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Report to the Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate

August 2000

AUTOMOBILE FUEL ECONOMY

Potential Effects of Increasing the Corporate Average Fuel Economy Standards

GAO/RCED-00-194

Contents

Abbreviations

ACEEE	American Council for an Energy-Efficient Economy
AISI	American Iron and Steel Institute
CAFE	Corporate Average Fuel Economy
DOE	Department of Energy

DOT	Department of Transportation
EEA	Energy and Environmental Analysis
EIA	Energy Information Administration
EPA	Environmental Protection Agency
mmbd	million barrels per day
mmtc	million metric tons of carbon
mpg	miles per gallon
NHTSA	National Highway Traffic Safety Administration
NRC	National Research Council
OTA	Office of Technology Assessment
PNGV	Partnership for a New Generation of Vehicles
SUV	sport utility vehicle
TRB	Transportation Research Board

United States General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-284406

August 15, 2000

The Honorable John McCain
Chairman, Committee on Commerce,
Science, and Transportation
United States Senate

Dear Mr. Chairman:

In the wake of the 1973 oil crisis, the Congress passed the Energy Policy and Conservation Act in 1975 as a means of reducing the country's dependence on foreign oil. The act established the Corporate Average Fuel Economy (CAFE) program, which required automobile manufacturers to increase the average fuel economy of passenger cars and light trucks—a category that now includes minivans, pickups, and sport utility vehicles (SUV)—sold in the United States. The act set standards for passenger cars, which rose from 18 miles per gallon (mpg) in automobile model year 1978 to 27.5 mpg by model year 1985. As authorized by the act, the Department of Transportation (DOT) set standards for light trucks for model years 1979 through 2002. The standards are currently 27.5 mpg for passenger cars and 20.7 mpg for light trucks. Provisions in DOT's annual appropriations since fiscal year 1996 have prohibited the agency from changing CAFE standards.

Between 1981 and 1999, the average price of gasoline, adjusted for inflation, declined more than 60 percent. During the same period, the U.S. transportation sector's consumption of oil rose from less than 10 million to nearly 13 million barrels per day. However, recent gasoline price increases, in some areas to more than $2.00 a gallon, have redirected attention to the costs and benefits of improving passenger vehicle fuel economy. These price increases have come at a time when light trucks have become much more popular. As the proportion of light trucks has increased and other shifts have occurred in the automotive fleet, the average fuel economy of new passenger vehicles has fallen to 23.8 mpg—a weighted average of 28.1 mpg for cars and 20.3 mpg for light trucks[1]—for model year 1999, the lowest level since 1980 and 8 percent below the peak of 25.9 mpg for model year 1988.

These overall fuel economy trends have prompted some energy conservationists and environmentalists to call for increasing CAFE standards. Those supporting an increase in the standards often cite energy security and environmental benefits that would result from improved fuel economy.[2] However, others opposed to raising the standards often cite decreased automobile safety, which they contend could result from producing smaller, more fuel-efficient vehicles. As a result of these issues, you asked us to review studies and interview experts to identify (1) the impact of increasing CAFE standards on oil consumption, the environment, and automobile safety in the United States and (2) other issues that affect the CAFE discussion.

[1]These fuel economy averages reflect the results of the Environmental Protection Agency's tests. The averages undergo a number of adjustments that can increase a manufacturer's effective fuel economy, which DOT uses to assess CAFE compliance. The averages are adjusted to account for changes in testing procedures since the beginning of the CAFE program. Other adjustments can include credits earned by manufacturers through the production of alternative- or dual-fuel vehicles, or by exceeding the standards in prior years. In addition, the averages are significantly higher than the values used on new car labels, which are adjusted downward to estimate on-road fuel economy.

[2]The environmental benefits cited relate mostly to reduced greenhouse gas emissions. Improving fuel economy reduces greenhouse gas emissions because they are directly related to the amount of fuel consumed—each gallon of gasoline consumed directly produces about 20 pounds of carbon dioxide. In contrast, fuel economy is not directly related to air pollutants from motor vehicle exhaust, such as nitrogen oxides, to the extent that pollution control equipment limits these emissions to specific amounts regardless of the amount of fuel consumed.

To respond to your request, we reviewed studies and interviewed experts from federal agencies, automobile manufacturers, and energy conservation and environmental interest groups. Appendix I provides the details of our scope and methodology. This report does not address whether CAFE standards should be increased or whether some other policy measures should be implemented to achieve national energy and environmental goals. Ultimately, this is a policy choice that the Congress must make after weighing the energy and environmental benefits and economic and other costs, including the potential safety consequences, of various policy alternatives.

Results in Brief

According to the studies we reviewed and the experts we interviewed, raising fuel economy standards would reduce future fuel consumption and greenhouse gas emissions; however, the impact of raising standards on vehicle safety is less certain. Three recent studies project that improving the fuel economy of new vehicles would reduce the annual fuel consumption and greenhouse gas emissions of cars and light trucks by between 6 and 37 percent over a 15- to 18-year period. The wide variation among these forecasts results from different assumptions about items such as the costs and effectiveness of new fuel-saving technologies and the rate at which new technologies penetrate the marketplace. The effect of increasing CAFE standards on vehicle safety is harder to quantify because it depends on many variables, such as the amount of lead time given to manufacturers, the size of the CAFE increase, and the strategies manufacturers use to achieve fuel economy gains. In addition, there is little current research linking CAFE increases and vehicle safety. The major concern about safety is that manufacturers might produce smaller, lighter vehicles to meet more stringent CAFE standards and thus sacrifice some level of protection for occupants. Ultimately, how auto manufacturers improve fuel economy will depend on the relative costs and benefits of the options and time available to them. We found consensus among safety experts and auto manufacturers that as long as there is sufficient lead time to meet higher CAFE levels, auto manufacturers could use fuel-saving technologies (such as continuously variable transmissions or lean-burn engines) instead of simply building smaller, lighter cars, thereby minimizing any negative impact on safety.

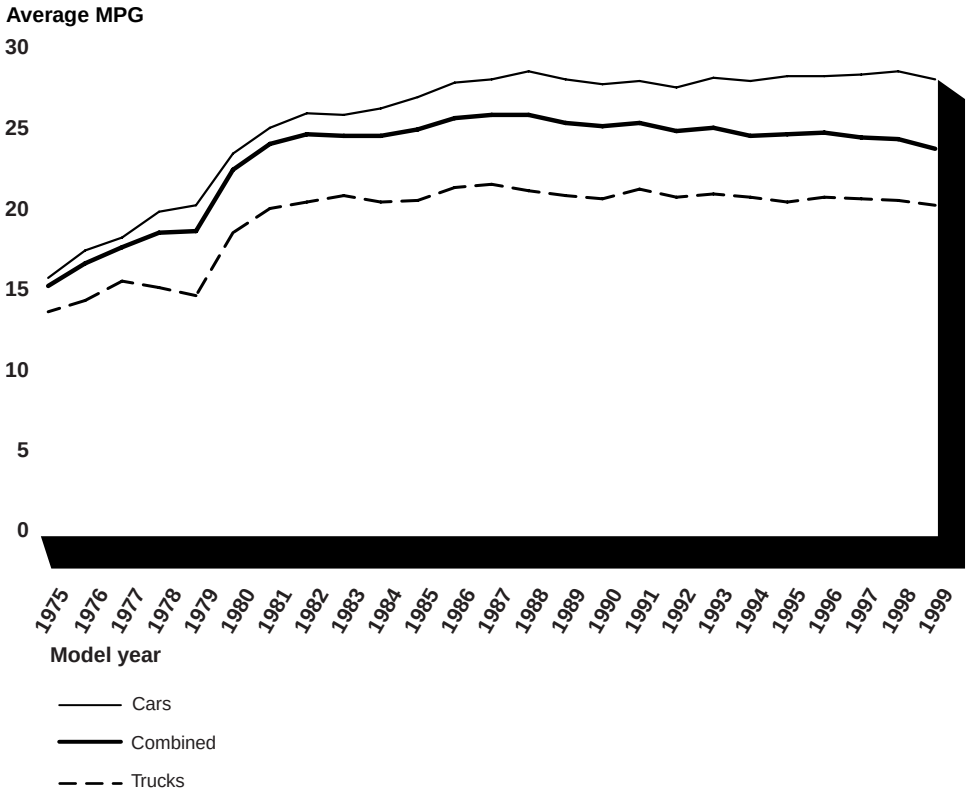
We also identified a number of other issues associated with raising CAFE standards. First, automobile manufacturers have had little incentive to improve fuel economy because, over the past decade, gas prices have been low and consumers have consistently purchased larger, more powerful

vehicles that emphasize performance over fuel economy. Second, the Environmental Protection Agency's (EPA) new, more stringent tailpipe emission standards may inhibit the use of certain technologies, such as diesel engines, that have great potential for improving fuel economy but may not meet these standards. Third, EPA and DOT are concerned that vehicle classification regulations may be outdated, reducing the incentive for manufacturers to increase the fuel economy of their light trucks. Fourth, it is possible that technology-driven fuel economy increases could occur without increasing CAFE standards. For example, the Partnership for a New Generation of Vehicles (PNGV) program has a goal of producing a prototype family sedan that achieves 80 mpg, and it is developing technologies to achieve this goal. Although it is unlikely that such vehicles can be cost-effectively produced and sold in the near future, it is possible that some of the technologies being developed through PNGV could lead to improvements in fuel economy without increases in CAFE standards. Finally, some analysts contend that increasing CAFE standards is not as cost-effective as other policy measures, such as increasing gasoline taxes, for reducing fuel consumption and greenhouse gas emissions, because CAFE standards do not affect older vehicles and may not result in reduced driving.

Background

Between model years 1975 and 1988, the average weight of new cars and light trucks fell by nearly 800 pounds—cars by over 1,000 pounds and light trucks by approximately 230 pounds. At the same time, their combined average fuel economy rose substantially, from 15 mpg to 26 mpg (see fig. 1). However, since 1988, fuel economy gains have leveled off, and overall new passenger vehicle fuel economy (combining cars and light trucks) has been declining as the market share of light trucks has increased. Sales of light trucks now constitute nearly 50 percent of total new vehicle sales, which is more than double their proportion in 1975—19 percent.

Figure 1: MPG by Model Year



Source: GAO's presentation of data from EPA.

In recent years, federal efforts to improve fuel economy have shifted away from regulation and have instead moved toward funding research and development on advanced vehicles. Each year, beginning in fiscal year 1996, the Congress has included a rider to DOT's annual appropriations act that prohibits the National Highway Traffic Safety Administration (NHTSA) from expending any funds to change CAFE standards. This rider stems, in part, from concerns that increasing CAFE standards could restrict the types of vehicles that manufacturers would produce and negatively affect automobile safety. However, during this period, various federal agencies and the U.S. automobile industry have been engaged in a cooperative research program known as the Partnership for a New Generation of Vehicles, which has a goal to develop vehicles that can achieve up to three times the fuel efficiency of comparable 1994 family sedans, or approximately 80 mpg by 2004.

Increasing CAFE Standards Would Reduce Fuel Consumption and Greenhouse Gas Emissions, but Its Impact on Safety Is Less Certain

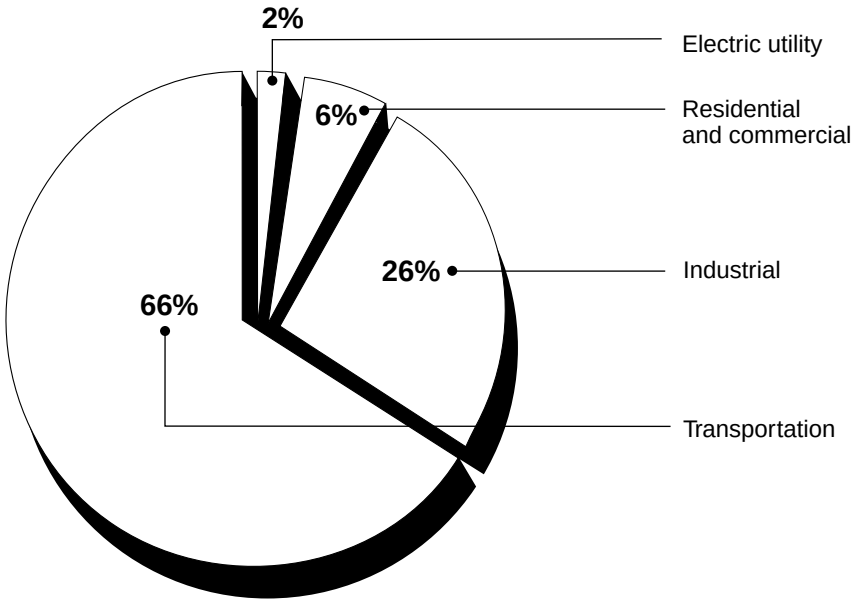
On the basis of the studies we reviewed and the experts we interviewed, we conclude that improving the fuel economy of passenger vehicles could help the U.S. transportation sector reduce its reliance on petroleum products and its emissions of greenhouse gases, such as carbon dioxide, which have been linked to global warming. The studies estimated that increasing CAFE standards could improve the average fuel economy of new passenger vehicles and could thus reduce future fuel consumption and greenhouse gas emissions.[3] The amount of these forecasted reductions varies widely among studies and depends on key assumptions used to generate the forecasts. The effect of increasing CAFE standards on vehicle safety is harder to quantify because safety is affected by numerous variables, including whether manufacturers downsize vehicles or use fuel-saving technologies to improve fuel economy. In addition, there is little research linking CAFE increases and vehicle safety. Ultimately, the strategies that manufacturers choose depend on their relative costs and benefits. However, we found consensus among safety experts and auto manufacturers that as long as there is sufficient lead time to meet higher CAFE levels, auto manufacturers could use fuel-saving technologies instead of building smaller cars and thus minimize any negative impact on safety.

The U.S. Transportation Sector Depends on Petroleum and Emits Substantial Amounts of Greenhouse Gases

The United States is the largest consumer of petroleum in the world, and the transportation sector accounts for the greatest portion of total U.S. consumption. According to the Department of Energy (DOE), the United States accounted for 26 percent of total worldwide petroleum consumption in 1997—19 million of the 73 million barrels per day consumed. In addition, as figure 2 shows, the transportation sector accounted for the largest portion of total U.S. consumption.

[3]Because CAFE standards apply only to new vehicles, their ability to reduce fuel consumption and greenhouse gas emissions is dependent, in part, on the rate new vehicles penetrate the overall automobile fleet.

Figure 2: U.S. Petroleum Consumption by Sector, 1997



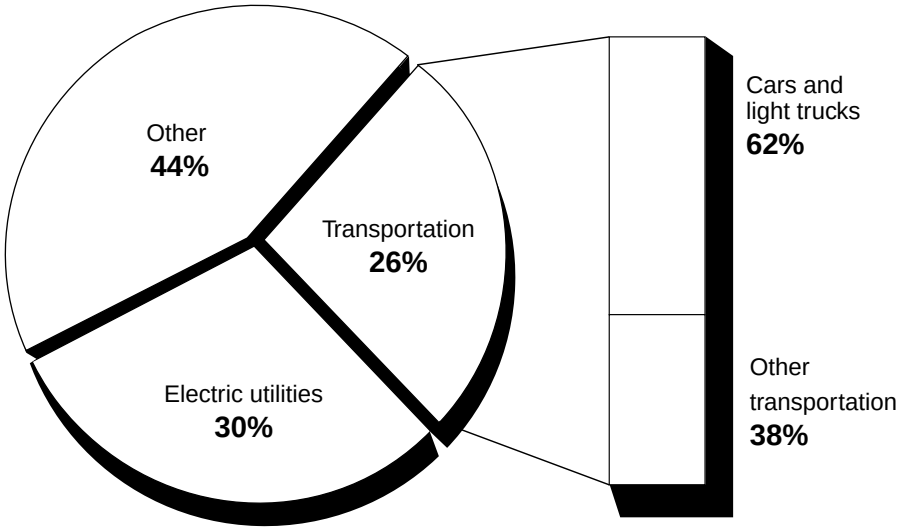
Source: GAO's presentation of data from DOE.

Of the transportation sector's share, cars and light trucks accounted for 60 percent, or about 40 percent of total U.S. petroleum use. Furthermore, the U.S. transportation sector relies on petroleum products for 97 percent of its energy needs.

Similarly, the United States is the largest emitter of greenhouse gases in the world and, according to EPA, the United States accounted for 25 percent of worldwide greenhouse gas emissions in 1997.[4] As figure 3 shows, the transportation sector accounted for a substantial portion of total U.S. greenhouse gas emissions, and cars and light trucks generated the largest share of the transportation sector's greenhouse gas emissions.

[4]According to many scientists, when added to the atmosphere, greenhouse gases, which include carbon dioxide and methane, increase the effectiveness of the earth's atmospheric blanket, warming the earth's surface and potentially leading to changes in climate. This phenomenon is commonly known as the "greenhouse effect."

Figure 3: U.S. Greenhouse Gas Emissions by Sector, 1997



Source: GAO's presentation of data from EPA.

Emissions from cars and light trucks in the United States accounted for 291 million metric tons of carbon (a measure of greenhouse gas emissions) in 1997. This amount exceeds the total greenhouse gas emissions of all but a few countries. In addition, according to EPA, the transportation sector is the fastest-growing U.S. sector in terms of greenhouse gas emissions.

Studies Link Improvements in Fuel Economy With Reductions in Fuel Consumption and Greenhouse Gas Emissions, but Projections Vary Widely

When policymakers debate whether to strengthen CAFE standards, one critical question is the extent to which increasing the standards would reduce fuel consumption and greenhouse gas emissions. Interest in reducing greenhouse gas emissions has grown because these gases have been linked to global warming. Of the studies we reviewed, three recent ones provided quantitative estimates of the extent to which increases in fuel economy would affect fuel consumption and greenhouse gas emissions (see app. II for further details on the studies). These studies all forecast future reductions in fuel consumption and greenhouse gas emissions; however, their results vary widely because they use different assumptions.

Two studies forecast substantial reductions in gasoline consumption and greenhouse gas emissions resulting from the introduction of new fuel-saving technologies (e.g., variable valve timing and continuously variable transmissions).[5] These studies were completed by DOE and the American Council for an Energy-Efficient Economy (ACEEE)[6] in 1997. They estimate future gasoline consumption and greenhouse gas emissions under scenarios ranging from no change in fuel economy to substantially higher levels of fuel economy—up to 51 mpg for new cars and 38 mpg for new light trucks in 2015. Under the studies' scenarios, the United States could reduce gasoline consumption and greenhouse gas emissions from cars and light trucks by between 18 and 37 percent annually by 2015. A key assumption underlying both of these studies is that fuel-saving technologies are cost-effective—the value of fuel savings to the consumer exceeds the increase in the retail price of the automobile through the use of the new technologies.

In contrast to DOE's and ACEEE's studies, a 1995 study done by Charles River Associates, Inc.,[7] for the American Iron and Steel Institute projects smaller reductions in fuel consumption and greenhouse gas emissions. The study estimates future gasoline consumption and greenhouse gas emissions under scenarios ranging from a modest improvement in fuel economy occurring with no regulatory intervention to substantially higher levels of fuel economy imposed by CAFE —36 mpg for new cars and 27 mpg for new light trucks in 2005. Under the study's scenarios, the United States could reduce gasoline consumption and greenhouse gas emissions from cars and light trucks by between 6 and 11 percent annually by 2010. These savings are substantially lower than either DOE's or ACEEE's primarily because this study assumes that much lower levels of fuel economy improvements are feasible and that implementing fuel-saving technologies is not nearly as cost-effective. As a result, the study concludes

[5]Variable valve timing increases engine efficiency by reducing the amount of air pressure lost while a vehicle engine is burning fuel. Continuously variable transmissions increase vehicle efficiency by allowing a vehicle to operate continuously at the most efficient gear and speed.

[6]ACEEE is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting economic prosperity and environmental protection. Based in Washington, D.C., ACEEE works closely with DOE, EPA, and other federal agencies.

[7]Charles River Associates, Inc., is an economics, finance, and business consulting firm that has completed thousands of projects for law firms, corporations, and government agencies worldwide.

that the price of cars and light trucks would increase so substantially that many consumers would decide to hold onto their older, less fuel-efficient vehicles longer, thus limiting the market penetration of more fuel-efficient vehicles and overall improvements in the automotive fleet's fuel economy.

The Impact of CAFE Increases on Automobile Safety Is Complex and Depends on Many Factors

Determining the impact of increasing CAFE standards on automobile safety is complicated by many factors, among them the size and weight of a vehicle, the behavior of individual drivers, and the presence or absence of car-specific safety features, such as airbags or side impact protection. In addition, most of the research we reviewed focused primarily on how vehicle weight reduction, rather than fuel economy increases, affects safety. Experts we spoke with said that the safety impact of increasing CAFE standards depends on the amount of lead time given to manufacturers, the size of the CAFE increase, and the strategies manufacturers use to achieve fuel economy gains. These experts also said that increasing CAFE standards would have a negative effect on automobile safety to the extent that the increase, in combination with other benefits and costs, encouraged manufacturers to build smaller, lighter, less crashworthy vehicles.

During our review, we found that although some studies address the relationship between automobile weight and safety, there is limited recent research that directly assesses the safety effects of raising CAFE standards. NHTSA recently conducted some research on how changes in vehicle weight and size affect vehicle safety. A 1997 NHTSA study estimated that reducing the weight of passenger cars by 100 pounds (while keeping the weight of all other vehicles constant) would result in approximately 300 additional fatalities each year (see app. II for further details on the study). The same study estimated that, conversely, reducing the weight of light trucks by 100 pounds (and keeping the weight of passenger cars constant) might have no effect or even result in a modest reduction in fatalities. The reduction could occur because reducing the weight of heavier vehicles on the road would cause those vehicles to do less damage to lighter vehicles in collisions. However, the Transportation Research Board (TRB) reviewed the study and expressed doubt about the precision of these numbers, suggesting they could be "substantially less, or possibly greater." Both NHTSA and TRB agree that drivers' behavior complicates this analysis. Furthermore, it is unlikely that estimates from past studies are applicable to today's vehicle fleet, since even the most recent studies include data for automobiles no later than model-year 1993. The automotive fleet has changed since that time with the introduction of additional safety

technologies and the dramatic increase in the proportion of light trucks on the road.

While auto manufacturers have downsized vehicles to increase fuel economy in the past, whether they would pursue this strategy in the future would depend on the economic costs and benefits of doing so. Instead, they may choose to use fuel-saving technologies as a means of increasing fuel economy. During our review, safety experts and auto manufacturer representatives said that giving auto manufacturers a longer lead time to meet new standards would give them time to implement fuel-saving technologies and help minimize the chance of a size and weight reduction.[8] Lead time is important because auto manufacturers set their product plans a number of years in advance, and making technological changes on short notice is difficult and costly. Automotive experts we spoke with said that providing auto manufacturers with 6 to 10 years' lead time should be sufficient to minimize negative safety effects.

Although experts generally agree that providing sufficient lead time can help manufacturers use fuel-saving technologies rather than downsize vehicles, there is no consensus on the potential of fuel-saving technologies to increase fuel economy over that period. Therefore, determining the level of CAFE standards achievable without affecting safety is difficult. A number of older studies indicate existing technologies are readily available that could increase fuel economy without reducing vehicle size and weight. Some of these technologies, such as variable valve timing, involve direct improvements to vehicle engines, while others, such as continuously variable transmissions, involve improvements to other vehicle features. As table 1 shows, these studies have estimated that the average fuel economy of passenger cars could be increased by 5.4 mpg to 8 mpg in approximately 10 years, primarily by introducing these technologies.

[8]While automobile manufacturers agreed that a long lead time would help avert any negative safety effects from increased CAFE standards, they did not indicate that they would favor increased CAFE standards if they were imposed with a long lead time.

Table 1: Selected Studies' Estimates of Technologically Feasible Fuel Economy Levels for Passenger Cars

Category	1991 Office of Technology Assessment (OTA)	1992 National Research Council (NRC)	1994 Energy and Environmental Analysis (EEA)
Lead time assumed	10 years	9 years	11 years
Predicted mpg feasible	35.5 mpg	33.0 mpg	36.0 mpg
Increase from actual mpg at date of study	7.5 mpg	5.4 mpg	8.0 mpg

Note: These estimates rely on a small amount of vehicle weight reduction.

Source: GAO's analysis of data from OTA, NRC, and EEA.

Many auto manufacturers contend that these studies overstate the potential benefits of existing technologies and underestimate their costs. NHTSA officials said that because the annual appropriations rider prohibits them from studying the issue, they do not have current information on the technological feasibility or cost-effectiveness of potential fuel-saving technologies. The officials also said they would have to study the effectiveness of these technologies and their potential impact on safety before they could set any new CAFE standards.

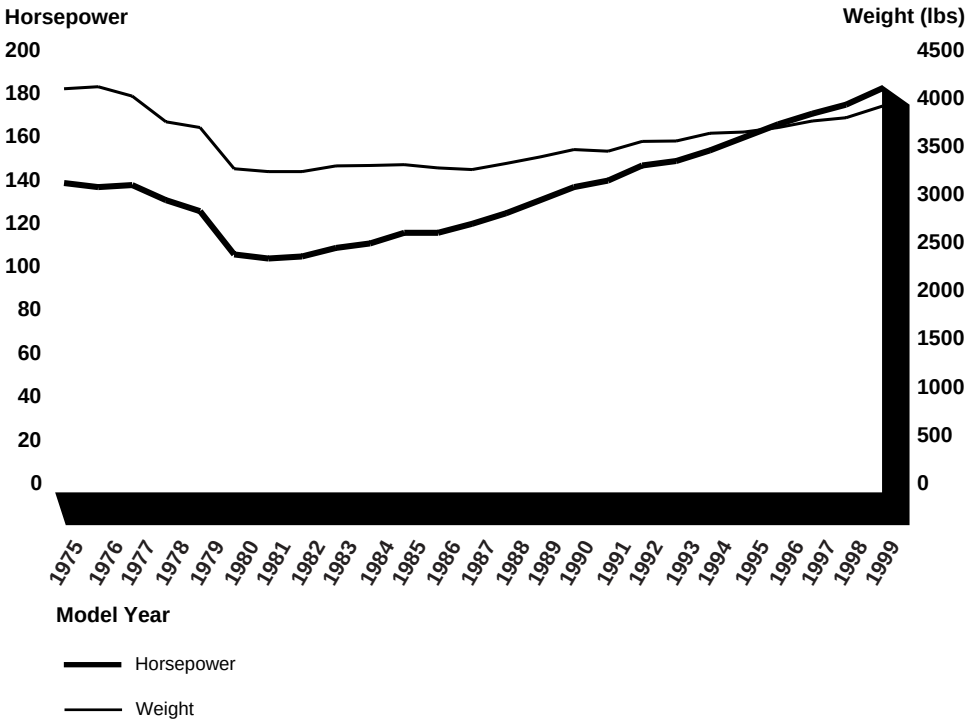
Other Issues Associated With the CAFE Discussion

During our review, we identified a number of other issues that should be considered when deciding whether to increase CAFE standards.

- Over the past 15 years, auto manufacturers have had little incentive to improve the fuel economy of new vehicles because, in a period of substantially declining real gasoline prices, U.S. consumers have preferred larger, more powerful vehicles. While automakers have introduced more efficient technologies that could have been used to improve fuel economy, they have instead applied these technologies to increase new vehicles' average weight and horsepower (attributes that consumers prefer). As figure 4 shows, the average weight and horsepower of new vehicles have increased in the past decade. Automakers contend that increasing CAFE standards runs counter to consumers' preferences and would require them to produce vehicles with attributes that consumers may not desire. While gasoline prices have recently risen substantially, it is too early to tell what effect these

increases will have on consumers' preferences for large, more powerful vehicles.

Figure 4: Average Horsepower and Weight in New Vehicles, 1975-99



Source: GAO's presentation of data from EPA.

- EPA recently issued new, more stringent air quality standards for controlling pollution from motor vehicle exhaust. For example, the standards will require a 77- to 95-percent reduction in emissions of nitrogen oxides by 2009. Some experts whom we contacted expressed concern that these standards may inhibit the use of certain technologies with great potential for improving fuel economy. This is because some of these technologies, which include lean-burn and diesel engines, while increasing fuel economy by as much as 30 percent over conventional gasoline engines, can result in increased emissions of some pollutants, such as nitrogen oxides, to levels higher than would be allowed under EPA's new standards. However, EPA believes the combination of regulatory flexibility within the standards and proposed lower sulfur diesel fuel requirements will permit auto manufacturers to develop future diesel engines that are clean, efficient, and in compliance with the new tailpipe emission standards.[9]
- Because there are separate CAFE standards for cars and light trucks, automakers must classify their vehicles as cars or trucks. To make these classification decisions, automakers follow rules established by DOT in 1978. The rules allow vehicles to be classified as light trucks if they have attributes such as back seats that can be easily removed to create a flat cargo area, off-highway capabilities, or other trucklike features. Minivans, SUVs, and pickup trucks are all classified as light trucks. However, auto manufacturers are now producing "crossover vehicles," which handle like cars but have expanded cargo capacity, and are classifying these vehicles as light trucks. EPA and DOT officials have expressed concern that the classification rules are outdated and allow manufacturers to meet the CAFE standard for light trucks without improving the fuel economy of their new SUVs, minivans, and pickup trucks. In addition, some environmental groups are concerned that certain vehicles—those with a gross vehicle weight rating (the maximum allowable weight of the fully loaded vehicle with passengers and cargo) of more than 8,500 pounds—are not subject to CAFE standards.

[9]According to EPA, the new standards give auto manufacturers ample time—up to 9 years—to develop better diesel emission control technologies. The standards also allow for fleetwide averaging, which means that manufacturers can produce some vehicles that emit higher levels of nitrogen oxides and some vehicles that emit lower levels so long as they meet an overall average.

- It is possible that technology-driven fuel economy increases could occur without increasing CAFE standards. For example, as we reported in March 2000,[10] the federal government and the automotive industry are jointly funding an advanced vehicle program known as PNGV. A goal of the PNGV program is to create an 80-mpg prototype family sedan by 2004, without sacrificing emission or safety standards, performance, utility, or affordability. Some believe that if 80-mpg vehicles are mass-produced and popular, the United States can achieve fuel economy goals without increasing CAFE standards. However, PNGV researchers must obtain significant cost savings before 80-mpg vehicles can be mass-produced and successfully marketed. To help offset the higher costs and launch the first generation of PNGV vehicles, the administration has proposed federal income tax credits for consumers who purchase advanced vehicles. Some automobile experts believe that, even without higher CAFE standards, technologies developed through PNGV will be incorporated gradually into existing product lines, thus improving fuel economy. Those who support CAFE argue that higher CAFE standards are needed to pull PNGV technologies into the marketplace and help ensure that these technologies are used to increase fuel economy rather than vehicle size and horsepower.
- Some research indicates that increasing CAFE standards is not as cost-effective as other policy measures for reducing fuel consumption and greenhouse gas emissions. Some studies we reviewed indicated that increasing gasoline taxes or further supporting the development of alternative fuels might achieve similar energy conservation and environmental goals, but at a lower cost.[11] For example, studies contend that the impact of CAFE standards is limited because they affect only new vehicles, do not reduce vehicle miles traveled, and may even encourage increased travel by reducing the marginal cost of driving. These studies also contend that because increasing gasoline taxes could affect all vehicles on the road and could possibly reduce the number of

[10] *Cooperative Research: Results of U.S.--Industry Partnership to Develop a New Generation of Vehicles* (GAO/RCED-00-81, Mar. 2000).

[11] The Alternative Motor Fuels Act of 1988 amended the CAFE program by allowing auto manufacturers to increase their fleetwide fuel economy averages by earning credits for producing vehicles that are capable of operating on alternative fuels such as ethanol or natural gas. This credit provision was seen as a way to encourage the development and use of alternative transportation fuels and vehicles. Because these credits enable manufacturers to produce other vehicles with lower fuel economy and still meet CAFE standards, EPA believes that the alternative fuel credits have resulted in a net reduction in fleetwide fuel economy and net increases in fuel consumption and greenhouse gas emissions.

vehicle miles traveled, it would be a more effective means of achieving energy conservation and environmental goals. Currently, there appears to be little national support for increasing gasoline taxes to meet energy conservation or environmental goals.

- The 2001 DOT appropriations bill passed by the House continued the prohibition against DOT's expending any funds to prepare new fuel economy standards. However, the Senate passed a motion instructing its conferees to DOT's appropriations conference to seek a final version of the bill that would authorize DOT, pursuant to a National Academy of Sciences study on the benefits and economic impact of CAFE standards, to recommend new standards if appropriate, but not to promulgate them without congressional approval.

Conclusion

Increasing the fuel economy of passenger motor vehicles was a key component of U.S energy policy during the 1970s and 1980s, and the average fuel economy of new vehicles rose from 15 mpg to more than 25 mpg during the same period. The CAFE standards program was seen as one of the key elements in realizing this goal. Clearly, increasing CAFE standards could reduce the forecasted growth in oil consumption and reduce greenhouse gas emissions; however, there is little consensus about the level of these benefits and the costs to achieve them. Despite potential safety concerns associated with a rapid increase in CAFE standards, there is general agreement that any negative safety effects of higher CAFE standards could be mitigated with appropriate automotive design, adequate time, and technical changes. With concerns growing about global warming and higher fuel prices, the Congress is once again confronted with key policy questions: Should government take additional steps to improve the fuel economy of passenger vehicles, and is the CAFE program the best mechanism to achieve this goal? Answering these questions involves difficult trade-offs and is further complicated by the lack of definitive research that addresses the interaction among all of these issues in the context of a 21st century automotive fleet.

Agency Comments

We provided DOT, EPA, and DOE with a draft of this report for review and comment. We met with officials from DOT and EPA, including the Chief, Consumers Program Division, and Assistant Chief Counsel, NHTSA; and the Leader, Climate Change Policy Team, National Vehicle and Fuel Emissions Laboratory, EPA, to discuss their comments on the report. Overall, DOT officials stated that the report accurately presented the

results of NHTSA's prior studies on vehicle weight and safety, and EPA officials stated that the report was accurate and presented a balanced view of a complex and controversial issue. DOT officials stated that the Department had tried in 1994 to pursue a long lead time approach to increasing CAFE standards, but that the auto industry had opposed the increases regardless of lead time. We indicated that our report did not attempt to address whether the auto industry would accept such long-term increases in CAFE standards. Instead, it was limited to a discussion of how providing sufficient lead time could help mitigate any potential adverse effects on safety of future increases in CAFE standards. We added language to the report to clarify this point.

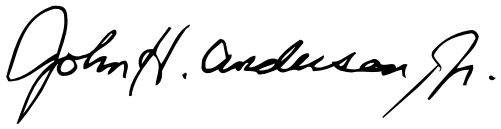
EPA officials also provided some specific comments. First, they stated that, in their opinion, the new tailpipe emission standards would not inhibit automobile manufacturers' ability to use diesel engines in the future. They stressed that the combination of regulatory flexibility designed into the standards program and proposed lower sulfur diesel fuel requirements would allow for future clean diesel engines. In response to this comment, we added information to the report to clarify EPA's position. Second, they suggested that we highlight an unintended consequence of the alternative fuels credit program—that auto manufacturers use credits to offset other low-fuel-economy vehicles and still maintain CAFE compliance. The result of this practice, they stated, has been to lower fleetwide fuel economy and increase fuel consumption and greenhouse gas emissions. We added information in the report to reflect EPA's concerns. Finally, EPA suggested that we include information about tax credits proposed by the administration to encourage the development of advanced vehicles. We included this information in the report.

Finally, officials from DOT, EPA, and DOE provided additional technical and editorial comments that we incorporated throughout the report, where appropriate.

As arranged with your office, unless you publicly release its contents earlier, we plan no further distribution of this report until 10 days after the date of this letter. At that time, we will send copies to the Senate and House Committees with jurisdiction and oversight of energy, commerce, and transportation issues; the Honorable Rodney Slater, Secretary of Transportation; the Honorable Bill Richardson, Secretary of Energy; and the Honorable Carol M. Browner, Administrator, Environmental Protection Agency. We will also make copies available to others on request.

If you have any questions about this report, please call me at (202) 512-2834. Key contributors to this assignment were David Lichtenfeld, Gail Marnik, Raymond Sendejas, and Robert White.

Sincerely yours,



John H. Anderson, Jr.
Director, Transportation Issues

Scope and Methodology

To determine the impact of changes in Corporate Average Fuel Economy (CAFE) standards on oil consumption, the environment, and automobile safety, we relied on two main sources of information. First, to gain a general understanding about how improving fuel economy relates to these three areas, we obtained and reviewed 68 studies. (See app. III for a list of these studies.) We compiled the list of studies using recommendations from transportation, environment, and energy experts, as well as the results of a library literature search. Of these 68 studies, we identified 3 recent ones that quantified the potential impact of improving fuel economy on oil consumption and the environment, and we relied extensively on these studies. These studies used computer models to project future fuel economy gains and the subsequent impact on oil consumption and greenhouse gas emissions. We did not attempt to verify the accuracy of the models' assumptions or results.

During our review, we found that little recent research directly assesses the safety effects of raising CAFE standards. However, we identified studies that evaluated the impact of automobile weight reduction on highway safety and focused on one study in particular that used a regression analysis to quantify the safety effects of vehicle weight reduction. (See app. II for a description of each study.) We did not attempt to verify the accuracy of this analysis.

Second, we supplemented our literature review with interviews of transportation experts who specialize in energy, environmental, and automobile safety issues. These experts included officials from the Department of Energy (DOE), the Department of Transportation (DOT), the Energy Information Administration (EIA), the Environmental Protection Agency (EPA), and Oak Ridge National Laboratory. These officials provided current information about the possible effects of raising fuel economy standards. We also spoke with automobile industry representatives at the Alliance of Automobile Manufacturers, a trade group that represents the three major U.S. automobile manufacturers and a number of foreign manufacturers, as well as with regulatory managers from the American Honda Motor Company about automakers' potential responses to CAFE increases. Furthermore, we interviewed representatives from organizations concerned with the environment and energy use, including the Sierra Club and the American Council for an Energy-Efficient Economy (ACEEE), to discuss the relationship among fuel economy, oil consumption, and greenhouse gas emissions. Finally, we interviewed safety experts, including representatives from the Insurance

Institute for Highway Safety and the Center for Auto Safety, to discuss the relationship between fuel economy and automobile safety.

To identify other issues that might affect the CAFE discussion, we also solicited input from these experts. They raised a number of issues that they indicated were relevant to the CAFE discussion, and we included those issues that were within the scope of our review.

We conducted our review from December 1999 through August 2000 in accordance with generally accepted government auditing standards.

Summaries of Studies by DOE, ACEEE, AISI, and NHTSA

This appendix summarizes studies by DOE; ACEEE; Charles River Associates, Incorporated, for the American Iron and Steel Institute (AISI); and the National Highway Traffic Safety Administration (NHTSA).

DOE's Five-Lab Study

DOE's report *Scenarios of U.S. Carbon Reductions* (informally referred to as the Five-Lab study) presents the results of a study conducted by five DOE national laboratories that quantifies the potential for energy-efficient and low-carbon technologies to reduce carbon emissions in the Unites States.[1] The study documents in detail how four key sectors of the economy—buildings, transportation, industry, and electric utilities—could respond to directed programs and policies to expand the adoption of energy-efficient and low-carbon technologies. Of particular interest to us was the analysis of the transportation sector's response—for passenger vehicles, in particular—to energy-efficient and low-carbon technologies.

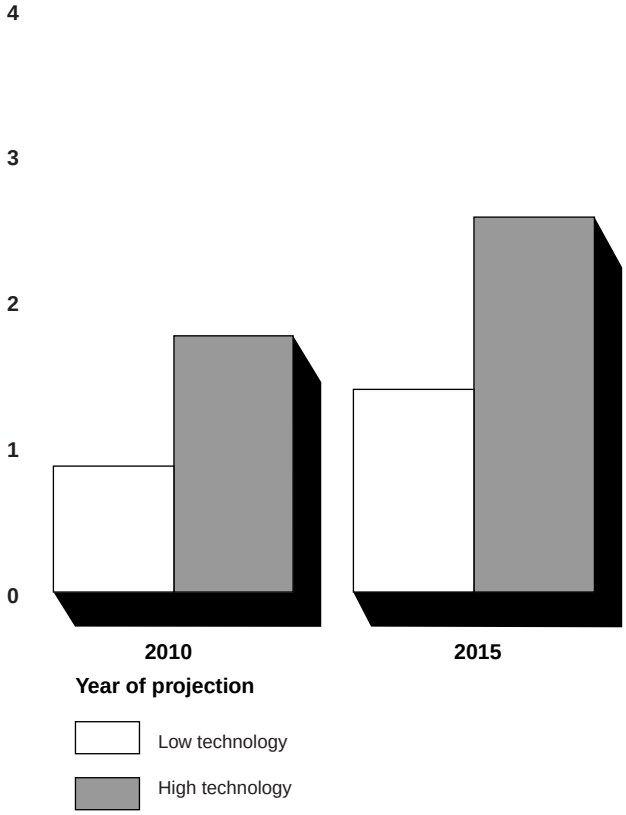
[1] *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, Interlaboratory Working Group (Lawrence Berkeley and Oak Ridge National Laboratories, LBNL-40533 and ORNL-444, Sept. 1997).

In its analysis of the transportation sector, DOE forecasts gasoline savings resulting from increases in fuel economy attributable to research and development. The study assumes that significant increases in government-sponsored research and development, coupled with government policies such as higher CAFE standards, lead to the implementation of advanced fuel economy technologies in new automobiles. The study also assumes that the technologies are cost-effective—that the value of fuel savings to the consumer exceeds the increase in the retail price of the automobile. Furthermore, the study takes into account the fact that fuel economy improvements can lead to increased driving, which offsets some of the overall fuel savings. Known as the "rebound effect," this phenomenon occurs because fuel economy improvements reduce the fuel cost per mile of travel and thus lead to increases in the miles driven. The study contrasts a "business-as-usual" scenario, which assumes a flat fuel economy, with more optimistic scenarios that assume greater use of available advanced fuel-saving technologies and the introduction of breakthrough technologies. The study does point out, however, that the results of its most optimistic scenario are less likely and require a certain degree of luck because it relies on breakthrough technologies. As we reported in September 1998, many questions surround the reasonableness of some key assumptions and the accuracy of the study's results.[2]

Under what we have termed the "low technology" scenario, which assumes greater use of readily available advanced fuel-saving technologies, the study projects that the United States could reduce gasoline consumption by 1.8 million barrels per day (mmbd) and greenhouse gas emissions by 66 million metric tons of carbon (mmtc) in 2015. Under the even more optimistic "high technology" scenario, in which technologies significantly improve fuel economy, the study indicates that the United States could reduce gasoline consumption by 2.6 mmbd and save 97 mmtc annually by 2015. These reductions represent a 27-percent reduction over the estimates of car and light truck gasoline consumption and greenhouse gas emissions in 2015 under the business-as-usual scenario. In this scenario, fuel economy rises to 50 mpg for new cars and to 38 mpg for new light trucks in 2015. See figures 5 and 6.

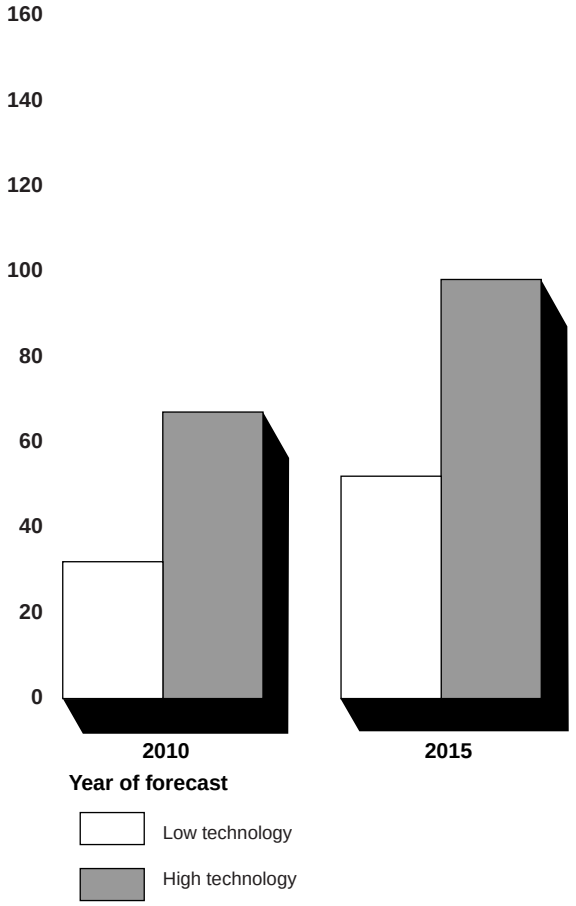
[2]*Climate Change: Information on Limitations and Assumptions of DOE's Five-Lab Study* (GAO/RCED-98-239, Sept. 8, 1998).

Figure 5: Projected Reduction in Gasoline Consumption Under DOE's Technology Scenarios Relative to the Baseline Scenario



Source: GAO's presentation of data from DOE.

Figure 6: Projected Reduction in Greenhouse Gas Emissions Under DOE's Technology Scenarios Relative to the Baseline Scenario



Source: GAO's presentation of data from DOE.

The ACEEE Study

We reviewed a 1997 study completed by ACEEE that forecasted gasoline and greenhouse gas emissions savings due to CAFE-driven increases in fuel economy.[3] The study contrasts a baseline scenario, which assumes a flat

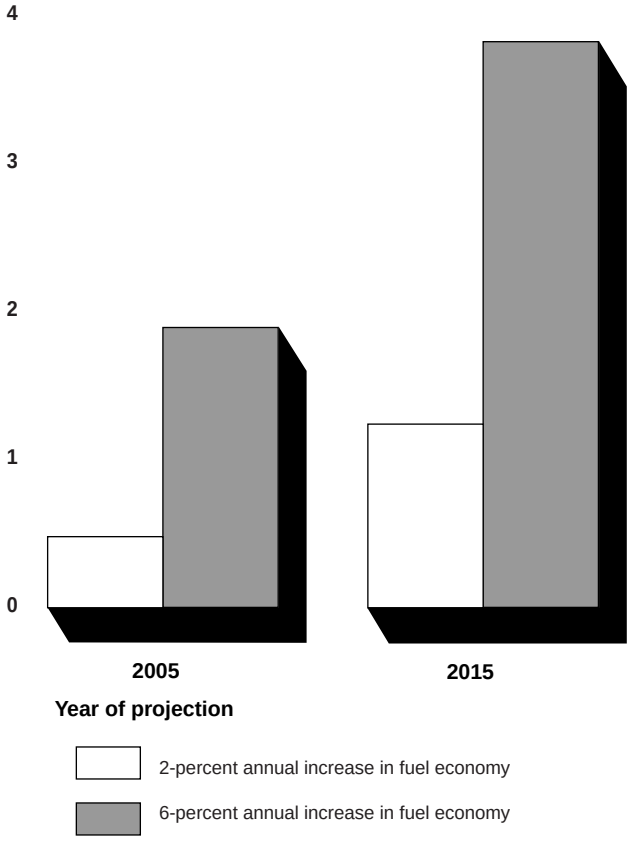
[3]John DeCicco and Lee Lynd, "Combining Vehicle Efficiency and Renewable Biofuels to Reduce Light-Vehicle Oil Use and CO_2 Emissions," *Transportation, Energy, and Environment: How Far Can Technology Take Us?* (ACEEE, 1997), pp. 75-108.

fuel economy, with scenarios involving incremental improvements in fuel economy from a base of 25 mpg. These improvements begin in 1998 and continue linearly at various rates of up to 6 percent per year. Our review focused on two of the study's scenarios—the 2-percent scenario, which assumes modest fuel economy improvements of 0.5 mpg annually (2 percent of 25 mpg), and the 6-percent scenario, which assumes more optimistic fuel economy improvements of 1.5 mpg annually (6 percent of 25 mpg). Like the DOE study, this study assumes that fuel-saving technologies are available and cost-effective and takes into account the reduction in fuel savings due to the rebound effect.

As indicated in figures 7 and 8, the study projects that, compared with a base case scenario of no fuel economy changes, fuel economy improvements of 2 percent annually could reduce fuel consumption by nearly 2 mmbd and greenhouse gas emissions by 72 mmtc annually in 2015.[4] Fuel economy improvements of 6 percent annually could save nearly 4 mmbd and 145 mmtc annually in 2015. Reductions in gasoline consumption and greenhouse gas emissions from cars and light trucks under the 6-percent scenario represent a 37-percent reduction, as compared with the baseline, in 2015. Increasing fuel economy 6 percent each year results in new cars reaching 51 mpg and new light trucks achieving 38 mpg in 2015.

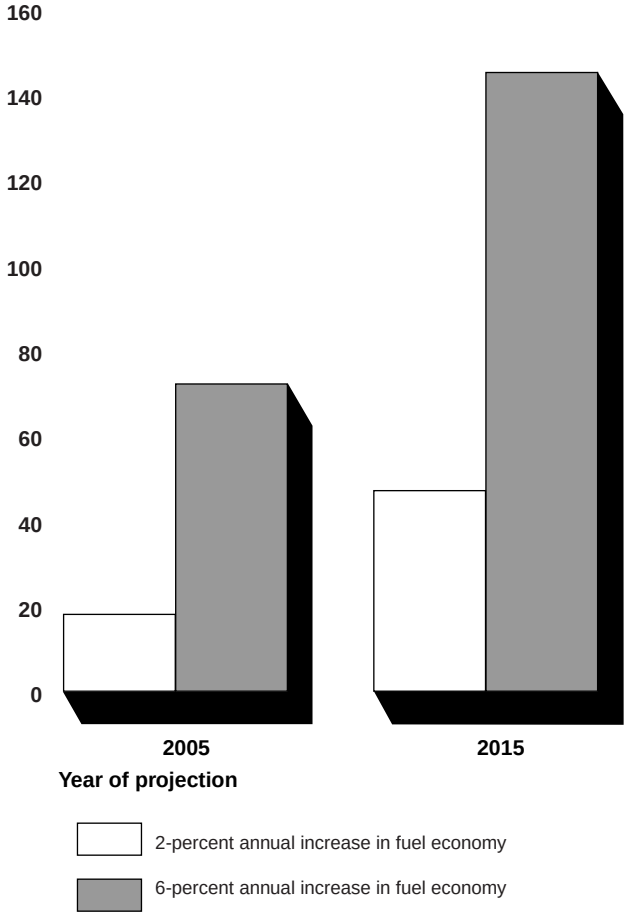
[4]The ACEEE study included greenhouse gases emitted directly by vehicles as well as those emitted during the production and distribution of motor fuels—"upstream emissions." Accounting for upstream emissions adds about 25 percent to total car and light-truck emissions under baseline and fuel economy improvement scenarios. To make the ACEEE study's results comparable with those of the other two studies, which account only for direct emissions, we adjusted the results to include only direct emissions.

Figure 7: Projected Reduction in Gasoline Consumption Under ACEEE's Scenarios Relative to the Baseline Scenario



Source: GAO's presentation of data from ACEEE.

Figure 8: Projected Reduction in Greenhouse Gas Emissions Under ACEEE's Scenarios Relative to the Baseline Scenario



Source: GAO's presentation of data from ACEEE.

The AISI Study

In 1995, Charles River Associates, Inc., completed a report evaluating the impact of raising CAFE standards for AISI.[5] The study assessed how the automotive industry could respond to changes in CAFE standards and

[5]*The Impact of Raising Corporate Average Fuel Economy (CAFE) Standards*, final report, prepared for AISI by Charles River Associates, Inc. (July 1995).

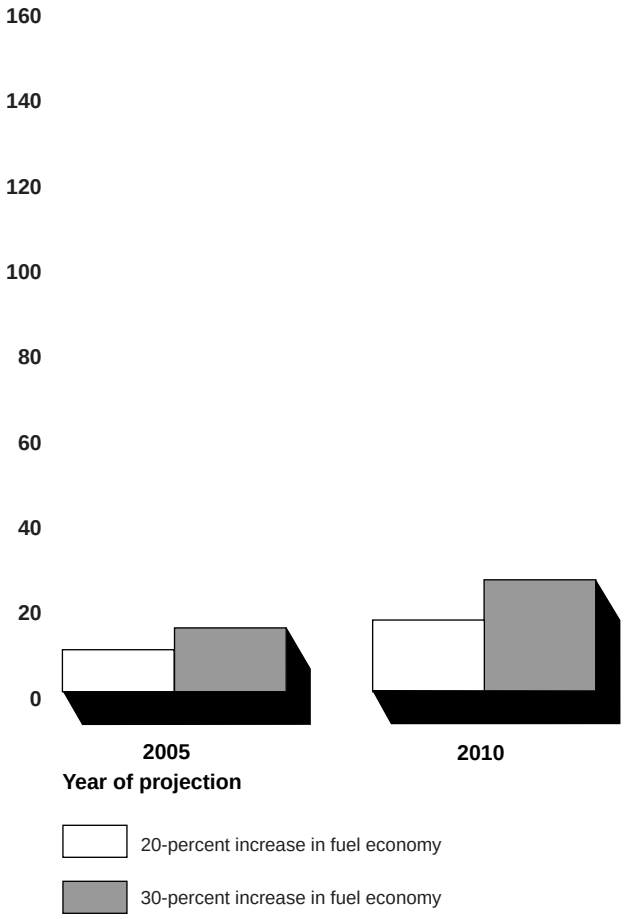
made assumptions about how these reactions would affect the affordability of new cars and light trucks and what impact they would have on fuel consumption and emissions. The study presents a baseline scenario, in which fuel economy increases slightly while CAFE standards remain constant through 2005, and two scenarios in which CAFE standards increase by 20 and 30 percent, respectively, by 2005. The study assumes much lower levels of feasible fuel economy improvements as compared with either DOE's or ACEEE's study and finds that although fuel-saving technologies are readily available, their implementation may not be cost-effective. The study also takes into account the reduction in fuel savings due to the rebound effect.

Under the 20-percent scenario, as indicated in figures 9 and 10, the study projects fuel savings of roughly 0.5 mmbd and greenhouse gas emissions savings of about 17 mmtc per year by 2010 as compared with the baseline scenario. Under the 30-percent scenario, the study projects fuel savings of roughly 0.8 mmbd and greenhouse gas emissions savings of roughly 31 mmtc per year by 2010. These savings represent an 11-percent reduction, as compared with the baseline, for cars and light trucks by 2010. Increasing fuel economy 30 percent results in fuel economies of 36 mpg for new cars and of 27 mpg for new light trucks in 2005.

Figure 9: Projected Reduction in Gasoline Consumption Under AISI's Study

Source: GAO's presentation of data from AISI.

Figure 10: Projected Reduction in Greenhouse Gas Emissions Under AISI's Study



Source: GAO's presentation of data from AISI.

The NHTSA Study

Finally, we reviewed a 1997 NHTSA study that estimated the change in highway fatalities if vehicle weights were reduced by 100 pounds.[6] The study uses crash data compiled from 11 states and the national Fatality

[6]Charles J. Kahane, *Relationships Between Vehicle Size and Fatality Risk in Model Year 1985-93: Passenger Cars and Light Trucks* (Washington, D.C.: National Highway Traffic Safety Administration, Jan. 1997).

Analysis Reporting System database to perform a regression analysis estimating the relationship between vehicle weight and fatality risk. The study uses vehicle and crash data from model years 1985 to 1993. The study attempts to control for confounding factors such as drivers' age and gender.

The study estimated that reducing the weight of passenger cars by 100 pounds, in the absence of any improvements in safety technology, could lead to approximately 300 additional fatalities per year. In performing this analysis, NHTSA assumes that light truck weights are kept constant and automakers maintain historical relationships between vehicle weight and parameters such as track width, center of gravity, and structural strength. Conversely, NHTSA modeled the effect of a 100-pound reduction in light truck weight while holding passenger car weight constant. The study found that although this scenario would result in approximately 80 fewer fatalities in car/light truck collisions, its overall effect across collisions of all types of vehicles was not statistically significant.

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