Chapter 2 Proposed Action and Alternatives

2.1 INTRODUCTION

The National Environmental Policy Act[1] (NEPA) requires an agency to compare the environmental impacts of its proposed action and alternatives. An agency must rigorously explore and objectively evaluate all reasonable alternatives, including a No Action Alternative. For alternatives an agency eliminates from detailed study, the agency must "briefly discuss the reasons for their having been eliminated."[2] The purpose of and need for the agency's action provides the foundation for determining the range of reasonable alternatives to be considered in its NEPA analysis.[3]

In developing the new Corporate Average Fuel Economy (CAFE) standards and possible alternatives, the National Highway Traffic Safety Administration (NHTSA) considered the four Energy Policy and Conservation Act (EPCA) factors that guide the agency's determination of "maximum feasible" standards:

- Technological feasibility
- Economic practicability
- The effect of other standards of the Government on fuel economy
- The need of the Nation to conserve energy[4]

In addition, NHTSA also considered relevant environmental and safety factors. For instance, NHTSA has placed monetary values on environmental externalities, including the benefits of reductions in carbon dioxide (CO_2) emissions. The NEPA analysis presented in NHTSA's Draft Environmental Impact Statement (DEIS) and this Final Environmental Impact Statement (FEIS) is informing the agency's action in setting final CAFE standards. During the standard-setting process, NHTSA consults with the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE) regarding a variety of matters as required by EPCA.

2.2 STANDARDS-SETTING AND BENEFIT-COST ANALYSIS

To inform the balancing of the EPCA factors relevant to standard setting, NHTSA examined various levels of stringencies (mpg levels) to conduct a benefit-cost analysis for each level. A benefit-cost analysis weighs the expected benefits against the expected costs of specific alternatives on a societal basis, relative to a "no action" baseline. Costs of any specific CAFE alternative include the aggregate costs to increase the utilization of fuel-saving technologies, where such costs are expressed on a retail price equivalent basis. The benefits of any specific alternative include fuel savings over the operational life of new vehicles with increased fuel economy and the social benefits of reducing petroleum consumption and environmental externalities.

For each alternative under all scenarios, NHTSA calculated the costs and the benefits. This information replaces the benefit-cost information discussed in the DEIS which relied on the PRIA. The tables are entitled "FEIS Benefit-Cost Information, October 2, 2008," and are shown in Appendix C.

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[1] 42 United States Code (U.S.C.) § 4332(2)(C). NEPA is codified at 42 U.S.C. §§ 4321 *et seq.*
[2] 40 Code of Federal Regulations (CFR) §§ 1502.14(a), (d).
[3] 40 CFR § 1502.13. *Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council*, 435 U.S. 519, 551 (1978); *City of Alexandria v. Slater*, 198 F.3d 862, 867-69 (DC Cir. 1999), cert. denied sub nom. 531 U.S. 820 (2000).
[4] 49 U.S.C. § 32902(f).

NHTSA has a long-standing practice of analyzing regulatory options based on the best available information regarding (1) the future vehicle market, (2) the technologies expected to be available during the relevant model years, and (3) the key economic factors, such as future fuel prices. Among these categories, all information except NHTSA's forecast of the future vehicle market is made available to the public. The forecast of the future vehicle market is based substantially on confidential product planning information manufacturers submit to the agency, as individual manufacturers are better able than any other entity to anticipate what mix of products they are likely to sell in the future.

2.2.1 Volpe Model

Until 2002, when NHTSA began work on CAFE standards for light trucks sold during model years 2005-2007, the agency used tools such as spreadsheets to analyze regulatory options. For that rulemaking and ensuing rulemakings, the agency has supplemented such tools with a modeling system developed specifically to assist NHTSA with applying technologies to thousands of vehicles and developing estimates of the costs and benefits of potential CAFE standards. The CAFE Compliance and Effects Modeling System, developed by DOT's Volpe National Transportation Systems Center and commonly referred to as "the Volpe model," enables the agency to efficiently, systematically, and reproducibly evaluate many more regulatory options, including attribute-based CAFE standards required by EISA, than was previously possible, and to do so much more quickly. The model assumes that manufacturers apply the most cost-effective technologies first, yielding the greatest net benefits. As more stringent fuel economy standards are evaluated, the model recognizes that manufacturers must apply less cost-effective technologies. The model then compares the discounted present value of costs and benefits for any specific CAFE standard.

Model documentation, publicly available in the rulemaking docket, explains how the model is installed, how the model inputs and outputs are structured, and how the model is used. The model can be used on any Windows-based personal computer with Microsoft Office 2003 and the Microsoft .NET framework installed (the latter available without charge from Microsoft). The executable version of the model, with all of its codes and accompanying demonstration files, is available upon request, and has been provided to manufacturers, consulting firms, academic institutions, nongovernmental organizations, research institutes, foreign government officials, and other organizations. The current version of the model was developed using Microsoft Development Environment 2003, and every line of computer code (primarily in C#.NET) has been made available to individuals who have requested the code. Many of these individuals have run the model using market forecast data that they estimated on their own.[5]

The Volpe model requires the following types of input information: (1) a forecast of the future vehicle market, (2) estimates of the availability, applicability, and incremental effectiveness and cost of fuel-saving technologies, (3) estimates of vehicle survival and mileage accumulation patterns, the rebound effect, future fuel prices, the "social cost of carbon," and many other economic factors, (4) fuel characteristics and vehicular emissions rates, and (5) coefficients defining the shape and level of CAFE curves to be examined. The model makes no *a priori* assumptions regarding inputs such as fuel prices and available technology, and does not dictate the form or stringency of the CAFE standards to be examined. The agency makes those selections and, in the case of technology assumptions, has determined that confidential product plans are a vital source of information.

Using inputs selected by the agency based on the best available information and data, NHTSA projects a set of technologies each manufacturer could apply in attempting to comply with the various levels of potential CAFE standards to be examined. The model then estimates the costs associated with

[5] Resources for the Future (RFF) has run the model and is working under contract with EPA to expand its capability.

this additional technology utilization, as well as accompanying changes in travel demand, fuel consumption, fuel outlays, emissions, and economic externalities related to petroleum consumption and other factors.

Recognizing the uncertainty inherent in many of the underlying estimates in the model, NHTSA has used the Volpe model to conduct both sensitivity analyses, by changing one factor at a time, and a probabilistic uncertainty analysis (a Monte Carlo analysis that allows simultaneous variation in these factors) to examine how key measures (*e.g.*, mpg levels of the standard, total costs, and total benefits) vary in response to change in these factors. This type of analysis is used to estimate the uncertainty of the costs and benefits of a given set of CAFE standards.

The model can also be used to fit coefficients defining an attribute-based standard, and to estimate the stringency that either (a) maximizes net benefits to society, (b) achieves a specified stringency at which total costs equal total benefits, (c) imposes a specified average required CAFE level, or (d) results in a specified total incremental cost, *etc*. The agency uses this information from the Volpe model as a tool to assist in setting standards.

Although NHTSA has used the Volpe model as a tool to inform its consideration of potential CAFE standards, the Volpe model, alone, does not determine the CAFE standards NHTSA will propose or promulgate as final regulations. NHTSA considers the results of analyses conducted using the Volpe model and external analyses, including assessments of greenhouse gases and air pollution emissions, and technologies that may be available in the long term. NHTSA also considers whether the standards could expedite the introduction of new technologies into the market, and the extent to which changes in vehicle prices and fuel economy might affect vehicle production and sales. Using all of this information, the agency considers the governing statutory factors, along with environmental issues and other relevant societal issues, such as safety, and promulgates the maximum feasible standards based on its best judgment on how to balance these factors.

2.2.2 Input Scenarios

As noted in the public comments, there is a vast number of model input values that could be used to calculate costs and benefits of the alternatives, including, but not limited to, future fuel prices, the value of carbon dioxide emissions reductions (referred to as the social cost of carbon or SCC), the discount rate, and oil import externalities.[6,7] These model parameters are estimated forecasts of future economic conditions. These estimates are subject to uncertainty and debate, and as several commenters noted, the CAFE standards and resulting environmental impacts could depend on the choice of the economic assumptions utilized by the Volpe model. These commenters urged NHTSA to examine impacts under different input scenarios.

The sensitivity analysis reported in the Preliminary Regulatory Impact Analysis (PRIA) revealed changes in required fuel economy levels due to variations in the value of CO_2, oil import externalities, the rebound effect (the estimated increase in driving due to higher fuel economy standards), and higher fuel prices. In the DEIS, NHTSA addressed these concerns in Section 3.4.4.2, "Sensitivity Analysis."

[6] For further discussion of what constitutes "oil import externalities," *see* page 24410 of the Notice of Proposed Rulemaking, Average Fuel Economy Standards (NHTSA 2008b).

[7] Council on Environmental Quality (CEQ 1981) guidance instructs that "[w]hen there are potentially a very large number of alternatives, only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS" (emphasis in original).

In this FEIS, NHTSA further addresses these concerns by presenting analytical results for the alternatives under four model input scenarios: Reference Case, High Scenario, Mid-1 Scenario, and Mid-2 Scenario. The Reference Case uses the Energy Information Administration's (EIA's) reference case fuel price forecast ($2.41 per gallon) and a domestic SCC. The High Scenario uses the EIA high fuel price forecast ($3.33 per gallon) and a global SCC. The Reference Case value for oil import externalities ($0.326 per gallon) is higher than the High Scenario input value ($0.116 per gallon) due to higher fuel price and SCC values in the High Scenario. *See* Section 10.2.2.10 for a description of the components of the oil externality values. In analyzing the benefits of future CO_2 emissions reductions, the Reference Case, High Scenario, Mid-1 Scenario, and Mid-2 Scenario all employ a 3-percent discount rate. For non-CO_2 impacts, the High Scenario uses a 3-percent discount rate, while the Reference Case and Mid-1 and Mid-2 Scenarios use a 7-percent discount rate. *See* Table 2.3-1 for a list of the different input values used in the scenarios. Sections 3.4 and 4.4 describe in detail the environmental impacts of the Reference Case and High Scenario alternatives, and briefly discuss the impacts of the Mid-1 and Mid-2 Scenarios. Appendix B shows the full analysis results for the Mid-1 and Mid-2 Scenarios.

Table 2.2-1

Economic Model Input Scenarios

	Value of CO_2 (2007$/ton)	Oil Import Externalities (2007$/gallon)	AEO 2008 a/ Fuel Price	Discount Rate
Reference Case	$2.00 (Domestic)	$0.326	$2.41 (Reference)	3% CO_2 – 7% Other
Mid-2 Scenario	$2.00 (Domestic)	$0.382	$3.33 (High)	3% CO_2 – 7% Other
Mid-1 Scenario	$33.00 (Global)	$0.116	$3.33 (High)	3% CO_2 – 7% Other
High Scenario	$33.00 (Global)	$0.116	$3.33 (High)	3% CO_2 – 3% Other

a/ Both the Reference and High *Annual Energy Outlook* fuel price vary by year. Price shown is the average 2011-2030 price for gasoline expressed in 2007 dollars.

The analysis of costs and benefits employed in the Volpe model reflects NHTSA's current assessment of a broad range of technologies that can be applied to passenger cars and light trucks. NHTSA consulted with EPA to develop a list of fuel-saving technologies cost and effectiveness numbers for the NPRM and DEIS. EPA published the results of this collaboration in a report (EPA 2008h). A copy of the report and other studies used in the technology update was placed in the rulemaking docket.

2.2.3 Technology Assumptions

NHTSA specifically sought comment on the estimates, which it had developed jointly with EPA, of the availability, applicability, cost, and effectiveness of fuel-saving technologies, and the order in which the technologies were applied. *See* 73 *FR* 24352, 24367. While NHTSA asked manufacturers to submit such information in the request for product plans, the agency also conducted its own independent analysis of the all the comments and data – including comments and information from entities outside the automobile manufacturing community – received through the rulemaking process. This involved hiring an international engineering consulting firm that specializes in automotive engineering, and that was used by the EPA in developing its recent advance notice of proposed rulemaking to regulate greenhouse gas emissions under the Clean Air Act (CAA).[8]

[8] 73 *FR* 44354 (July 30, 2008).

NHTSA and its consultants undertook a thorough review of the NPRM technology assumptions and all comments received on those assumptions, based on both old and new public and confidential manufacturer information. NHTSA and its consultants reviewed and compared comments on the availability and applicability of technologies, and the logical progression between them. The agency also reviewed and compared the methodologies used for determining the costs and effectiveness of the technologies as well as the specific estimates provided. Relying on the expertise of its consultants and taking into consideration all the information available, NHTSA revised its estimates of the availability and applicability of many technologies, and revised its estimate of the order in which the technologies are applied. In addition, the agency and its consultant generally agreed with commenters who said that in several cases, the technology related costs used in the NPRM and DEIS were underestimated and benefits were overestimated. The agency also agreed with commenters that both sets of estimates were not well differentiated by vehicle class and that the technology decision trees needed to be expanded and refined. NHTSA used the revised technology and effectiveness estimates in analyzing all of the alternatives and scenarios presented in this FEIS. The agency believes that the representation of technologies—that is, estimates of the availability, applicability, cost, and effectiveness of fuel-saving technologies, and the order in which the technologies are applied—used in this action is the best available.

The technologies considered by the model are briefly described below, under the five broad categories of engine, transmission, vehicle, electrification/accessory, and hybrid technologies.

Types of engine technologies that were considered under the benefit-cost analysis include the following:

- *Low-friction lubricants* – reduce fuel consumption, and more advanced engine oils are now available with improved performance and better lubrication.

- *Reduction of engine friction losses* – can be achieved through low-tension piston rings, roller cam followers, improved material coatings, more optimal thermal management, piston surface treatments, and other improvements in the design of engine components and subsystems that improve engine operation and fuel economy, and reduce friction and emissions.

- *Conversion to dual overhead cam with dual cam phasing* – as applied to overhead valves designed to increase the air flow with more than two valves per cylinder and thermal efficiencies by reducing pumping losses.

- *Cylinder deactivation* – does not inject fuel into some cylinders during light-load operation, such as coasting, and when cruise control is activated. Active cylinders combust at almost double the load required if all cylinders are operating, with pumping losses substantially reduced so long as the engine is operated in this mode.

- *Variable valve timing* – alters the timing or phase of the intake valve, exhaust valve, or both, primarily to reduce pumping losses, increase specific power, and control residual gases.

- *Discrete variable valve lift* – reduces fuel consumption by improved air flow and thermal efficiency by pumping loss reduction. Accomplished by hydraulically controlled switching between two or more cam profile lobe heights.

- *Continuous variable valve lift* – is an electromechanically controlled system in which cam period and phasing is changed as lift height is controlled. This yields a wide range of performance optimization and combustion efficiency, including enabling the engine to be valve throttled.

- *Stoichiometric gasoline direct-injection technology* – injects fuel at high pressure directly into the combustion chamber to improve cooling of the air/fuel charge within the cylinder, which allows for higher compression ratios and increased thermodynamic efficiency.

- *Combustion restart* – can be used in conjunction with gasoline direct-injection systems to enable idle-off or start-stop functionality. Similar to other start-stop technologies, additional enablers, such as electric power steering, accessory drive components, and auxiliary oil pump, might be required.

- *Turbocharging and downsizing* – increases the available airflow and specific power level, allowing a reduced engine size while maintaining or improving performance. This reduces pumping losses at lighter loads in comparison to a larger engine, while reducing net friction losses.

- *Exhaust-gas recirculation boost* – increases the exhaust-gas recirculation used in the combustion process to increase thermal efficiency and reduce pumping losses. Might require additional enablers, such as intake manifold pressure monitoring.

- *Diesel engines* – have several characteristics that give superior fuel efficiency, including reduced pumping losses due to lack of (or greatly reduced) throttling, and a combustion cycle that operates at a higher compression ratio, with a very lean air/fuel mixture, than an equivalent-displacement gasoline engine. Might require additional enablers, such as NO_x trap catalyst after-treatment or selective catalytic reduction NO_x after-treatment.

Types of transmission technologies considered under the benefit-cost analysis include:

- *Improved automatic transmission controls and externals* – optimizes shift schedule to maximize fuel efficiency under wide ranging conditions, and minimizes losses associated with torque converter slip through lock-up or modulation.

- *Six-, seven-, and eight-speed automatic transmissions* – influence the width of gear ratio spacing and transmission ratio optimization available under different operating conditions, thereby offering greater engine optimization and higher fuel economy.

- *Dual clutch or automated shift manual transmissions* – are similar to conventional transmissions, but the vehicle controls shifting and launch functions. A dual-clutch automated shift manual transmission uses separate clutches for even-numbered and odd-numbered gears, so the next expected gear is pre-selected, which allows for faster and smoother shifting.

- *Continuously variable transmission* – commonly uses V-shaped pulleys connected by a metal belt rather than gears to provide ratios for operation. Unlike manual and automatic transmissions with fixed transmission ratios, continuously variable transmissions can provide fully variable transmission ratios with an infinite number of gears, enabling finer optimization of the transmission ratio under different operating conditions so that the powertrain can operate at its optimum efficiency.

- *Manual 6-speed transmission* – like automatic transmissions, increases the number of available ratios in a manual transmission to improve fuel economy by allowing the driver to select a ratio that optimizes engine operation at a given speed.

Types of vehicle technologies considered under the benefit-cost analysis include:

- *Low-rolling-resistance tires* – have characteristics that reduce frictional losses associated with the energy dissipated in the deformation of the tires under load, therefore improving fuel economy.

- *Low-drag brakes* – reduce the sliding friction of disc brake pads on rotors when the brakes are not engaged because the brake shoes are pulled away from the rotating drum.

- *Front or secondary axle disconnect for four-wheel drive systems* – provides a torque distribution disconnect between front and rear axles when torque is not required to the non-driving axle. This results in the reduction of associated parasitic energy losses, therefore improving fuel economy.

- *Aerodynamic drag reduction* – is achieved by changing vehicle shape or frontal area, including skirts, air dams, underbody covers, and more aerodynamic side view mirrors.

- *Material substitution* – encompasses a variety of techniques that include application of lighter-weight materials, higher-strength materials, component redesign, and size matching of components.

Types of electrification/accessory technologies considered under the benefit-cost analysis include:

- *Electric power steering* – is an electrically-powered, decoupled steering system that has advantages over traditional hydraulic power steering because it draws power only when required by the operator to steer the vehicle, which is only a small percentage of vehicle operating time.

- *Improved accessories* – the technology associated with an intelligent cooling system. This ignores other electrical accessories (electrical lubrication and electrical air conditioning), which might be present in full hybrid applications.

- *Higher-voltage, Improved alternator* – provides a mechanical-to-electrical power conversion for the numerous electrical load requirements of a vehicle. Traditionally, alternators are optimized for cost. Increased conversion efficiency alternators cost more, but result in less fuel required to power the electrical loads, thus improving vehicle fuel economy.

- *12-volt micro-hybrid* – commonly implemented as a 12-volt belt-driven integrated starter-generator, this is the most basic hybrid system that facilitates idle-stop capability. Along with other enablers, this system replaces a common alternator with an enhanced power starter-alternator, both belt driven, and a unique accessory drive system.

- *Integrated starter generator* – is similar to the 12-volt micro-hybrid in function and design, except that it uses a 110- to 144-volt battery that contains greater battery capacity and maintains a smaller electric machine than other hybrid electric vehicle designs. Along with other enablers, this system replaces a common alternator with an enhanced power starter-alternator, either accessory belt driven or crank mounted, with a generator for recovering energy while slowing down.

Types of hybrid technologies considered under the benefit-cost analysis include:

- *2-mode hybrid* – is a full hybrid system that uses an adaptation of a conventional stepped-ratio automatic transmission by replacing some of the transmission clutches with two electric motors that control the ratio of engine speed to vehicle speed, while clutches allow the motors to be bypassed, which improves both the transmission torque capacity for heavy-duty applications and fuel economy at highway speeds.

- *Power-split hybrids* – is a full hybrid system that replaces the vehicle's transmission with a single planetary gear and a motor/generator. This motor/generator uses its engine torque to either charge the battery or supply additional power to the drive motor. A second, more powerful motor/generator, is permanently connected to the vehicle's final drive and always turns with the wheels. The planetary gear splits the engine's torque between the first motor/generator and the drive motor to either charge the battery or supply power to the wheels.

- *Plug-in hybrid electric vehicles* – are vehicles with the means to charge the battery packs from an outside source of electricity (usually the electric grid). These vehicles have larger battery packs with more energy storage and a greater capability to be discharged and have a control system that allows the battery pack to be substantially depleted under electric-only operation.

2.2.4 FEIS Analytical Improvements

A number of changes occurred from the NPRM and DEIS that provide analytical improvements in this FEIS. These changes explain why the CAFE levels, fuel savings, and CO_2 emissions that are attributable to each alternative and scenario in this FEIS differ from those presented in the NPRM and DEIS.

As discussed in the NPRM and the DEIS, the agency requested new product plans from manufacturers for analyzing alternative standards for the final rule. The product plans submitted in May 2007 did not take into consideration the passage of EISA and the minimum 35 mpg combined fleet requirement by 2020. In addition, during that time, the fuel prices rose substantially. The new product plans reflect those new realities in the following ways:

- Companies provided product plans that implemented some of the cost effective technologies that the agency had projected in the NPRM. This increased the baseline against which the fuel saving from the standards is measured. Some of the savings and CO_2 emission reductions attributed in the NPRM to the rulemaking action must now be attributed to improved product plans.

- The size of the overall fleet has declined from the time of the NPRM to the final rule resulting in less vehicle miles traveled.

In the NPRM, the two-wheel drive vehicles were classified in the same way they were classified by their manufacturers in their May 2007 product plans. For the purposes of this analysis and the final rule, however, they were reclassified in accordance with the discussion in the NPRM of the proper classification of those vehicles. This resulted in the shifting of slightly over one million two-wheel drive vehicles from the truck fleet to the car fleet, which lowers average car mpg due to the inclusion of vehicles previously categorized as trucks, and lowers truck mpg because the truck category now has a larger proportion of heavier trucks. Following our careful consideration of the public comments on that discussion, we reaffirm the reasoning and conclusions of that discussion.

As discussed in Section 2.2.3, NHTSA also revised the technology assumptions proposed in the NPRM based on comments and new information received during the comment period and used those assumptions for analyzing alternatives and scenarios for the FEIS and final rule. In several cases, the costs in the NPRM and DEIS were underestimated and benefits overestimated, and in most cases, these estimates were not well differentiated by vehicle class. The agency also revised its phase-in schedule of the technologies to account for lead time.

The agency, working with other agencies of the U.S. government, also updated its estimates of the domestic and global values of the SCC as well as estimates for other externalities based on comments and updated information received during the comment period. Specifically, this FEIS uses a domestic SCC of $2, which is lower than the DEIS/NPRM SCC of $7.00, but a higher global SCC at $33 as compared to $14 used in the NPRM and DEIS. These are discussed in greater detail in Chapter 10 Responses to Public Comments.

2.3 ALTERNATIVES

EPCA, as amended by EISA, requires attribute-based fuel economy standards for passenger cars and light trucks. NHTSA first employed this Reformed CAFE approach in establishing standards for MY 2008-2011 light trucks.[9] In May 2008, NHTSA proposed separate standards for MY 2011-2015 passenger cars and light trucks, again using this approach.[10] The alterations reflect the agency's best assessment based on the comments received and analyzed. Under the standards, fuel economy targets are established for vehicles of different sizes. Each manufacturer's required level of CAFE is based on its distribution of vehicles among those sizes and the fuel economy target required for each size. Size is defined by vehicle footprint.[11] The fuel economy target for each footprint reflects the technological and economic capabilities of the industry. These targets are the same for all manufacturers, regardless of the differences in their overall fleet mix. Compliance is determined by comparing a manufacturer's harmonically averaged fleet fuel economy levels in a model year with an average required fuel economy level calculated using the manufacturer's actual production levels and the targets for each footprint of the vehicles that it produces.

A large number of alternatives can be defined along a continuum from the least to the most stringent levels of CAFE. The specific alternatives NHTSA examined, described below, were selected to illustrate estimated costs and benefits. The fuel economy levels associated with the alternatives encompass a reasonable range to evaluate the potential environmental impacts of the CAFE standards and alternatives under NEPA, in view of EPCA requirements.

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[9] *See* Average Fuel Economy Standards for Light Trucks, Model Years 2008-2011, 71 *FR* 17566, 17587-17625, April 6, 2006 (describing that approach).

[10] The proposed standards include light truck standards for one model year (MY 2011) that were previously covered by a 2006 final rule, Average Fuel Economy Standards for Light Trucks, Model Years 2008-2011, 71 *FR* 17566, April 6, 2006.

[11] A vehicle's footprint is generally defined as "the product of track width [the lateral distance between the centerlines of the base tires at ground, including the camber angle] … times wheelbase [the longitudinal distance between front and rear wheel centerlines] … divided by 144 …." 49 CFR § 523.2.

At one end of this range is the No Action Alternative (Alternative 1), which assumes that NHTSA would not issue a rule regarding CAFE standards. The No Action Alternative also assumes that average fuel economy levels in the absence of CAFE standards beyond 2010 would equal the higher of a manufacturer's product plans or the manufacturer's required level of average fuel economy for MY 2010. Costs and benefits of other alternatives are calculated relative to the baseline of the No Action Alternative. The No Action Alternative, by definition, would yield no incremental costs or benefits (and it would not satisfy the EPCA requirement to set standards such that the combined fleet achieves a combined average fuel economy of at least 35 mpg for MY 2020).

At the other end of the range of possible alternatives is the Technology Exhaustion Alternative (Alternative 7). This alternative would require every manufacturer to apply the maximum technology expected to be available over the period necessary to meet the statutory goals of EPCA, as amended by the EISA, without consideration of the accompanying costs. By definition, this alternative would apply all known technologies by make and model in the manufacturers' product plans while recognizing constraints associated with vehicle manufacturing and design cycles. It produces a CAFE standard that requires the use of technologies where costs exceed benefits. (*See* the NPRM for additional details on how the agency arrives at a CAFE standard, after application of the Volpe model).

NHTSA has examined five alternatives that fall between the extremes of the No Action Alternative and the Technology Exhaustion Alternative as defined below. Table 2.3-1 shows the estimated fuel economy levels for each alternative under the Reference Case.

Table 2.3-1

Reference Case Alternative CAFE Standards
MY 2015 Required MPG

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Passenger Cars	27.5	33.3	33.4	33.5	33.7	33.9	47.1
Light Trucks	23.4	25.8	26.0	26.2	26.5	27.0	37.2

Analyzing the environmental impacts of these alternatives provides information on the full spectrum of CAFE choices reasonably available to the decisionmaker. Although NEPA requires – and this FEIS analyzes – a full spectrum of alternatives, EPCA contains additional requirements and factors that NHTSA must apply in setting "maximum feasible" CAFE standards: (1) technological feasibility, (2) economic practicability, (3) the effect of other motor vehicle standards of the government on fuel economy, and (4) the need of the Nation to conserve energy.

Table 2.2-1 shows model input values for the SCC, the value of oil import externalities, fuel prices, and the discount rate for the Reference Case, High Scenario, and two intermediate scenarios – Mid-1 and Mid-2. Tables 2.3-2 and 2.3-3 show how the specific mpg standards associated with each of the seven alternatives vary across the Reference Case and the three Input Scenarios for cars and for light trucks, respectively. Table 2.3-4 shows the combined fuel economy standards for cars and light trucks for the seven alternatives for the Reference Case and the three Input Scenarios. These are the combined average fuel economy levels that would occur if each manufacturer exactly met its obligations under these standards.[12]

Table 2.3-2

MY 2015 Required MPG for Passenger Cars by Alternative and Model Input Scenario

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Input Scenario	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Reference Case	27.5	33.3	33.4	33.5	33.7	33.9	47.1
Mid-2 Scenario	27.5	36.7	37.1	37.5	37.9	38.7	47.1
Mid-1 Scenario	27.5	36.7	37.2	37.8	38.3	39.3	47.1
High Scenario	27.5	37.2	37.7	38.2	38.8	39.8	47.1

Table 2.3-3

MY 2015 Required MPG for Light Trucks by Alternative and Model Input Scenario

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Input Scenario	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Reference Case	23.4	25.8	26.0	26.2	26.5	27.0	37.2
Mid-2 Scenario	23.4	26.2	27.1	27.9	28.8	30.6	37.2
Mid-1 Scenario	23.4	29.3	29.6	29.9	30.2	30.8	37.2
High Scenario	23.4	28.9	29.6	30.3	31.0	32.3	37.2

Table 2.3-4

MY 2015 Required MPG for Passenger Cars and Light Trucks by Alternative and Model Input Scenario

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Input Scenario	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Reference Case	25.5	29.4	29.6	29.8	30.0	30.4	42.0
Mid-2 Scenario	25.5	31.1	31.8	32.5	33.2	34.6	42.0
Mid-1 Scenario	25.5	32.9	33.3	33.8	34.2	35.0	42.0
High Scenario	25.5	32.9	33.6	34.2	34.8	36.0	42.0

Tables 2.3-2 through 2.3-4 show that the estimated fuel economies under the No Action and Technology Exhaustion Alternatives are the same for the Reference Case and the three Input Scenarios. Therefore, environmental impacts for the Reference Case and the three Input Scenarios fall between the impacts of the No Action Alternative and the Technology Exhaustion Alternative.

[12] NHTSA notes that the precise level of CAFE that each manufacturer will be required to meet will be determined after the manufacturers submit final production and fleet mix figures at the end of each model year in question.

2.3.1 Preferred Alternative

The agency's Preferred Alternative is the Optimized Alternative, the level at which marginal costs equal marginal benefits. For any set of economic assumption model inputs, the Optimized Alternative yields the greatest net benefits. As fuel economy standards are increased beyond this level, manufacturers would need to apply technologies that entail higher incremental costs than benefits, thereby reducing net benefits. This alternative is described in more detail in Section 2.3.4. Table 2.2-1 lists the inputs (social cost of carbon, oil import externalities, fuel price, and discount rate) for the Reference Case and the Mid-1, Mid-2, and High Scenarios. The required fuel economy levels (combined for cars and light trucks) for the Optimized Alternative can be found in Table 2.3-4.

2.3.2 Alternative 1: No Action

The No Action Alternative assumes that NHTSA would not issue a rule regarding CAFE standards. The No Action Alternative assumes that average fuel economy levels in the absence of CAFE standards beyond 2010 would equal the higher of a manufacturer's product plans or the manufacturer's required level of average fuel economy for MY 2010. The MY 2011 fuel economy in mpg (27.5 mpg and 23.3 mpg for passenger cars and light trucks, respectively) represents the standard the agency believes manufacturers would continue to achieve, assuming that the agency does not issue a rule.[13] The No Action Alternative will yield different levels of impacts under the Reference Case and the Input Scenarios, as the Input Scenarios include the high values for fuel price. Relatively higher fuel prices serve to dampen future VMT growth and result in less fuel consumption and greenhouse gases. The air quality emissions analysis would also be different because it relies on VMT estimates and the amount of fuel produced.

NEPA requires agencies to consider a No Action Alternative in their NEPA analyses (*see* 40 CFR § 1502.14(b)), although the recent amendments to EPCA direct NHTSA to set new CAFE standards and do not permit the agency to take no action on fuel economy. In the NPRM, NHTSA refers to the No Action Alternative as the no increase or baseline alternative.

2.3.3 Alternative 2: 25 Percent Below Optimized

This alternative reflects standards that are more stringent than the No Action Alternative but less stringent than the Optimized Alternative (Alternative 3). Alternative 2 is less stringent than the Optimized Alternative by 25 percent of the difference in fuel economy between the Optimized Alternative and Alternative 6 (Total Costs Equal Total Benefits). This alternative falls below the Optimized Alternative by the same absolute amount by which the 25 Percent Above Optimized Alternative exceeds the Optimized Alternative.

As shown for passenger cars, the average required fuel economy in mpg for the industry in MY 2015 would range from 33.3 mpg for the Reference Case to 37.2 for the High Scenario. For light trucks, the average required fuel economy in mpg for the industry in MY 2015 would range from 25.8 mpg for the Reference Case to 28.9 for the High Scenario. The combined industry-wide average fuel economy for all passenger cars and light trucks would range from 29.4 mpg for the Reference Case to 32.9 for the High Scenario.

[13] *See* 40 CFR §§ 1502.2(e) and 1502.14(d).

2.3.4 Alternative 3: Optimized

The Optimized Alternative, which applies technologies until marginal benefits equal marginal costs and net benefits are maximized, is NHTSA's Preferred Alternative. For any set of economic assumption model inputs, the Optimized Alternative yields the greatest net benefits. As fuel economy standards are increased beyond this level, manufacturers would need to apply technologies that entail higher incremental costs than benefits, thereby reducing net benefits.

As shown for passenger cars, the average required fuel economy for the industry in MY 2015 would range from 33.4 mpg for the Reference Case to 37.7 for the High Scenario. For light trucks, the average required fuel economy for the industry in MY 2015 would range from 26.0 mpg for the Reference Case to 29.6 for the High Scenario. In MY 2015, the combined industry-wide average fuel economy for all passenger cars and light trucks would range from 29.6 mpg for the Reference Case to 33.6 for the High Scenario.

2.3.5 Alternative 4: 25 Percent Above Optimized

This alternative reflects standards that increase the fuel economy levels of the Optimized Alternative by 25 percent of the difference between the Optimized and the Total Costs Equal Total Benefits Alternative fuel economy levels.

As shown for passenger cars, the average required fuel economy in mpg for the industry in MY 2015 would range from 33.5 mpg for the Reference Case to 38.2 for the High Scenario. For light trucks, the average required fuel economy for the industry in MY 2015 would range from 26.2 mpg for the Reference Case to 30.3 for the High Scenario. In MY 2015, the combined industry-wide average fuel economy for all passenger cars and light trucks would range from 29.8 mpg for the Reference Case to 34.2 for the High Scenario.

2.3.6 Alternative 5: 50 Percent Above Optimized

This alternative reflects standards that increase the fuel economy levels to the Optimized Alternative level by 50 percent of the difference between the Optimized and the Total Costs Equal Total Benefits Alternative fuel economy levels.

As shown for passenger cars, the average required fuel economy for the industry in MY 2015 would range from 33.7 mpg for the Reference Case to 38.8 for the High Scenario. For light trucks, the average required fuel economy or the industry in MY 2015 would range from 26.5 mpg for the Reference Case to 31.0 for the High Scenario. In MY 2015, the combined industry-wide average fuel economy for all passenger cars and light trucks would range from 30.0 mpg for the Reference Case to 34.8 for the High Scenario.

2.3.7 Alternative 6: Total Costs Equal Total Benefits

This alternative reflects standards based on applying technologies until total costs equal total benefits. It results in zero net benefits because the benefits to society are completely offset by the costs. This is known as the Total Costs Equal Total Benefits Alternative.

As shown for passenger cars, the average required fuel economy for the industry in MY 2015 would range from 33.9 mpg for the Reference Case to 39.8 for the High Scenario. For light trucks, the average required fuel economy for the industry in MY 2015 would range from 27.0 mpg for the Reference Case to 32.3 for the High Scenario. In MY 2015, the combined industry-wide average fuel economy for all passenger cars and light trucks would range from 30.4 mpg for the Reference Case to 36.0 for the High Scenario.

2.3.8 Alternative 7: Technology Exhaustion

NHTSA developed the Technology Exhaustion Alternative by progressively increasing the stringency of the standard in each model year until every manufacturer (among those without a history of paying civil penalties) exhausted technologies estimated to be available during MY 2011-2015. Except for phase-in constraints, this analysis was performed using the same technology-related estimates (*e.g.*, incremental costs, incremental fuel savings, availability, applicability, and dependency on vehicle freshening and redesign) as used for other alternatives, such as those that maximize net benefits and those that produce total benefits approximately equal to total costs. For the Technology Exhaustion Alternative, NHTSA removed phase-in constraints in order to develop an estimate of the effects of fuel economy increases that might be achieved if manufacturers could apply as much technology as theoretically possible, while recognizing that some technologies must still be installed as part of a vehicle freshening or redesign.

In each year, NHTSA increased the stringency until the first manufacturer exhausted available technologies; beyond this stringency, NHTSA estimated that the manufacturer would be unable to comply (NHTSA is precluded from considering manufacturers' ability to use CAFE credits) and would be forced to pay civil penalties. NHTSA then increased the stringency until the next manufacturer was unable to comply, and continued to increase the stringency of the standard until every manufacturer was unable to apply enough technology to comply.

For passenger cars, the average required fuel economy for the industry would be 47.1 mpg in MY 2015 and 37.2 mpg for light trucks in MY 2015. The combined industry-wide average fuel economy for all passenger cars and light trucks would be 42.0 mpg in MY 2015.

2.4 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

As a result of the scoping and DEIS comment process, several suggestions were made to NHTSA regarding alternatives that should be included in this DEIS and examined in detail. NHTSA considered these alternatives and discusses them below along with the reasons why we believe these referenced alternatives do not warrant further analysis in this FEIS.

- **Downweighting Vehicles.** NHTSA was requested by commenters to consider as an alternative in the FEIS the potential for increased fuel economy by replacing heavy materials in passenger cars with lighter materials; a practice known as downweighting. As discussed in Chapter 1 and the NPRM, NHTSA's analysis does include the potential to improve fuel economy through greater utilization of lightweight materials on heavier vehicles, for which doing so would be unlikely to compromise highway safety. This request relates to specific technology choices (which CAFE standards do not require) rather than regulatory alternatives. Consequently, this comment does not warrant analysis of an additional alternative within the FEIS.

- **Least Capable Manufacturer Approach.** NHTSA's earlier Unreformed CAFE standards specified a "one size fits all" (uniform) level of CAFE that applied to each manufacturer and that was set with particular regard to the lowest projected level of CAFE among the manufacturers that have a substantial share of the market. The major manufacturer with the lowest projected CAFE level is typically known as the "least capable" manufacturer. However, NHTSA's 2006 CAFE standards for light trucks adopted a different Reformed

CAFE approach (71 *FR* 17566, April 6, 2006). EISA recently codified that approach, requiring that all CAFE standards be based on one or more vehicle attributes (49 U.S.C. § 32902(b)(3)(A); 73 *FR* 24352, 24354-24355, May 2, 2008) (discussing NHTSA's proposal to base CAFE standards on the attribute of vehicle size, as defined by vehicle footprint).

As NHTSA explained when proposing Reformed CAFE standards for MY 2008-2011 light trucks, "[u]nder Reformed CAFE, it is unnecessary to set standards with particular regard to the capabilities of a single manufacturer in order to ensure that the standards are technologically feasible and economically practicable for all manufacturers with a substantial share of the market. This is true both fleet-wide and within any individual category of vehicles" (70 *FR* 51414, 51432, August 30, 2005). Specifically:

> There is no need under Reformed CAFE to set the standards with particular regard to the capabilities of the "least capable" manufacturer. Indeed, it would often be difficult to identify which manufacturer should be deemed the "least capable" manufacturer under Reformed CAFE. The "least capable" manufacturer approach was simply a way of implementing the guidance in the conference report (part of EPCA's legislative history)[14] in the specific context of Unreformed CAFE….
>
> …The very structure of Reformed CAFE standards makes it unnecessary to continue to use that particular approach in order to be responsive to guidance in the conference report. Instead of specifying a common level of CAFE, a Reformed CAFE standard specifies a variable level of CAFE that changes based on the production mix of each manufacturer. By basing the level required for an individual manufacturer on that manufacturer's own mix, a Reformed CAFE standard in effect recognizes and accommodates differences in production mix between full- and part-line manufacturers, and between manufacturers that concentrate on small vehicles and those that concentrate on large ones.
>
> There is an additional reason for ceasing to use the "least capable" manufacturer approach. There would be relatively limited added fuel savings under Reformed CAFE if we continued to use the "least capable" manufacturer approach even though there ceased to be a need to use it…." (70 *FR* 51433, August 30, 2005).

In addition, the commenter's suggested approach would not result in the increases in fuel economy mandated by EISA – namely, 35 mpg by MY 2020. In light of the fact that Congress recently codified the Reformed CAFE approach for both passenger cars and light trucks, and for all of the reasons stated above, NHTSA declines to consider in detail an alternative tied to the historic "least capable manufacturer" approach as the commenter suggested.

2.5 COMPARISON OF ALTERNATIVES

The CEQ NEPA regulations (40 CFR Part 1500.2(e)) direct federal agencies to use the NEPA process to identify and assess the reasonable alternatives to proposed actions that would avoid or minimize adverse effects of these actions upon the quality of the human environment. CEQ regulations (40 CFR 1502.14) state:

[14] *See* 70 *FR* 51414, 51425-51426, August 30, 2005 (discussing the conference report).

> Based on the information and analysis presented in the sections on the Affected Environment (Sec. 1502.15) and the Environmental Consequences (Sec. 1502.16), it [an EIS] should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public.

This section summarizes the direct, indirect, and cumulative effects of the CAFE alternatives on energy, air quality, and climate. No quantifiable, alternative-specific effects were identified for the other resources discussed in Chapters 3 and 4. Refer to the text in Chapter 4 for qualitative discussions of the potential direct and indirect effects of the alternatives on these other resources. Reductions in fuel consumption are demonstrated for all the alternatives in Section 3.2 and 4.2. Emissions of criteria pollutants and mobile source air toxics generally show reductions although carbon monoxide emissions increase slightly under some of the alternatives. *See* Section 3.3 and 4.3. Although the alternatives have the potential to substantially decrease GHG emissions, they do not prevent climate change from occurring, but only result in reductions of less than 1 percent in the anticipated increases in CO_2 concentrations, temperature, precipitation, and sea level. As discussed below, NHTSA's presumption is that these reductions in climate effects will be reflected in reduced impacts on affected resources. The resources addressed in Chapter 4 of the FEIS include freshwater resources, terrestrial ecosystems, coastal ecosystems, land use, and human heath. However, the magnitudes of the changes in these climate effects that the alternatives produce – a few parts per million (ppm) of CO_2, one-hundredth of a degree Celsius (°C) difference in temperature, a small percentage change in the rate of precipitation increase, and 1 or 2 millimeters (mm) of sea level – are too small to address quantitatively in terms of their impacts on resources. Given the enormous resource values at stake, these distinctions may be important – very small percentages of huge numbers can still yield measurable results – but they are too small for current quantitative techniques to resolve. Consequently, the discussion of resource impacts does not distinguish among the CAFE alternatives, but rather provides a qualitative review of the benefits of reducing GHG emissions and the magnitude of the risks involved in climate change. Thus, there are no differences in resource impacts to report in this comparison of the alternatives.

To illustrate how different economic assumptions could affect estimates of fuel consumption, emissions reductions, and resulting health and climate effects, NHTSA examined four model input scenarios: Reference Case, High Scenario, Mid-1 Scenario, and Mid-2 Scenario. Table 2.2-1 shows the key input assumptions for these four scenarios. This section examines direct and indirect effects and cumulative effects on energy, air quality, and climate, across alternatives for the Reference Case and the High Scenario. Specific methodologies are discussed in Chapters 3 and 4, and corresponding results for the Mid-1 and Mid-2 Scenarios are presented in Appendix B.

2.5.1 Direct and Indirect Effects

2.5.1.1 Energy

President George W. Bush signed the EISA on December 17, 2007. In his signing statement, he reiterated his 2007 State of the Union goal to reduce car and light truck fuel consumption by 20 percent over 10 years. Consistent with the President's goals, EISA requires an industry-wide combined average fuel economy through vehicle and fuel standards of at least 35 miles per gallon by 2020, saving billions of gallons of fuel and also fulfilling a U.S. promise to reduce national greenhouse gas emissions.

Under NEPA, direct effects "are caused by the action and occur at the same time and place" (40 CFR 1508.8). CEQ regulations define indirect effects as those that "are caused by the action and are later in time or father removed in distance but are still reasonably foreseeable. Indirect effects may include …

effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Below is a description of the direct and indirect effects of the CAFE alternatives on energy, air quality, and climate.

2.5.1.1.1 Reference Case

Table 2.5-1 shows the impact on fuel consumption for passenger cars and light trucks from 2020 through 2060, a period in which an increasing volume of the fleet will be MY 2011-2015 passenger cars. The table shows total fuel consumption (both gasoline and diesel) under the No Action Alternative and the six other alternatives. Fuel consumption under the No Action Alternative is 264.9 billion gallons in 2060. Consumption falls to 256.3 billion gallons under the Optimized Alternative (Alternative 3) and falls to 214.3 billion gallons under the Technology Exhaustion Alternative (Alternative 7).

Table 2.5-1

Reference Case Passenger Car and Light Truck Annual Fuel Consumption and Fuel Savings (billion gallons)

	Alternative CAFE Standards for Model Years 2011-2015						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Calendar Year	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Cost Equal Total Benefit	Technology Exhaustion
Passenger Cars and Light Trucks Annual Fuel Consumption (billion gallons)							
2020	151.8	149.4	149.2	148.7	148.4	147.8	134.9
2030	172.4	167.7	167.2	166.5	165.8	164.9	141.8
2040	198.5	192.8	192.1	191.3	190.4	189.3	161.1
2050	229.7	222.9	222.2	221.2	220.1	218.7	185.9
2060	264.9	257.1	256.3	255.1	253.8	252.3	214.3
Passenger Cars and Light Trucks Annual Fuel Savings from No Action (billion gallons)							
2020	--	2.4	2.6	3.1	3.4	3.9	16.9
2030	--	4.7	5.2	5.8	6.6	7.5	30.5
2040	--	5.8	6.4	7.2	8.2	9.2	37.4
2050	--	6.8	7.4	8.5	9.5	10.8	43.8
2060	--	7.8	8.6	9.7	11.0	12.5	50.5

2.5.1.1.2 High Scenario

Table 2.5-2 lists the impact on fuel consumption under the High Scenario in the Volpe model for passenger cars and light trucks from 2020 through 2060. The High Scenario uses the economic inputs presented in Table 2.2-1. The table lists total fuel consumption for passenger cars and light trucks, both gasoline and diesel, under the No Action Alternative and the six alternative CAFE standards. The No Action Alternative in the High Scenario reflects a higher fuel price input than in the Reference Case, resulting in lower fuel consumption with no regulatory action by 2060, when the entire fleet is likely to be composed of MY 2011 or later cars, fuel consumption reaches 230.8 billion gallons. With the assumption of higher fuel prices, lower consumption is also expected across the alternatives. Consumption totals 210.2 billion gallons under the Optimized Alternative in 2060, as opposed to 256.3 billion gallons under the Optimized Alternative in the Reference Case.

Table 2.5-2

High Scenario Passenger Car and Light Truck Annual Fuel Consumption and Fuel Savings (billion gallons)

	Alternative CAFE Standards for Model Years 2011-2015						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Calendar Year	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Cost Equal Total Benefit	Technology Exhaustion
Passenger Cars and Light Trucks Annual Fuel Consumption (billion gallons)							
2020	139.1	133.4	132.4	131.4	130.5	129.6	123.7
2030	155.4	144.4	142.6	140.8	139.5	138.2	127.8
2040	177.2	163.7	161.6	159.5	157.7	156.3	143.8
2050	202.6	187.0	184.6	182.1	180.1	178.5	164.0
2060	230.8	213.0	210.2	207.4	205.1	203.1	186.7
Passenger Cars and Light Trucks Annual Fuel Savings from No Action (billion gallons)							
2020	--	5.6	6.7	7.8	8.6	9.4	15.5
2030	--	11.0	12.8	14.6	15.9	17.2	27.5
2040	--	13.5	15.6	17.8	19.4	20.9	33.4
2050	--	15.5	18.0	20.6	22.5	24.2	38.6
2060	--	17.8	20.6	23.4	25.6	27.6	44.1

2.5.1.2 Air Quality

2.5.1.2.1 Reference Case

Table 2.5-3 summarizes the total national criteria and air toxic pollutant emissions in 2035[15] for the seven alternatives under the Reference Case, left to right in order of increasing fuel economy requirements. Under the Reference Case, the No Action Alternative has the highest emissions of all the alternatives for NO_x, $PM_{2.5}$, SO_x, VOCs, acetaldehyde, 1,3-butadiene, and diesel particulate matter. Alternative 3 has the highest emissions of all the alternatives for CO_2 and benzene. Alternative 7 has the highest emissions of all the alternatives for acrolein and formaldehyde.

Localized increases in criteria and toxic air pollutant emissions could occur in some nonattainment areas as a result of implementation of the CAFE standards under the action alternatives. These localized increases represent a slight decline in the rate of reductions being achieved by implementation of Clean Air Act standards. All of the action alternatives would reduce adverse health outcomes and health costs related to motor vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

2.5.1.2.2 High Scenario

Table 2.5-4 summarizes the national criteria and air toxic pollutant emissions in 2035 for the seven alternatives for the High Scenario. For the High Scenario, emissions with the action alternatives are generally lower than under the Reference Case.

[15] NHTSA uses 2035 as the latest projection year because by 2035 almost all passenger cars and light trucks in operation would meet at least the MY 2011-2015 standards and the impact of the standards would start to come only from VMT growth rather than further tightening of the standards. NHTSA believes the year 2035 is a practical maximum for impacts of criteria and toxic air pollutants to be considered reasonably foreseeable rather than speculative.

Table 2.5-3

Reference Case Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year) (Calendar Year 2035)

	Alt. 1 No Action	Alt. 2 25% Below Optimized	Alt. 3 Optimized	Alt. 4 25% Above Optimized	Alt. 5 50% Above Optimized	Alt. 6 Total Costs Equal Total Benefits	Alt. 7 Technology Exhaustion
Criteria Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks (Calendar Year 2035)							
Carbon monoxide (CO)	19,745,847	19,809,449	19,866,650	19,460,737	19,411,428	19,219,623	11,050,380
Nitrogen oxides (NO_x)	1,369,135	1,360,018	1,360,519	1,347,773	1,344,759	1,336,616	1,057,996
Particulate matter ($PM_{2.5}$)	99,707	98,692	98,625	98,064	97,853	97,861	91,101
Sulfur oxides (SO_x)	265,792	259,517	258,951	257,164	255,984	254,228	203,047
Volatile organic compounds (VOCs)	1,906,119	1,894,399	1,896,272	1,869,506	1,863,351	1,844,280	1,205,722
Toxic Air Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks (Calendar Year 2035)							
Acetaldehyde	8,209	8,206	8,208	8,198	8,197	8,165	7,733
Acrolein	351	354	353	367	369	378	720
Benzene	47,515	47,428	47,517	46,703	46,570	46,154	29,324
1,3-butadiene	3,885	3,834	3,834	3,818	3,815	3,781	3,231
Diesel particulate matter (DPM)	119,499	116,161	115,786	115,400	114,858	114,592	104,644
Formaldehyde	13,035	12,949	12,915	13,122	13,142	13,169	16,745

Table 2.5-4

High Scenario Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year) (Calendar Year 2035)

	Alt. 1 No Action	Alt. 2 25% Below Optimized	Alt. 3 Optimized	Alt. 4 25% Above Optimized	Alt. 5 50% Above Optimized	Alt. 6 Total Costs Equal Total Benefits	Alt. 7 Technology Exhaustion
Criteria Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks (Calendar Year 2035)							
Carbon monoxide (CO)	17,713,991	16,946,492	17,052,955	16,475,978	16,127,830	15,629,753	9,913,291
Nitrogen oxides (NO_x)	1,228,251	1,181,455	1,180,414	1,159,073	1,146,599	1,129,532	949,127
Particulate matter ($PM_{2.5}$)	89,447	86,654	86,251	86,389	85,756	85,318	81,727
Sulfur oxides (SO_x)	238,442	221,475	219,361	215,533	212,881	209,978	182,153
Volatile organic compounds (VOCs)	1,709,979	1,620,442	1,621,526	1,572,211	1,546,659	1,507,558	1,081,653

Table 2.5-4 (cont'd)

High Scenario Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year) (Calendar Year 2035)

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Toxic Air Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks (Calendar Year 2035)							
Acetaldehyde	7,364	7,318	7,326	7,244	7,239	7,211	6,938
Acrolein	315	356	353	379	393	412	646
Benzene	42,626	40,639	40,753	39,588	38,860	37,822	26,306
1,3-butadiene	3,885	3,815	3,821	3,790	3,754	3,709	3,231
Diesel particulate matter (DPM)	107,203	99,856	98,495	98,385	97,499	96,932	93,876
Formaldehyde	11,694	11,933	11,878	12,000	12,178	12,394	15,022

Localized increases in criteria and toxic air pollutant emissions could occur in some nonattainment areas as a result of implementation of the CAFE standards under the action alternatives. These localized increases represent a slight decline in the rate of reductions being achieved by implementation of Clean Air Act standards. All of the action alternatives would reduce adverse health outcomes and health costs related to motor vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

2.5.1.3 Climate

2.5.1.3.1 Reference Case

GHG Emissions

Table 2.5-5 shows total emissions and emissions reductions from new passenger cars and light trucks from 2010-2100 for each of the seven alternatives for the Reference Case. Compared to the No Action Alternative, projections of emissions reductions over the 2010 to 2100 timeframe due to other MY 2011-2015 CAFE standard alternatives ranged from 5,922 to 28,047 million metric tons of carbon dioxide ($MMTCO_2$).[16] Over this period, this range of alternatives would reduce global CO_2 emissions by about 0.1 to 0.6 percent (based on global emissions of 4,850,000 $MMTCO_2$).

Climate: CO_2 Concentration and Global Mean Surface Temperature

Table 2.5-6 shows estimated CO_2 concentrations, increase in global mean surface temperature, and sea-level rise in 2030, 2060, and 2100 for the No Action Alternative and the six action alternative CAFE levels for the Reference Case. There is a fairly narrow band of estimated CO_2 concentrations as of 2100, from 714.6 ppm for Technology Exhaustion to 717.2 ppm for the No Action Alternative. As CO_2 concentrations are the key driver of all the other climate effects, this narrow range implies that the differences among alternatives are difficult to distinguish.

[16] The values here are summed from 2010 through 2100, and are thus considerably higher than the value of 520 $MMTCO_2$ that is cited in the NPRM for the "Optimized" alternative. The latter value is the reduction in CO_2 emissions by only MY 2011-15 cars and light trucks over their lifetimes resulting from the optimized CAFE standards, measured as a reduction from the NPRM baseline of extending the CAFE standards for MY 2010 to apply to 2011-15.

Table 2.5-5

Reference Case Emissions and Emissions Reductions Due to the MY 2011-2015 CAFE Standards from 2010-2100 ($MMTCO_2$)

Alternative	Emissions ($MMTCO_2$)	Emissions Reductions Compared to No Action Alternative ($MMTCO_2$)
1 No Action	221,258	0
2 25 Percent Below Optimized	215,337	5,922
3 Optimized	214,643	6,616
4 25 Percent Above Optimized	214,144	7,114
5 50 Percent Above Optimized	213,254	8,004
6 Total Costs Equal Total Benefits	212,345	8,913
7 Technology Exhaustion	193,212	28,047

Table 2.5-6

Reference Case MY 2011-2015 Alternative CAFE Standards Impact on CO_2 Concentrations, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using the MAGICC Model (A1B a/)

Totals by Alternative	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)			Sea-level Rise (cm)		
	2030	2060	2100	2030	2060	2100	2030	2060	2100
1 No Action	455.5	573.7	717.2	0.874	1.944	2.959	7.99	19.30	37.10
2 25 Percent Below Optimized	455.5	573.4	716.7	0.873	1.943	2.957	7.99	19.29	37.08
3 Optimized	455.5	573.4	716.6	0.873	1.943	2.956	7.99	19.29	37.08
4 25 Percent Above Optimized	455.5	573.4	716.6	0.873	1.943	2.956	7.99	19.29	37.08
5 50 Percent Above Optimized	455.5	573.4	716.5	0.873	1.943	2.956	7.99	19.29	37.08
6 Total Costs Equal Total Benefits	455.4	573.3	716.4	0.873	1.943	2.956	7.99	19.28	37.07
7 Technology Exhaustion	455.3	572.5	714.6	0.872	1.938	2.946	7.99	19.25	36.99
Reduction from CAFE Alternatives									
2 25 Percent Below Optimized	0.0	0.3	0.5	0.000	0.001	0.002	0.00	0.01	0.02
3 Optimized	0.0	0.3	0.6	0.000	0.001	0.002	0.00	0.01	0.02
4 25 Percent Above Optimized	0.0	0.3	0.6	0.000	0.001	0.003	0.00	0.01	0.02
5 50 Percent Above Optimized	0.0	0.3	0.7	0.000	0.001	0.003	0.00	0.01	0.02
6 Total Costs Equal Total Benefits	0.1	0.4	0.8	0.000	0.002	0.003	0.00	0.02	0.03
7 Technology Exhaustion	0.2	1.2	2.6	0.002	0.007	0.013	0.00	0.05	0.11

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Climate: Global Mean Rainfall and Global Mean Surface Temperature

The CAFE alternatives reduce temperature increases slightly with respect to the No Action Alternative, and thus reduce increases in precipitation slightly, as shown in Table 2.5-7. As shown in the table and figures, there is a fairly narrow band of estimated precipitation increase reductions as of 2090, from 4.50 percent to 4.51 percent, and there is very little difference among the alternatives for the Reference Case.

Table 2.5-7

Reference Case MY 2011-2015 CAFE Alternatives: Impact on Reductions in Global Mean Precipitation based on A1B a/ SRES Scenario Using Increases in Global Mean Surface Temperature Simulated by MAGICC for 2020, 2055, and 2090 b/

Scenario	2020	2055	2090
Global mean rainfall change	1.45	1.51	1.63
Global Temperature Above Average 1980-1999 Levels (°C) for the A1B Scenario by 2100, Mid-level Results			
1 No Action	0.560	1.764	2.765
2 25 Percent Below Optimized	0.560	1.763	2.763
3 Optimized	0.560	1.763	2.763
4 25 Percent Above Optimized	0.560	1.763	2.762
5 50 Percent Above Optimized	0.560	1.763	2.762
6 Total Costs Equal Total Benefits	0.560	1.763	2.762
7 Technology Exhaustion	0.560	1.758	2.753
Reduction in Global Temperature (°C) for the A1B Scenario, Mid-level Results			
2 25 Percent Below Optimized	0.000	0.001	0.002
3 Optimized	0.000	0.001	0.002
4 25 Percent Above Optimized	0.000	0.001	0.002
5 50 Percent Above Optimized	0.000	0.001	0.003
6 Total Costs Equal Total Benefits	0.000	0.001	0.003
7 Technology Exhaustion	0.000	0.006	0.011
Mid level Global Mean Precipitation Change (%)			
1 No Action	0.81	2.66	4.51
2 Percent Below Optimized	0.81	2.66	4.50
3 Optimized	0.81	2.66	4.50
4 25 Percent Above Optimized	0.81	2.66	4.50
5 50 Percent Above Optimized	0.81	2.66	4.50
6 Total Costs Equal Total Benefits	0.81	2.66	4.50
7 Technology Exhaustion	0.81	2.65	4.49
Reduction in Global Mean Precipitation (%)			
2 25 Percent Below Optimized	0.00	0.00	0.00
3 Optimized	0.00	0.00	0.00
4 25 Percent Above Optimized	0.00	0.00	0.00
5 50 Percent Above Optimized	0.00	0.00	0.00
6 Total Costs Equal Total Benefits	0.00	0.00	0.00
7 Technology Exhaustion	0.00	0.01	0.02

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.
b/ The difference in the years displayed for the temperature and precipitation table is due to choosing a midpoint from ranges developed by the IPCC. *See* Table 3.4-6.

Climate: Impact on Sea-level Rise

Table 2.5-6 lists the impact on sea-level rise under the alternatives and shows sea-level rise in 2100 ranging from 37.1 centimeters (cm) under the No Action Alternative to 36.99 centimeters under the Technology Exhaustion Alternative, for a maximum reduction of 0.11 centimeter by 2100 from the CAFE alternatives for the Reference Case.

2.5.1.3.2 High Scenario

Comparing High Scenario Table 2.5-8 with Reference Case Table 2.5-5 shows that total emissions under the High Scenario were lower for all alternatives. Correspondingly, emissions reductions compared to the No Action Alternative were higher for all alternatives under the High Scenario. The primary reason for this difference is the higher mpg and lower VMT forecasted under the High Scenario.

Table 2.5-8

High Scenario Emissions and Emissions Reductions Due to the MY 2011-2015 CAFE Standards from 2010-2100 (MMTCO$_2$)

	Alternative	Emissions (MMTCO$_2$)	Emissions Reductions Compared to No Action Alternative (MMTCO$_2$)
1	No Action	195,501	0
2	25 Percent Below Optimized	182,890	12,611
3	Optimized	180,591	14,910
4	25 Percent Above Optimized	179,079	16,422
5	50 Percent Above Optimized	177,669	17,832
6	Total Costs Equal Total Benefits	176,736	18,765
7	Technology Exhaustion	170,829	24,672

Table 2.5-9 shows the resulting effects on CO_2 concentration, global mean surface temperature, and sea-level rise. Under the High Scenario, the resulting CO_2 concentration, global mean surface temperature, and sea-level rise were lower for all alternatives except the Technology Exhaustion Alternative (which were the same for both scenarios). Thus, the differences for the action alternatives compared to the No Action Alternative are greater for the High Scenario than the Reference Case.

2.5.2 Cumulative Effects

The CEQ identifies the impacts that must be addressed and considered by federal agencies in satisfying the requirements of NEPA. This includes permanent, temporary, indirect and cumulative impacts. CEQ regulations implementing the procedural provisions of NEPA define cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions” (40 CFR 1508.7). The following sections describe the cumulative effects of the CAFE alternatives on energy, air quality, and climate.

2.5.2.1 Energy

2.5.2.1.1 Reference Case

Table 2.5-10 shows the cumulative fuel consumption of the fleet of passenger cars and light trucks under Alternative 1 (No Action) and the six alternative CAFE standards for the Reference Case. By 2060, when the entire fleet is likely to comprise MY 2011 or later cars, cumulative fuel consumption (from 2010) reaches 9.7 trillion gallons under the No Action Alternative. Cumulative consumption declines across the alternatives, from 8.8 trillion gallons under the Optimized Alternative (Alternative 3) to 7.4 trillion gallons under the Technology Exhaustion Alternative (Alternative 7), which represent cumulative savings of 2.3 trillion gallons relative to the Reference Case No Action Alternative.

Table 2.5-9

High Scenario 2011-2015 CAFE Alternatives Impact on CO_2 Concentration, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using the MAGICC Model (A1B a/)

Totals by Alternative	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)			Sea-level Rise (cm)		
	2030	2060	2100	2030	2060	2100	2030	2060	2100
1 No Action	455.5	573.7	717.2	0.874	1.944	2.959	7.99	19.30	37.10
2 25 Percent Below Optimized	455.4	573.2	716.1	0.873	1.942	2.954	7.99	19.28	37.06
3 Optimized	455.4	573.1	715.8	0.873	1.942	2.953	7.99	19.28	37.05
4 25 Percent Above Optimized	455.4	573.0	715.7	0.873	1.941	2.953	7.99	19.28	37.04
5 50 Percent Above Optimized	455.4	572.9	715.6	0.873	1.941	2.952	7.99	19.27	37.04
6 Total Costs Equal Total Benefits	455.3	572.9	715.5	0.873	1.940	2.951	7.99	19.27	37.03
7 Technology Exhaustion	455.3	572.6	714.9	0.872	1.938	2.948	7.99	19.26	37.00
Reduction from CAFE Alternatives									
2 25 Percent Below Optimized	0.1	0.5	1.1	0.001	0.002	0.005	0.00	0.02	0.04
3 Optimized	0.1	0.6	1.4	0.001	0.003	0.006	0.00	0.02	0.05
4 25 Percent Above Optimized	0.1	0.7	1.5	0.001	0.003	0.006	0.00	0.02	0.06
5 50 Percent Above Optimized	0.1	0.8	1.6	0.001	0.004	0.007	0.00	0.03	0.06
6 Total Costs Equal Total Benefits	0.2	0.8	1.7	0.001	0.004	0.008	0.00	0.03	0.07
7 Technology Exhaustion	0.2	1.1	2.3	0.002	0.006	0.011	0.00	0.04	0.10

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Table 2.5-10

Reference Case Passenger Car and Light Trucks Cumulative Fuel Consumption and Cumulative Fuel Savings (billion gallons)

Calendar Year Range	Alternative CAFE Standards for Model Years 2011-2020						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized (Preferred)	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Passenger Cars and Light Trucks Cumulative Fuel Consumption							
2010-2020	1,601.3	1,583.2	1,581.8	1,579.5	1,577.7	1,574.5	1,510.9
2010-2030	3,229.6	3,083.6	3,076.0	3,063.1	3,051.9	3,038.5	2,786.4
2010-2040	5,092.6	4,731.3	4,714.0	4,684.5	4,658.6	4,630.4	4,125.8
2010-2050	7,245.2	6,620.1	6,591.1	6,541.1	6,497.2	6,451.1	5,647.9
2010-2060	9,733.2	8,800.2	8,757.5	8,683.5	8,618.6	8,551.6	7,401.6
Passenger Cars and Light Trucks Cumulative Fuel Savings							
2010-2020	--	18.1	19.5	21.8	23.6	26.7	90.3
2010-2030	--	146.0	153.7	166.5	177.7	191.1	443.2
2010-2040	--	361.3	378.6	408.1	434.0	462.2	966.8
2010-2050	--	625.1	654.1	704.1	748.0	794.1	1,597.2
2010-2060	--	933.1	975.7	1,049.8	1,114.6	1,181.6	2,331.7

2.5.2.1.2 High Scenario

In response to public comments, and to test how different economic assumptions could affect estimates of fuel consumption, NHTSA ran a series of scenarios (called the High, Mid-1 and Mid-2 Scenarios) using various economic input assumptions and compared the results to the Reference Case. Results from the High Scenario are presented in Table 2.5-11. The High Scenario assumes higher fuel prices than are assumed in the Reference Case, which results in lower fuel consumption across all of the CAFE alternatives examined. This is true even for the No Action Alternative (Alternative 1), because higher fuel prices in the High Scenario would reduce fuel consumption (relative to the Reference Case) even in the absence of any change in CAFE standards.

Table 2.5-11

High Scenario Passenger Car and Light Trucks Cumulative Fuel Consumption and Cumulative Fuel Savings (billion gallons)

Calendar Year Range	Alternative CAFE Standards for Model Years 2011-2020						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized (Preferred)	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Passenger Cars and Light Trucks Cumulative Fuel Consumption							
2010-2020	1,498.6	1,464.8	1,458.8	1,452.6	1,447.8	1,443.0	1,415.4
2010-2030	2,971.5	2,738.3	2,709.5	2,683.5	2,660.0	2,643.7	2,569.1
2010-2040	4,641.6	4,086.9	4,024.5	3,970.4	3,919.4	3,888.5	3,769.9
2010-2050	6,550.8	5,608.3	5,506.0	5,418.6	5,334.6	5,287.1	5,119.9
2010-2060	8,731.1	7,341.4	7,193.3	7,067.6	6,945.6	6,879.3	6,656.6
Passenger Cars and Light Trucks Cumulative Fuel Savings							
2010-2020	--	33.9	39.9	46.0	50.9	55.6	83.3
2010-2030	--	233.2	262.0	288.0	311.4	327.8	402.4
2010-2040	--	554.7	617.1	671.2	722.2	753.2	871.8
2010-2050	--	942.6	1,044.9	1,132.3	1,216.2	1,263.8	1,430.9
2010-2060	--	1,389.6	1,537.8	1,663.5	1,785.5	1,851.8	2,074.5

Table 2.5-11 shows the cumulative fuel consumption of the fleet of passenger cars and light trucks under the No Action Alternative and the six alternative CAFE standards in the High Scenario. By 2060, when the entire fleet is likely to comprise MY 2011 or later cars, cumulative fuel consumption (from 2010) reaches 8.7 trillion gallons under the No Action Alternative. Cumulative consumption declines across the alternatives from 7.2 trillion gallons under the Optimized Alternative (Alternative 3) to 6.7 trillion gallons under the Technology Exhaustion Alternative (Alternative 7), which represents cumulative savings of 2.1 trillion gallons relative to the High Scenario No Action Alternative.

2.5.2.2 Air Quality

2.5.2.2.1 Reference Case

Table 2.5-12 summarizes the cumulative national emissions of toxic and criteria pollutants in 2035, showing that the Reference Case No Action Alternative has the highest cumulative emissions of all the alternatives for all pollutants except CO, acetaldehyde, acrolein, and formaldehyde. Alternative 3 has the highest cumulative emissions of CO and acetaldehyde. Alternative 7 has the highest cumulative emissions of all the alternatives for acrolein and formaldehyde.

Table 2.5-12

Reference Case Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year)
Cumulative Effects with MY 2011-2015 Standards and Potential MY 2016-2020 Standards

	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Criteria Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks							
Carbon monoxide (CO)	19,745,847	20,068,580	20,145,455	19,664,457	19,615,715	19,406,046	11,524,825
Nitrogen oxides (NO_x)	1,369,135	1,335,125	1,335,545	1,318,678	1,314,728	1,305,570	1,048,518
Particulate matter ($PM_{2.5}$)	99,707	95,588	95,468	94,650	94,333	94,305	89,788
Sulfur oxides (SO_x)	265,792	240,446	239,437	236,567	234,662	232,370	183,541
Volatile organic compounds (VOCs)	1,906,119	1,861,129	1,862,621	1,832,904	1,825,138	1,803,935	1,196,950
Toxic Air Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks							
Acetaldehyde	8,209	8,224	8,229	8,211	8,214	8,183	7,974
Acrolein	351	362	361	377	381	392	758
Benzene	47,515	47,256	47,364	46,405	46,251	45,791	29,613
1,3-butadiene	3,885	3,852	3,854	3,839	3,839	3,803	3,331
Diesel particulate matter (DPM)	119,499	105,773	105,131	104,372	103,457	102,999	94,643
Formaldehyde	13,035	12,717	12,677	12,899	12,924	12,961	17,034

Localized increases in criteria and toxic air pollutant emissions could occur in some nonattainment areas as a result of implementation of the CAFE standards alternatives. These localized increases represent a slight decline in the rate of reductions being achieved by implementation of CAA standards. All of the action alternatives would reduce adverse health outcomes and health costs related to motor vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

2.5.2.2.2 High Scenario

Table 2.5-13 summarizes the national criteria and air toxic pollutant emissions in 2035 for the seven alternatives for the High Scenario. For the High Scenario, emissions with the action alternatives are generally lower than for the Reference Case. Localized increases in criteria and toxic air pollutant emissions could occur in some nonattainment areas as a result of implementation of the CAFE standards alternatives. These localized increases represent a slight decline in the rate of reductions being achieved by implementation of CAA standards. All of the action alternatives would reduce adverse health outcomes and health costs related to motor vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

Table 2.5-13

High Scenario Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year)
Cumulative Effects with MY 2011-2015 Standards and Potential MY 2016-2020 Standards

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Criteria Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks							
Carbon monoxide (CO)	17,713,991	17,102,067	17,249,166	16,551,203	16,107,699	15,482,276	10,338,916
Nitrogen oxides (NO_x)	1,228,251	1,147,887	1,145,748	1,120,053	1,102,988	1,082,932	940,625
Particulate matter ($PM_{2.5}$)	89,447	83,017	82,423	82,542	81,642	81,247	80,549
Sulfur oxides (SO_x)	238,442	198,158	194,471	189,553	185,397	182,149	164,654
Volatile organic compounds (VOCs)	1,709,979	1,575,147	1,574,616	1,518,089	1,486,823	1,440,609	1,073,784
Toxic Air Pollutant Emissions (tons/year) for Passenger Cars and Light Trucks							
Acetaldehyde	7,364	7,351	7,372	7,282	7,278	7,255	7,153
Acrolein	315	374	374	406	424	450	680
Benzene	42,626	40,169	40,301	38,917	37,990	36,721	26,566
1,3-butadiene	3,885	3,833	3,846	3,810	3,766	3,713	3,331
Diesel particulate matter (DPM)	107,203	87,624	85,380	85,166	83,729	83,295	84,904
Formaldehyde	11,694	11,783	11,730	11,897	12,127	12,433	15,281

2.5.2.3 Climate

2.5.2.3.1 Reference Case

GHG Emissions

Total emissions reductions from 2010-2100 new passenger cars and light trucks for each of the seven alternatives for the Reference Case are shown in Table 2.5-14. Projections of emissions reductions over the 2010 to 2100 timeframe due to the MY 2011-2020 CAFE standards ranged from 24,321 to 49,157 $MMTCO_2$. Compared against global emissions of 4,850,000 $MMTCO_2$ over this period (projected by the IPCC A1B-medium scenario), the incremental impact of this rulemaking is expected to reduce global CO_2 emissions by about 0.5 to 1.0 percent.

Climate: CO_2 Concentration and Global Mean Surface Temperature

The mid-range results of MAGICC model simulations for the No Action Alternative and the six alternative CAFE levels, in terms of CO_2 concentrations and increase in global mean surface temperature in 2030, 2060, and 2100 are presented in Table 2.5-15 and Figures 2.5-1 to 2.5-4. As Figures 2.5-1 and 2.5-2 show, the impact on the growth in CO_2 concentrations and temperature is just a fraction of the total growth in CO_2 concentrations and global mean surface temperature. However, the relative impact of the CAFE alternatives is illustrated by the reduction in growth of both CO_2 concentrations and temperature in the Technology Exhaustion Alternative, which is nearly double that of the 25 Percent Below Optimized Alternative, as shown in Figures 2.5-3 to 2.5-4.

Table 2.5-14

Reference Case Cumulative Emissions and Emissions Reductions Due to the MY 2011-2015 Standards and Potential MY 2016-2020 CAFE Standards Projected for 2010-2100 ($MMTCO_2$)

Alternative	Emissions ($MMTCO_2$)	Emissions Reductions Compared to No Action Alternative ($MMTCO_2$)
1 No Action	221,258	0
2 25 Percent Below Optimized	196,937	24,321
3 Optimized	195,816	25,442
4 25 Percent Above Optimized	194,057	27,201
5 50 Percent Above Optimized	192,478	28,780
6 Total Costs Equal Total Benefits	191,073	30,185
7 Technology Exhaustion	172,101	49,157

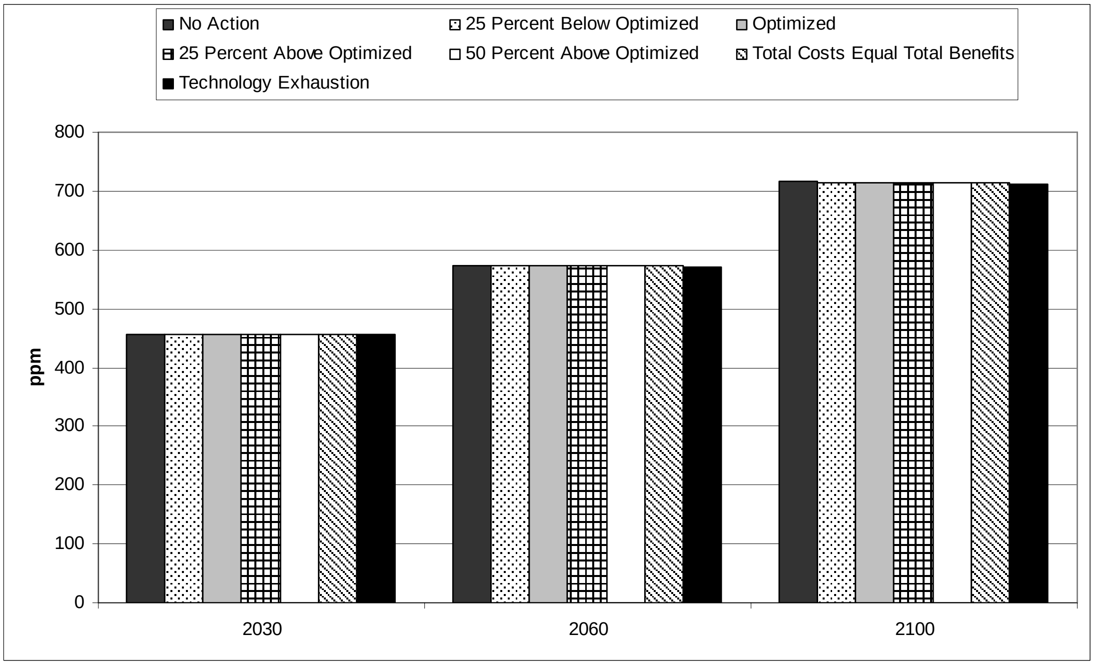
Table 2.5-15

Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 CAFE Standards Cumulative Impact on CO_2 Concentration, Surface Temperature Increase, and Sea-level Rise in 2100 Using MAGICC (A1B a/)

	CO_2 Concentration (ppm)			Surface Temperature Increase (°C)			Sea-level Rise (cm)		
	2030	2060	2100	2030	2060	2100	2030	2060	2100
Totals by Alternative									
1 No Action	455.5	573.7	717.2	0.874	1.944	2.959	7.99	19.30	37.10
2 25 Percent Below Optimized	455.4	572.7	714.9	0.873	1.940	2.950	7.99	19.27	37.02
3 Optimized	455.4	572.7	714.8	0.873	1.940	2.950	7.99	19.27	37.02
4 25 Percent Above Optimized	455.3	572.6	714.7	0.873	1.940	2.949	7.99	19.27	37.01
5 50 Percent Above Optimized	455.3	572.5	714.5	0.873	1.940	2.948	7.99	19.27	37.01
6 Total Costs Equal Total Benefits	455.3	572.5	714.4	0.873	1.939	2.948	7.99	19.26	37.00
7 Technology Exhaustion	455.1	571.7	712.6	0.871	1.934	2.938	7.99	19.23	36.92
Reduction from CAFE Alternatives									
2 25 Percent Below Optimized	0.1	1.0	2.3	0.001	0.004	0.009	0.00	0.03	0.08
3 Optimized	0.1	1.0	2.4	0.001	0.004	0.009	0.00	0.03	0.08
4 25 Percent Above Optimized	0.2	1.1	2.5	0.001	0.005	0.010	0.00	0.03	0.09
5 50 Percent Above Optimized	0.2	1.2	2.7	0.001	0.005	0.011	0.00	0.03	0.09
6 Total Costs Equal Total Benefits	0.2	1.2	2.8	0.001	0.005	0.011	0.00	0.04	0.10
7 Technology Exhaustion	0.4	2.0	4.6	0.002	0.010	0.020	0.00	0.07	0.18

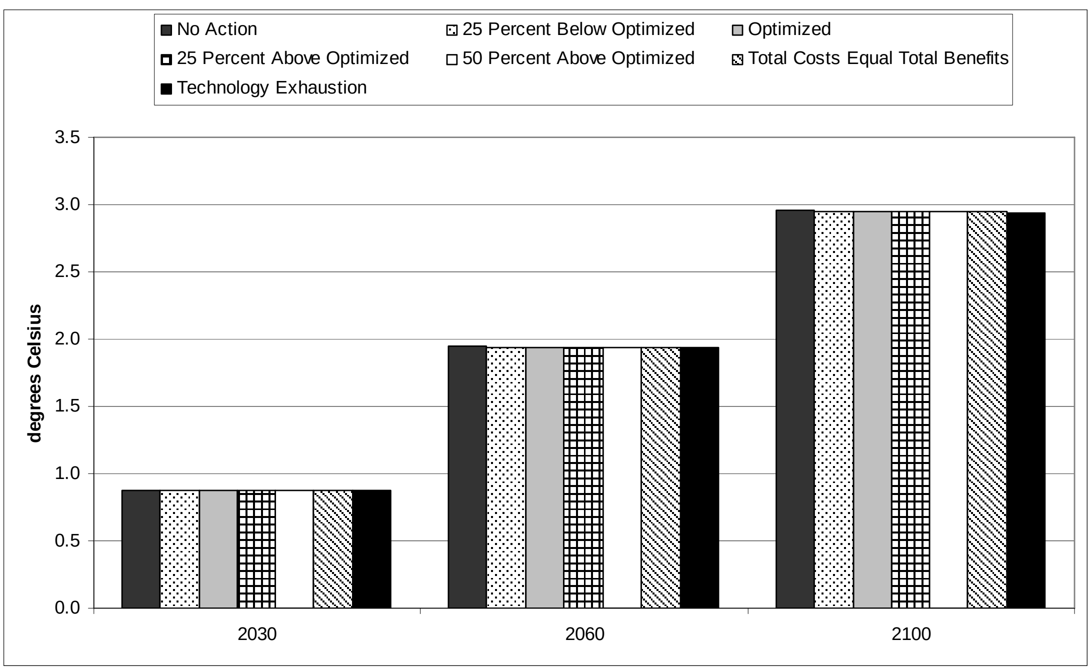
a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Figure 2.5-1. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on CO_2 Concentrations Using the MAGICC Model (A1B a/)



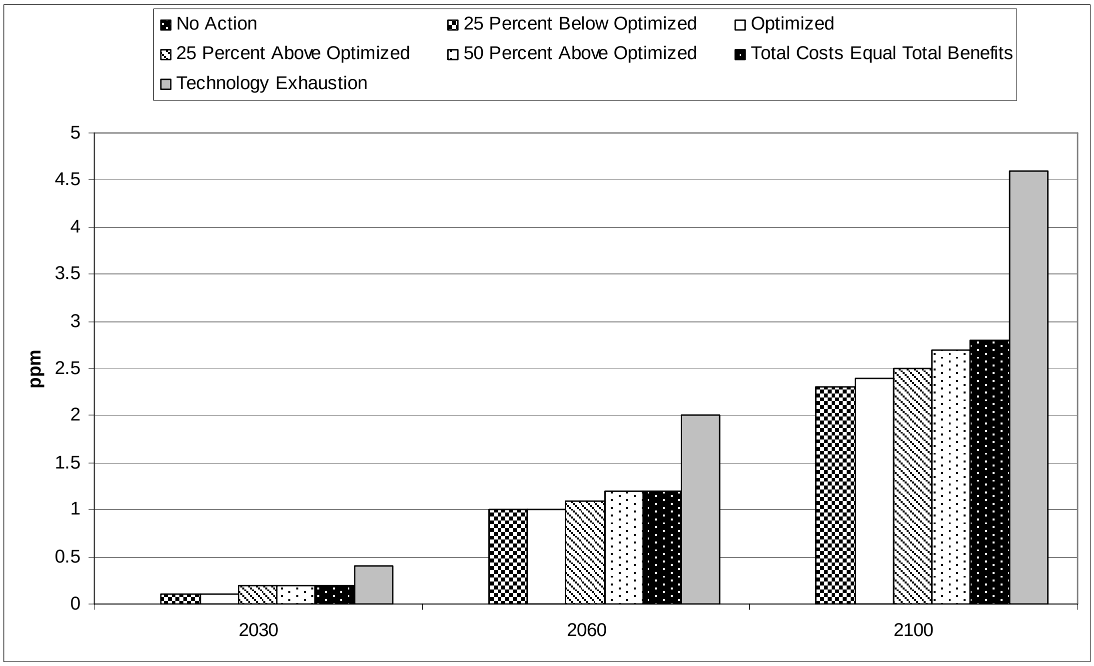
a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Figure 2.5-2. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on the Increase in Global Mean Surface Temperature Using MAGICC (A1B a/)



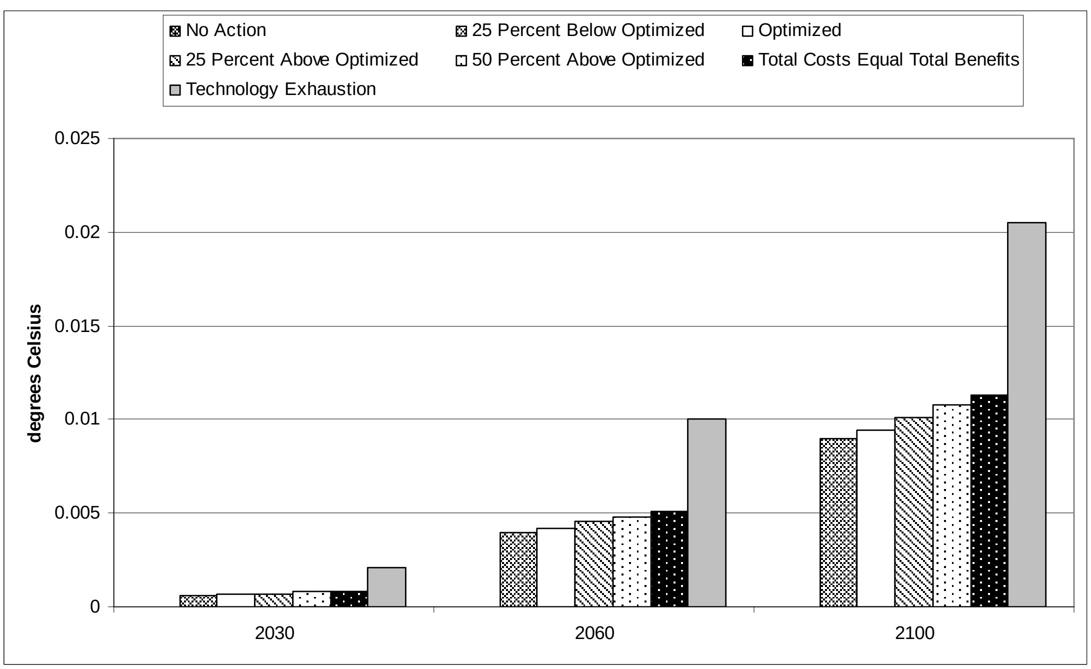
a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Figure 2.5-3. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on the Reduction in the Growth of CO_2 Concentrations Using MAGICC (A1B a/)



a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Figure 2.5-4. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on the Reduction in the Growth of Global Mean Temperature Using MAGICC (A1B a/)



a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

As shown in Table 2.5-15 and Figures 2.5-1 through 2.5-4, there is a fairly narrow band of estimated CO_2 concentrations as of 2100, from 712.6 ppm for the Technology Exhaustion Alternative to 717.2 ppm for the No Action Alternative. As CO_2 concentrations are the key driver of all the other climate effects, this narrow range implies that the differences among alternatives are difficult to distinguish. The MAGICC simulations of mean global surface air temperature increases are also shown below in Table 2.5-15. For all alternatives, the temperature increase is about 0.9 °C as of 2030, 1.9 °C as of 2060, and 2.9 °C as of 2100. The differences among alternatives are small. As of 2100, the reduction in temperature increase, with respect to the No Action Alternative, ranges from 0.009 °C to 0.02 °C. These estimates include considerable uncertainty due to a number of factors of which the climate sensitivity is the most important. The IPCC Fourth Assessment Report estimates a range of the climate sensitivity from 2.5 to 4.0 °C with a mid-point of 3.0 °C which directly relates to the uncertainty in the estimated global mean surface temperature.

Climate: Global Mean Rainfall and Global Mean Surface Temperature

The CAFE action alternatives for the Reference Case reduce temperature increases slightly with respect to the No Action Alternative. Thus, they also reduce predicted increases in precipitation slightly, as shown in Table 2.5-16. As shown in the Table 2.5-16 and Figures 2.5-1 through 2.5-4, there is a fairly narrow band of estimated precipitation increase reductions as of 2100, from 4.48 percent to 4.51 percent, and there is very little difference between the alternatives.

Table 2.5-16

Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 CAFE Standards: Cumulative Impact on Reductions in Global Mean Precipitation Based on A1B a/ SRES Scenario, Using Increases in Global Mean Surface Temperature Simulated by MAGICC

Scenario	2020	2055	2090 b/
Global Mean Precipitation Change	1.45	1.51	1.63
Global Temperature above average 1980-1999 levels (°C) for the A1B scenario and CAFE Alternatives, mid-level results			
1 No Action	0.560	1.764	2.765
2 25 Percent Below Optimized	0.560	1.759	2.753
3 Optimized	0.560	1.758	2.752
4 25 Percent Above Optimized	0.560	1.758	2.751
5 50 Percent Above Optimized	0.560	1.757	2.750
6 Total Costs Equal Total Benefits	0.560	1.757	2.750
7 Technology Exhaustion	0.559	1.756	2.749
Reduction in Global Temperature (°C) for CAFE Alternatives, mid-level results (compared to No Action Alternative)			
2 25 Percent Below Optimized	0.000	0.005	0.011
3 Optimized	0.000	0.006	0.013
4 25 Percent Above Optimized	0.000	0.006	0.014
5 50 Percent Above Optimized	0.000	0.007	0.015
6 Total Costs Equal Total Benefits	0.000	0.007	0.015
7 Technology Exhaustion	0.000	0.008	0.016

Table 2.5-16 (cont'd)

Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 CAFE Standards: Cumulative Impact on Reductions in Global Mean Precipitation Based on A1B a/ SRES Scenario, Using Increases in Global Mean Surface Temperature Simulated by MAGICC

Scenario	2020	2055	2090 b/
Mid Level Global Mean Precipitation Change (%)			
1 No Action	0.81	2.66	4.51
2 25 Percent Below Optimized	0.81	2.66	4.49
3 Optimized	0.81	2.65	4.49
4 25 Percent Above Optimized	0.81	2.65	4.48
5 50 Percent Above Optimized	0.81	2.65	4.48
6 Total Costs Equal Total Benefits	0.81	2.65	4.48
7 Technology Exhaustion	0.81	2.65	4.48
Reduction in Global Mean Precipitation Change for CAFE Alternatives (% compared to No Alternative Action)			
2 25 Percent Below Optimized	0.00	0.01	0.02
3 Optimized	0.00	0.01	0.02
4 25 Percent Above Optimized	0.00	0.01	0.02
5 50 Percent Above Optimized	0.00	0.01	0.02
6 Total Costs Equal Total Benefits	0.00	0.01	0.02
7 Technology Exhaustion	0.00	0.01	0.03

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.
b/ The difference in the years displayed for precipitation is due to choosing a mid-point from ranges developed by the IPCC

Climate: Impact on Sea-level Rise

The impact on sea-level rise from the CAFE Standards alternatives is presented in Table 2.5-18, showing sea-level rise in 2100 ranging from 37.10 cm in Alternative 1 (No Action) to 36.94 cm in the Technology Exhaustion Alternative, for a maximum reduction of 0.16 cm by 2100 from the CAFE alternatives for the Reference Case.

2.5.2.3.2 High Scenario

The results for the High Scenario are presented in Tables 2.5-17 and 2.5-18. Comparing High Scenario Table 2.5-17 with Reference Case Table 2.5-14 shows that total emissions under the High Scenario were lower for all alternatives except the Technology Exhaustion Alternative (which was the same for both scenarios). Correspondingly, emissions reductions compared to the No Action Alternative were higher for all alternatives under the High Scenario except the Technology Exhaustion Alternative (which was the same for both scenarios). The primary reason for this difference is the higher mpg and lower VMT forecasted under the High Scenario.

Table 2.5-17

High Scenario Alternative CAFE Standards Cumulative Emissions and Emissions Reductions Due to the MY 2011-2015 Standards and Potential MY 2016-2020 Standards for 2010 through 2100 ($MMTCO_2$)

Alternative	Emissions ($MMTCO_2$)	Emissions Reductions Compared to No Action Alternative ($MMTCO_2$)
1 No Action	195,501	0
2 25 Percent Below Optimized	160,903	34,598
3 Optimized	157,088	38,413
4 25 Percent Above Optimized	154,618	40,884
5 50 Percent Above Optimized	151,781	43,721
6 Total Costs Equal Total Benefits	150,919	44,583
7 Technology Exhaustion	152,290	43,211

Table 2.5-18

High Scenario Alternative CAFE Standards MY 2011-2015 and Potential MY 2016-2020 Standards Cumulative Impact on CO_2 Concentrations, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using the MAGICC Model (A1B a/)

Totals by Alternative	CO_2 Concentration (ppm)			Global Mean Surface Temperature Increase (°C)			Sea-level Rise (cm)		
	2030	**2060**	**2100**	**2030**	**2060**	**2100**	**2030**	**2060**	**2100**
1 No Action	455.5	573.7	717.2	0.874	1.944	2.959	7.99	19.30	37.10
2 25 Percent Below Optimized	455.3	572.3	714.0	0.873	1.938	2.946	7.99	19.26	36.99
3 Optimized	455.2	572.1	713.6	0.872	1.937	2.944	7.99	19.25	36.97
4 25 Percent Above Optimized	455.2	572.0	713.4	0.872	1.937	2.943	7.99	19.25	36.96
5 50 Percent Above Optimized	455.2	571.9	713.1	0.872	1.936	2.942	7.99	19.25	36.95
6 Total Costs Equal Total Benefits	455.2	571.9	713.0	0.872	1.936	2.942	7.99	19.24	36.95
7 Technology Exhaustion	455.2	571.9	713.1	0.872	1.935	2.941	7.99	19.24	36.94
Reduction from CAFE Alternatives									
2 25 Percent Below Optimized	0.2	1.4	3.2	0.001	0.006	0.013	0.00	0.04	0.11
3 Optimized	0.3	1.6	3.6	0.001	0.007	0.015	0.00	0.05	0.13
4 25 Percent Above Optimized	0.3	1.7	3.8	0.001	0.007	0.016	0.00	0.05	0.14
5 50 Percent Above Optimized	0.3	1.8	4.1	0.001	0.008	0.017	0.00	0.05	0.15
6 Total Costs Equal Total Benefits	0.3	1.8	4.2	0.002	0.008	0.017	0.00	0.06	0.15
7 Technology Exhaustion	0.3	1.8	4.1	0.002	0.009	0.018	0.00	0.06	0.16

a/ The IPCC A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

Table 2.5-18 shows the resulting effects on CO_2 concentration, global mean surface temperature, and sea-level rise. Under the High Scenario, the resulting CO_2 concentration, global mean surface temperature, and sea-level rise were lower for all alternatives except the Technology Exhaustion Alternative (which were the same for both scenarios). Thus, the differences for the action alternatives compared to the No Action Alternative are greater for the High Scenario than the Reference Case.

2.5.3 Scenario Comparison

The data shown in Table 2.3-5, and graphed in Figure 2.5-5, show the required combined mpg standards for cars and light trucks associated with the seven alternatives across the Reference Case the three Input Scenarios. As noted above, the information provided in this FEIS, across alternatives for the Reference Case and the three Input Scenarios, is designed to allow the public and decisionmakers to evaluate environmental impacts for the entire range of feasible alternatives. Table 2.5-19 demonstrates the continuum of fuel savings and greenhouse gas reductions associated with the Optimized Alternatives of each Input Scenario. Table 2.5-20 compares energy and climate effect results for the alternatives of each Input Scenario.

Figure 2.5-5. MY 2015 Required MPG for Passenger Cars and Light Trucks by Alternative and Input Scenario

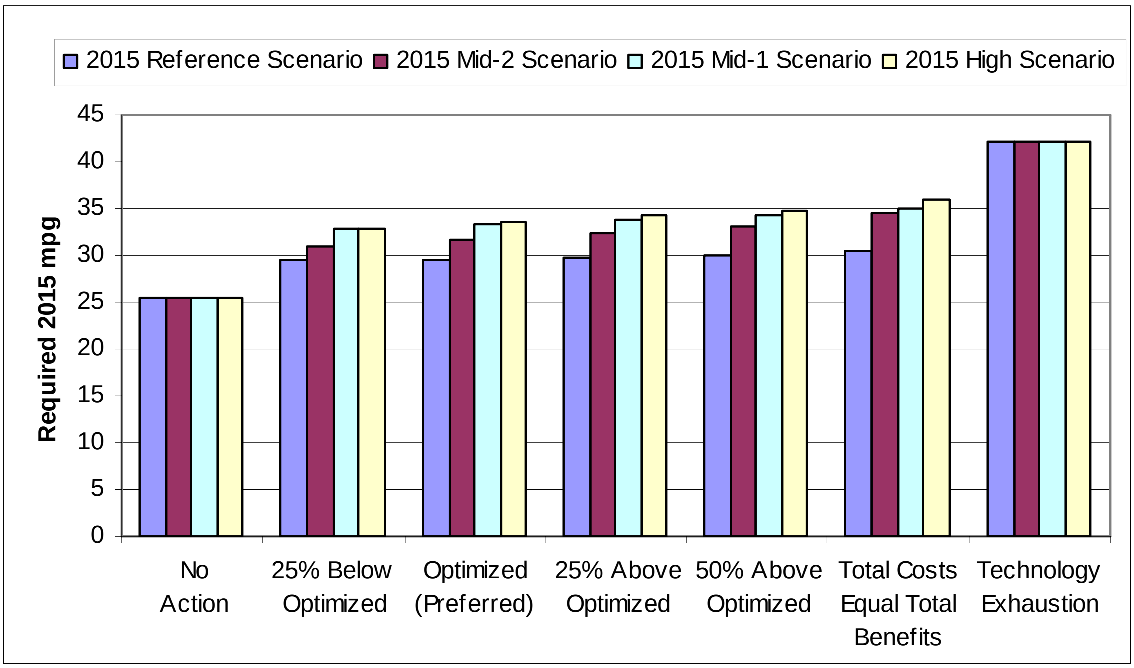


Table 2.5-19
Volpe Model Scenario Inputs and Outputs for Optimized Alternative

Input Scenario	Fuel Price	SCC	Oil Import Externalities (2007$/gallon)	Discount Rate	Cars (Baseline 27.5) 2015 (mpg)	Trucks (Baseline 23.5) 2015 (mpg)	Combined (Baseline 25.3) 2015 (mpg)	Fuel Savings 2010-2060 (billion gallons)	CO_2 Emission Reduction 2010-2100 (MMT) b/
1: Reference	$2.41	$2	$0.326	3% CO_2 – 7% Other	33.4	26.0	29.6	975.7	6,616
2: Mid-2	$3.33	$2	$0.382	3% CO_2 – 7% Other	37.1	27.1	31.8	1302.4	11,463
5: Mid-1	$3.33	$33	$0.116	3% CO_2 – 7% Other	37.2	29.6	33.3	1490.9	13,992
9: High	$3.33	$33	$0.116	3% CO_2 – 3% Other	37.7	29.6	33.6	1537.8	14,910

Table 2.5-20

Volpe Model Scenario Inputs and Outputs for Optimized Alternative

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
	No Action	25% Below Optimized	Optimized	25% Above Optimized	50% Above Optimized	Total Costs Equal Total Benefits	Technology Exhaustion
Combined 2015 (mpg)							
Reference Case	25.5	29.4	29.6	29.8	30.0	30.4	42.0
Mid-2 Scenario	25.5	31.1	31.8	32.5	33.2	34.6	42.0
Mid-1 Scenario	25.5	32.9	33.3	33.8	34.2	35.0	42.0
High Scenario	25.5	32.9	33.6	34.2	34.8	36.0	42.0
Fuel Use (billion gallons)							
Reference Case	151.8	149.4	149.2	148.7	148.4	147.8	134.9
Mid-2 Scenario	139.1	134.5	133.8	132.9	132.2	130.8	123.7
Mid-1 Scenario	139.1	133.6	133.0	132.3	131.7	130.4	123.7
High Scenario	139.1	133.4	132.4	131.4	130.5	129.6	123.7
CO_2 Emissions (MMT)							
Reference Case	221,258	215,337	214,643	214,144	213,254	212,345	193,212
Mid-2 Scenario	195,501	185,761	184,038	182,281	180,886	178,093	170,829
Mid-1 Scenario	195,501	182,893	181,509	180,401	179,464	177,743	170,829
High Scenario	195,501	182,890	180,591	179,079	177,669	176,736	170,829
Sea-level Rise (cm)							
Reference Case	37.10	37.08	37.08	37.08	37.08	37.07	36.99
Mid-2 Scenario	37.10	37.07	37.06	37.06	37.05	37.04	37.00
Mid-1 Scenario	37.10	37.06	37.05	37.05	37.05	37.04	37.00
High Scenario	37.10	37.06	37.05	37.04	37.04	37.03	37.00
Mean Global Temperature Increase (Degrees C)							
Reference Case	2.959	2.957	2.956	2.956	2.956	2.956	2.946
Mid-2 Scenario	2.959	2.955	2.955	2.954	2.953	2.952	2.948
Mid-1 Scenario	2.959	2.954	2.954	2.953	2.953	2.952	2.948
High Scenario	2.959	2.954	2.953	2.953	2.952	2.951	2.948