actually increase), reflecting the complex interactions between tailpipe emission rates of the various vehicle types, the technologies assumed to be incorporated by manufacturers to comply with the standards, upstream emission rates, the relative proportions of gasoline and diesel in total fuel consumption reductions, and increases in VMT.

Figure S-5. HD Vehicle Total 2014–2050 Fuel Savings by Alternative, Cumulative Impacts



Under the authority of the Clean Air Act and its amendments, EPA has established National Ambient Air Quality Standards (NAAQS) for six relatively common air pollutants—known as "criteria" pollutants because EPA regulates them by developing human-health based or environmentally based criteria for setting permissible levels. The criteria pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, sulfur dioxide (SO_2), lead, and particulate matter (PM) with an aerodynamic diameter equal to or less than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$ or fine particles). Ozone is not emitted directly from vehicles, but is formed from emissions of the ozone precursor pollutants nitrogen oxides (NO_x) and volatile organic compounds (VOCs).

In addition to criteria pollutants, motor vehicles emit some substances defined by the 1990 Clean Air Act Amendments as hazardous air pollutants. Hazardous air pollutants include certain VOCs, compounds in PM, pesticides, herbicides, and radionuclides that present tangible hazards, based on scientific studies of human (and other mammal) exposure.

Hazardous 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. EPA and the Federal Highway Administration have identified these air toxics as the MSATs that typically are of greatest concern when analyzing impacts of highway vehicles. DPM is a component of exhaust from diesel-fueled vehicles and falls almost entirely within the $PM_{2.5}$ particle-size class.

Health Effects of the Pollutants

The criteria pollutants assessed in this EIS have been shown to cause a range of adverse health effects at various concentrations and exposures, including:

- 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; and
- Cancer and premature death.

MSATs are also associated with adverse health effects. For example, acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and certain components of DPM are all classified by EPA as either known or probable human carcinogens. In addition, many MSATs are also associated with noncancer health effects, 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 (including HD vehicles) have declined dramatically since 1970 as a result of pollution controls on vehicles and regulation of the chemical content of fuels.

Highway vehicles (including vehicles covered by this proposed rule) are responsible for about 50 percent of total U.S. emissions of carbon monoxide, 4 percent of $PM_{2.5}$ emissions, and 1 percent of PM_{10} emissions. HD vehicles contribute 6 percent of U.S. highway emissions of CO, 66 percent of highway emissions of $PM_{2.5}$, and 55 percent of highway emissions of PM_{10}. Highway vehicles also contribute about 21 percent of total nationwide emissions of VOCs and 32 percent of NO_x, both of which are chemical precursors of ozone. In addition, NO_x is a $PM_{2.5}$ precursor and VOCs can be $PM_{2.5}$ precursors. HD vehicles contribute 8 percent of U.S. highway emissions of VOC and 50 percent of NO_x. Highway vehicles contribute less than 1 percent of SO_2, but SO_2 and other oxides of sulfur (SO_x) are important because they contribute to the formation of $PM_{2.5}$ in the atmosphere. With the elimination of lead in automotive gasoline, it is no longer emitted from motor vehicles in more than negligible quantities and therefore is not assessed in this analysis.

Key Findings for Air Quality

The findings for direct and indirect effects are shown for year 2030, a mid-term forecast year when a large proportion of HD vehicles would be expected to meet the MY 2014–2018 standards. Findings for cumulative effects are shown for 2050. By 2050, almost all HD vehicles in operation would meet the MY 2014–2018 standards, and the impact of these standards would be determined primarily by VMT growth. The No Action Alternative results in the highest emissions of all criteria pollutants except $PM_{2.5}$. The action alternatives result in slightly higher emissions of $PM_{2.5}$. As compared to the No Action Alternative, the action alternatives result in reduced emissions of acetaldehyde, acrolein, benzene, and formaldehyde, approximately equivalent emissions of 1,3-butadiene, and slightly higher emissions of DPM levels.

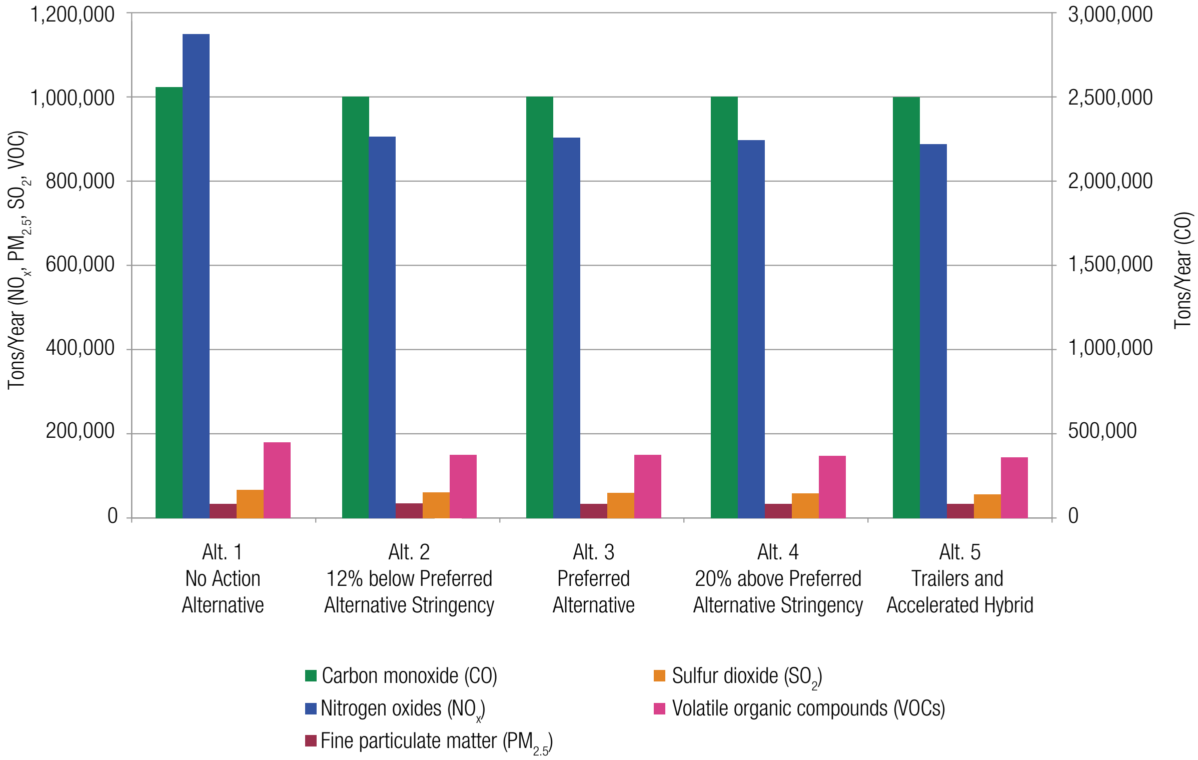
Monetized $PM_{2.5}$-related health benefits and related incidence of reduced adverse health effects from the emission reductions were estimated by multiplying direct $PM_{2.5}$ and $PM_{2.5}$ precursor emission reductions (NO_x, SO_2, and VOCs) by the pollutant-specific benefit-per-ton estimates provided by EPA. Adverse health outcomes include premature mortality, chronic bronchitis, respiratory emergency room visits, and work-loss days.

Direct and Indirect Impacts

Criteria Pollutants

- Emissions of criteria pollutants are highest under the No Action Alternative, except for $PM_{2.5}$, and generally decline as fuel consumption decreases across the alternatives, as shown in Figure S-6.
- Emissions of $PM_{2.5}$ are slightly higher under Alternatives 2 through 5 than under the No Action Alternative. Emissions generally decline as fuel consumption decreases under Alternatives 2 through 5 due to the assumption that sleeper cab tractor trucks would use auxiliary power units to comply with the standards instead of idling for long time periods.
- Emissions of NO_x, $PM_{2.5}$, SO_2, and VOCs are lowest under Alternative 5, and emissions of CO are lowest under Alternative 2.
- Under the Preferred Alternative, emissions of CO, NO_x, SO_2, and VOCs would be reduced compared to the No Action Alternative. Emissions under the Preferred Alternative generally would be equivalent to or lower than under Alternatives 1 and 2, but higher than under

Figure S-6. Nationwide Criteria Pollutant Emissions (tons per year) from HD Vehicles for 2030 by Alternative, Direct and Indirect Impacts

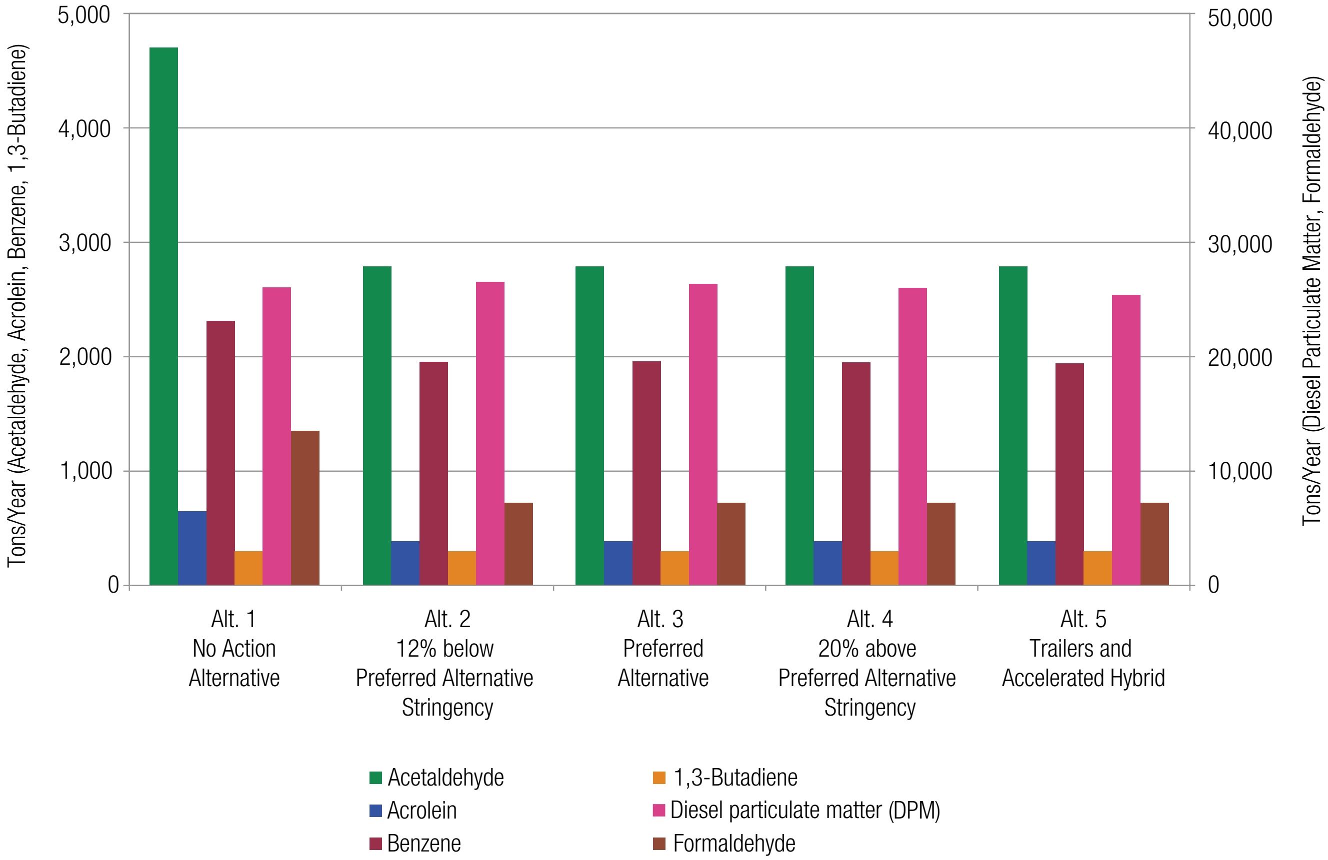


Alternatives 4 and 5. Under the Preferred Alternative emissions of $PM_{2.5}$ would be lower than under Alternative 2, but higher than under Alternatives 1, 4, and 5.

Hazardous Air Pollutants

- Emissions of toxic air pollutants are generally highest under the No Action Alternative, except for 1,3-butadiene and DPM, and generally decline as fuel consumption decreases across the alternatives, as shown in Figure S-7. Emissions of 1,3-butadiene are approximately equivalent under all alternatives.
- Emissions of DPM are slightly higher under Alternatives 2 through 5 than under the No Action Alternative, but generally decline as fuel consumption decreases under Alternatives 2 through 5 due to the assumption that sleeper cab tractor trucks would use auxiliary power units to comply with the standards instead of idling for long time periods.
- Emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde are approximately equivalent under Alternatives 2 through 5.
- Under the Preferred Alternative, emissions of acetaldehyde, acrolein, benzene, and formaldehyde would be reduced compared to the No Action Alternative. Emissions under the Preferred Alternative generally would be equivalent to or lower than under Alternative 1, and equivalent to those under Alternatives 2, 4, and 5. Under the Preferred Alternative emissions of DPM would be lower than under Alternative 2 but higher than under Alternatives 1, 4, and 5.

Figure S-7. Nationwide Toxic Pollutant Emissions (tons per year) from HD Vehicles for 2030 by Alternative, Direct and Indirect Impacts



Health and Health Benefits

- Alternatives 2 through 5 would result in reduced adverse health effects nationwide compared with the No Action Alternative. Reductions generally increase as fuel consumption decreases across alternatives.
- The monetized benefits follow the same patterns as reductions in adverse health effects. When estimating quantified and monetized health impacts, EPA relies on results from two $PM_{2.5}$-related premature mortality studies it considers equivalent (Pope *et al.* 2002 and Laden *et al.* 2006). EPA recommends that monetized benefits be shown using incidence estimates derived from each of these studies and valued using both a 3-percent and 7-percent discount rate to account for an assumed lag in the occurrence of mortality after exposure (EPA assumes a 20-year distributed "cessation lag"), for a total of four separate calculations of monetized health benefits. *See* Sections 3.3.2.7.2 and 3.5.2.3 of this EIS. Estimated monetized health benefits range from $570 million under Alternative 2 (the lowest of the four calculations) to $5.65 billion under Alternative 5 (the highest of the four calculations).
- Under the Preferred Alternative, adverse health outcomes would be fewer and monetized health benefits would be greater than under Alternatives 1 and 2. Adverse health outcomes would be greater and monetized health benefits would be less under the Preferred Alternative than under Alternatives 4 and 5.

See Tables 3.5.2-1 through 3.5.2-10 in Section 3.5 of this EIS for data on the direct effects of criteria and hazardous air pollutant emissions, as well as monetized health benefits for the alternatives.

Cumulative Impacts

Criteria Pollutants

- Cumulative emissions of criteria pollutants are highest under the No Action Alternative and generally decline as fuel consumption decreases across the alternatives, as shown in Figure S-8.
- Emissions of CO are approximately equivalent under all of the action alternatives. Emissions of NO_x, $PM_{2.5}$, SO_2, and VOCs are lowest under Alternative 5.
- Under the Preferred Alternative, emissions of NO_x, $PM_{2.5}$, SO_2, and VOCs would be reduced compared to the No Action Alternative. Emissions under the Preferred Alternative generally would be equivalent to or lower than under Alternatives 1 and 2 but higher than under Alternatives 4 and 5. Under the Preferred Alternative emissions of CO would be slightly higher than under Alternatives 1 and 2, but slightly lower than under Alternatives 4 and 5. Emissions of $PM_{2.5}$ would be slightly lower under the Preferred Alternative than under Alternative 2, but slightly higher than under Alternatives 1, 4, and 5.

Hazardous Air Pollutants

- Cumulative emissions of toxic air pollutants in 2050 are highest under the No Action Alternative and decline as fuel consumption decreases under the action alternatives, as shown in Figure S-9.
- Emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde are approximately equivalent under Alternatives 2 through 5.
- Under the Preferred Alternative, emissions of all studied toxic air pollutants would be reduced compared to the No Action Alternative. Except for DPM, emissions of all studied air pollutants under the Preferred Alternative would be equivalent to those under Alternatives 2, 4, and 5. Under the Preferred Alternative emissions of DPM would be slightly lower than under Alternative 2, but higher than under Alternatives 4 and 5.

Health and Health Benefits

- Alternatives 2 through 5 would result in reduced adverse health effects nationwide compared with the No Action Alternative. Reductions generally increase as fuel consumption decreases across alternatives.
- The monetized benefits also follow the same patterns as reductions in adverse health effects. Estimated annual monetized health benefits in 2050 range from $4.19 billion under Alternative 2 (lowest of the four calculations) to $12.5 billion under Alternative 5 (highest of the four calculations).
- Under the Preferred Alternative, cumulative adverse health outcomes would be fewer and monetized health benefits would be greater than under Alternatives 1 and 2. Cumulative adverse health outcomes would be greater and monetized health benefits would be less under the Preferred Alternative than under Alternatives 4 and 5.

See Tables 4.3.3-1 through 4.3.3-4 in Section 4 of this EIS for cumulative effects data on criteria and hazardous air pollutant emissions. *See* Table 4.3.3-10 in Section 4.3 of this EIS for cumulative effects data on monetized health benefits for the alternatives.

Figure S-8. Nationwide Criteria Pollutant Emissions (tons per year) from HD Vehicles for 2030 by Alternative, Cumulative Impacts

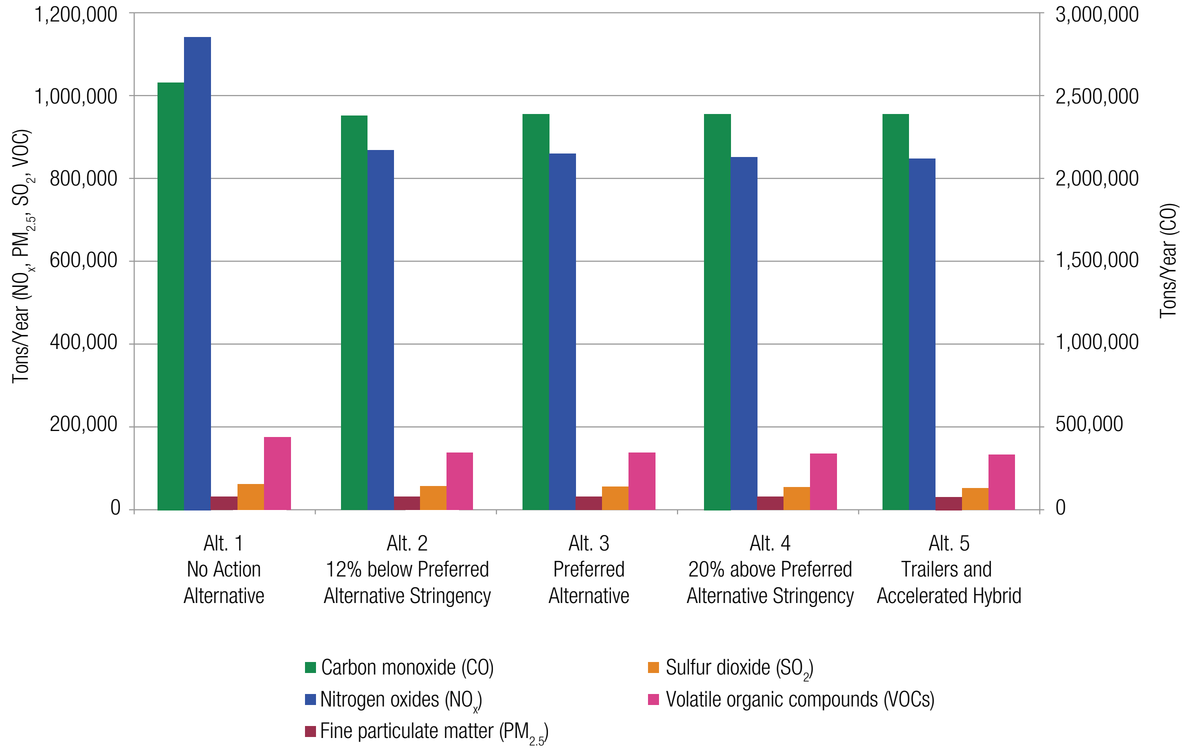
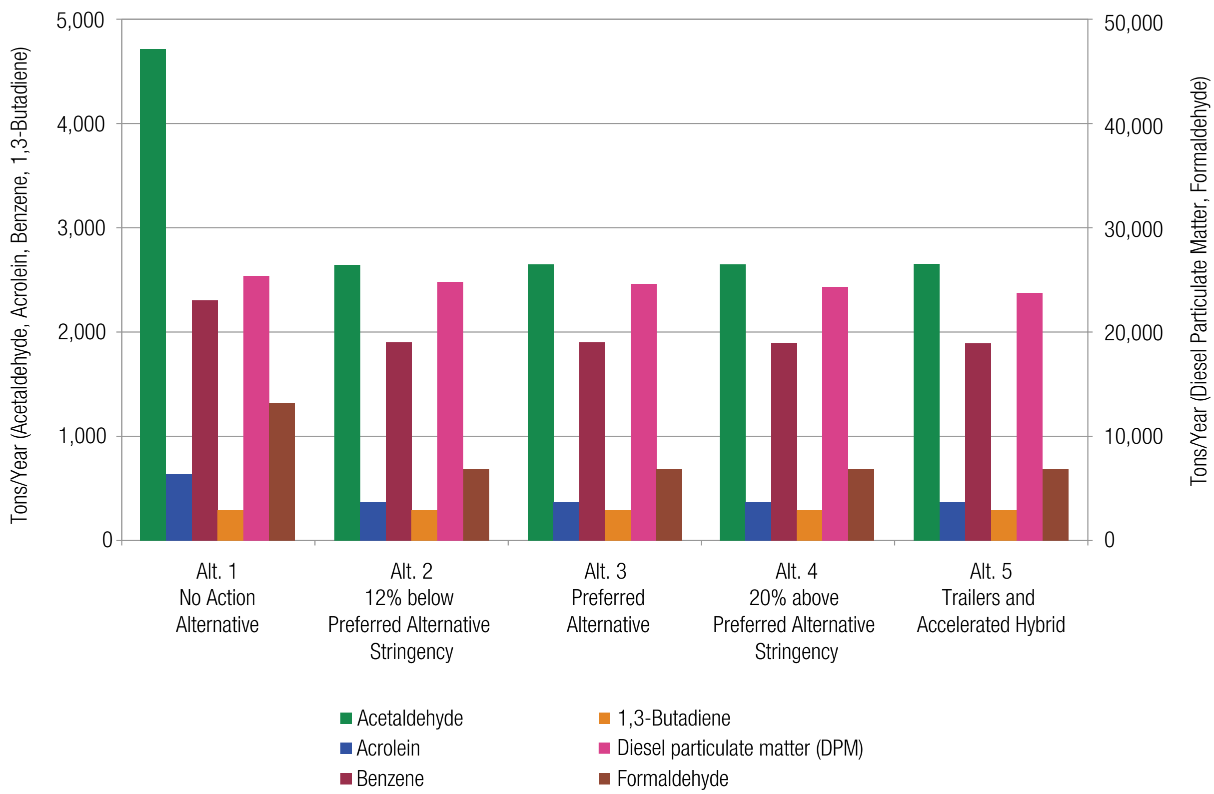


Figure S-9. Nationwide Toxic Pollutant Emissions (tons per year) from HD Vehicles for 2030 by Alternative, Cumulative Impacts



Climate

Earth's natural greenhouse effect makes the planet habitable for life (*see* Figure S-10). CO_2 and other GHGs trap heat in the troposphere (the layer of the atmosphere that extends from Earth's surface up to about 8 miles), absorb heat energy emitted by Earth's surface and its lower atmosphere, and re-radiate much of it back to the surface. Without GHGs in the atmosphere, most of this heat energy would escape back to space.

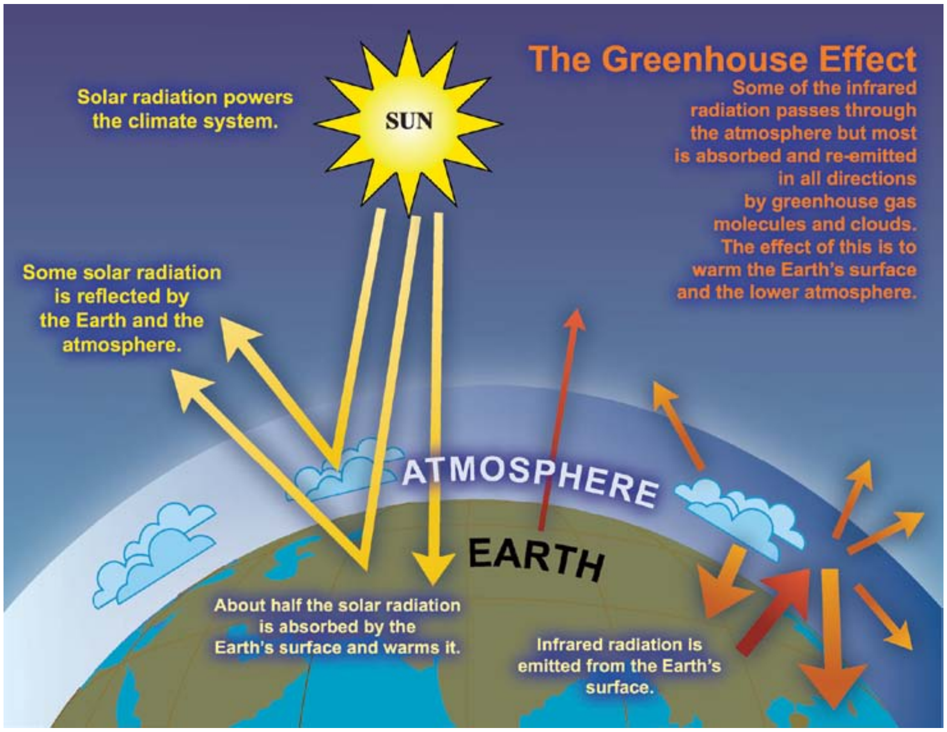
The amount of CO_2 and other natural GHGs in the atmosphere—such as methane (CH_4), nitrous oxide (N_2O), water vapor, and ozone—has fluctuated over time, but natural emissions of GHGs are largely balanced by natural sinks, such as vegetation (which, when buried and compressed over long periods of time, becomes fossil fuel) and the oceans, which remove the gases from the atmosphere.

Since the industrial revolution, when fossil fuels began to be burned in increasing quantities, concentrations of GHGs in the atmosphere have increased. CO_2 has increased by more than 38 percent since pre-industrial times, while methane's concentration is now 149 percent above pre-industrial levels.

This buildup of GHGs in the atmosphere is upsetting Earth's energy balance and causing the planet to warm, which in turn affects sea levels, precipitation patterns, cloud cover, ocean temperatures and currents, and other climatic conditions. Scientists refer to this phenomenon as "global climate change."

During the past century, Earth's surface temperature has risen by an average of about 1.3 degrees Fahrenheit (°F) or 0.74 degrees Celsius (°C), and sea levels have risen 6.7 inches (0.17 meter), with a maximum rate of

Figure S-10. The Greenhouse Effect



Source: IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: The Physical Science Basis. Contribution of working group I to the Fourth Assessment report of the Intergovernmental Panel on Climate Change. [Solomon, S., d. Qin, M. Manning, Z. Chen, M. Marquis, k.B. Averyt, M. Tignor and H.l. Miller (eds.)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 996 pgs.

about 0.08 inch (2 millimeters) per year over the past 50 years on the northeastern coast of the United States.

As stated in a recent NRC report, "There is a strong, credible body of evidence, based on multiple lines of research, documenting that climate is changing, and these changes are in large part caused by human activities" (NRC 2010). These activities—such as the combustion of fossil fuel, the production of agricultural commodities, and the harvesting of trees—contribute to increased concentrations of GHGs in the atmosphere, which in turn trap increasing amounts of heat, altering the earth's energy balance.

Throughout this EIS, NHTSA has relied extensively on findings of the United Nations Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), the National Research Council (NRC), the U.S. Global Change Research Program (GCRP), and EPA. Our discussion focuses heavily on the most recent, thoroughly peer-reviewed, and credible assessments of global and U.S. climate change: the IPCC Fourth Assessment Report (Climate Change 2007), the EPA Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act and the accompanying Technical Support Document (TSD), and CCSP, GCRP, NRC, and National Science and Technology Council reports that include Synthesis and Assessment Products, Global Climate Change Impacts in the United States, America's Climate Choices, and Scientific Assessment of the Effects of Global Change on the United States. This EIS frequently cites these sources and the studies they review.

Impacts of Climate Change

Climate change is expected to have a wide range of effects on temperature, sea level, precipitation patterns, severe weather events, and water resources, which in turn could affect human health and safety, infrastructure, food and water supplies, and natural ecosystems.

- Impacts on freshwater resources could include changes in precipitation patterns; decreasing aquifer recharge in some locations; changes in snowpack and timing of snowmelt; saltwater intrusion from sea-level changes; changes in weather patterns resulting in flooding or drought in certain regions; increased water temperature; and numerous other changes to freshwater systems that disrupt human use and natural aquatic habitats.
- Impacts on terrestrial ecosystems could include shifts in species range and migration patterns, potential extinctions of sensitive species unable to adapt to changing conditions, increases in the occurrence of forest fires and pest infestation, and changes in habitat productivity due to increased atmospheric concentrations of CO_2.
- Impacts on coastal ecosystems could include the loss of coastal areas due to submersion and erosion, additional impacts from severe weather and storm surges, and increased salinization of estuaries and freshwater aquifers.
- Impacts on land use could include flooding and severe-weather impacts on coastal, floodplain, and island settlements; extreme heat and cold waves; increases in drought in some locations; and weather- or sea-level-related disruptions of the service, agricultural, and transportation sectors.
- Impacts on human health could include increased mortality and morbidity due to excessive heat, increases in respiratory conditions due to poor air quality, increases in water and food-borne diseases, changes in the seasonal patterns of vector-borne diseases, and increases in malnutrition.

In addition to its role as a GHG in the atmosphere, CO_2 is transferred from the atmosphere to water, plants, and soil. In water, CO_2 combines with water molecules to form carbonic acid. When CO_2 dissolves in seawater, a series of well-known chemical reactions begins that increases the concentration of hydrogen ions and make seawater more acidic, which has adverse effects on corals and other marine life.

Increased concentrations of CO_2 in the atmosphere can also stimulate plant growth to some degree, a phenomenon known as the CO_2 fertilization effect. The available evidence indicates that different plants respond in different ways to enhanced CO_2 concentrations.

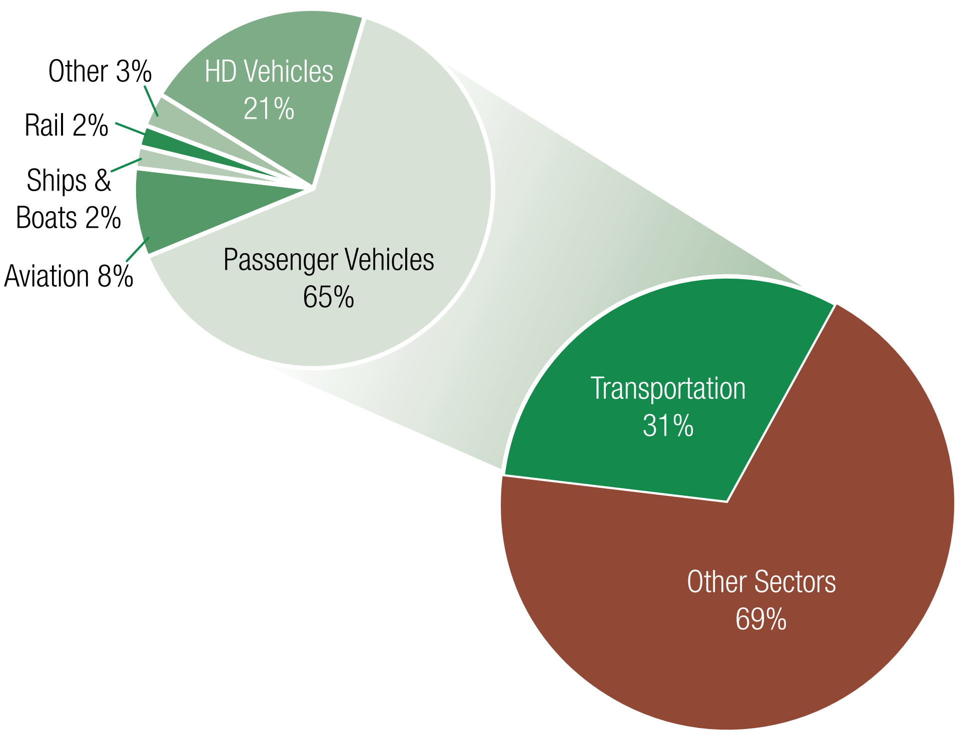
Contribution of U.S. Transportation Sector to Climate Change

Contributions to the buildup of GHGs in the atmosphere vary greatly from country to country and depend heavily on the level of industrial and economic activity. Emissions from the United States account for about 17.4 percent of total global CO_2 emissions. As shown in Figure S-11, the U.S. transportation sector contributed 31.2 percent of total U.S. CO_2 emissions in 2009, with HD vehicles accounting for 21.2 percent of total U.S. CO_2 emissions from transportation. Thus, 6.6 percent of total U.S. CO_2 emissions come from HD vehicles. From a global perspective, HD vehicles in the United States account for roughly 1.1 percent of total global CO_2 emissions, as compared to 4.1 percent for U.S. light-duty vehicles.

Key Findings for Climate

The proposed action and alternatives would decrease the growth in global GHG emissions, resulting in reductions in the anticipated increases that are otherwise projected to occur in CO_2 concentrations, temperature, precipitation, and sea level. They would also, to a small degree, reduce the impacts and risks of climate change.

Figure S-11. U.S. Transportation Sector's Contribution to U.S. CO_2 Emissions in 2009



Source: EPA (U.S. Environmental Protection Agency). 2011. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2009. Tables 2-14 and 2-15. Washington, D.C. EPA 430-R-11-005. 441 pgs. Last revised: April 2011. Available at: <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>. (Accessed: May 20, 2011).

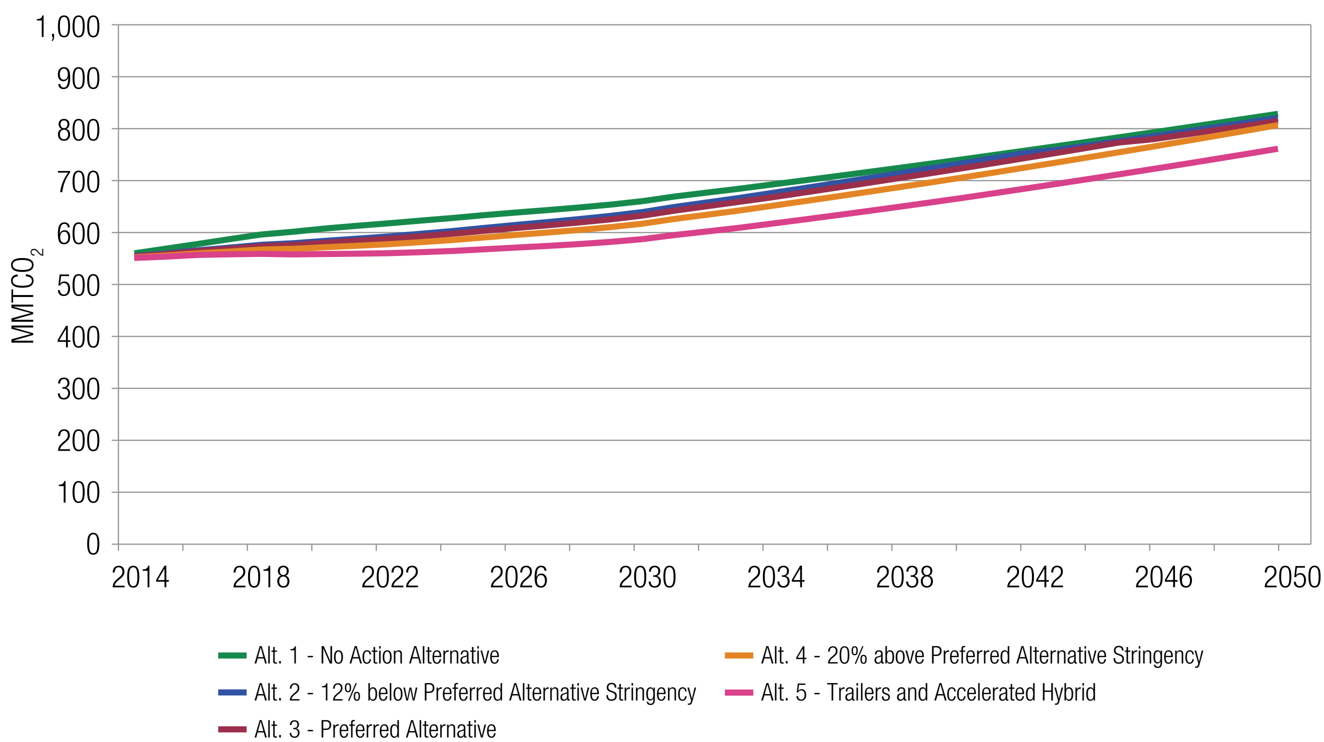
Note that under all alternatives analyzed in this EIS, growth in the number of HD vehicles in use throughout the United States, combined with assumed increases in their average use (annual VMT per vehicle), is projected to result in growth in total HD vehicle travel. This growth in travel outpaces improvements in fuel efficiency for each of the action alternatives, resulting in projected increases in total fuel consumption by HD vehicles in the United States.

Because CO_2 emissions are a direct consequence of fuel consumption, the same result is projected for total CO_2 emissions from HD vehicles. NHTSA estimates that the proposed HD Fuel Efficiency Improvement Program will reduce fuel consumption and CO_2 emissions from what they would be in the absence of the program (*i.e.*, fuel consumption and CO_2 emissions under the No Action Alternative) (*see* Figure S-12).

The global emissions scenario used in the cumulative effects analysis (and described in Chapter 4 of this EIS) differs from the global emissions scenario used for the climate change modeling for direct and indirect effects. In the cumulative effects analysis, the reference case global emissions scenario used in the climate modeling analysis reflects reasonably foreseeable actions in global climate change policy; in contrast, the global emissions scenario used for the analysis of direct and indirect effects assumes that no significant global controls on GHG emissions are adopted. *See* Section 4.4.3.3 of this EIS for additional explanation of the cumulative effects methodology.

Below, estimates of GHG emissions and reductions (both direct and indirect effects and cumulative effects) are summed for the period 2014 through 2100 under each of the five alternatives. Climate effects such as mean global increase in surface temperature and sea level rise are

Figure S-12. Projected Annual CO_2 Emissions (million metric tons) from U.S. HD Vehicles by Alternative, Direct and Indirect Impacts



typically modeled to 2100 or longer due to the amount of time required for the climate system to show the effects of the greenhouse gas emissions (or in this case emission reductions). This inertia primarily reflects the amount of time required for the ocean to warm in response to the increased radiative forcing.

While this analysis shows small differences in climate effects (CO_2 concentration, temperature, sea-level rise, precipitation) when expressed in terms of climate endpoints, *i.e.*, the results at the end of an analysis period, NHTSA believes that this is likely true for any given short-term GHG emission mitigation action when taken alone. A suite of many GHG emission reduction policies in many countries and economic sectors would need to be implemented to mitigate climate change substantially. Thus, a long-term commitment to the HD Fuel Efficiency Improvement Program, in addition to policies in many countries and economic sectors, is necessary to have a significant effect in reducing global fuel consumption and CO_2 emissions.

Direct and Indirect Impacts

Greenhouse Gas Emissions

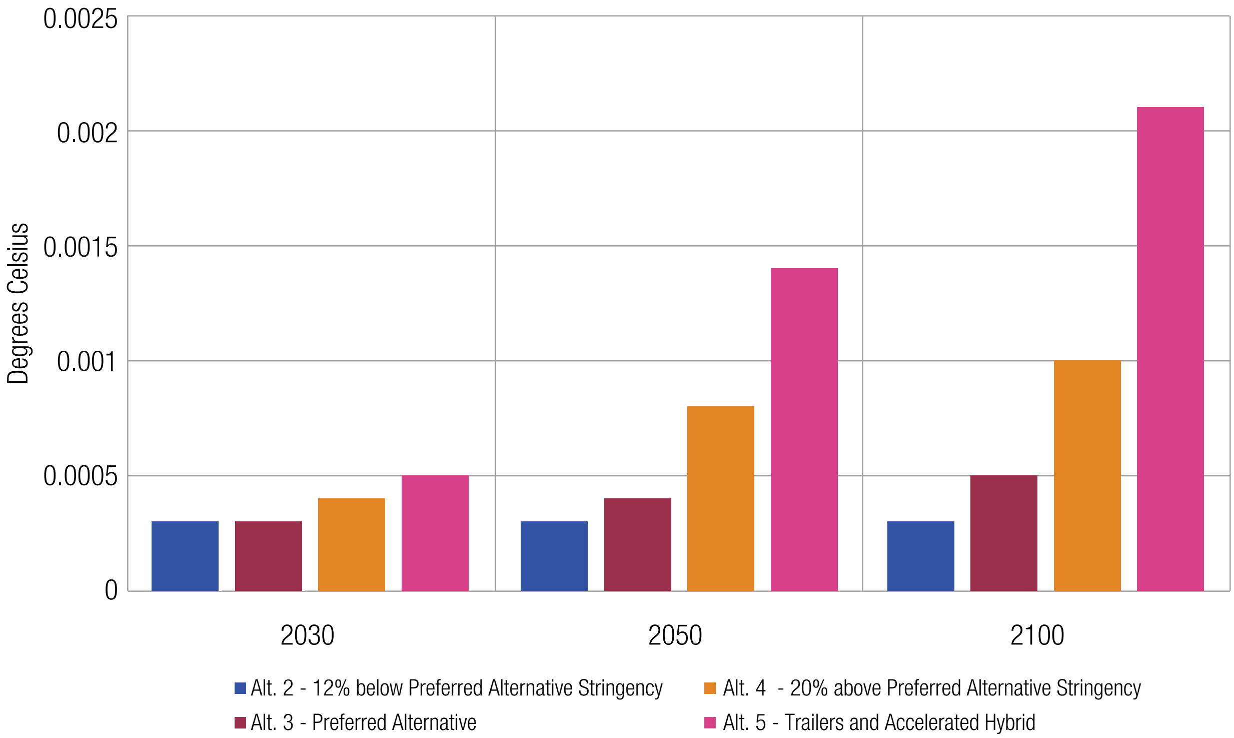
- Compared with total projected U.S. CO_2 emissions in 2100 of 7,193 million metric tons of carbon dioxide equivalent ($MMTCO_2$), the action alternatives would reduce total U.S. CO_2 emissions by 0.1 to 0.8 percent in 2100. Figure S-12 shows projected annual GHG emissions and reductions from HD vehicles by alternative.
- Compared with cumulative global emissions of 5,204,115 $MMTCO_2$ from 2014 through 2100, the action alternatives are expected to reduce global CO_2 emissions by between 0.02 percent (Alternative 2) and 0.11 percent (Alternative 5).
- Average annual CO_2 emission reductions from the alternatives range from 11 to 63 $MMTCO_2$ over 2014–2100, equivalent to the annual CO_2 emissions of 3 to 15 coal-fired power plants.
- The emission reductions from the alternatives are equivalent to the annual emissions of between 0.72 million HD vehicles (Alternative 2) and 1.35 million HD vehicles (Alternative 5) in 2018, compared with the No Action Alternative. Emission reductions in 2018 from the Preferred Alternative are equivalent to the annual emissions of 0.83 million HD vehicles.

CO_2 Concentration, Global Mean Surface Temperature, Sea-Level Rise, and Precipitation

CO_2 emissions affect the concentration of CO_2 in the atmosphere, which in turn affects global temperature, sea level, and precipitation patterns. For the analysis of direct and indirect effects, NHTSA used the GCAMReference scenario to represent the reference case emissions scenario; that is, future global emissions assuming no additional climate policy. The impacts of the proposed action and alternatives on temperature, precipitation, or sea-level rise are small in absolute terms because the action alternatives result in a small proportional change to the emissions trajectories in the Reference Case scenario to which the alternatives were compared. Although these effects are small, they occur on a global scale and are long-lived.

- Estimated CO_2 concentrations in the atmosphere for 2100 range from 784.4 parts per million (ppm) under Alternative 5 to 784.9 ppm under the No Action Alternative.
- For 2100, the reduction in temperature for the action alternatives, as compared to the No Action Alternative, ranges from 0.0005 °F (0.0003 °C) to 0.0037 °F (0.0021 °C). *See* Figure S-13.

Figure S-13. Reduction in Global Mean Temperature (°C) Compared with the No Action Alternative, Direct and Indirect Impacts



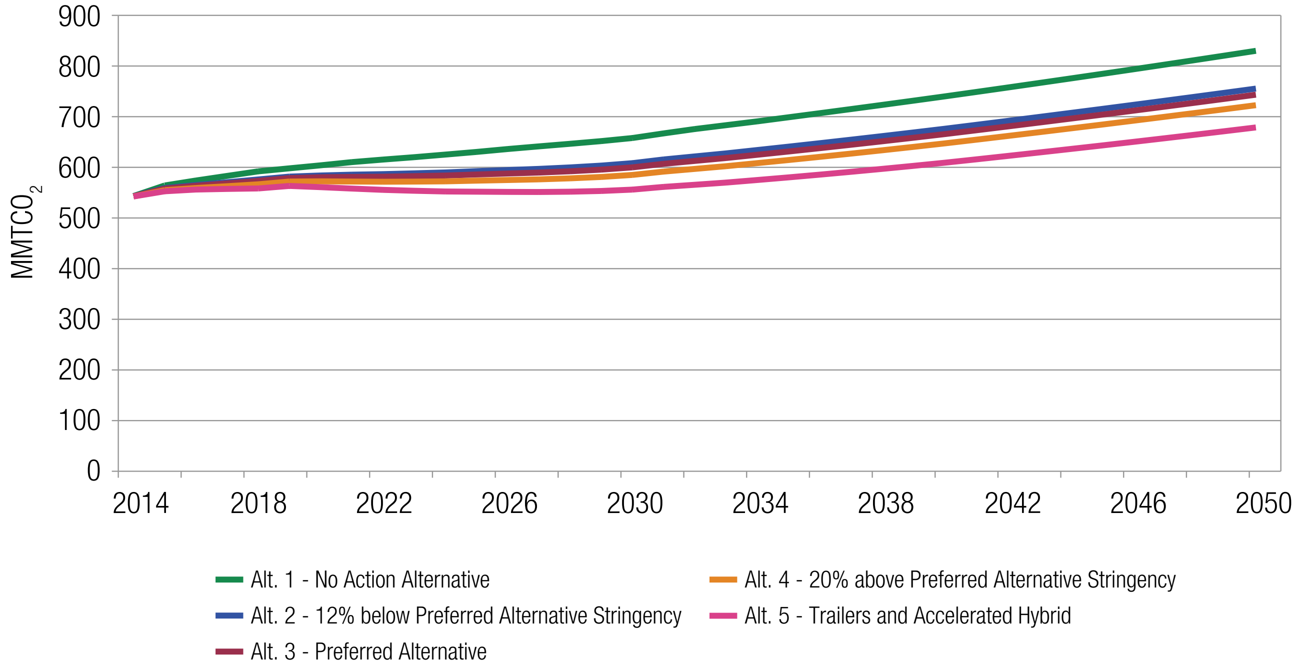
- Projected sea-level rise in 2100 ranges from 14.724 inches (37.40 centimeters) under the No Action Alternative to 14.717 inches (37.38 centimeters) under Alternative 5. Thus, the action alternatives will result in a maximum reduction of sea-level rise equal to 0.008 inch (0.02 centimeter) by 2100 from the level projected under the No Action Alternative.
- For 2090, the reduction in global mean precipitation (percent change) for the action alternatives, as compared to the No Action Alternative, ranges from 0.001 percent to 0.003 percent.

Cumulative Impacts

Greenhouse Gas Emissions

- Projections of total emission reductions over the 2014 through 2100 period due to the HD standards and other reasonably foreseeable future actions (*i.e.*, forecasted fuel efficiency increases resulting from market-driven demand) range from 5,600 to 10,900 $MMTCO_2$. Figure S-14 shows projected annual CO_2 emissions and reductions from U.S. HD vehicles by alternative.
- Compared with projected global emissions of 4,294,482 $MMTCO_2$ from 2014 through 2100, the incremental impact of this rulemaking is expected to reduce global CO_2 emissions by about 0.1 to 0.3 percent from their projected levels under the No Action Alternative.

Figure S-14 Projected Annual CO_2 Emissions (million metric tons) from U.S. HD Vehicles by Alternative, Cumulative Impacts



CO_2 Concentration, Global Mean Surface Temperature, Sea-Level Rise, and Precipitation

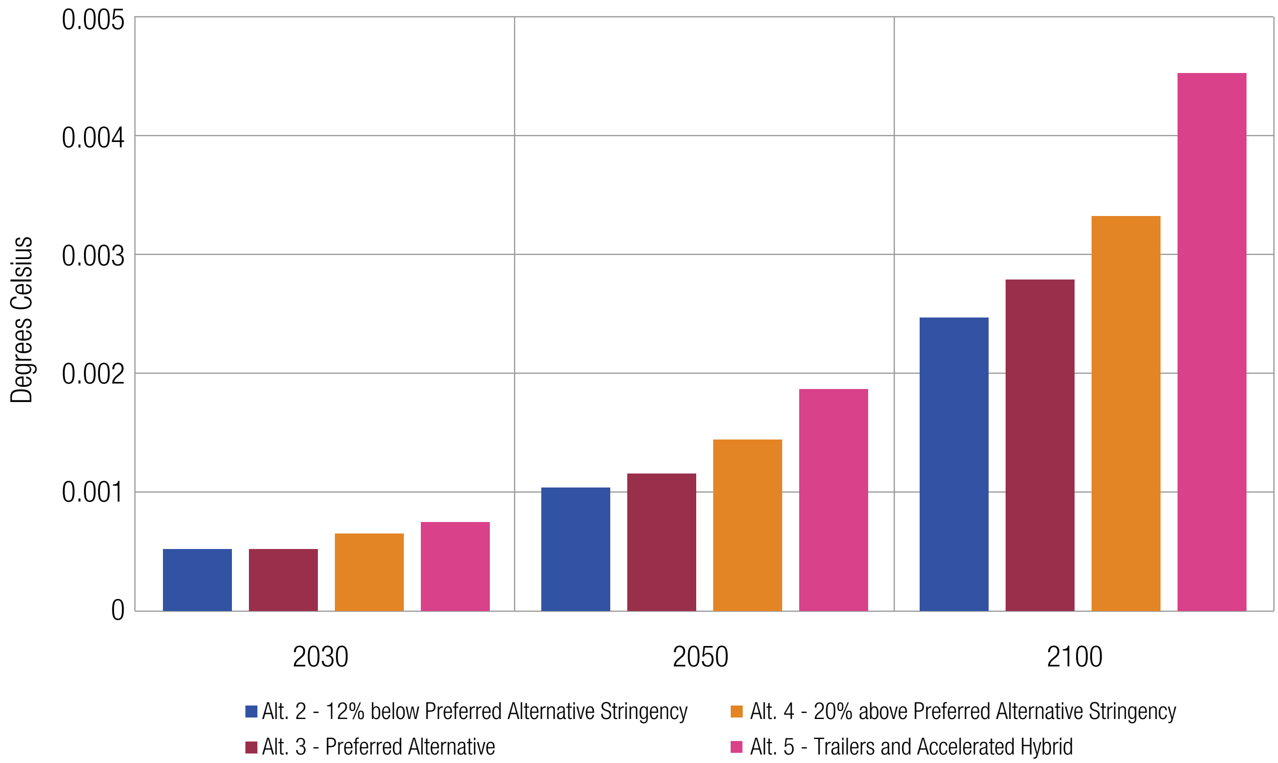
- Estimated CO_2 concentrations in the atmosphere for 2100 range from 676.8 ppm under Alternative 5 to 677.8 ppm under the No Action Alternative.
- For 2100, the reduction in temperature increase for the action alternatives in relation to the No Action Alternative is about 0.004 to 0.007 °F (0.002 to 0.004 °C). *See* Figure S-15.
- Projected sea-level rise in 2100 ranges from 13.16 inches (33.42 centimeters) under the No Action Alternative to 13.14 inches (33.38 centimeters) under Alternative 5. Thus, the action alternatives will result in a maximum reduction of sea-level rise equal to 0.02 inch (0.04 centimeter) by 2100 from the level that could occur under the No Action Alternative.

See Sections 3.5 and 4.4 of this EIS for further details about the direct, indirect, and cumulative climate impacts.

Health, Societal, and Environmental Impacts of Climate Change

The magnitude of the changes in climate effects that would be produced by the most stringent alternative is roughly 1 ppm less of CO_2, less than one hundredth of a degree difference in temperature increase, less than one hundredth of one percent change in the rate of precipitation increase, and less than one millimeter of sea-level rise. These changes are too small to address quantitatively in terms of their impacts on health, society, and the environment. Given the enormous resource values at stake, these distinctions could be important, but they are too small for current quantitative

Figure S-15. Reduction in Global Mean Temperature (°C) Compared with the No Action Alternative, Cumulative Impacts



techniques to resolve. For detailed discussion of the impacts of climate change on various resource sectors, *see* Section 4.5 of this EIS.

The changes in non-climate impacts (such as ocean acidification by CO_2) associated with the alternatives have also been assessed qualitatively. A reduction in the rate of increase in atmospheric CO_2, which all the action alternatives would provide to some extent, would reduce the ocean acidification effect and the CO_2 fertilization effect. For additional discussion of non-climate environmental impacts, *see* Section 4.7 of this EIS.