IMPROVING THE NATION'S ENERGY SECURITY: CAN CARS AND TRUCKS BE MADE MORE FUEL EFFICIENT?

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

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IMPROVING THE NATION'S ENERGY SECURITY: CAN CARS AND TRUCKS BE MADE MORE FUEL EFFICIENT?

WEDNESDAY, FEBRUARY 9, 2005

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 2:30 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Improving the Nation's Energy Security: Can Cars and Trucks Be Made More Fuel Efficient?

Wednesday, February 9, 2005
2:30 p.m. – 4:30 p.m.
2318 Rayburn House Office Building (WEBCAST)

Witness List

The Honorable William Reilly
Aqua International Partners

Dr. Paul Portney
President
Resources for the Future

Dr. David Greene
Oak Ridge National Laboratory
Center for Transportation Analysis
National Transportation Research Center

Mr. K.G. Duleep
Managing Director of Transportation
Energy and Environmental Analysis, Inc.

Mr. Michael J. Stanton
Vice President of Government Affairs
Alliance of Automobile Manufacturers

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Improving the Nation's Energy Security: Can Cars and Trucks Be Made More Fuel Efficient?

WEDNESDAY, FEBRUARY 9, 2005
2:30 P.M.—4:30 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On February 9, the Committee on Science will hold a hearing on the availability of technologies to improve fuel economy in cars and trucks and the potential for fuel economy improvements to reduce the Nation's dependence on foreign oil.

The U.S. depends on imports to meet nearly 60 percent of its oil needs, much of it from troubled countries or regions of the world, including Nigeria, Venezuela, Russia, and the Middle East. The gasoline burned by cars and trucks accounts for about 45 percent of the Nation's oil consumption. Total U.S. daily oil consumption is expected to rise from 20 million barrels today to 29 million barrels by 2025, mostly as a result of increasing consumption for transportation.

The hearing will focus on the pros and cons of tightening federal fuel economy standards for cars and light trucks (known as Corporate Average Fuel Economy, or CAFE standards) and reforming the program as a way to reduce U.S. oil consumption and encourage the use of new technologies. But witnesses have also been asked to discuss more generally how the Federal Government could promote the deployment of fuel-saving technologies. Other options include tax incentives, fuel taxes, and research, development and demonstration programs.

More specifically, the hearing will review and update the findings of the National Academy of Sciences on CAFE standards issued in 2002. The Academy report, which was commissioned by the Congress, concluded that the technology exists to significantly improve the fuel economy of cars and light trucks without reducing safety.

In December, the National Commission on Energy Policy, a bipartisan group of leaders from business, government, and academia that included experts in national security, energy, and the environment released a set of recommendations for U.S. energy policy. The recommendations included a call to raise CAFE standards to enhance the Nation's energy security. The privately funded group was chaired by William Reilly, who was Administrator of the Environmental Protection Agency (EPA) under President George H.W. Bush, and John Holdren, the Teresa and John Heinz Professor of Environmental Policy at Harvard University.

The Committee plans to explore the following overarching questions at the hearing:

1. To what extent can improving fuel economy in cars and trucks improve the economic and energy security of the Nation?
2. What technologies are available or will soon be available to improve fuel economy in cars and trucks? How much could these technologies improve fuel economy without compromising safety or the economy?
3. What policy options are available to Congress to encourage the adoption of automobile efficiency technologies? What are the advantages and disadvantages of each?

Witnesses:

1. **William Reilly** co-chaired the National Commission on Energy Policy, which in December released a report entitled *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges.* Mr. Reilly is founding partner of the investment firm Aqua International Partners and was the Administrator of EPA under President George H.W. Bush.

2. **Paul Portney** was Chairman of the National Academy of Science's Committee on the Effectiveness and Impact of Corporate Fuel Economy (CAFE) Standards, which authored the 2002 report. An economist, he is the President of Resources for the Future, a D.C.-based energy and environmental policy research institute.
3. **K.G. Duleep** is Transportation Managing Director of the energy and environmental consulting firm Energy and Environmental Analysis, Inc. He is an internationally recognized expert on vehicular fuel economy and emissions issues. He has been involved with automotive technology, fuel economy, and emissions issues for over 20 years.
4. **Michael Stanton** is Vice President of Government Affairs at the Alliance of Automobile Manufacturers, a trade association representing the BMW Group, DaimlerChrysler, Ford Motor Company, General Motors, Mazda, Mitsubishi Motors, Porsche, Toyota, and Volkswagen.
5. **David Greene** is a Corporate Fellow at the National Transportation Research Center, Oak Ridge National Laboratory. He has spent 25 years researching transportation and energy policy issues.

Issues:

- **Has the Corporate Average Fuel Economy (CAFE) law worked?** Congress created the CAFE program in 1975 after the Arab oil embargo, which resulted in a tripling of the price of oil in the early 1970s. Average new car fuel economy rose from 12.9 miles per gallon (mpg) in 1974 to 27.6 mpg in 1985—slightly more than the 27.5 mpg required by the CAFE standards that year. (The average for new light trucks, the category that now includes pickups, SUVs and mini-vans, rose to 19.5 mpg over the same time period.) Today, the standards stand at 27.5 mpg for cars and 21.0 mpg for light trucks.

  Experts argue over the extent to which the increase in fuel economy in the 1970s and 1980s can be attributed to CAFE or to high fuel prices. Some say that the sudden hike in prices in the 1970s and the threat of competition from Japanese automakers (who were entering the U.S. market with more fuel efficient cars) were the predominant forces driving the increase in domestic fuel economy. But the National Academy of Sciences panel concluded that CAFE standards have played a leading role in preventing fuel economy levels from dropping as much as they otherwise would have as fuel prices declined in the 1990s, and that fuel use by cars and trucks today is roughly one-third lower than it would have been had fuel economy not improved since 1975.

  Experts also argue whether, regardless of their effectiveness, CAFE standards are the most efficient and effective way to increase fuel economy.

- **Why has the fuel economy of new vehicles been on a downward trend since 1987?** The average fuel economy of new vehicles sold in the U.S. has declined since reaching a peak in 1987. The major reason is the explosive growth in SUVs, mini-vans, and pickup trucks, which must meet a fuel economy standard that is lower than that for passenger cars. The number of light trucks sold has more than tripled since 1980, while the number of passenger cars has declined slightly over the same period. Today more than half the new cars sold are light trucks. At the same time, CAFE standards have remained stagnant. The fuel economy standard for new cars has not changed since 1990. And until this year, the standard for new light trucks had not changed since 1996.

  The fact that the average fuel economy has declined since 1987 does not mean that no new cars or light trucks use newer, more fuel-efficient technologies. But any improvements in fuel economy in a particular model have been offset by declines in fuel economy in other models (or by increased sales of models with lower fuel economy), allowing the average—which is based on sales of all makes and models—to drop. Proponents of CAFE standards argue that government action is the only way to raise the average by pushing improvements across automakers' fleets.

  Automakers point out that they have made cars and trucks more efficient, pound for pound, in recent years. They note that they have significantly increased the power and size of vehicles without much change in fuel economy. And they argue that customers prefer power, size and luxury over fuel effi-

ciency. As a result, average vehicle weight has increased by 24 percent since 1981 and average horsepower has increased by 93 percent.

- **Does the technology exist to improve the fuel economy of cars and trucks?** The National Academy of Sciences report identified 14 technologies that were readily available in 2002 to improve the efficiency of automotive engines, transmissions, and overall design (such as a vehicle's aerodynamics and rolling resistance). The Academy also identified nine emerging technologies, some of which had already been introduced in European or Japanese markets, but not in the U.S.

  The Academy concluded that the technologies it identified, in combination, would allow fuel economy increases of 12 to 27 percent for cars and 25 to 42 percent for light trucks without any reduction of safety. (The technologies would also pay for themselves in fuel savings, the Academy found. See attachment.)

  The Academy did not include hybrid vehicles among the technologies it identified because they had just been introduced into the American market when the Academy conducted its study. Sales of hybrids have continued to grow since the Academy issued its report. The National Commission on Energy Policy report, released late last year, found that the ability of hybrid technologies to make substantial improvements in fuel economy has been clearly demonstrated.

  Automakers question whether consumers will be willing to pay for efficiency technologies. Even if the technology pays for itself in gasoline savings over the life of the vehicle, they say, many consumers do not consider those kinds of long-term benefits when choosing a vehicle.

- **Can fuel economy be improved without eroding passenger safety?** The relationship between fuel economy and safety is fiercely debated. Even the National Academy of Sciences panel was split on this issue. A majority found that when automakers in the 1970s and 1980s made vehicles more efficient by making them smaller and lighter, they also likely increased the number of crash fatalities by several percent. (Two members of the panel believed the relationship between weight, size and safety to be too uncertain to determine whether any additional casualties occurred due to fuel economy improvements during that time.)

  The Academy panel concluded unanimously, however, that fuel economy could be increased in the future without any detriment to safety. The Academy said that the technologies it had identified for improving fuel economy would not reduce safety and could even increase it. The panel also called for a reduction in the weight of the heaviest vehicles in the light truck category as a way to increase safety and fuel economy simultaneously. The Academy found that if the weight and size of the heaviest vehicles, particularly those over 4,000 pounds, were reduced, vehicle safety would improve by reducing the damage caused by those vehicles in crashes.

- **Would raising fuel economy standards disadvantage domestic manufacturers?** The National Academy of Sciences report concluded that CAFE regulations could have different effects on different manufacturers, but that those effects could be minimized. The sales and especially the profits of General Motors, Ford, and the Chrysler division of DaimlerChrysler, are much more dependent on light trucks than are their competitors. If fuel economy standards were raised for light trucks, but not for cars, U.S.-based companies would likely suffer. (This assumes that redesigning light trucks to improve fuel economy would either raise the prices of the vehicles, driving customers away, or require automakers to absorb some of the costs of redesign, eating into profits.) Conversely, if standards were raised for cars only, U.S.-based companies might be advantaged. But fuel economy increases in light trucks would produce greater oil savings.

  To minimize the costs of improving fuel economy, both the National Academy of Sciences and the National Commission on Energy Policy recommended reforming CAFE regulations to allow manufacturers to trade fuel economy credits with one another in much the same way that electric utilities trade pollution allowances. Under such a system, an automaker that could not improve its average fuel economy to the extent required by CAFE standards could purchase credits from an automaker that had exceeded CAFE standards. (The government could also sell credits.) Tradable CAFE credits would give

manufacturers an incentive to exceed the standards since they could then sell the credits to others. And it could minimize the overall cost of the program by ensuring that the auto industry as a whole made the most economical improvements in fuel economy.

Even under a CAFE program that allowed tradable credits, however, domestic automakers, which sell the largest and least fuel efficient vehicles, would likely have to invest the most, either in purchasing credits from other manufacturers or in developing fuel efficient technologies.

That is one reason why the National Commission on Energy Policy further recommended that an increase in CAFE standards be coupled with a tax incentive program to encourage the domestic production of vehicles with fuel efficient technologies like hybrid and diesel technologies.

The Academy also recommended that Congress eliminate the separate categories for cars and light trucks. That would enable CAFE standards to allow automakers more flexibility because they could meet a single CAFE standard for their entire fleet in more ways. An automaker could choose to meet a tighter CAFE standard either by improving the fuel mileage of cars or light trucks or both. However, eliminating the current categories would likely severely disadvantage U.S.-based automakers because their fleets are so weighted toward light trucks that the bulk of any fuel economy improvements would still have to be made in that class of vehicles. However, new categories based on weight, size or horsepower, might go a long way toward leveling the playing field.

- **How would higher fuel economy standards likely affect workers in the automotive industry?** The National Academy of Sciences panel believed that fuel economy standards could be raised without negative consequences on employment if the increase were implemented with enough lead-time. Even existing technologies, the report said, could take four to eight years to penetrate the market.

  The Academy panel pointed out, however, that larger scale trends have a much greater effect on employment than do CAFE standards. Employment in the auto industry increased from little over 600 million in the early 1980s to over one million in 1999, largely because of foreign-owned companies' decisions to build manufacturing plants in the U.S. Over the same time period, however, organized labor lost almost half of its members due to the domestic manufacturers' improvements in automobile production, shifts of parts production overseas, and loss of market share to foreign-owned manufacturers. (Workers in their plants, even those in the U.S., generally are not unionized.)

  The National Commission on Energy Policy argued that its recommendation for tax incentives for the domestic production of hybrid and diesel vehicles would help staunch this flow. The Commission argued that some jobs would be lost in any event as foreign manufacturers expand their efforts to introduce hybrid and diesel vehicles in the U.S. market. But the Commission calculated that its tax incentives would result in about 25 percent fewer jobs being lost.

- **How much oil would an increase in fuel economy save?** According to the National Commission on Energy Policy, improving car and light truck fuel economy by 10, 15, and 20 percent by 2015 would result, by 2025, in an estimated fuel savings of approximately two, three, and 3.5 million barrels of oil a day respectively. Such savings represent a 25 to 40 percent reduction in the additional amount of oil by which U.S. demand is currently projected to grow by that time, absent other policy interventions.

Background:

Origins of the CAFE Program

The early 1970s saw the price of oil triple, an increase precipitated by an embargo orchestrated by the oil cartel OPEC (Organization of Petroleum Exporting Countries). The crisis threw into stark relief the fuel inefficiency of U.S. manufactured automobiles, and consumers began switching to relatively fuel efficient imported vehicles. Congress passed the *Energy Policy and Conservation Act* in 1975 with the goal of reducing the Nation's dependence on foreign oil, which established, among other things, the Corporate Average Fuel Economy (CAFE) program to raise the fuel economy of the U.S. fleet.

The CAFE program requires the fuel economy of an automaker's entire product line of cars and light trucks sold in the U.S., averaged across all models and weighted by sales, to meet a miles-per-gallon level set by the government. Under the 1975 law, Congress sets the target for passenger cars, which rose from 18 mpg in 1978 to 27.5 mpg in 1990, where it remains today. Congress delegated the authority to set fuel economy standards for light trucks to the National Highway Transportation Safety Administration (NHTSA). Light truck standards rose from 17.5 mpg in 1982 to 20.7 mpg in 1996. Beginning this year, the standard for light trucks is to rise gradually to 22.2 mpg in 2007. The increase this year is the first since 1996, in part, because language added to appropriations bills forbade NHTSA from raising the standard between 1996 and 2000.

When Congress created the CAFE program, light trucks accounted for a small portion of vehicle sales and generally included trucks used on farms or at construction sites. According to the Congressional Research Service, the number of new passenger cars sold each year in the U.S. has decreased somewhat since 1980, but the number of light trucks sold has more than tripled, from 2.2 million in 1980 to 8.7 million in 2001.

Domestic manufacturers still dominate the light truck market, but their share has declined from 86 percent in 1993 to less than 77 percent in 2002 as foreign automakers have aggressively targeted this popular sector of the U.S. market, focusing on somewhat smaller, more fuel efficient models.

Recent Actions

In 2003 NHTSA issued a final rule to boost the CAFE standard for light trucks by 1.5 miles per gallon by 2007. NHTSA estimates that the increase will save approximately 75,000 barrels of oil a day between 2006 and 2012, or less than 0.4 percent of current consumption.

In 2003 NHTSA also issued an Advance Notice of Proposed Rule-making inviting comments on a wide variety of potential ways to change the CAFE program to address a number of criticisms that have been made, including those made by the National Academy of Sciences panel. For example, NHTSA has invited comments on whether it ought to discard the distinction the program makes between cars and light trucks (which would require a statutory change); establish separate fuel economy standards for various classes of light trucks based on weight, size, or some other attribute; or extend fuel economy standards to light trucks weighing up to 10,000 pounds (since such vehicles are currently not subject to fuel economy standards). NHTSA has set no date for when it might propose actual reforms based on these comments.

Questions Asked of the Witnesses:

The witnesses were asked to address the following questions in their testimony:

Mr. Reilly:

Please describe the Commission's recommendation to improve fuel economy (particularly those related to Corporate Average Fuel Economy (CAFE) Standards), and address the following questions:

1. What are the expected economic and energy security benefits from reducing the Nation's dependence on oil? If we are to reduce our dependence on oil, how important is it to improve the fuel economy of cars and light trucks?
2. What effect would your recommendations have on the relative competitiveness of American and foreign-owned automobile manufacturers, on American workers in the automotive industry and on automotive safety?

Mr. Portney:

Please describe the findings of the Academy report, with particular emphasis on the following questions:

1. Have Corporate Average Fuel Economy (CAFE) standards been effective at saving the country oil?
2. How much of an increase in fuel economy did your panel find was technologically possible? How much did you find could pay for itself in gasoline savings to the consumer?
3. To what extent could the technologies to improve fuel economy described in the report be adopted without eroding safety?
4. What are the Academy report's recommendation's for improving the CAFE law?

Mr. Duleep:

1. What technologies are available now or are emerging that provide the best opportunities for automakers to boost fuel efficiency? How much could they improve fuel economy?
2. What are the prospects that hybrid technologies and diesel vehicle technologies, in particular, will achieve a large degree of market penetration? How much could they contribute to improving overall fuel economy?
3. To what extent can any of these technologies be used to improve fuel economy without eroding safety?
4. What steps could the government take to accelerate market penetration of these technologies?

Alliance for Automobile Manufacturers Representative:

1. Do you agree with the findings of the National Academy of Sciences regarding the availability and performance of technologies to increase fuel economy?
2. What potential do hybrid technologies and new diesel technologies have to reduce fuel consumption?
3. Do you believe that the U.S. should reduce its dependence on foreign oil? If so, what steps should the government take to accomplish this?
4. What do you believe is the best way the government can encourage greater adoption of technologies to improve fuel economy?

Dr. Greene:

1. What are the policy options for encouraging the adoption of fuel efficient technologies in the marketplace and the advantages and disadvantages of each?
2. Can the government encourage the adoption of technologies to improve fuel economy without leading automakers to make vehicles less safe?
3. Can the government encourage the adoption of technologies to improve fuel economy without giving any individual automaker a significant advantage?

Attachment

TABLE 4-2 Case 1: Cost-Efficient Fuel Economy (FE) Analysis for 14-Year Payback (12% Discount Rate)[a]

			Low Cost/High mpg			Average			High Cost/Low mpg		
Vehicle Class	Base mpg[b]	Base Adjusted[c]	FE mpg, (%)	Cost ($)	Savings ($)	FE mpg, (%)	Cost ($)	Savings ($)	FE mpg, (%)	Cost ($)	Savings ($)
Cars											
Subcompact	31.3	30.2	38.0 (21)	588	1,018	35.1 (12)	502	694	31.7 (1)	215	234
Compact	30.1	29.1	37.1 (23)	640	1,121	34.3 (14)	561	788	31.0 (3)	290	322
Midsize	27.1	26.2	35.4 (31)	854	1,499	32.6 (20)	751	1,140	29.5 (9)	554	651
Large	24.8	23.9	34.0 (37)	1,023	1,859	31.4 (27)	985	1,494	28.6 (15)	813	1,023
Light trucks											
Small SUVs	24.1	23.3	32.5 (35)	993	1,833	30.0 (25)	959	1,460	27.4 (14)	781	974
Mid SUVs	21.0	20.3	30.2 (44)	1,248	2,441	28.0 (34)	1,254	2,057	25.8 (23)	1,163	1,589
Large SUVs	17.2	16.6	25.7 (49)	1,578	3,198	24.5 (42)	1,629	2,910	23.2 (35)	1,643	2,589
Minivans	23.0	22.2	32.0 (39)	1,108	2,069	29.7 (29)	1,079	1,703	27.3 (19)	949	1,259
Small pickups	23.2	22.4	32.3 (39)	1,091	2,063	29.9 (29)	1,067	1,688	27.4 (18)	933	1,224
Large pickups	18.5	17.9	27.4 (48)	1,427	2,928	25.5 (38)	1,450	2,531	23.7 (28)	1,409	2,078

[a]Other key assumptions: See Table 4-1.
[b]Base is before downward adjustment of –3.5 percent for future safety and emissions standards.
[c]Base after adjustment for future safety and emissions standards (–3.5 percent).

TABLE 4-3 Case 2: Cost-Efficient Fuel Economy (FE) Analysis for 3-Year Payback (Undiscounted)[a]

			Low Cost/High mpg			Average			High Cost/Low mpg		
Vehicle Class	Base mpg[b]	Base Adjusted[c]	FE mpg, (%)	Cost ($)	Savings ($)	FE mpg, (%)	Cost ($)	Savings ($)	FE mpg, (%)	Cost ($)	Savings ($)
Cars											
Subcompact	31.3	30.2	33.3 (6)	180	237	30.3 (–3)	11	11	30.2 (–4)	0	0
Compact	30.1	29.1	32.3 (7)	202	268	29.1 (–2)	29	29	29.1 (–4)	0	0
Midsize	27.1	26.2	29.8 (10)	278	363	26.8 (–1)	72	76	26.2 (–4)	0	0
Large	24.8	23.9	28.2 (14)	363	488	25.4 (3)	173	190	23.9 (–4)	0	0
Light trucks											
Small SUVs	24.1	23.3	27.3 (13)	358	492	24.7 (2)	174	193	23.3 (–4)	0	0
Mid SUVs	21.0	20.3	25.0 (19)	497	721	22.7 (8)	341	407	20.3 (–4)	0	0
Large SUVs	17.2	16.6	21.1 (23)	660	992	19.7 (15)	567	740	18.3 (6)	373	424
Minivans	23.0	22.2	26.5 (15)	411	570	24.2 (5)	247	284	22.2 (–4)	0	0
Small pickups	23.2	22.4	26.9 (16)	412	579	24.4 (5)	247	285	22.4 (–4)	0	0
Large pickups	18.5	17.9	22.7 (23)	600	918	20.8 (12)	477	608	18.7 (1)	178	189

[a]Other key assumptions: See Table 4-1.
[b]Base is before downward adjustment of –3.5 percent for future safety and emissions standards.
[c]Base after adjustment for future safety and emissions standards (–3.5 percent).

Chairman BOEHLERT. I want to welcome everyone here for this important hearing on fuel economy.

This committee has a special responsibility to review this issue, because part of our charge is to ensure that new energy technologies are developed and that they make their way into the marketplace.

And new fuel economy technologies are not making their way into the market, at least not to an acceptable extent because of market failures and, quite frankly, political failures.

Correcting those failures should be of surpassing interest to every citizen of our country, because fuel economy is not just an energy issue, it is not just an environmental issue, it is, first and foremost, a national security issue.

Our nation is ever more dependent, stunningly dependent on the world's most unstable region for the energy that is the lifeblood of our economy. Could anything be more critical? We are like a patient in critical care who needs a daily transfusion and can only hope to get it from an iffy, black market supplier.

And yet we act as if everything will be healthy forever. We are doing next to nothing to reduce our reliance on foreign oil. About 60 percent of the oil we consume each day is used for transportation; 45 percent of it is just for cars and light trucks. We can not reduce our oil consumption meaningfully unless we address transportation. That is a simple, unarguable fact.

And yet while many areas of the economy have been significantly more energy efficient over the past three decades or so, our nation's fuel economy is worse than it was 15 years ago. That ought to be unacceptable.

It ought to be especially unacceptable, intolerable, really, when we have the technology to improve fuel economy without reducing safety, without harming the economy, and without reducing the options people have in the automobile showroom.

I think we will learn today that there really is no debate about whether we have the technology we need to improve fuel economy. The only debate is whether we are willing to do something about it, and that we will hear more of today.

But while we listen to the experts before us today, I want everyone to remember the costs of inaction: they can be measured in dollars, particularly in the funds we spend on the military and homeland security, and they can also be measured in lives, as we can see in daily news reports. We need to consider the very real costs of being utterly dependent on unstable regions to carry out our most basic daily tasks.

I am not arguing, by the way, that we can become entirely energy independent or that fuel economy is the sole answer to our energy woes. That would be silly. We will markup a bill tomorrow that reflects the full range of steps we need to take in energy research and development to improve our energy profile, and they involve work on energy efficiency and renewable energy, but also on fossil fuels and nuclear energy; and they involve supply as well as demand.

But we ought to do everything we can to reduce our demand. That is in our national interest. It is an interest we share as a society, but one that is not reflected adequately in individual decisions

in the marketplace, a classic market failure that cries out for corrective government action. But the government has not risen to the task, and we are all in greater danger as a result.

We have a very distinguished and balanced panel of experts before us. I am especially gratified that my old friend, former EPA Administrator Bill Reilly is here to tell us the results of the bipartisan study he co-chaired. Mr. Administrator, welcome.

And I am also very pleased to have Paul Portney with us to review the National Academy of Sciences study that was requested by Congress and that should be the foundation for any discussion of CAFE standards. Unfortunately, the Academy study was released right as the Energy Bill debate was starting 4 years ago, and it never received the full and fair airing it deserved. Today, with a new Energy Bill debate pending, we have a chance to make up for our previous missed opportunities.

In my view, we need more stringent CAFE standards, and we need them now, for the reasons I have discussed. But the exact level and timing of the standards and how the CAFE program should be administered, that is all up for grabs, and I hope we can have a full discussion of those issues today. I look forward to hearing from our panel. And I thank them all for being witnesses and sharing their expertise with us.

Mr. Gordon.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to welcome everyone here for this important hearing on fuel economy. This committee has a special responsibility to review this issue because part of our charge is to ensure that new energy technologies are developed and that they make their way into the marketplace.

And new fuel economy technologies are not making their way into the market, at least not to an acceptable extent, because of market failures and political failures.

Correcting those failures should be of surpassing interest to every citizen of our country because fuel economy is not just an energy issue, it's not just an environmental issue, it is, first and foremost, a national security issue.

Our nation is ever more dependent—startlingly dependent—on the world's most unstable regions for the energy that is the lifeblood of our economy. Could anything be more critical? We are like a patient in critical care who needs a daily transfusion and can only hope to get it from an iffy, black-market supplier.

And yet we act as if we will be healthy forever. We are doing next to nothing to reduce our reliance on foreign oil. About 60 percent of the oil we consume each day is used for transportation; 45 percent of it just for cars and light trucks. We cannot reduce our oil consumption meaningfully unless we address transportation. That is a simple, inarguable fact.

And yet while many areas of the economy have become significantly more energy efficient over the past three decades or so, our nation's fuel economy is worse than it was 15 years ago. That ought to be unacceptable.

It ought to be especially unacceptable—intolerable, really—when we have the technology to improve fuel economy without reducing safety, without harming the economy, and without reducing the options people have in the automobile showroom.

I think we'll learn today that there really is no debate about whether we have the technology we need to improve fuel economy. The only debate is whether we're willing to do something about it, and that we'll hear more of today.

But while we listen to the experts before us today, I want everyone to remember the costs of inaction—they can be measured in dollars, particularly in the funds we spend on the military and homeland security, and they can also be measured in lives, as we can see in daily news reports. We need to consider the very real costs of being utterly dependent on unstable regions to carry out our most basic daily tasks.

I am not arguing, by the way, that we can become entirely energy independent or that fuel economy is the sole answer to our energy woes. That would be silly. We will markup a bill tomorrow that reflects the full range of steps we need to take in energy research and development (R&D) to improve our energy profile, and they involve work on energy efficiency and renewable energy but also on fossil fuels and nuclear energy; and they involve supply as well as demand.

But we ought to be doing everything we can to reduce our demand. That's in our national interest. It's an interest we share as a society, but one that is not reflected adequately in individual decisions in the marketplace—a classic market failure that cries out for corrective government action. But the government has not risen to the task, and we are all in greater danger as a result.

We have a very distinguished and balanced panel of experts before us. I'm especially gratified that my old friend, former EPA Administrator Bill Reilly is here to tell us the results of the bipartisan study he co-chaired.

And I'm also very pleased to have Paul Portney with us to review the National Academy of Sciences study that was requested by Congress and that should be the foundation for any discussion of CAFE standards. Unfortunately, the Academy study was released right as the Energy Bill debate was starting four years ago, and it never received the full and fair airing it deserved. Today, with a new Energy Bill debate pending, we have a chance to make up for our previous missed opportunities.

In my view, we need more stringent CAFE standards and we need them now, for the reasons I've discussed. But the exact level and timing of the standards and how the CAFE program should be administered, that's all up for grabs, and I hope we can have a full discussion of those issues today. I look very forward to hearing from our panel.

Mr. Gordon.

Mr. GORDON. Thank you, Mr. Chairman. As you pointed out, the topic that we are here to discuss today is very important on many levels. Energy security is now synonymous with national security. The U.S. uses a quarter of the world's oil and over 60 percent of that oil is imported, primarily from unreliable and politically unstable regions of the world. The slightest movement in the energy markets can have substantial impacts on our economy. That is not to mention the disastrous effect that it might have on the disruption of oil supply around the world.

While reserving judgment on any one solution, I am appreciative of you for having this hearing and look forward to learning more.

[The prepared statement of Mr. Gordon follows:]

PREPARED STATEMENT OF REPRESENTATIVE BART GORDON

Thank you Mr. Chairman for holding this hearing today on an issue that is particularly important given the flurry of activity in Congress on energy legislation. It appears that we will see a House energy bill on the Floor very soon and I look forward to tomorrow's markup of the Science Committee's contributions.

The topic we're here to discuss today is important on many levels. Energy security is now synonymous with national security. The U.S. uses a quarter of the world's oil and over 60 percent of that oil is imported, primarily from unreliable and politically unstable regions of the world.

The slightest movements in energy markets can have substantial impacts on the economy. That's not to mention the disastrous effect that a major disruption in oil supply would have on the world, but most especially the U.S. While we do use oil for a variety of industrial and heating purposes, about 80 percent goes into the transportation sector, and almost half of the oil we consume goes into cars and light trucks—moms taking kids to soccer practice and suburban commuters driving to work.

This thirst for oil comes at a price. Not only is it a weak link in our national security chain, but the harmful health effects of air pollution from fossil fuel use are yet to be fully understood. I don't believe anyone would argue that we can continue at our present rate of oil consumption, but the steps we take must be very calculated. CAFE standards were responsible for successfully doubling the fuel economy in the 1980's, but those too can have unforeseen economic repercussions.

We should take care that, in our quest to lessen our dependence on oil, we do not put excess burden on the industries that have made this economy what it is today.

While reserving judgment on any one solution, I welcome the discussion today of mechanisms such as tax incentives, tradable CAFE credits, re-categorization of car and light truck standards, and weight-based reclassifications schemes.

If increasing of CAFE standards is inevitable, as many believe it is and should be, we should recognize both the limitations and the technological achievements of individual automakers. In this regard, some companies perform better than others. The Union of Concerned Scientists' ranking of automakers by pollution impact places Honda and Nissan at the top of the list.

Nissan, for example, produces the Pathfinder SUV in my district. Despite not having a hybrid gas-electric vehicle on the market, it has surpassed Toyota in the UCS rankings I spoke of. Even while transforming itself into a full-line automaker, Nissan is incorporating a suite of existing cutting edge technologies, such as Continuously Variable Transmission, to increase their overall fleet fuel economy. This hints at how complex the range of CAFE-related technology options can be for automakers.

And there is an army of scientists and researchers outside of the auto companies, discovering ways to revolutionize the transportation sector with fuel efficient technologies. For example, Dr. Cliff Ricketts at Middle Tennessee State University has transformed a standard Nissan pickup truck into an emissions free alternative fuel electric-hybrid vehicle.

I would like to thank the witnesses for coming to Washington to testify on technologies supporting the Corporate Average Fuel Economy of cars and trucks. Thank you again, Mr. Chairman for this important hearing.

Chairman BOEHLERT. Thank you very much, Mr. Gordon. And all Members will have the opportunity to have their statements inserted in the record at this juncture.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good afternoon. I want to thank the witnesses for appearing before our committee to examine available technologies to improve the fuel economy in cars and trucks, while also working towards reducing the Nation's dependence on foreign oil.

Congress passed the *Energy Policy and Conservation Act* in 1975, with a goal to reduce the Nation's dependence on foreign oil. As a result, the Corporate Average Fuel Economy (CAFE) program raised the fuel economy of the U.S. fleet, hoping that Congress's objective would be met. Thirty years later, we are still working towards achieving this goal. Today we depend on imports to meet nearly 60 percent of our oil needs. Gasoline burned by cars alone, constitutes about 45 percent of the Nation's oil consumption. Looking towards the future, in 2025, it is projected that the U.S. will consume 29 million barrels of oil a day, mostly on transportation. According to the National Commission on Energy Policy, improving car and light truck fuel economy by 10, 15, and 20 percent by 2015 would result, by 2025, in an estimated fuel savings of approximately up to 3.5 million barrels of oil a day. At the same time, there are good arguments as to why we need to approach any new CAFE standards carefully. If we have the technology today to significantly improve the fuel economy of cars and light trucks, without reducing safety, we must balance these advancements in a way that does not place constrictive regulations on the automotive industry, causing them to suffer economically. I am pleased to learn that a National Commission on Energy Policy report from last year found that the ability of hybrid technologies to make substantial improvements in fuel economy has been clearly demonstrated.

As we look for ways to reduce our foreign dependence on foreign oil and rely more on other domestic energy sources, such as coal, hydrogen, and ethanol it is critical that we utilize the technological advancements we have today to improve fuel efficiency, without disregarding the legitimate concerns of the workers in the automotive industry.

I look forward to hearing from our panel of witnesses.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. I am very grateful you have decided to call a hearing today on our nation's energy security. I also wish to thank our distinguished witnesses who have submitted testimony and have agreed to answer our questions.

Corporate Average Fuel Economy [CAFE] standards were enacted into law by Congress in 1975 as a part of the "Energy Policy Conservation Act," [EPCA]. This Act, passed in response to the 1973–74 Arab oil embargo, was established to double new car fuel economy for passenger cars and light trucks by model year 1985.

It has been stated that raising CAFE stands could potentially save more oil than our Persian Gulf imports, thereby reducing our dependency on Mid-Eastern imports and also curb global warming.

Unfortunately, some theorize that making cars more fuel efficient will lead to greater safety concerns, reduced American auto choices and a loss of American Auto job to overseas plants.

Everyday we, as Members of Congress, must make tough choice as to how we deal with the issues such as the protection of our environment (this is the only planet we have) and the safety of our highways. The responsibility of weighing the pros and cons of every can be a life or death matter.

Hopefully our witness here today can clear up these issues. We appreciate your input.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

I commend Chairman Boehlert and Ranking Member Gordon for convening this hearing on fuel economy.

I continue to be amazed by the response of many people in this country to the prospect of conserving energy. We know that fossil fuel supplies both here and abroad are limited—they are fossil fuels, remnants from biological processes that took place centuries ago but which are not occurring now. These fuels will run out eventually. There may be legitimate debate about exactly when that will happen, but the fact is that they will run out.

Since our nation is nearly completely dependent on a finite source of energy, it seems to me that what we need to do in the short-term is reduce our levels of consumption of our finite energy supplies to make them last longer, and for the long-term, develop renewable sources of energy to meet our future needs.

But in complete opposition to common sense, Vice President Cheney has indicated that conservation is a "personal virtue," but not a sufficient basis for a sound energy policy. I might almost be convinced to buy into this if reducing energy consumption meant everyone had to stay at home, in the dark, either too cold or too hot depending on where they live. But that is not necessary. We have the technologies available to us to day to reduce energy consumption in our vehicles, in our homes, and in our offices, but because there is an up-front cost associated with these new technologies, their adoption has been stalled. No one factors in the long-term costs to public health and our environment of not being energy efficient, though. If they did, economics could be the driver. But instead, we need something else to encourage efficiency.

CAFE standards are an excellent way of improving fuel economy in vehicles. By requiring vehicles to be efficient, the government can stand up for the long-term health of our nation and planet. Standards have not increased over the years, however, because of industry insistence that increased standards would make U.S. manufacturers less competitive and would make vehicles less safe.

I am glad that we are having this hearing today so we can learn about existing technologies that can increase fuel economy, and strategies for implementing higher standards that would not compromise the safety of our vehicles. I believe it is essential for our national security to take all steps we can to reduce our consumption of fossil fuels.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman, thank you for taking the initiative to hold this important hearing on improving automobile fuel efficiency technologies and considering raising CAFE standards. We are lucky to have a leader that recognizes the role that new technologies play in securing our nation, bringing us closer to energy independence and protecting our environment.

There is clearly a benefit to introducing new technologies to increase fuel efficiency. I am most curious in hearing today what policy options are available to us to take these important steps forward.

I look forward, in particular, to Mr. Stanton's testimony and hope to gain a better understanding of how the auto industry feels about potential policy options. It is my

hope that Congress can not only work with the industry and energy providers, but also incorporate the opinions of auto workers and citizens concerned about the environment who also have a strong interest in our policy decisions.

Chrysler is an important employer to our region. I am proud to have a strong American auto manufacturer in the midst of my district and also to represent many of the plant's hardworking Americans.

I urge everyone to pay particular attention to balancing the increase of CAFE standards while keeping our American auto companies strong and viable.

I look forward to hearing the testimony of the panelists. Thank you very much for being here today.

[The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Chairman Boehlert, Ranking Member Gordon,

I want to thank you for organizing this important hearing on fuel efficiency standards for cars and light trucks. As we prepare to discuss the Energy Bill, we all appreciate the importance of energy efficiency as an essential component of the policies that affect our nation's economy and security. The Department of Energy's Energy Information Agency (EIA) reports that since 1985, the transportation sector's consumption of primary energy sources has been second only to the energy consumption used for electric generation. Between 2001 and 2004, light duty vehicles consumed nearly 60 percent of the primary energy sources used for transportation. Clearly, effective national policies to control the consumption of fuel used by light duty vehicles would have a significant positive impact on the Nation. Over the past three decades, national policies for vehicle fuel efficiency have included both regulatory and "technology-push" approaches.

In response to the then-restricted world supply of oil, the Congress enacted the *Energy Policy and Conservation Act of 1975,* which was intended, among other things, to induce automobile manufacturers to improve the fuel economy of their cars. The Act set a Corporate Average Fuel Economy (CAFE) standard for passenger cars that increased several times and then leveled off at 27.5 miles per gallon for model years 1985 and beyond.

Congress authorized the National Highway Traffic Safety Administration (NHTSA) to raise or lower the standard for a particular model year in order to achieve the "maximum feasible average fuel economy," taking into account technological feasibility, economic feasibility, the effect upon fuel economy of other federal motor vehicle standards, and the need of the Nation to conserve energy.

CAFE standards are calculated separately for a manufacturer's domestic and import car fleet. In 1988 the NHTSA was concerned that the 27.5 mpg standard might lead American automobile manufacturers to shift some of their large-car manufacturing overseas in order to average the fuel economy of those cars with more of their small cars, thereby raising the average fuel economy of their domestic fleets and lowering the comfortably high average fuel economy of their non-domestic fleets.

The possible shift of large car manufacturing to off-shore plants raised concerns of domestic job losses. Anticipating possible job losses and "potential economic harm," the NHTSA lowered the CAFE standard in 1988 for MY 1989 from 27.5 mpg to 26.5 mpg. In 1989, however, the agency terminated the MY 1990 aspect of the rule-making without changing the CAFE standard for that year based on the agency's conclusion that retention of the 27.5 mpg standard for MY 1990 not have a significant adverse effect on U.S. employment or on the competitiveness of the U.S. auto industry.

CAFE standards affect manufacturers differently. Those with full product lines will be burdened more than manufacturers specializing in small to medium size vehicles. Policy analysts may argue that would force the marketing of smaller cars as they believe CAFE intends. However, this ignores the engineering differences between some large and small cars. For example, Ford's Crown Victoria is one of the few cars now sold that built as a "body on frame" design—in contrast to the unibody construction used on virtually all small to medium size cars. "Body on frame" designs are inherently heavier than unibody construction, but the durability this provides under harsh driving conditions makes "body on frame" the preferred vehicle design for police cars and taxicabs.

In addition to the distinction that CAFE makes between domestic and imported passenger cars, there is also separate classification for light duty trucks, whose standards are set by the NHTSA rather than by statute. The present standard for light duty trucks is 20.7 miles per gallon. The determination about what is consid-

ered a car or a truck can be confusing—some of the NHTSA and EPA regulations define certain kinds of trucks as those vehicles that look similar to a 1977 Jeep or a 1977 Land Cruiser,[1] with 'trucks' generally defined as those vehicles having a flat cargo floor. Thus, the regulatory scheme allows for the classification of the Dodge Neon as a compact car and the Chrysler PT Cruiser as a truck for the purposes of fuel economy standards even though both are built on the same vehicle platform.

In addition to mandatory vehicle fuel economy standards specified in federal laws and regulations, Congress and the Executive Branch have supported research programs to develop new technologies intended to enable the development of vehicles with increased fuel economy or reduced emissions.

Beginning in 1991, the Department of Energy partnered with the domestic car companies and electric utilities to form the U.S. Advanced Battery Consortium (USABC), a research and development initiative to develop batteries that would enable the deployment of practical electric cars. In 1993, a number of federal agencies led by the Department of Commerce again joined Detroit's Big-3 to form the Partnership for a New Generation of Vehicles (PNGV) to build prototype five-passenger vehicles capable of 80 MPG fuel economy. In 2000, the Department of Energy led "21st Century Truck," a government-industry partnership in the development of technologies to enable more fuel efficient large trucks. In 2002, the Department of Energy, DaimlerChrysler, Ford, and General Motors created "FreedomCAR," a research initiative to develop technologies to enable petroleum-free cars and light trucks. Federal funding for these initiatives range from hundreds of millions of dollars for USABC to several billions of dollars for PNGV and FreedomCAR.

Both of these approaches have had mixed results. Some will argue that CAFE has shifted the market for family-sized vehicles away from station wagons to the somewhat heavier and less aerodynamic mini-vans, sport utility vehicles, and "king cab" pick-up trucks. U.S.-funded "technology push" initiatives need also to be evaluated against privately-funded vehicle development programs in Japan that have deployed the first three hybrid electric vehicle models commercially sold in the U.S., Asia, and Europe.

The National Academy of Sciences studied the issue of increasing vehicle fuel economy in considerable detail. While finding that the CAFE regulations were effective in maintaining fleet fuel economy above what it would have been with falling gasoline prices in the early 1980s, the Academies noted that "there is a marked inconsistency between pressing automotive manufacturers for improved fuel economy from new vehicles on the one hand and insisting on low real gasoline prices on the other." The Academies' study included "cost efficient" analyses to illustrate how rational consumers will balance fuel cost savings with the added expenses associated with fuel saving technologies in the selection of the vehicles they buy and how many miles they drive—analyses that are not considered by either regulatory or technology-push approaches. The National Academies also addressed demand reduction policies—including gasoline taxes, carbon taxes, and carbon cap-and-trade systems. These approaches do address consumer demand for fuel, but many have criticized these approaches for a variety of reasons, including they have the characteristics of a regressive tax.

Successful policies may include an integrated combination of regulations, technology development, and energy demand reduction policies. Today's hearing will help to address these approaches.

Chairman BOEHLERT. Let me introduce our first and only panel of the day, and it is a very distinguished panel: the Honorable William Reilly, Aqua International Partners; Mr. Paul Portney, President, Resources for the Future; Dr. David Greene, Oak Ridge National Laboratory, Center for Transportation Analysis, National Transportation Research Center; Mr. K. G. Duleep, Managing Director of Transportation, Energy and Environmental Analysis, Incorporated; and Mr. Michael Stanton, Vice President of Government Affairs, Alliance of Automobile Manufacturers.

Gentlemen, the floor is yours, and we will go in the order introduced. We ask that you try to summarize in 5 minutes or so, but those of you who have been here before, and Mr. Reilly, you have been here many times, know that we are all offended by the propo-

[1] 40 C.F.R. § 600.002–85; 40 C.F.R. § 600.002–93; 49 C.F.R. § 533.4.

sition that you are going to take a very important subject like this and condense it into 300 seconds. But—so don't get nervous if that green turns to caution and then red. If you have got a point to make or you have got a thought to complete, please do it.

With that, I present Mr. Reilly.

STATEMENT OF THE HONORABLE WILLIAM K. REILLY, AQUA INTERNATIONAL PARTNERS

Mr. REILLY. Thank you. Thank you very much.

And my congratulations and my compliments to you, sir, and to this committee for scheduling this hearing on a matter that I fully agree with you is vital to our national security, vital to our economy, and I think also vital to our environment.

I want to present my statement to you in summary, and I ask that my written testimony be inserted in the record at this time, if I might.

Chairman BOEHLERT. And without objection, so ordered. And I want to advise all of our panelists that your complete record will be part of the complete testimony and will be available to all of the Members for their examination.

Mr. REILLY. Thank you.

As you mentioned, I have, over the past 2½ years, served as co-chairman of the National Commission on Energy Policy, which released this report, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges,* in early December. This report, which was financed in large part by the Hewlett Foundation, involved some $10 million from them and also support from the MacArthur Foundation, the Pew Charitable Trust, and the Packard Foundation, was conceived to try to address some of the most intractable problems confronting our energy situation in the United States and in the world and to develop some consensus solutions, drawing on the experiences and insights of a very diverse group of members.

I was the Co-chair of this Commission. My fellow co-chairs were John Holdren, a Professor at the Kennedy School, and John Rowe, the Chairman and CEO of Excelon Corporation, one of the Nation's largest electric power utilities based in Chicago. It included the Chief Economist of Ford Motor Company, Group Vice President, Marty Zimmerman. It included the Chairman of ConocoPhillips Corporation, the country's largest refiner of oil and gas. It included the Chairman of the Board of Consumers Union and a representative from the United Steelworkers of America Union, and the head of the energy program for the Natural Resources Defense Council. It was, in all respects, I think, as balanced, as diverse, as representative of the different sectors of the economy, the non-governmental community, the scientific community—we had a Nobel prize winning scientist as a member, Mario Molina—that you could find. And I think the significance of much of what I will say is not so much in the novelty of what we recommend as it is in the backgrounds of the people who supported it. And the recommendation that I am going to discuss with you was the product of a consensus in our Commission.

We placed, in this Commission, oil security at the top of our energy priorities. And I would say that one of the most interesting

charts in our report, and it is included in my submitted testimony, is one that shows that over the next 20 years, the United States and the world at large anticipate a 50 percent-plus increase in oil demand. That is a very large number. If you look back at the 20 years from 1980 to the year 2000, it was a time of tremendous innovation in technology, new development capacity on the part of the oil industry. It was the period when the oil industry learned to reduce, or rather to increase the amount of hydrocarbons it got from a field, from 20 percent to 50 percent. It was a period when deep-water oil exploration and development became possible in the Gulf and other places to go beyond 5,000 feet deep. It was a period when there was a lot of new technology that allowed drilling from one well to go out into several fields from that single point.

Nevertheless, with all of that innovation, with all of that new technology, with all of that effort, the oil industry worldwide experienced a 20 percent increase in production over that 20-year period. As we look ahead to the next 20 years, seeing a 50 percent expected demand increase, it just isn't there. We are going to have to find new efficiencies, new opportunities to be more productive in our use of liquid fuels, alternative fuels, and try to put an economy together, for transportation particularly, that respects a new energy environment.

There has been, over the last 30 years, significant improvements in the efficiency of our economy with respect to oil. It takes significantly less oil to produce $1,000 of GDP. However, in recent years, we have seen an important slowdown in those improvements. The intensity improvements have waned.

We note, and you have noted in your opening remarks, the transportation sector has had the fastest growth in greenhouse gas emissions over the past two decades. Two key solutions we recommend: increases in investment to spur global oil production, and reductions in demand domestically.

We reviewed at the Commission several options, a gas tax, CAFE increases, alternative fuels. In our view, CAFE increases provided the largest demand reduction by far. New technologies like hybrids and diesels will enter the fleet slowly and be used, we believe, in large part to increase power, weight, and other performance attributes instead of fuel economy absent increases in CAFE.

In summary, we recommended that Congress should instruct the National Highway Traffic Safety Administration to significantly strengthen automobile fuel requirements. New standards, we propose, should be phased in between 2010 and 2015. We did not, frankly, reach agreement, but we discussed several possibilities. We recommended a significant increase in mandatory automobile fuel efficiency.

There is some direction given in the report on appropriate or plausible CAFE levels to take full advantage of current and emerging technologies, including hybrids and passenger diesels.

Our proposal is specifically designed to address political and technical objections to traditional CAFE increases which are: one, impacts on competitiveness of domestic manufacturers; two, impacts on domestic jobs; and three, safety concerns. These are the big three that are raised as objections to increases in CAFE.

To deal with some of these concerns, U.S. manufacturers and jobs, we would propose reducing compliance costs by allowing trading of compliance credits across companies. This is not now permitted. According to the Office of Management and Budget, this would net you a 17 percent reduction in the overall cost of compliance with this program.

We recommended that future costs of compliance with CAFE requirements be kept through the use of what we call a "safety valve" to ensure that industry is protected if technology costs exceed government projections.

And finally, we would propose to offer manufacturer incentives to retool existing domestic auto plants to produce hybrids and advanced diesels, and we proposed that this be at the level of $1.5 billion over five years.

With respect to safety, hybrids can significantly boost mileage per gallon with the same vehicle size and equal or better performance, in our judgment. And we have seen enough experience with hybrids to know that the concerns about downsizing and downweighting as the only option available to the auto manufacturers to meet higher standards are misplaced.

Finally, I would just say the stakes for our Nation, as you have pointed out, are tremendous. Our security, economy, and environment will all benefit considerably if we seize the opportunity to significantly increase the fuel economy of our vehicle fleet.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Reilly follows:]

PREPARED STATEMENT OF WILLIAM K. REILLY

Good afternoon Chairman Boehlert. My thanks to you and to the Members of the Committee for organizing this hearing on a matter of great importance for our country.

I am one of three co-chairs of the National Commission on Energy Policy. My other Co-chairs are John Rowe, CEO of Excelon, and John Holdren, a professor at the Kennedy School at Harvard. We are an independent bipartisan group of 16 persons who came together in 2002 with support from the Hewlett Foundation and several other leading foundations: The MacArthur Foundation, Packard Foundation, and the Pew Charitable Trusts. The Commission released a report at the end of last year entitled *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges.* The first chapter of this report is about enhancing oil security. The placement of oil security first among all issues reflects the Commission's view that improving our nation's oil security is the most significant near term energy challenge we face. I'm pleased to have an opportunity to summarize the Commission's recommendations on vehicle fuel economy.

Consistent with the focus of this hearing, I will direct the bulk of my remarks to the Commission's proposals to significantly increase vehicle fuel economy. However, I must note that try as we might, our Commission could not construct a plausible scenario in which U.S. and global oil demand does not increase over the next twenty years. For this reason, we also propose a series of measures designed to increase the global production of oil during this same time period. I will submit our entire report and ask that it be made part of the record.

Rationale for Action

From the Commission's perspective, there are three considerations that reinforce the need to strengthen passenger vehicle fuel economy:

FIRST, both domestic and global demand for oil is projected to grow by roughly 50 percent by 2025. This rate of growth is at more than double the historical rate since 1980 (Figure 1–1). At the same time, spare capacity to compensate for supply disruptions has fallen to a mere two percent of global demand. Left unchanged, these factors suggest that the U.S. economy will continue to suffer from high and volatile oil prices and is at risk of more frequent and serious supply disruptions.

The energy sector has for several years experienced a consistent and growing gap between oil production and the discovery of replacement reserves.

SECOND, the rate of improvement in U.S. oil economic intensity has slowed in recent years. Oil economic intensity is a measure of how much oil is required for the U.S. economy to produce a dollar of economic output. This measure is important because the ability of the U.S. economy to weather oil price shocks improves as oil's share of our economic output decreases. Since 1970, the U.S. oil economic intensity has dropped by half—a tremendous achievement—largely due to CAFE standards in the late 1970s and early 1980s, and to a shift in the electricity sector away from the use of petroleum. Further improvements would further insulate the U.S. economy from oil price shocks (Figure 1–2).

THIRD, hybrid and passenger diesel vehicles hold the promise for dramatic improvements in vehicle fuel economy. But historical trends suggest that potential fuel economy gains may be undermined unless government acts to reinforce the need for improved vehicle fuel economy.

Although U.S. fuel economy has been stagnant sine 1987, the vehicle industry has made considerable strides in efficiency. However, these efficiency improvements have been used to increase vehicle horsepower and weight, while still complying with Corporate Average Fuel Economy (CAFE) standards. This trend—favoring horsepower, weight and other attributes over fuel economy improvements—is likely to continue absent government action. If we as a nation are serious about addressing our dependence upon oil, we must seize the opportunity presented by hybrids and passenger diesels (Figure 1–3) to improve the fuel economy of our vehicle fleet.

The Importance of Strengthening Fuel Economy Standards

During its deliberations, the Commission considered a variety of both major and minor transportation policy measures. These included many of the usual suspects: a gasoline tax, a CAFE increase, alternative fuels, as well as some new ideas: heavy-duty tractor trailer fuel economy, efficiency standards for replacement tires, congestion charges in urban areas. We examined these policy measures against four criteria: (1) the ability to save one million barrels per day of oil by 2025, (2) the cost per barrel of oil saved, (3) administrative complexity, (4) political feasibility. Of all the policies reviewed by the Commission, passenger vehicle fuel economy improvements represented the largest opportunity for oil savings over the next 20 years.

Accordingly, the Commission recommended that Congress instruct the National Highway Traffic Safety Administration (NHTSA) to significantly strengthen CAFE standards, giving due consideration to vehicle performance, safety, job impacts, and competitiveness concerns consistent with statutory requirements. We recommended that new standards be phased in over a five-year period beginning no later than 2010. The Commission did not reach agreement on a specific increase in fuel economy.

Of course, it would be naïve to make recommendations about a CAFE increase without considering how to break the current political stalemate on fuel economy standards. The Commission identified three issues that have dominated past debates about raising CAFE standards and which we believe are largely responsible for the current stalemate: (1) uncertainty over impacts on the competitiveness of domestic manufacturers; (2) fear that more stringent standards will lead to smaller, lighter vehicles and increased traffic fatalities; and (3) concerns that higher standards will lead to losses in domestic jobs.

Competitiveness and U.S. Jobs

To address concerns about competitiveness impacts on U.S. domestic manufacturers and U.S. auto workers, the Commission recommends that a significant increase in CAFE standards be accompanied by reforms to the current program that would increase compliance flexibility and reduce compliance costs, together with manufacturer incentives designed to promote the domestic manufacture of hybrid-electric and advanced diesel vehicles.

Specifically, the Commission recommends that the current program be altered to allow manufacturers to trade compliance credits with one another and across their car and light truck fleets. The Congressional Budget Office has estimated that this reform alone would reduce the cost of the CAFE program by about 17 percent. An additional reform that should be considered in concert with higher standards is a cost-capping mechanism similar to the "safety valve" the Commission is recommending in connection with a tradable permits system for greenhouse gas emissions. In this case, the government could make additional CAFE compliance credits available to manufacturers at a pre-determined price. Such a mechanism would have the effect of protecting automakers and consumers if the regulatory estimates

used to set new standards understate true costs and thus holds promise for overcoming the inevitable and inherently irresolvable disagreements about future technology development that have stymied past CAFE debates.

With respect to manufacturer incentives, the Commission is specifically recommending a program of tax incentives for U.S. manufacturing facilities that are retooled to produce hybrid-electric and advanced diesel vehicle with superior fuel economy. Consistent with international trade agreements, the incentive would be available to both domestic and foreign companies, including both assembly plants and parts supplies. The recommended subsidy level would total $1.5 billion over ten years, with the amount of credit set to reflect up to two-thirds of the capital investment associated with producing vehicles or vehicle components. Commission analysis indicates that federal outlays under such a program would be more than offset by increased tax receipts as a result of maintaining domestic manufacturing jobs.

Relationship between Safety and Fuel Economy

A paramount concern for us when seeking to improve vehicle fuel economy has been to ensure that there is no reduction in overall vehicle safety. This is the concern so often expressed: That mandating higher fuel economy will require production of less safe, lighter vehicles and compromise vehicle performance. Our Commission considered this concern and tested it against currently marketed hybrid vehicles. Hybrids and passenger diesels offer the potential to boost fuel economy while maintaining vehicle size and performance. The Ford Escape, Honda Civic hybrid, the Honda Accord hybrid, and the forthcoming Toyota Highlander hybrid, all achieve substantial fuel economy improvements while maintaining or increasing horsepower (by as much as 17 percent) compared to their conventional counterparts, and without reductions in weight or size. These vehicles clearly demonstrate that substantial fuel economy improvements can be achieved using already-available technologies and without compromising vehicle performance and safety.

Conclusion

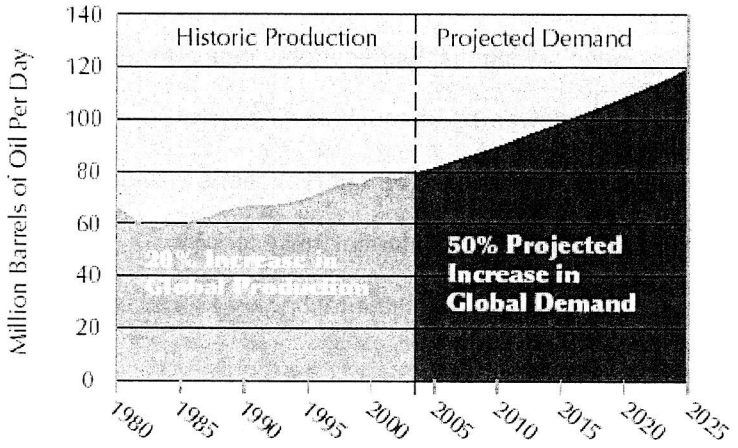
Hybrids and advanced diesels potentially change the game. They offer the uncompromised features of conventional vehicles while improving dramatically automobile fuel economy. It should be national policy to foster early introduction on a significant scale of these technologies for they promise to make a major contribution to U.S. energy security.

Figures from *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges,* National Commission on Energy Policy (2005).

Figure 1-1

Trends in Global Oil Production and Future Demand

Future demand for oil is projected to grow at more than double the historical rate since 1980.

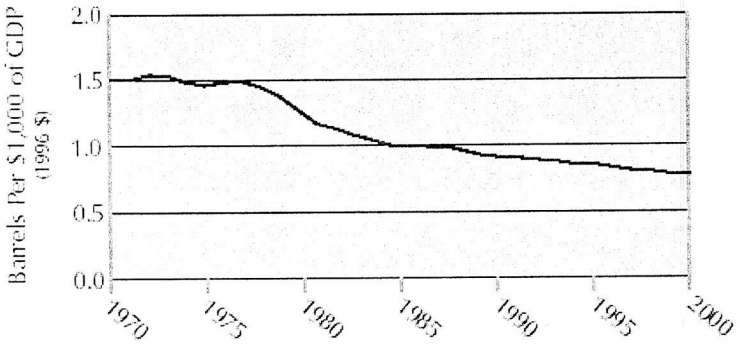


Data Source: Energy Information Administration, 2004

Figure 1-2

Oil and the Economy

The ability of the U.S. economy to weather oil price shocks improves as oil's share of GDP decreases. This share has declined over the past several decades, although the rate of decline has slowed in recent years.

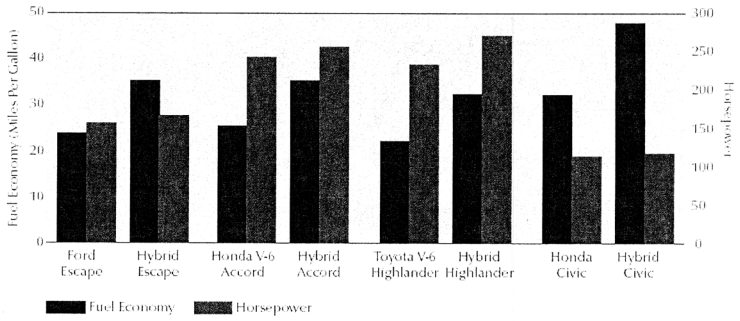


Resources for the Future, 2004

Figure 1-3

Why Hybrids Change the Game

Hybrids can increase fuel economy and horsepower.



Note: The popular Toyota Prius hybrid is not included here because it does not have a conventional vehicle counterpart.

Data Sources: NewCars.com 2004; American Honda Motor Co. 2004; AIC Autosite 2004

BIOGRAPHY FOR WILLIAM K. REILLY

William Kane Reilly is President and Chief Executive Officer of Aqua International Partners, an investment group that finances the purification of water and waste water in developing countries, and invests in projects and companies that serve the water sector. Aqua International is sponsored by the U.S. Overseas Private Investment Corporation and is part of the Texas Pacific Group, an investment partnership based in Fort Worth and San Francisco, which invests in environmental, airline, apparel, health, wine, technology and other companies in the United States, Latin America and Asia. During the 1993–94 academic year, Mr. Reilly served as the first Payne Visiting Professor at Stanford University's Institute for International Studies and delivered five public lectures on the challenges to the global community.

From 1989 to 1993, he served as the seventh Administrator of the U.S. Environmental Protection Agency. With 18,000 employees and a $7 billion budget, EPA is an independent federal regulatory agency charged with improving and protecting public health and the environment.

Prior to becoming EPA Administrator, he held five environment-related positions over two decades. He was President of World Wildlife Fund (1985–1989) and President of The Conservation Foundation (1973–1989). Those two organizations joined formally in 1985 at which time Reilly became President of both. He was Executive Director of the Rockefeller Task Force on Land Use and Urban Growth from 1972 to 1973. From 1970 to 1972, he served as a senior staff member of the President's Council on Environmental Quality and, from 1968 to 1970, as Associate Director of the Urban Policy Center and the National Urban Coalition. He served as Chairman of the Natural Resources Council of America, an association of all major conservation groups, from 1981 to 1983.

Reilly has written and lectured extensively on environmental issues. He has served on the boards of numerous public and private sector organizations and received a number of awards and medals for his contributions to environmental progress. He currently serves on the boards of Dupont, Eden Springs, Ltd., ConocoPhillips, Ionics, and Royal Caribbean International, and is a member of the Advisory Board of ERM *CVS*. His service to non-profit organizations includes chairmanship of the Board of World Wildlife Fund and of the Board of Advisors of the Goldman School of Public Policy at the University of California, Berkeley, and membership on the Boards of Trustees of the American Academy in Rome, National Geo-

graphic Society and The Packard Foundation. By appointment of the President, Reilly serves as one of the seven trustees of the Presidio Trust, with responsibility for running the Presidio National Park of San Francisco.

An alumnus of Yale University, Reilly holds a law degree from Harvard University and a Master's degree in urban planning from Columbia University. He was born in Decatur, Illinois, on January 26, 1940, and attended high school in Fall River, Massachusetts. He served in the U.S. Army to the rank of Captain in 1966 and 1967.

He is married to Elizabeth "Libbie" Bennett Buxton Reilly. They have two daughters, Katherine Buxton Reilly, an environmental lawyer with Beveridge and Diamond in San Francisco, and Margaret Mahalah Reilly, Megan, a student at Harvard Business School. The family resides in San Francisco, California, and Alexandria, Virginia.

AQUA

February 10, 2005

The Honorable Sherwood Boehlert
Chairman, Science Committee
2320 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Boehlert,

Thank you for the invitation to testify before the Committee on Science of the U.S. House of Representatives on September 30th for the hearing entitled "***H.R. 4670, Establishing a Center for Scientific and Technical Assessment at the General Accountability Office***." In accordance with the Rules Governing Testimony, this letter serves as formal notice of the federal funding I currently receive in support of my research.

I received no federal funding directly supporting the subject matter on which I testified, in the current fiscal year or either of the two preceding fiscal years.

Sincerely yours,

William K. Reilly

AQUA INTERNATIONAL PARTNERS, L.P.
345 CALIFORNIA STREET, SUITE 3300 SAN FRANCISCO, CA 94104 U.S.A. TEL: 415 743-1505 FAX: 415 743-1504

Chairman BOEHLERT. Thank you very much, Mr. Reilly.
Dr. Portney.

STATEMENT OF MR. PAUL R. PORTNEY, PRESIDENT, RESOURCES FOR THE FUTURE

Mr. PORTNEY. Chairman Boehlert, Members of the Committee, thank you very much for having me here today, and thank you, also, Mr. Chairman, for your kind words about the 2001 National Research Council report on fuel economy standards. I appreciate that. As you mentioned, it was somewhat overtaken by the debate in the Energy Bill, but a month and a week later, overtaken by the events of September 11, 2001, to which I will come back in my testimony here.

I will summarize, as you have indicated, my remarks here today. Thank you for allowing me to put my complete remarks into the record.

I am testifying before you today principally in my capacity as having been chairman of the National Academy of Sciences 2001 report on the effectiveness and impact of Corporate Average Fuel Economy standards. Let me also say that nothing I should say today should be construed or attributed to Resources for the Future. I am appearing in my—as an individual and in my role as the chairman of the National Academy of Sciences committee.

I thought what I would do for you is very briefly summarize for you the findings of that National Academy report. Some time has passed since that report. Because it has been 3½ years, I would also like to reflect back on what has changed during the past 3½ years. Those views will be my own. I can purport to speak for the whole committee, because we haven't met during that period of time, but I thought it might be useful for me to reflect on the recommendations of the committee in light of the events over the last 3½ years.

So let me start by giving you sort of very quickly the basic conclusions that that National Academy of Sciences committee reached in 2001.

First of all, we found that CAFE has played an important role in boosting the fuel economy of the new vehicle fleet in the United States. That occurred principally between the period 1978 or so until the early 1980s. And the committee was very careful to say that while CAFE, in the view of the committee members, indisputably played a role in the improvements in fuel economy that happened during that period of time. Of course, also during that period of time, gasoline prices had increased dramatically so that there became, on the part of the public, a demand for more fuel-efficient vehicles to which car makers responded.

And because these two events happened more or less contemporaneously, both pushing in the direction of improved fuel economy, we couldn't separate out how much of the improvement in fuel economy was due to higher prices and how much was due to the CAFE standards. We will note, however, that after about 1982, when gasoline prices collapsed, fuel economy did not go back to its old level, suggesting that the improvements that we got were permanent improvements that we might not have gotten had we not instituted a CAFE program during that period of time.

The committee also found that CAFE had some adverse effects. You were—we were requiring car makers to devote resources to improving fuel economy. These are resources that they could not devote to improving the performance characteristics of vehicles or to doing other things with those resources during that period of time. And, and I can't emphasize how important this point is, because car makers were required to boost fuel economy by almost 50 percent in a relatively short period of time, they didn't have the option of rolling in a lot of new fuel-saving technologies. Rather, the way they chose to meet much tougher fuel economy standards in a short period of time was by making cars smaller and lighter. And the CAFE committee, with two exceptions, was of the mind that this accelerated very quick reduction—or improvement in fuel economy through downsizing had adverse effects on the safety of the vehicle fleet. We predicted, or estimated, that an additional 1,300 to 2,600 fatalities by 2003 would have—or took place that wouldn't have taken place if car makers had not had to quickly downsize and downweight vehicles to meet the fuel economy standards.

Again, this was not a unanimous view of the committee. David Greene, one of the two committee members who dissented from that particular conclusion of the panel, is here today, and he will have an opportunity to speak for himself later.

Third, we found that technologies clearly exist or, at that time, were in the process of being developed that would make it possible to improve the fuel economy of the new vehicle fleet at a cost, certainly, but nevertheless a cost that would be more than offset by the fuel economy savings that would result from these more fuel-efficient vehicles over the next 14 years. The estimated improvements that would be possible by putting into widespread use in the new vehicle fleet ranged from 12 to 25 percent for passenger cars and from 25 to 42 percent for light-duty trucks. That comprises minivans, pick-up trucks, and sport utility vehicles. And, importantly, if car makers were given enough time to meet these new fuel economy goals, and by enough time, we were looking in the range of 10 to 12 to 15 years, then these improvements would be capable of being made without downsizing or without downweighting, and therefore, without adverse effects on the safety of the fleet.

I can't emphasize how important it is, in the view of the committee, that in contemplating tightening fuel economy standards that you do so over a long enough period of time that the car makers have an opportunity to take advantage of these technologies that are out there and are currently being developed so that they don't have to engage in a, and I don't intend to bad pun here, a crash program to improve fuel economy that might compromise safety.

Reinforcing one point that Bill Reilly has already made, the committee felt very, very strongly that the credits that can currently be earned in a very limited way in the CAFE program ought to be made fully tradable so that someone who beats their fuel economy standards can not only use those credits themselves in a later year, they can trade across passenger car and light-duty truck fleets, or they could sell these credits to other car companies that are falling short of hitting their targets.

Let me give you my brief update of things that have happened in the 3½ years since the committee report that I think are material to your deliberations.

First of all, September 11 happened one month and one week after the committee issued its final report. Since that time, quite unsurprisingly, oil security is—looms much more importantly in the national debate. And if the committee were doing its work today, it is conceivable that we might give an even greater value to reduced oil consumption on account of the potential for macroeconomic disruptions associated with fluctuations in oil import and oil domestic produced—domestically produced oil prices.

Second, during the period of time since the issuance of the report, gasoline prices have gone up between 20 and 25 percent. This pushes the car companies in the direction of making more fuel-efficient vehicles, because passengers have an incentive to demand more fuel-efficient cars the more expensive the price of gasoline is. I actually think we are seeing some evidence of this. But for this price effect to continue, consumers have to believe that prices will remain high, not slip down to the $1.60 a gallon that they were when the National Academy committee was doing its work.

Third, in the 3½ years since we have issued our report, hybrids have penetrated much more significantly into the new vehicle market than we anticipated at the time. I think we were probably too conservative in our report about the potential for hybrids. Recent estimates suggest that by 2008/2009 there could be as many as 800,000 hybrids sold in the United States. Last year, I think the total was between 45,000 and 50,000. And if that number of hybrids sold grows dramatically, the cost per hybrid sold comes down, and that could make a big difference in the costs associated with meeting tighter fuel economy standards.

I would also like to emphasize that in the 3½ years since we completed our report, much progress has been made on a new generation of clean diesel engines. And I think this is very important for the fuel economy debate, because diesel engines, all of the things being constant, hold out the possibility of improvements of 25 to 40 percent in fuel economy. If we were writing that report today, I think we would pay more attention to the potential for these clean diesels to help in the fuel economy challenge.

And finally, research has been done since that time on the so-called rebound effect. I won't go into great detail on this, but this suggests that as people own cars that get better fuel economy, they may drive those cars more. And some of the adverse effects associated with more vehicle miles traveled, depending on the way you value those, actually have the potential to cancel out some or all of the beneficial effects of improved fuel economy.

So that is my quick summary of what has happened in the time we have done the report. Thank you, again, for having me here. And I would be happy to take any questions later.

Thanks.

[The prepared statement of Mr. Portney follows:]

PREPARED STATEMENT OF PAUL R. PORTNEY

Good afternoon, Mr. Chairman and Members of the Committee. I am Paul R. Portney, President of Resources for the Future. In 2001 I served as Chair of the Committee on Effectiveness and Impact of the Corporate Average Fuel Economy

(CAFE) Standards of the National Research Council (NRC). The Research Council is the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, charted by Congress in 1863 to advise the government on matters of science and technology. My comments today reflect my own views and, to the best of my abilities, those of the NRC committee members. They do not reflect the views of Resources for the Future, an independent and non-partisan research organization that takes no institutional positions on legislative matters.

It is a pleasure to be here to discuss with you the NRC's 2001 report. This study was requested by Congress to provide assistance in its decisions related to fuel economy standards. I would like to provide a brief overview of the report, while noting that it was detailed and cannot be done justice to in a few minutes. Therefore I request that we include the Executive Summary of that report as part of the record. *(See Appendix 2: Additional Material for the Record.)* Following my overview of the 2001 report, I will make a few remarks about developments in the three-and-a-half years since the committee did its work. Let me say here, as I will again later, that I will not be speaking for the committee in offering this update.

The NRC committee had a three-part mission in 2001 when it did its work:

1. Determine the effect that CAFE standards have had on fuel economy, and their impact on the industry, consumers, safety, and other issues;
2. Estimate the impact that changes to CAFE standards might have in the future; and
3. Evaluate the structure of the CAFE program and recommend potential improvements.

Review of the Then-Current CAFE Program

Our review of the impacts of CAFE standards through mid-2001 convinced us that the program had significantly reduced fuel consumption. Other factors also have been important, especially the reaction of consumers and the automotive industry to higher fuel prices in the 1970s and early 1980s. The committee could not apportion responsibility among these factors, but noted that CAFE was clearly important. In the years since the early- to mid-1980s, CAFE indisputably played an important role in maintaining higher fuel economy than otherwise would have resulted, especially during periods when gasoline prices were much lower than those prevailing today.

There have been adverse consequences associated with the CAFE program as well. Safety is most important. The majority of the committee concluded in 2001 that the downsizing and downweighting that occurred in the late 1970s and 1980s (partially in response to CAFE) resulted in an additional 1,300 to 2,600 fatalities in 1993. While fatalities were declining in this period, most committee members believe that they would have declined this much more had the downweighting and downsizing not occurred. Two members of the committee dissented from this view. They believed that the data did not support this conclusion, and that the net effect on highway fatalities of the increases in fuel economy may have been zero.

An additional impact, although one we were unable to quantify, had to do with restrictions on consumer choice. Requiring automotive manufacturers to focus on fuel economy diverted their resources from improving other attributes valued by consumers, such as acceleration and carrying capacity.

Impact of Higher Standards

First let me note that the committee did not recommend whether or by how much the government should tighten the current fuel economy standards. We believed that is a decision belonging to Congress, the President, and appointed officials because it involves tradeoffs among factors very important to the people of this country—the costs of driving, the environment, national security, consumer choice, safety, and others. In so far as possible, the committee identified these tradeoffs, but a full analysis was not possible within the short time allotted to this study.

The committee believed that it is incumbent on decision-makers to understand the benefits of fuel economy improvements and to ensure that the costs associated with these improvements don't outweigh the benefits. The two main benefits the committee considered were the macro-economic gains associated with reduced exposure to fluctuating world oil markets and reduced emissions of the greenhouse gases that may be linked to global climate change. Analysts have assigned a wide variety of values to reducing these externalities. The committee considered this range and ultimately chose values which, in total, are equivalent to about 30 cents/gallon of fuel. That is, each gallon of gasoline consumed has adverse economic and environmental consequences that, when combined, amount to as much as $0.30. I mention this fig-

ure not because the committee endorsed it (indeed other analysts might chose values much higher or lower), but because it helps to understand how hard one can push on fuel economy.

With that as context, the committee concluded that significant improvements in fuel economy are quite possible at reasonable cost. A variety of technologies to improve fuel economy are available for cars and light trucks. Many have been developed and are being implemented in Europe and Japan where fuel prices are much higher than here. Specifically, Variable Valve Lift and Timing can reduce fuel consumption by 3–8 percent. Continuously variable transmissions can achieve another 4–8 percent. Other technologies are under development and will be available for wide scale use within 15 years. Fuel economy can be raised more for heavier vehicles than for light ones, and the resulting fuel savings will be much higher for the heavier vehicles as well. For example, the fuel economy of a mid-size SUV could be improved by 34 percent (from 21 to 28 miles per gallon). Over the lifetime of the vehicle, these improvements would save nearly 2,000 gallons, which would more than pay for their incremental cost.

As with the current CAFE program, raising standards will have other consequences as well, with safety again being the most contentious. Any increase in fatalities will depend on how manufacturers meet higher standards. While the technologies examined by the committee generally appear to be more cost-effective than weight reduction, CAFE standards, as currently structured, do not preclude any methods. Thus some manufacturers might include some weight reduction, which the majority of the committee believed could involve some safety consequences. However, it is also possible that weight reductions could be concentrated in the heavier vehicles. This would reduce the weight disparity in the fleet, which could have beneficial consequences for safety. This could occur because the greater risk for the occupants of the downsized vehicles would be more than balanced by the lessened risk for other road users.

A key point to make here is that the committee felt strongly that automakers must be given sufficient time to accommodate more stringent fuel economy standards. The less time they are given to meet new requirements, especially significantly more stringent ones, the more likely it is that they will respond not through the introduction of fuel-saving technologies but rather through down-weighting and/or down-sizing. This could have adverse consequences for safety.

Recommendations on the Structure of the CAFE Program

First, it was the committee's view that there is a marked inconsistency between raising fuel economy standards while keeping fuel taxes low. The committee certainly did not recommend raising taxes to the level of European countries (or to any specific level for that matter), but the members believed strongly that efforts to raise fuel economy would work much better if consumers had more motivation from higher fuel prices. Since the 2001 report was written, gasoline prices in the United States have risen roughly 20 percent. If consumers perceive this increase to be permanent, it will begin to affect their new-vehicle purchases. In fact, there is some anecdotal evidence to suggest that it already has.

The committee recommended that a tradable credit program be part of any regulatory program on fuel economy. Even if the current structure of CAFE is maintained and the standards not raised, the program can be made more efficient and effective with tradable credits. All manufacturers would have incentive to raise the economy of all their vehicles, and the results are likely to be less costly than the current approach of treating each manufacturer and each vehicle segment separately. Tradable credits have worked well in reducing the costs of sulfur dioxide emissions from coal-fired power plants, and the committee believes they will work as well on fuel economy.

Finally, the committee recommended that consideration be given to modifying the current structure of the CAFE program in such a way that the applicable fuel economy standards for varying types of vehicles depend at least in part on their attributes—that is, their weight, interior size, or some combination of characteristics. I would note that the National Highway Traffic Safety Administration is giving thought to this approach now. The committee also recommended the elimination of both the two-fleet rule that distinguishes between the domestic and foreign "content" of vehicles and the granting of extra fuel economy credits for the production of dual-fuel vehicles.

Update

Three and a half years have passed since the NRC committee on CAFE did its work. I thought it might be useful for me to reflect on developments since August

of 2001 and what they might mean for the fuel economy debate. It should be clear that I am speaking for myself here and not for the members of the NRC committee.

The CAFE committee issued its report about a month before the horrific events of September 11, 2001. Those events and their ongoing aftermath have made us think much more seriously than before about the consequences of U.S. oil consumption and our growing dependence for imported oil on nations that are unstable and/or may bear us ill will. Were the 2001 NRC committee meeting today, its members might assign an even larger value to reducing oil consumption so as to reduce our economic vulnerability to oil price shocks, either accidental or deliberate.

Next, oil prices have risen considerably since the time of the 2001 report, principally a reflection of rapidly growing demand for oil in the developing world (especially China and India), coupled with slower growth in production. If sustained, these higher prices will act as a stimulus to the production of more fuel-efficient vehicles, for the simple reason that people will demand better fuel economy. However, the externalities associated with oil consumption and its effect on both the economy and the environment would still justify government intervention to further improve fuel economy.

Third, in its deliberations on new technologies that might be used to improve future fuel economy, the 2001 NRC committee gave little consideration to either gasoline-electric hybrids or diesel-powered passenger cars and light-duty trucks. The former, the committee felt, were too expensive to make a significant difference in fleet-wide fuel economy over the next ten to fifteen years, while the latter faced stiff challenges related to vehicle emissions standards for both oxides of nitrogen and also fine particulate matter.

We may have been too conservative in both these assessments. Hybrid vehicle sales have grown faster than anyone expected—to 86,000 in the U.S. in 2004. According to industry experts, hybrid sales could amount to 400,000-500,000 by the 2008–09 model year, with significant penetration in both the passenger car and light-duty truck segments of the market. Similarly, considerable progress is being made in the development of much cleaner diesel engines; this is important because diesel-powered vehicles get 30 percent better fuel economy than conventional internal combustion gasoline engines. If the cost penalty associated with hybrids falls significantly because of larger-than-expected volumes, and if car makers find a way to produce diesel engines that are capable of meeting tougher emissions standards in California and the rest of the U.S. for the lifetime of vehicles, things could be different. That is, it might be possible to meet more stringent fuel economy standards at lower costs for less than the committee foresaw in 2001. Once again, this is speculation on my part alone; this view should not be attributed to the 2001 committee.

Finally, looking back on our 2001 report, I wish we had had the time to pay closer attention to the so-called "rebound effect" (this refers to the additional miles motorists may drive in vehicles that get better fuel economy). Some recent research by my colleagues at Resources for the Future suggests that the negative consequences resulting from the added congestion, air pollution and accident risks could cancel out the beneficial economic and environmental effects of improved fuel economy, depending on how all these effects are valued. I take responsibility for having given this important issue less attention than I believe it deserves, and I urge the committee to consider it in future deliberations over the CAFE program.

Thank you, Mr. Chairman and Members of the House Science Committee. That concludes my prepared remarks. I would be happy to answer any questions you have.

BIOGRAPHY FOR PAUL R. PORTNEY

Paul R. Portney is President of Resources for the Future (RFF), an independent, non-partisan research and educational organization specializing in natural resources and the environment. Portney joined the staff of RFF in 1972; from 1986–1989 he headed two of its research divisions; in 1989 he became its Vice President, and was named President in 1995. In 1977, he took leave to become a Visiting Professor at the Graduate School of Public Policy at the University of California at Berkeley. Between 1992–1996, he was a Visiting Lecturer at Princeton University's Woodrow Wilson School. In 1979–1980, Portney was Chief Economist at the Council on Environmental Quality in the Executive Office of the President.

Portney received his B.A. in economics in 1967 from Alma College (Michigan), and his Ph.D. in economics from Northwestern University. He is currently a member of the Sustainable Forestry Board and the Board of Directors of The Johnson Foundation, where he chairs the Finance and Investment Committee. He recently joined the Advisory Council of the Comptroller General of the United States. In 2001, he

was chairman of a National Academy of Sciences' Committee on the future of Corporate Average Fuel Economy standards. From 1994–97, he was a member of the Executive Committee of EPA's Science Advisory Board (SAB) and Chairman of the SAB's Environmental Economics Advisory Committee. He has published widely on the costs and benefits of environmental regulation, including the 2nd edition of his book, *Public Policies far Environmental Protection,* used in college and university classrooms around the country. He also lectures frequently on developments in U.S. and international environmental policy.

Education

Ph.D. in economics, Northwestern University, 1973.

B.A. in economics, Alma College, 1967.

Professional Experience

- President, Resources for the Future, 1995–present.
- Vice President, Resources for the Future, 1989–1995.
- Senior Fellow, Resources for the Future, 1980–present.
- Director, Resources for the Future, Center for Risk Management, 1987–1992.
- Director, Resources for the Future, Quality of the Environment Division, 1986–1987.
- Visiting Lecturer, Princeton University, 1992–1995.
- Senior Staff Economist, Executive Office of the President, Council on Environmental Quality.
- Visiting Professor, University of California at Berkeley, Graduate School of Public Policy, 1977.
- Senior Research Associate, Resources for the Future, 1973–1977.
- Dissertation Fellow, The Brookings Institution, 1971–1972.

Journal Articles

On Valuing Nature, Raymond J. Kopp, N.E. Bockstael, A.M. Freeman III, Paul R. Portney, and V.K. Smith, *Environmental Science and Technology,* 2000, Vol. 24, No. 8, pp. 1384–1389.

Chairman BOEHLERT. Thank you very much, Mr. Portney. And I want to thank both you and Administrator Reilly for focusing on the fact that this is, first and foremost, a national security issue. Then it is a consumer economy issue. It also happens to be an issue of importance to those of us concerned about the environment. And I would submit that most of us are concerned about the environment. I don't want it to be portrayed as the greens against the rest of the world. It is not the case at all.

So—and the other thing I am glad you made reference, as I did in my opening statement, to the debate in '01 just prior to 9/11, because it was just within hours of the issuance of your report that Congress began the debate. And I would suggest in many respects, it was not an informed debate, because the Congress did not have the benefit of a thorough examination of your outstanding work.

So thank you for what you have done.

Am I indicating to some of my fellow colleagues my preference in this issue?

Mr. Duleep.

STATEMENT OF MR. K.G. DULEEP, MANAGING DIRECTOR OF TRANSPORTATION, ENERGY AND ENVIRONMENTAL ANALYSIS, INC.

Mr. DULEEP. Mr. Chairman, thank you for having me here.

The Committee's staff has asked me to focus on technology issues, and that will be the focus. They asked me four specific ques-

tions. I will try and summarize my comments and have the written testimony submitted to the record.

The first question I will focus on is what technologies are available to improve fuel economy. I have a chart in there on what I call conventional technologies that you can go out and actually buy on some car made today. So you can actually just walk into a dealership and buy one of these. They haven't yet penetrated the fleet. They are in just a few cars now, and we estimate that if you take all of those technologies, and I have a table in my written testimony, and you put them onto one car or one truck, you can get something like 24 or 25 percent improvement from these technologies in the fuel economy. They would add about $800 to $1,000 on the price of a vehicle, the retail price.

If you look at how much fuel they save and what the value of it, they pretty much pay for themselves over 50,000 miles of use, so a consumer buying these technologies would get paid back in three or four years. That is a typical measure used by auto companies to judge whether, in fact, they are to introduce these technologies.

One of the important points on this is that I believe that most of these technologies will be adopted, or could be adopted, in most cars by the manufacturers just on the free market, just on a competitive basis, largely because they make sense. If they pay for themselves, why not? We have looked at many of the public announcements made by General Motors and Ford and so on, and we can see all of these technologies coming in the next few years.

At the same time, I don't want to imply that this means that fuel economy will improve by 25 percent in the next 10 years, largely because the consumers are buying more performance, larger vehicles, and so on. So I expect about half of the improvements will actually be lost to consumers buying more vehicles, four-wheel-drive, and so on. And that is assuming that gas prices stay about where they are today, about $2 a gallon.

Next, I will briefly discuss the issue that Dr. Portney raised, which is the issue of diesel engines and hybrids. At the time the National Academy met, there was a lot of debate about whether the diesel could meet U.S. emissions standards. There is still some debate today, but having spoken to a lot of the leading diesel engine manufacturers in the world, I am fairly confident that they will meet these standards in the next three or four years.

The diesel engine can improve—just by itself, can improve vehicle fuel economy by something like 35 to 40 percent, and they are widely used in Europe. If you add some of the other conventional technology improvements, the vehicle fuel economy can go up by more than 50 percent. So it is a huge fuel economy improvement possibility, but the cost of the diesel engine is pretty high. A four-cylinder diesel engine with all of the advanced emission controls will add something like $2,200 to the price of a car. If you use a V6 or a larger engine, it will add something like $3,500 to the price of a truck.

At those prices, you don't get the payback. It won't pay for itself, but I think consumers will still value things like it has a lot of torque so it can tow trailers and so on, and it has at least the image of great durability so it can run maybe a half a million miles

without a major overhaul. Consumers value that, and they appear to certainly prefer diesel engines in the larger pick-up trucks even today.

Going back to the hybrid, that has become very popular now, but there are lots of different kinds of hybrids. At the one end, we have the Toyota Prius, and I think Ford uses a very similar design, and some people call that a full hybrid. Somewhere in between, we have the Honda Accord and Honda Civic, which uses a much smaller motor and the battery than the Toyota Prius. Then we have other designs by General Motors and DaimlerChrysler. And all of these are different implications for fuel economy. So when people use the word "hybrid," they don't use it in a very consistent way, and there are lots of flavors of them.

But there is one common characteristic that hybrids have. Most of their fuel economy improvement occurs in city driving. So it has to be stop-and-go driving. On the highway, hybrids don't give you much, whereas with the diesel engine, the fuel economy gains are more robust across all of the driving conditions.

One of the things I do want to point out is that there has been a lot of attention paid to the Toyota Prius, and rightly so. It is a wonderful car. But if you look at how much it costs to make, and you assume that manufacturers take their standard profit margins and pay back their cost of capital and so on, we estimate that, at today's prices, if you built a Toyota hybrid-like mid-sized car, the retail price should go up about $6,000. It gives you about a 50 to 55 percent fuel economy improvement. And clearly, that—you are not going to make that money back in fuel savings.

But the other thing that the press does not seem to notice is that there are other very smart ways to do it. Honda, for example, as I mentioned, uses a motor that is maybe half the size of the one in the Prius, a battery that is less than half the size, and they get fuel economy numbers that are almost as good as the Prius. So there are very advanced ways to exploit synergies between the engine, the electric motor, and the transmission that may cut the costs tremendously. So we see something like the cost coming down below $2,000, at which point it starts to make sense to the consumer.

I would also mention that we know some companies are working on diesel hybrid combinations in Europe, and we expect to see them in something like 2008.

One of the continuing issues has been this issue of safety and fuel economy. Others on this panel will comment on it. But a lot of those issues that the panel—that people on this panel talk about is what happens after the crash has occurred. I think this committee should be made aware that there are really amazing changes in new technology in preventing crashes from occurring in the first place. These are technologies like blind spot warning, precrash sensing, lane departure warning, night vision, and so on. In fact, I think in—perhaps five or 10 years down the road, a vehicle will be able to brake itself before it hits anything else, and so the whole issue of safety and fuel economy links becomes almost moot.

Lastly, I was asked to address issues regarding government policy in fuel economy. Like Dr. Portney, I agree that the CAFE standards did achieve some goals. But I think that it did disadvan-

tage the domestic manufacturers, because all manufacturers, regardless of what you produce, have to meet the same MPG number, even if you build large cars or small cars, whatever your mix is.

Dr. Greene and I have done some studies looking at some other forms of standards, and I expect Dr. Greene will address this more fully, but the basic fact is there are different ways of doing this that are, perhaps, more equitable in this treatment of manufacturers.

Second, I want to just briefly touch on the issue of consumer response. Here I would take some issue at the Honorable Reilly's recommendations from the National Commission on Energy, which were all focused on manufacturers. Here we have a situation, as you know, even with record prices last year, light truck market share reached a new record in 2004: 55 percent of all vehicles bought in the U.S. were light trucks. Today, we see cars with 400, 500, and even 600 horsepower that are meant for street use. So clearly consumers are going in the direction that needs some restraint, and I would suggest that an important part of energy policy has to be—has to include the consumer or has to be some form of consumer education.

Another point that I would like to touch on is this issue that Dr. Portney, again, briefly touched on, which is many economists continue to believe that if you raise fuel prices, that is going to solve the problem. We have to remember that five years ago, gas was $1.20 a gallon. Last year, it was almost $2.00 a gallon, and that is a 50 percent price increase. Yet if I look at the numbers in terms of fuel economy, what people are buying, the vehicle miles of travel, it is hard to see that there has been a big effect. I personally feel that the estimates that were put forward by the National Academies were, perhaps, an order of magnitude too large in this issue.

Lastly, I would touch on subsidies and fees for technology. Here I think the experience has shown that it is probably not a good idea to subsidize specific technologies. I would mention in this—example the issue between, say, the Toyota Prius and the Honda design, if you can figure out a smarter, cheaper way of doing something, it may not be covered by the specific definition used to subsidize a technology. I would certainly advocate that tax rebates or subsidies for fuel-efficient vehicles be independent of the kind of technology used to get there, whether it be diesel or some very advanced type of gasoline engine or some hybrid, because ultimately, we want to reduce fuel use, and that should be the goal of the subsidy. These subsidies could be phased out over some period. The principle idea behind the subsidy would be to reduce manufacturer risk of investing in something that we have no idea whether the consumers are going to buy.

Thank you for your attention. I will be pleased to answer your questions.

[The prepared statement of Mr. Duleep follows:]

PREPARED STATEMENT OF K.G. DULEEP

Mr. Chairman and Members of the House Science Committee,

Thank you for inviting me to participate in this hearing on the topic of vehicle fuel efficiency. I am the Managing Director at Energy & Environmental Analysis (EEA), a consulting firm. EEA has been involved in analyzing this topic for the last

25 years and has provided the Department of Energy with many analyses of technologies over this period. EEA has also worked for a number of foreign governments, notably Canada and Australia, on this issue. The views expressed by me at this hearing, however, are my own and do not reflect the views of the DOE or any of my other clients. I was instructed by the Committee's staff to respond to four questions, and I will focus on these questions in my testimony. I have highlighted the key points in my written testimony

CONVENTIONAL TECHNOLOGY IMPROVEMENTS

The first question posed was on the identification of technologies available to improve light-duty vehicle fuel economy and their potential benefit. This is a question that has received much attention and most analyses separate "conventional" technologies that are evolutionary improvements to existing technology from "revolutionary" technologies that involve new types of engines and/or fuels. In this context, hybrid and diesel vehicles could be described as revolutionary and their benefits are described in the response to the second question. All of the fuel economy benefits cited are on the EPA combined city-highway test unless an alternative is specifically mentioned.

The available conventional technologies have been extensively researched and I can state that there is a consensus among engineers regarding these technologies and their costs and benefits. Table 1 (attached) provides such a listing and is restricted to conventional technologies that are sold in at least one mass-market model in the U.S. as of 2005, to avoid any controversy about technology readiness for the market place. In addition, I have ignored the potential for weight reduction through the use of alternative materials because of the unfortunate controversy over the link between weight and safety. The data in the table suggests that a total fuel economy improvement of about 26 percent in small cars to 28 percent in larger cars and light trucks is possible for much of the new car fleet with no weight reduction whatsoever. At the same time it should be noted that all of the technologies are (by definition) in some vehicles, so that the fleetwide benefit available relative to 2004 model year vehicles is about two percent lower than the estimate in the table. If one were to choose only those technologies that pay for themselves in terms of fuel savings over 50,000 miles (a measure used by manufacturers to gauge consumer acceptance), then the gasoline direct injection system would not be included in the list. However, direct injection with lean combustion could be cost effective as it could double the fuel economy benefit from this technology alone and eliminate the need to employ cylinder de-activation or variable valve lift. Hence, *the available improvement from cost effective conventional technology would be about 24 to 26 percent.* Half of the improvement is associated with engine technology. The technologies would add about $800 to $1,000 to the retail price of a vehicle while the value of fuel saved over 50,000 miles at $2/gallon would be in the same range.

These estimates are a little lower than the ones derived by the National Academy of Sciences for two reasons. First, the choice of only those technologies already in the market as of 2005 is more restrictive than the definition used by the NAS. Adding most of the excluded technologies like "camless valve actuation" or " variable compression ratio" will increase the total available benefit but will not change the listing of cost-effective technology as these excluded technologies are typically quite expensive for the benefit delivered. Second, the NAS study was completed four years ago and some of the technologies on their list have already been widely adopted in the interim period. However, it can be argued that the costs of these excluded technology improvements could come down in the future. A comparison of studies on fuel economy completed since 1985 suggests that *at any given point in time, there always appears to be the potential to increase fuel economy by 25 to 30 percent in a cost-effective way.* As available technologies are adopted into most new cars, new technologies are developed to lead to this conclusion.

More importantly, I also believe that *all of the cost-effective technology in the table could be adopted under free market conditions in most vehicles* by 2015 if gasoline prices do not decline significantly, simply due to the fact these technologies pay for themselves. As examples, GM has publicly announced that most of the V–8 and V–6 engines will have cylinder cutout in the future. GM and Ford are collaborating on a six speed automatic transmission that will be used on most of their front wheel drive cars by 2012. DaimlerChrysler's new four-cylinder engine will be equipped with variable valve timing. Most current Honda models offer variable valve lift systems. These examples confirm our computations of cost-effectiveness. At the same time, this does not imply that 2015 fuel economy under free market conditions will be 25 percent higher than it is today. *We estimate that about half of the improvement will counterbalanced by consumers buying more luxurious and larger vehicles, SUV models and four-wheel drive* even if fuel prices remain at around $2 per gallon.

If gasoline prices decline in the future to $1.25 per gallon, there may be no improvement in fleet fuel economy at all as some technologies become cost ineffective.

HYBRID AND DIESEL TECHNOLOGY

The second question asks about the prospects for diesel and hybrid technology, and their expected contribution to fuel economy. Dr. Greene of Oak Ridge National Laboratory and I completed a study of these technologies last year on this very question, but because technological changes are happening quickly, I have modified my answers to reflect new data. I will focus on technology issues and let Dr. Greene respond to market penetration issues. Both technologies offer the prospect for fuel economy improvements of 40 to 50 percent, more than double the total available from all cost effective conventional technology.

TABLE 1: CONVENTIONAL TECHNOLOGIES TO IMPROVE FUEL ECONOMY FOR THE 2005 TO 2015 TIME FRAME
(technologies introduced in at least one model in the US market)

	TECHNOLOGY	F/E(%) BENEFIT*	COMMENT
ENGINE	VARIABLE VALVE TIMING	2 ± 0.5	ALLREADY USED ON MANY CARS
	VARIABLE VALVE LIFT or	5 ± 1.0	USED PRIMARILY BY HONDA AND BMW
	CYLINDER CUTOUT (V-6 & V-8 ONLY)	8 ± 1.0	INTRO. ON V-8 BY GM & CHRYSLER IN '05
	ENGINE FRICTION REDUCTION	2 ± 1.0	ADOPTED IN VARYING DEGREES
	DIRECT INJECTION (stoichiometric)	5.5 ± 1.0	INTRO. BY AUDI IN 2005 A6
TRANS-MISSION	6 SPEED AUTOMATIC (V-6 & V-8) or	4 ± 1.0	INTRODUCED IN SOME LUXURY CARS
	CVT (4 CYLINDER) relative to 4-speed unit	5 ± 1.0	INTRODUCED BY HONDA AND GM
	LOW LOSS TORQUE CONVERTER	1.5 ± 0.5	INTRODUCED IN SOME LUXURY CARS
OTHER	IMPROVED WATER, OIL PUMP	1 ± 0.3	ELECTRIC DRIVE MAY SAVE MORE
	IMPROVED ALTERNATOR	0.5 ± 0.2	APPEARING IN SOME HIGH FE MODELS
	ELECTRIC POWER STEERING	2 ± 0.5	INTRODUCED BY GM IN 2005 MALIBU
	REDUCED TIRE ROLLING FRICTION	2 ± 1.0	INTRODUCED IN HYBRID MODELS
	REDUCED AERO. DRAG	2 ± 0.5	ADOPTED IN VARYING DEGREES
TOTAL	ALL IMPROVEMENTS IN ONE VEHICLE	26 ± 2.5	4 CYLINDER
		28 ± 2.5	V-6 AND V-8

*FE benefits are measured at constant performance, defined as constant torque/weight over typical driving conditions. Individual benefits of technologies shown above are not necessarily additive for groups of technologies in the same vehicle.
** All technologies except direct injection are cost effective at $2 per gallon in terms of fuel savings exceeding technology price over 50,000 miles of driving on midsize car. Technologies in "other" category are marginal and may not be cost effective at lower gasoline prices.

Diesel engines are not a new technology and half of all new cars sold in Europe are diesel powered. They are revolutionary only in the U.S. context due to the difficulty in meeting emissions standards in force here. Although much has been made of the diesel's emissions, I am now reasonably confident that *the diesel engine will be able to meet the stringent new Tier 2 emission standards in most vehicles in the near future.* Existing diesel engines can definitely meet this standard with an urea-SCR system and particulate trap, but vehicles need periodic refueling with urea. Distributing urea to refueling stations is not an insurmountable problem, but is of some concern to the EPA. Other solutions that do not require urea like the NO_X adsorber are also close to meeting emission standards but extract a fuel economy penalty of three to five percent. More exciting developments are in emission control by modifying the combustion process itself. There are three approaches being pursued, and the U.S. EPA has developed one. Last week, Ford and EPA announced an agreement to develop this technology for production, demonstrating its potential.

Modern diesel engines with direct injection and turbocharging can improve fuel economy by 38 ± 5 percent relative to a gasoline engine of equal size.[1] These engines can provide 40 to 50 percent more mid-range torque than the gasoline engine and near equal horsepower. In addition, there is evidence from Europe that diesel vehicles perform better on the road than gasoline vehicles and real-world (as opposed to EPA test) fuel economy may be about 50 percent better than a gasoline vehicle. However, the diesel engine (with advanced emission control) will have a *price premium of about $2200 for a four cylinder engine used in a compact car to about $3400 for a large V–6 used in a pickup truck.* At these prices, the fuel savings over 50,000 miles will not pay for the full cost, but consumers value the torque and durability of the engine. I should also note that the "conventional" technologies not related to the gasoline engine in Table 1 are also applicable to diesel powered vehicles, so that *the vehicle fuel economy potential is about 50 ± 6 percent.* Our study estimated the ultimate market potential of the diesel in the 2015 time frame at about 30 percent of the market if there is no hybrid competition.

The hybrid gasoline—electric vehicle has received much attention, but there are many kinds of hybrids and the terminology to describe them is both confusing and biased. The Toyota Prius is one reference sometimes referred to as a "full" hybrid, and it uses two high powered electric motors, a gasoline engine and a high power battery. (Ford's Escape hybrid uses a similar system.) The Honda Civic and Accord hybrids use a different and simpler system with one motor of relatively low power and a smaller battery than the one used in the Toyota Prius. GM and DaimlerChrysler currently offer a system in a hybrid pickup truck conceptually similar to the Honda system but with a much lower power battery. GM also plans to introduce a fourth type of system, called a Belt drive Alternator Starter (BAS) system that is significantly cheaper than any of the other systems. All of these types are hybrids but have quite different price and performance implications.

In general, *all hybrids improve fuel economy in city (or stop-and-go) driving by significant amounts, but offer little or no improvement in fuel economy under highway (steady high speed) conditions.* In addition, the hybrid vehicle's fuel economy benefits, even under city driving conditions, are a function of trip length and ambient conditions. In contrast, the fuel economy benefit of the diesel is more robust across all driving conditions.

It is difficult to provide a single fuel economy benefit number to hybrids even of a particular type since it is a function of the performance trade-offs chosen by the manufacturer. *"Full" Hybrids using a two electric motor design similar to that used by Toyota and Ford can provide a 50 to 55 percent improvement in composite fuel economy if optimized for maximum fuel efficiency.* This improvement includes the effect of the conventional technologies listed in Table 1 and the benefit of hybridization alone is about 25 to 30 percent. Such hybrids provide comparable low speed acceleration but reduced continuous power for hill climb or trailer towing. Vehicles that offer no compromise in continuous power and significantly better low speed acceleration will offer a benefit of 30 to 35 percent (again including most conventional technologies). In a mid-size car for example, we estimate that the additional hybrid related components will add $5,600 to retail price currently if manufacturers utilize standard retail markup and expect to earn an average profit margin on these vehicles. There are significant cost reductions likely to be realized over the next five years and we estimate that by 2010 prices can be below $3,900. Since the fuel savings over 50,000 miles are only on the order of $1,300 to $1,500, many believe that this technology will never succeed in the market even after cost reductions are realized.

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[1] Europeans often quote a diesel fuel consumption (the inverse of fuel economy) benefit of 25 to 30 percent, and this is equal to a fuel economy benefit of 33.3 to 42.85 percent.

These issues regarding the "full" hybrid have been debated publicly, but the potential of other hybrid designs has received much less attention in the press. Honda has introduced three hybrid vehicles in the U.S. that have a single electric motor of less than half the power of the motors in the Toyota Prius, and an advanced battery that is half the size of the one in the Prius. Yet, the fuel economy gains in the Honda hybrid vehicles are almost as good as the ones from the Toyota hybrids. Honda has cleverly managed to exploit synergies between engine, transmission and electric motor technology to maximize fuel economy. We estimate the cost of these hybrids to be less than half the cost the "full" hybrid designs, so that future prices will be relatively close to the value of fuel saved. Other innovative designs using ultra-capacitors have been shown by Continental of Germany that could be a low cost solution for some types of vehicles. *These alternative types of hybrid designs in synergy with engine technologies could provide fuel economy gains of 30 to 35 percent with no loss in performance, and will be cost effective in terms of fuel savings over the life of the vehicle.* Dr. Greene's analysis suggests that hybrids of different types can capture 25 percent of the market by 2015, and this figure could be higher with some of the more innovative designs under study now.

Some analysts have discounted the diesel engine and hybrid powertrain combination as too expensive, but I do not agree. Some alternative cheaper hybrid designs could make sense with advanced diesel engines by eliminating the need for costly emission control equipment like NO_X adsorbers, partially offsetting hybrid costs. I have heard that several European manufacturers are developing hybrid-diesel combinations and I anticipate that the first models will be available in the U.S. by 2008.

SAFETY RELATED EFFECTS

The *data presented above for conventional and revolutionary technology do not include any weight or size reduction, so there are no reasons to be concerned for safety.* In addition, both the diesel and hybrid vehicle weigh three to five percent more than conventional vehicles, so that there could be positive benefits if weight is indeed a factor. I am not a safety expert, but recent analyses sponsored by Honda suggest that size rather than weight is more important for safety.

In addition, the safety relationship to weight and size is debated in the context of injury *after* a crash has occurred. This committee should be made aware of amazing new advances in active crash prevention technologies. Technologies being introduced into the marketplace in the near-term include:

— Blind Spot Warning through radar or infra-red detection
— Pre-Crash sensing using radar or vision based technology
— Lane Departure Warning using camera based technology
— Active Lane Keeping systems
— Stability control, soon to be standard on most vehicles
— Rollover prevention on trucks and SUV models
— Rear Vision and Night Vision systems
— Drowsy Driver Detection systems

Indeed, there are plans to incorporate systems to completely sense the vehicle driving environment and warn the driver or prevent a crash. *I believe that active safety technology has the potential to completely change the safety debate and remove any link between fuel economy and safety,* and hope that this committee will examine these technologies more closely.

GOVERNMENT POLICIES

I was also asked to comment on government policies to accelerate technology introduction. I am aware of public initiatives to raise CAFE standards with the premise that this policy has worked in the past. While the CAFE standards did achieve the goals, there is no question that the current form of the standard requiring all manufacturers to meet the same MPG target disadvantaged domestic manufacturers. Dr Greene and I have investigated *other forms of the standard such as size or weight based standards and these seem to be more equitable in treatment of different manufacturers. However, no form of standard is without some drawbacks, and all are susceptible to "gaming."* I am also hesitant to suggest the European method that set a "voluntary" fuel consumption improvement target for all manufacturers and let the manufacturers negotiate individual targets between themselves. I understand some strains are being caused between European manufacturers by this agreement, and intra-industry agreements could be construed as anti-competitive behavior under U.S. laws. I will let others on the panel comment on standards and focus my attention on promoting technology for fuel economy.

The consumer side of the equation should also not be neglected. Consumers appear to value other attributes, notably size, luxury features and performance over fuel economy, and the appeal for SUV models has not diminished much even at the current gasoline price of $2 per gallon. The market share for light trucks continues to increase and reached a record of almost 55 percent of the total light vehicle market in 2004. Cars and light trucks with astounding horsepower ratings of 400, 500 and 600 HP are in demand in a country where the national speed limit rarely exceeds 70 mph. These trends will serve to eventually erase the benefits of any amount of technology introduction. Hence, future fuel economy related efforts should include efforts directed at consumer motivation to purchase more efficient rather than more powerful or larger vehicles. This has always been a difficult area for Congress, as any restriction on consumer choice appears politically unacceptable.

Just a few years ago, many economists believed that raising fuel prices alone would solve this problem of consumer motivation. Some computations purported to show that gasoline savings equivalent to a 25 percent increase in CAFE standards could be obtained by raising the fuel price to $1.75 (or by about 50 cents) at that time. It can now be demonstrated from U.S. data from 2003–2004 that the assumed elasticities of consumer response to gasoline prices for vehicle choice and vehicle use were in error, by almost an order of magnitude. The Canadian experience with high fuel prices for the last 20 years also proves the same point. Hence, *increasing taxes on gasoline as the primary conservation measure is not a particularly powerful strategy unless very large price increases ($2 to $3) are contemplated.* At the same time, higher gasoline prices do make some modest contribution to saving fuel and can set the stage for making higher priced fuel efficient technology more palatable to the consumer, i.e., it may be a necessary but not a sufficient condition.

Subsidies and fees for fuel efficiency or fuel-efficient technology to motivate consumer purchase are a common suggestion, and there are some subsidies now available for hybrid vehicles. I believe that the experience has shown technology specific credit or subsidy programs to be quite unpredictable in supporting the best outcome. For example, California's current ZEV mandate provides credits to hybrid vehicles as a function of electric motor power and battery voltage, independent of the actual fuel economy or emissions results attained by a specific design. In future, this could have the effect of promoting more expensive designs and disfavoring less expensive but more innovative designs that provides a similar outcome. I also believe that *diesel and hybrid technologies are not in direct competition,* as the primary benefits of hybrids accrue to passenger vehicles which operate mostly under city driving conditions. Diesel technology is most useful for vehicles that carry loads, tow trailers occasionally, and/or operate primarily on the highway. Hence, the availability of both diesel and hybrid technologies in the marketplace would extend benefits to different groups of consumers with different needs.

I would suggest tax rebates or subsidies for fuel efficient vehicles that are independent of technology, be it advanced diesel, gasoline direct injection, hybrid or some combination. These subsidies could be phased out over a 10-year period, and the main purpose would be to reduce manufacturer's risk of investing in the production of a high fuel economy technology that is rejected by the consumer.

Thank you for your attention. I will be pleased to answer any questions the committee may have for me.

BIOGRAPHY FOR K.G. DULEEP

As Managing Director at EEA, Mr. K.G. Duleep has been involved with automotive technology, fuel economy, and emissions issues for nearly 25 years. He has directed a number of studies evaluating new technologies for vehicular engine and fuel combinations (including methanol, natural gas, and other alternative fueled vehicles). These studies have compared the technical feasibility, economics, performance, maintenance, and air emissions impacts of alternative vehicle technologies. Mr. Duleep has completed projects for the U.S. Federal and State governments, and for several other countries (notably Canada and Australia) where his technology evaluations and forecasts have formed the basis for fuel economy related initiatives and regulations. Mr. Duleep has testified on transportation technology issues for the U.S. Congress during debates on the Clean Air Act and CAFE (fuel economy) standards during the 1990s.

In 2000, Mr. Duleep supported the National Academy of Sciences' Committee on the Effectiveness and Impact of CAFE Standards by providing information to the committee on the availability, cost and benefit of several automotive technologies. Much of the data on the cost of fuel economy and alternative fuel technology available in the public domain can be traced to his work for the Department of Energy.

He also provides technology analysis support to auto-manufacturers and Tier 1 suppliers.

Mr. Duleep has a Masters' degree in Engineering from the University of Michigan and an MBA from Wharton.

Chairman BOEHLERT. Thank you very much.

Mr. Stanton.

STATEMENT OF MR. MICHAEL J. STANTON, VICE PRESIDENT OF GOVERNMENT AFFAIRS, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Mr. STANTON. Thank you, Mr. Chairman.

I represent the Alliance of Automobile Manufacturers, which is BMW, DaimlerChrysler, Ford, GM, Toyota, Mazda, Mitsubishi, Porsche, and Volkswagen of America. So it is a broad group of international manufacturers.

And the Alliance supports efforts to create an effective energy policy based on broad market-oriented principles. Policies that promote research and development and accelerate the deployment of advanced technologies by providing customer-based incentives should be the foundation for these efforts. This focus leverages the intense competition of automobile manufacturers worldwide. Competition drives automakers to develop and introduce technologies as rapidly as possible to meet the demands and needs of customers.

The auto industry is committed to developing and utilizing emerging technologies to produce cleaner, safer, and more fuel-efficient cars and light trucks. The NAS, in its 2001 report to Congress, cited a number of promising technologies that are being developed for use in vehicles. The report notes that they fall into a variety of categories, from production intent to emerging. In many cases, the production intent technologies are already in vehicles. The emerging technologies are ones that may achieve significant penetration in the market if economic and regulatory conditions permit, and in some cases, if there are engineering breakthroughs. All of this suggests that purchasing a course of—or pursuing a course of incentivizing the introduction of technologies to accelerate their implementation would be more effective than attempting to effectively mandate their use.

Auto manufacturers are working on advanced longer-term technologies, such as hybrid, clean diesel, and internal combustion engines and fuel cells. These efforts may lead to substantial improvements in efficiency and emissions performance, all, we hope, without sacrificing safety, utility, comfort, or performance. Fuel cell technology, or liquid hydrogen powered ICEs, also serve as a potential path to move away from a petroleum-dependent transportation sector. Successful introduction of these new and emerging technologies all share the need for cooperative efforts that bring together all of the stakeholders, including auto makers, energy providers, government policymakers, and most important, consumers.

The Alliance supports enactment of consumer tax credits for the purchase of these advanced technology vehicles. These credits will help offset the initial higher cost until greater volumes make them less expensive to produce and purchase. The Alliance believes that the overall concepts and provisions for consumer tax incentives found in last year's conference report for the Energy Bill are the

right approach and would benefit consumers. And I am pleased to say that yesterday Congressman Camp introduced similar legislation, and we hope that the Committee Members would be able to support it.

CAFE levels are critical to auto makers for a variety of reasons. First, if standards are too high, they will preclude vehicle attributes that can put the manufacturer at odds with their customers. Second, the level of CAFE standards can result in unintended consequences, such as the adverse safety consequences of pushing manufacturers to making vehicles lighter and smaller. Third, there are competitive implications for some manufacturers relative to others due solely to the mix of vehicles that are offered and sold. For instance, a manufacturer specializing in large, high-performance vehicles will have a more difficult challenge than a full-line manufacturer, and that full-line manufacturer will have a more difficult challenge than a limited-line manufacturer on compacts and sub-compact vehicles. And finally, for consumers sensitive to costs, fuel economy gains must be compared to the increased costs for their new vehicle purchase decisions.

To summarize, Mr. Chairman, the Alliance believes that we must continue our efforts to reduce our dependence on foreign oil, which is one of the reasons we support the President's Hydrogen Fuel Initiative. In the near term, Alliance members will continue to compete with advanced technology vehicles, such as hybrids, clean diesel, and alternative fuel vehicles. Meanwhile, we will continue to work with NHTSA as it fulfills its congressional mandate to set new light truck vehicle CAFE standards at their maximum feasible level.

Mr. Chairman, this concludes my statement. Thank you.

[The prepared statement of Mr. Stanton follows:]

PREPARED STATEMENT OF MICHAEL J. STANTON

Mr. Chairman,

Thank you for the opportunity to testify before the Committee on Science regarding fuel efficient technologies for motor vehicles. I represent the Alliance of Automobile Manufacturers, a trade association of nine car and light-truck manufacturers. Our member companies include BMW Group, DaimlerChrysler Corporation, Ford Motor Company, General Motors Corporation, Mazda, Mitsubishi, Porsche, Toyota Motor North America and Volkswagen of America.

Alliance member companies have more than 600,000 employees in the United States, with more than 230 manufacturing facilities in 35 states. Overall, a University of Michigan study found that the entire automobile industry creates more than 6.6 million direct and spin-off jobs in all 50 states and produces almost $243 billion in payroll compensation annually.

The Alliance supports efforts to create an effective energy policy based on broad, market-oriented principles. Policies that promote research and development and accelerate the deployment of advanced technologies by providing customer-based incentives should set the foundation for these efforts. This focus on "accelerating the implementation of advanced technologies" leverages the intense competition of the automobile manufacturers worldwide. Competition drives automakers to develop and introduce breakthrough technologies as rapidly as possible to meet the demands and needs of consumers.

According to EPA data, the results of these efforts have been steady *fuel efficiency* increases of nearly two percent per year on average from 1975 to 2003 for both cars and light trucks. Fuel efficiency is a measure of the energy needed to move a given mass a specified distance. Fuel efficiency has been increased through improvements in aerodynamics, powertrains and reductions in accessory losses—in essence, through the use of the technologies of concern to the Committee and mentioned in

reports by the National Academy of Sciences (NAS). As a result, the average vehicle each year, everything else being equal, consumes about two percent less fuel than it did the year previously.

To accomplish these great results, the auto industry spending on R&D each year is approximately $18.4 billion, with much of it in the high tech sector. In fact, the University of Michigan study noted earlier stated the following: "The level of automotive R&D spending and the relatively high employment of research scientists and engineers in the U.S. auto industry has traditionally earned a place in any U.S. Government listing of high technology industries generally thought to be central to the long-term performance of the U.S. economy."

The auto industry is committed to developing and utilizing "emerging" technologies to produce cleaner, safer, and more fuel efficient cars and light trucks. The NAS, in its 2001 report to Congress, "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) standards," cited a number of promising technologies that are being developed for use in vehicles. The report notes that they fall into a variety of categories—from "production intent" to "emerging." In many cases, the production intent technologies have already begun to be introduced into vehicles. The "emerging" technologies are ones that may achieve significant penetration into the market over 10 or more years, IF economic and regulatory conditions permit and at times ONLY IF engineering "breakthroughs" are achieved. All of this suggests to us that pursuing a course of incentivizing the introduction of technologies to accelerate their implementation would be more effective than attempting to effectively mandate their use.

Auto manufacturers are also working on advanced longer-term technologies such as hybrid, clean diesel, and hydrogen powered vehicles, including fuel cells and internal combustion engines (ICE). These efforts may lead to substantial improvements in efficiency and emissions performance—all, we hope, without sacrificing safety, utility, and performance. Fuel cell technology, or liquid hydrogen powered vehicles using an ICE, also serve as a potential to move away from a petroleum dependent transportation sector. Successful introduction of these new and emerging technologies all share the need for cooperative efforts that bring all the key stakeholders together. . .including the automakers, energy providers, government policy makers and most importantly, the consumers.

The NAS summarized the diversity of demand and priorities in the marketplace when it stated that "automotive manufacturers must optimize the vehicle and its powertrain to meet the sometimes-conflicting demands of customer-desired performance, fuel economy goals, emissions standards, safety requirements and vehicle cost within the broad range of operating conditions under which the vehicle will be used."

What this says is a fact that the auto industry must deal with every day in designing and producing vehicles—the customer is in the driver's seat. This helps explain why, when fuel *efficiency* has been increasing by two percent per year, fuel *economy* (the miles per gallon a vehicle obtains) has not kept pace. Consumers are not placing as high a value on fuel economy as they are on other vehicle attributes (e.g., price and safety). Thus, while vehicles continue to get more fuel efficient, the miles per gallon obtained by a given vehicle or the vehicle fleet as a whole, has not increased as much because consumers are either choosing larger and heavier vehicles or choosing vehicle attributes such as larger engines and advanced safety equipment, that dampens the increase in fuel economy.

Market-based incentives ultimately will help consumers deal with the initial higher cost barriers of advanced technologies during early market introduction. The important consideration here is to increase demand, bringing more energy efficient vehicles into the marketplace. This will help drive cost reduction as economies of scale are achieved in a timelier fashion.

As a result, the Alliance supports enactment of consumer tax credits for the purchase of advanced technology vehicles. These credits will help offset the initial higher costs of advanced technology and alternative fuel vehicles until further technological advancements and greater volumes make them less expensive to produce and purchase. The Alliance believes that the overall concepts and provisions for consumer tax incentives found in last year's energy bill conference report are the right approach and would benefit American consumers.

Unfortunately, there have also been Congressional efforts in the past to consider amendments to the energy bill to increase CAFE standards. The Alliance has opposed these attempts to Congressionally set arbitrarily higher CAFE levels. The original CAFE program was designed to allow the Department of Transportation to set new standards by conducting rule-makings that consider the "maximum feasible fuel economy level" that is achievable for a given model year.

Two years ago, the National Highway Traffic Safety Administration (NHTSA) used this authority to set higher standards for the 2005–07 model year light trucks. The NHTSA rule increased the standards by 1.5 mpg over that period—to 22.2 mpg by 2007—the largest increase in 20 years. NHTSA set these standards after considering key elements such as technological feasibility, cost, safety, emissions controls, consumer choice, the need of the Nation to conserve energy, and the effect on American jobs. While the standard for 2007 may not be viewed by some as sufficiently "aggressive," NHTSA stated in the preamble to the final rule that it will pose a "substantial challenge" to at least one of our member companies.

In its rule-making, NHTSA noted that advanced fuel saving technologies, such as hybrid electrics and advanced clean diesels, could substantially enhance the average fuel economy of the American light vehicle fleet as even more advanced technologies, such as fuel cells, are being developed.

Where CAFE levels are set is critical to automakers for a variety of reasons. First, there are competitive implications for some manufacturers, relative to others, due solely to the mix of vehicles that are offered and sold. The current system emphasizes these disparate impacts by more severely challenging manufacturers that already provide vehicles in the heavier and larger segments of the vehicle fleet, such as full-size SUVs and pick-up trucks. While there are approaches to restructuring the CAFE program that can help address these concerns, the details of implementing them are critical and must be fully explored to avoid creating a system with new competitive consequences. The Administration is currently examining a number of CAFE restructuring proposals through rule-making and the Alliance and its Member companies are actively involved in the process.

Second, the level of CAFE standards can result in unintended consequences, such as the adverse safety consequences of pushing manufacturers to make vehicles lighter and smaller. The NAS report noted the increased fatalities that are attributable to the impacts of downweighting and downsizing due to past CAFE standards and urged care in setting future levels to avoid aggravating this effect. The report said, "If an increase in fuel economy is effected by a system that encourages either downweighting or the production and sale of more small cars, some additional traffic fatalities would be expected. For fuel economy regulations not to have an adverse impact on safety, they must be implemented using increased fuel efficiency technology."

Third, the emphasis of customers on improving the safety of the vehicles they purchase results in automakers adding more equipment to provide safety in collisions. Safety improvements continuously add weight to vehicles, and the heavier the vehicle, the more energy it takes to move it down the road, resulting in a decrease in fuel economy. This is a classic dilemma and reflects the tradeoffs that automakers face constantly in designing vehicles to achieve improvements in safety, fuel efficiency and emission performance.

Finally, for consumers sensitive to cost, fuel economy gains must be compared to the increased investment costs and risks in their new vehicle purchase decision. Assuming a fuel cost of $2 per gallon, a 20 percent increase in vehicle fuel efficiency offers an annual fuel savings of under $150. This cost must be weighed against the convenience, utility and performance of the alternative. As automakers, we are keenly aware of the importance of consumer choices and the challenges we have to deliver new technologies that meet their affordability, performance and utility needs.

So where is the industry headed:

Fuel Cell Vehicles

A promising long-term technology offers breakthrough fuel economy improvements, zero emissions and a shift away from petroleum-based fuels. From a vehicle perspective, hydrogen-fueled fuel cells offer the biggest improvement in efficiency and emissions but at high cost and with major infrastructure challenges. On-board hydrogen storage also presents some difficulty. The gasoline infrastructure is well established, but gasoline reformers are the least developed and the most costly of reformer technology.

A robust fuel cell commercialization plan incorporates breakthroughs and complementary research in stationary power units. A primary challenge in the introduction of fuel cells into America's light vehicle passenger and truck fleets are the packaging restrictions of size and weight.

Hybrid-Electric Vehicles

Hybrid-electric vehicles offer significant improvements in fuel economy and in tailpipe emissions. These products capture power through regenerative braking. When decelerating an internal combustion vehicle, the brakes convert the vehicle's

kinetic energy into heat, which is lost to the air. By contrast, a decelerating hybrid vehicle can convert kinetic energy into stored energy that can be reused during the next acceleration. Hybrid vehicles do not require additional investment in fuel infrastructure which helps reflect their potential for near-term acceptance.

Advanced Lean Burn Technology Vehicles

Vehicles that are powered by advanced lean burn technology such as clean, direct injection diesels offer greater fuel economy and better performance. The auto industry is working now to introduce technologies that will allow diesel automobiles to meet the EPA's Tier 2 emissions regulations. These types of vehicles, widespread in Europe *today,* could provide fuel economy gains in excess of 25 percent above comparable conventional vehicles.

Internal Combustion Engine powered by liquid hydrogen

Another promising and enabling technology towards a hydrogen economy are hydrogen-powered ICEs. The concept of using hydrogen in internal combustion engines offers several advantages: near zero emissions, maintaining the utility, flexibility, and driving dynamic of today's automobile and helping to promote a hydrogen fueling infrastructure.

Battery Electric Vehicles

Vehicles that utilize stored energy from "plug-in" rechargeable batteries offer zero emissions from the vehicle. However, battery electric vehicles continue to face weight, energy density, and cost challenges that limit their customer range and affordability.

Beyond gasoline, the auto industry is working with a variety of suppliers of alternative fuels. In fact, the industry already offers more than 25 vehicles powered by alternative fuels. Approximately three million of these vehicles are on the road today and more are coming. Today, we find vehicles that use:

- Natural gas, which reduces carbon monoxide emissions;
- Ethanol, a renewable fuel domestically produced with the longer term potential to substantially reduce greenhouse gases;
- Liquefied petroleum gas (propane), the most prevalent of the alternative fuels, which reduces VOC emissions; and
- For the future, liquid hydrogen, which has the potential to emit nearly zero pollutants depending on feedstock.

One of the key hurdles to overcome in commercializing alternative fuel vehicles is the lack of fueling infrastructure. For nearly a century, infrastructure has focused primarily on gasoline and diesel products. Infrastructure and fuel incentives will help the distributors overcome the costs to establish the alternative fuel outlets and support distributors during initial lower sales volumes as the number of alternative fuel vehicles increases.

As you can tell, the automobile companies are constantly competing for the next breakthrough innovations. All manufacturers have advanced technology programs to improve vehicle fuel efficiency, lower emissions and increase motor vehicle safety. These are not "pie in the sky" concepts on a drawing board. In fact, many companies have advanced technology vehicles in the marketplace right now or have announced production plans for the near future. That is why now is the perfect time for the enactment of consumer tax credits to help spur the purchase of these new vehicles which years of research and development have made possible.

Thank you.

BIOGRAPHY FOR MICHAEL J. STANTON

Michael J. Stanton, Vice President, Government Affairs, is responsible for implementing and coordinating the Alliance of Automobile Manufacturers (Alliance) and its members' programs to assure that their views on federal issues are appropriately communicated to Members of Congress and their staffs, executive departments and federal agencies and other associations and organizations. He is also responsible for international relations to ensure that U.S. automakers interests are represented throughout the world.

Mr. Stanton was named to his present position in 1999 when the Alliance was formed. Prior to the Alliance, he served as Director of Federal Relations for eight years with the American Automobile Manufacturers Association (AAMA). Before joining AAMA, Mr. Stanton was responsible for federal and State legislation for the Motor Vehicle Manufacturers Association.

Mr. Stanton has more than 25 years experience representing auto manufacturers before federal and State legislatures.

Mr. Stanton spent two years as an officer in the Navy, serving aboard the U.S.S. America during the Vietnam War. A native of Washington, D.C., Mr. Stanton holds a Master's Degree from George Washington University.

Chairman BOEHLERT. Thank you very much, Mr. Stanton.

Dr. Greene.

STATEMENT OF DR. DAVID L. GREENE, OAK RIDGE NATIONAL LABORATORY, CENTER FOR TRANSPORTATION ANALYSIS, NATIONAL TRANSPORTATION RESEARCH CENTER

Dr. GREENE. Thank you, Mr. Chairman. Good afternoon, and good afternoon to Members and staff and guests here.

I am pleased to be here, and I hope I can help advance the discussion.

Could I have the first slide, please?

[Slide.]

I have been asked three questions that pertain to policy.

The first question, essentially, is what are the policy options and what are their pluses and minuses. I have dealt with this, or tried to, at some length in my testimony. I will just try to hit some high points here.

The second question is directly aimed at whether or not the government can encourage adoption of fuel-efficient technologies without leading manufacturers to make vehicles less safe. My simple answer to that is yes, but I will elaborate on that in a moment.

And can the government encourage the adoption of technologies to improve fuel economy without significant negative impacts on manufacturers? And this is more complicated, but I think things can be done to improve the current system, let me say that.

Next, please.

[Slide.]

Well, there are lots of standards that can be used, and there are lots of policies that can be used to encourage fuel economy improvement. And countries—almost every developed country around the world has some form of fuel economy standards, and almost all of them are different. We have the CAFE standards. Japan has weight-based standards. China is adopting weight-based standards. The European Union has comprehensive voluntary standards, which has some advantages for them. My bottom line here is I think there are many ways to do this and to do it effectively. There are some pluses and minuses.

For example, I think the one criticism of the CAFE standards that stands up to analysis is that they did have differential competitive impacts, which were more onerous for the Big Three U.S. manufacturers to meet than for foreign manufacturers. On the other hand, the situation in the auto market has changed considerably. The largest manufacturers now are much more supplying vehicles across the board, as compared with back in 1975 when the foreign manufacturers were highly specialized in small vehicles. So these differential impacts will be inherently smaller today than they were back then, and there are further ways to mitigate them by having class-based standards or attribute-based standards.

The chief problem I see with the CAFE standards is that once you meet the standards, then you stop. There is not a continuing

incentive to improve fuel economy to add technologies as they come along. This kind of problem can be addressed by market-based incentives, such as feebate systems, which consist of a fee charged for vehicles that are below a pivot point or a certain fuel economy level and a rebate or incentive that are given to vehicles above that level. Pivot points can be chosen, such there is one for the entire marketplace, one for passenger cars, one for light trucks, or perhaps many classes of vehicles. This provides ongoing incentives to continue to adopt fuel economy technology in order to avoid a fee or gain a rebate.

Other market-based approaches include gasoline taxes, and I would like to say that our National Research Council report, once again, recommended higher fuel taxes. I think that is still a good idea. It may be unpopular, but I think it is incumbent on people like myself and like my colleague, Dr. Portney, to recommend such things when we get the opportunity.

Next, please.

[Slide.]

I would like to spend a moment trying to elaborate on the point that the Chairman made earlier that there is market failure in the market for fuel economy and to see if I can help us understand what the nature of that is.

What matters to the consumer of an automobile is not the total value of fuel savings that fuel-efficient technology will provide, nor is it solely the price increase that will come about when these technologies are added to the vehicle. Rather, it is the difference between the two, the net value: the fuel savings minus the price increase. I show here on the higher graph data from our own National Research Council study. The dotted red line is the cost of improving the fuel economy using the technologies we described in the study of a typical 28-mile-per-gallon passenger car. The solid black line is the discounted present value of fuel savings that would be realized over the life of the car. I see some people are already eyes glazing over with that kind of terminology. But essentially, that is the value of these fuel savings to a perfectly rational economic consumer who calculates out exactly what he is going to do and how much he is going to save over the life of the car. By the way, the evidence is there probably are no such consumers out there.

But in any case, what is of interest to the consumer is the difference between the two, which is that lower curve, which doesn't vary by more than plus or minus $200 or $250 over approximately 50 percent increase in fuel economy. I think this explains, given the uncertainty in the consumer's mind about what those fuel economy numbers on the car really mean and what the future price of gasoline is going to be. It is no surprise that this is not an important issue to the typical car buyer. This is way down the list of things that are of importance.

On the other hand, to achieve this kind of dramatic improvement in fuel economy, manufacturers have to completely redesign their vehicles, invest billions of dollars in retooling, and it is a very risky, expensive proposition for something that their customers are barely interested in. This, I think, is the principle reason why fuel

economy technologies today do not get incorporated into vehicles for the purpose of improving fuel economy.

Now many in the industry believe that consumers only count the first three years of fuel savings and not the fuel savings over the life of the car. The lower graph shows that same net value curve if you only count the first three years of fuel savings, and obviously at that point, there is nothing worth doing. So that explains, if that is your perspective, on why you would not improve the fuel economy of vehicles.

Next slide, please.

[Slide.]

Turning to this question of whether the government can encourage fuel-efficient technology without harming safety, first, let me say the question of fuel economy and weight reduction is greatly exaggerated. According to data published by the Environmental Protection Agency, the average light-duty vehicle, combined passenger car and light truck fleet vehicles, sold in 2004 weighed six pounds more than the average light-duty vehicles sold in 1975. Yet it got 58 percent, almost 60 percent better fuel economy. So we have improved the fuel economy of vehicles over 1975 levels by 60 percent. The vehicles weigh six pounds more than they did back then. The issue that weight reduction is the chief method of improving fuel economy is, using Mark Twain's phrase, greatly exaggerated.

Now there is still this issue of whether they are downsizing weight reduction, which did occur in the early years following the passage of the Fuel Economy Standards in 1975 and the price shocks in '73 and '74, whether that was harmful to safety. At the time the National Research Council report was written, there were no scientific studies contradicting the prevailing view that increasing fuel economy led to smaller, lighter cars, which led to greater fatalities. There are now four scientific studies that have been published, which do contradict that view, and these studies indicate that, one, there is no link between fuel economy and traffic safety, and two, that, in the case of the studies done by DRI and supported by Honda of America, it indicates that increasing the weight of vehicles while maintaining size would be—actually be harmful to safety. Decreasing the weight of vehicles somewhat while maintaining the size of vehicles would be beneficial to safety.

So now I think we have something we didn't have at the time of the NRC report, which is scientific evidence that this link is not what we thought it was and that we can proceed to improve fuel economy without harming safety.

Next slide, please.

[Slide.]

This is just a slide which illustrates the point. The upper line shows total highway traffic fatalities, which, by and large, decreased over time, while fuel economy was improving. Your eyes don't deceive you: fuel economy increased, traffic fatalities went down. And the issue is a lot more complicated than that, but I think that does summarize, reasonably well, what was achieved.

Final slide, please.

[Slide.]

With respect to differential impacts, there are many things that can cause differential impacts on firms from a fuel economy standard or any kind of market-based fuel economy policy as well. The one that I think is most salient is the product mix, which does differ, to some extent, across manufacturers and will be an issue. There are ways to mitigate this with class-based standards, attribute-based standards, and adding flexibility features, like tradable credits that we recommended in the National Research Council report.

Final slide, please.

[Slide.]

I think all I wanted to say from this slide is to reiterate what Dr. Portney said. That is that it is extremely important to allow adequate lead time for design changes so that manufacturers have time to do the proper engineering and the resources to do the proper engineering and to turn over their productive capital in an orderly fashion. It is also important to set the standards at levels that are close to being cost-effective from the point of view of fuel savings so that they do not create excessive market distortions.

[Slide.]

With that, let me go to the last slide and just say thank you very much, and I will be happy to answer any questions.

[The prepared statement of Dr. Greene follows:]

PREPARED STATEMENT OF DAVID L. GREENE

1. WHAT ARE THE POLICY OPTIONS FOR ENCOURAGING THE ADOPTION OF FUEL EFFICIENT TECHNOLOGIES AND THEIR ADVANTAGES AND DISADVANTAGES?

There are many ways to structure policies to achieve significant increases in fuel economy effectively and efficiently. I will focus on five below. It is possible to create policies that are reasonably effective, efficient, and fair. Our own experience with our CAFE standards and difficulties we have had updating the CAFE law indicates that we should also prefer policies that provide a continuing incentive to improve fuel economy.

Following the oil crises of the 1970s, nearly every developed economy in the world adopted fuel economy standards in some form (IEA, 1984; 1991). Though the forms and means of implementing standards varied, and although fuel economy standards have been criticized on a variety of grounds, all these standards were effective in raising fuel economy levels. Fuel economy standards contributed to curbing the growth of world oil demand in the 1980s and, in combination with the market response to higher oil prices led to the OPEC cartel's loss of control over world oil markets in 1986. We *do* know how to reduce dependence on petroleum and we have done so effectively in the past. The combination of higher oil prices and policies aimed at increasing energy efficiency led to almost 15 years of low oil prices (Figure 1). Unfortunately, after these efforts were successful and oil prices crashed in 1986, we stopped trying. With OPEC nations holding more than two thirds of the world's proven oil reserves and more than half of the world's ultimate conventional oil resources, and with growing demand for oil for transportation in developed and developing economies, it was only a matter of time before they regained control of world oil markets.

Potentially effective fuel economy policies range from standards to market-based measures. Developed economies that have recently tightened their fuel economy or carbon emission standards for motor vehicles include Japan, the entire European Union (EU) and Australia. China has also recently adopted fuel economy standards with the aim of curbing their rapidly growing demand for oil (An and Sauer, 2004). Each country has a different form of standard, and each one is different from our own Corporate Average Fuel Economy (CAFE) Standards. Japan and China have mandatory standards that vary (in different ways) across vehicle weight classes. The EU and Australia negotiated voluntary standards with automobile manufacturers

collectively that are based on the sales-weighted average emissions of carbon dioxide per vehicle kilometer.

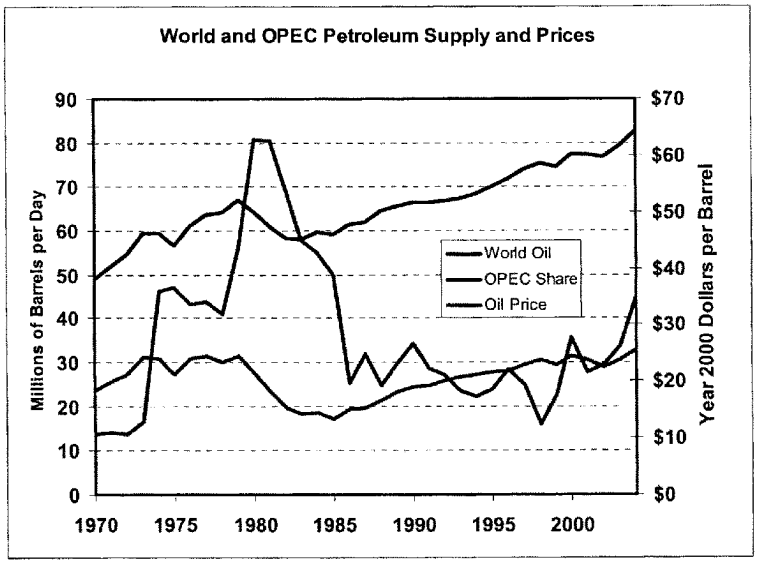

Figure 1. World Oil Demand, OPEC Market Share and Oil Prices

CAFE OR UNIFORM PERCENTAGE INCREASES (UPI)

Our CAFE standards were effective in raising passenger car and light truck fuel economy and curbing the growth of petroleum demand. They have been criticized on many grounds, but the one criticism that stands up to analysis is that they created a more severe burden for the "big three" domestic manufacturers than for much of their competition. Differential competitive impacts are inherent in the CAFE system whenever manufacturers specialize in different market segments because it requires each manufacturer to meet the same MPG target, regardless of its product mix. Manufacturers emphasizing larger light trucks and passenger cars will clearly have a more difficult task than those concentrating in smaller vehicle market segments. This problem was ameliorated but not eliminated in the CAFE law by defining separate targets for passenger cars and light trucks. Another provision to increase flexibility allows manufacturers to average their fuel economy numbers over a six year moving window (three years forward, three back). The economic efficiency of the CAFE law could be improved further by allowing manufacturers to trade fuel economy credits as recommended by the National Research Council (NRC, 2002) CAFE report. Still, these trades will result in income transfers among firms unless credits are initially allocated to firms in a way that compensates in advance for such transfers. That might be difficult to do because it effectively amounts to giving money to some firms and not others.

UPI have been proposed as an alternative to CAFE. This system requires each manufacturer to achieve not the same MPG level, but the same percentage increase in MPG. The UPI system essentially produces a mirror image of the differential competitive impacts of CAFE (Greene and Hopson, 2004; Plotkin et al., 2002), putting smaller vehicle manufacturers and manufacturers that have already adopted advanced fuel economy technologies at a disadvantage. A UPI system would also discourage manufacturers from adopting more fuel economy technology than was absolutely required, since exceeding the standard might later lead to having to meet a more difficult standard. In addition, while CAFE can discourage manufacturers from abandoning smaller vehicle production, UPI can discourage small vehicle manufacturers from moving into larger vehicle markets.

ATTRIBUTE-BASED STANDARDS

Attribute-based standards set fuel economy standards based on measurable vehicle attributes, such as weight or size. This can help reduce, but probably cannot eliminate (see, e.g., Plotkin et al., 2002, Ch. 6), the competitive impacts of CAFE or UPI style fuel economy standards. Japan has had successful weight-class fuel economy standards for decades, and China has just adopted a weight-based system. Weight-based standards take account of the product mix but do not recognize differences in manufacturers' current use of fuel economy technology. They do not recognize the possibility that different manufacturers may be serving customers with different preferences for fuel economy. For these reasons, some degree of differential competitive impacts will occur even under a weight-based system. Finally, weight-based standards, depending on how there are designed, may or may not provide an incentive for substituting advanced lightweight materials in vehicles as a way of increasing fuel economy.

Size-based standards are a promising but largely untested alternative to weight-based standards. Size-based standards could be based on dimensions such as wheelbase times track width, or interior volume. Such standards would have the advantage of preserving the option of reducing vehicle weight to increase fuel economy without sacrificing vehicle size. There is some recent evidence to indicate that moderate reductions in vehicle weight while maintaining basic vehicle dimensions would be beneficial to highway safety (Van Auken and Zellner, 2004). Because there is no experience with size-based fuel economy standards, the engineering and design implications of such standards should be carefully studied before they are formulated and implemented.

VOLUNTARY STANDARDS

Voluntary fuel economy standards were effective in Europe in the 1970s and 1980s, and the current EU–ACEA carbon dioxide emissions standard also appears to be headed for success in meeting its 2008 target. Canada also adopted voluntary standards, but they mirrored the U.S. CAFE standards which essentially guaranteed their success. According to economic theory, voluntary standards can be effective if there is a credible threat of mandatory standards. Voluntary standards can take any of the forms of mandatory standards.

The EU–ACEA voluntary standards are worthy of note because they apply to the entire industry, leaving the determination of individual firms' responsibilities to negotiations among the firms. While this certainly has risks, it also creates the opportunity for firms to allocate responsibilities in an efficient and fair manner by setting each firm's target at the same level of marginal cost per gallon of fuel saved. Because compliance is achieved voluntarily, there is no need for transfers of income among firms. Thus, economic efficiency, fairness and minimal competitive impacts can all be achieved simultaneously. *No other system can claim all three advantages.*

FEEBATES

Feebates are an entirely market-based approach. Vehicles above a chosen "pivot" level of fuel consumption (best measured as the inverse of fuel economy, i.e., gallons per mile or liters per 100 kilometers) pay a fee, while those below receive a rebate (Davis et al., 1995). The most efficient approach is to set both fees and rebates at a fixed rate in terms of dollars per 0.01 gallons per mile (or equivalent). This provides the same economic incentive to save a gallon of gasoline for all vehicles (assuming equal miles of use).

The economic response to feebates is solely a function of the rate and not the pivot points because the rate determines the marginal value of increasing fuel efficiency. The pivot points determine the transfer of revenues. This allows the creation of revenue-neutral feebate systems that pay out as much as they take in. Feebate systems can be designed with one pivot point or with vehicle class-specific pivot points. Analysis of feebate systems has shown that the transfer of revenues among manufacturers can be reduced significantly by a two pivot point system that distinguishes between cars and light trucks (Greene et al., 2005). The benefits of greater numbers of pivot points is unclear, and increasing the number of pivot points increases the opportunity to "game" the system by moving vehicles from one class to another to attain a more easily achieved pivot point.

A key advantage of feebate systems is that they provide a continuing incentive to adopt fuel economy technologies as long as they remain in effect. Whereas once a CAFE target is met there is no further incentive to increase fuel economy, the feebate rate always offers an additional economic incentive to avoid a dollar of fee or gain a dollar of rebate. In view of the difficulty of raising CAFE standards over the past 20 years, this could be an extremely valuable feature in the U.S. political context.

The United States currently has in place half of a feebate system on half of the vehicles, in the form of the gas guzzler tax. The rate of the gas guzzler tax is very high, and as a result, it has nearly eliminated gas guzzling passenger cars. Guzzler taxes or rebates alone cannot be as effective as a comprehensive feebate system (Greene et al., 2005). A gas-guzzler tax on passenger cars and not light trucks undoubtedly decreases the numbers of larger heavier passenger cars without similarly affecting light trucks. Given the current CAFE law, the gas-guzzler tax also produces no benefit in terms of raising passenger car fuel economy.

GASOLINE TAXES

If the market for automotive fuel economy operated efficiently, increasing the tax on gasoline would be the most economically efficient way to increase fuel economy. Over the years, higher gasoline taxes have proven to be unpopular, but that is not an argument against their desirability from an economic efficiency standpoint. There are, however, good reasons to believe that the market for fuel economy is not efficient and, therefore, that standards have an important role to play.

First, even nations with gasoline prices two to three times higher than those in the United States have felt it necessary to have fuel economy standards. This includes the entire EU and Japan. If the market for fuel economy were efficient, gasoline prices in the range of $3 to $5 per gallon should be sufficient to raise vehicle fuel economy. Still, the EU and Japan found it necessary to have fuel economy standards.

Second, the net value to consumers of technology-based fuel economy improvements appears to be small over a wide range of fuel economy levels. In general, advanced fuel economy technology costs more that conventional technology. The benefit to consumers is therefore the present value of fuel saved minus the initial higher cost of the technology. The two graphs below show the estimated price increase and value of fuel savings for an average U.S. passenger car as fuel economy is increased from 28 to 45 miles per gallon. The data are taken from the 2002 NRC CAFE study. In Figure 2, the customer is assumed to count fuel savings over the full life of the vehicle, yet there is no more than a ± $250 difference in net value (fuel savings minus price increase) over a range of zero percent to 50 percent increase in fuel economy. Considering the uncertainty in what the customers' true fuel economy number will be, what the future price of fuel will be, and what the consumer is likely to actually pay for higher fuel economy, it is no wonder that fuel economy is not high on the consumers' list of things to consider when buying a car. From the manufacturers' perspective, however, a large increase in fuel economy is a long-term, high-cost, high-risk decision, requiring nearly complete vehicle redesign and substantial retooling—all for something customers are essentially indifferent about.

The second graph (Figure 3) displays the net value if consumers count only the first three years of fuel savings. In this case, there is no economic incentive for consumers to demand higher fuel economy or for manufacturers to supply it.

Third, recent evidence from surveys indicates that consumers are indeed undervaluing fuel economy. First, survey evidence, generally supported by automobile manufacturers, indicates that consumers expect an expenditure on fuel economy technology to be paid back in fuel savings within 2–4 years, far less than the full lifetime of a modern automobile. A recent study by the University of California at Davis (Turrentine and Kurani, 2005) conducted in-depth interviews with 60 households in California. Few even considered fuel economy in their purchase decisions. None explicitly calculated the potential value of fuel savings by any method. In short, there was no evidence whatsoever of textbook, economically rational behavior with respect to fuel economy.

Despite the apparent imperfection of the market for fuel economy, increasing the price of gasoline would be a sound and beneficial policy. It would signal consumers of the importance of reducing fuel use, making it somewhat easier for manufacturers to sell higher fuel economy vehicles. It would mitigate and could eliminate the rebound effect, the tendency for motorists to drive a little more when higher fuel economy reduces the fuel cost per mile of travel. Finally, a higher tax on gasoline would make up for revenues that would otherwise be lost to the highway trust fund in the future when higher levels of fuel economy reduce the demand for motor fuel.

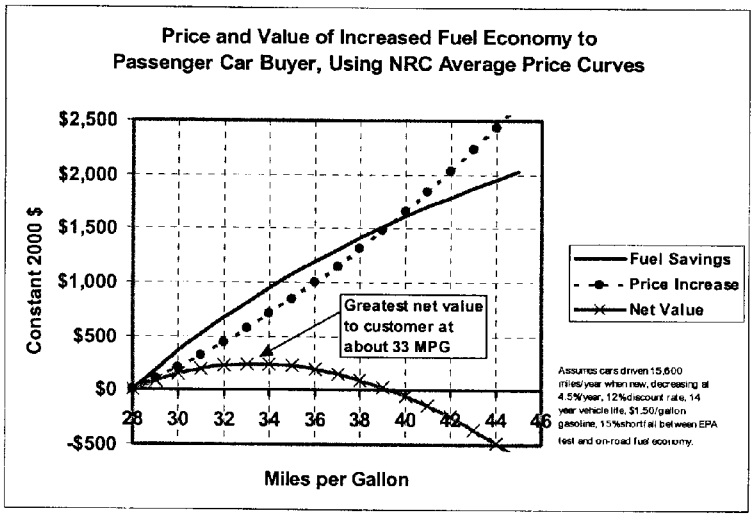

Figure 2. Net Value of Fuel Economy Technology to an Economically Rational Consumer

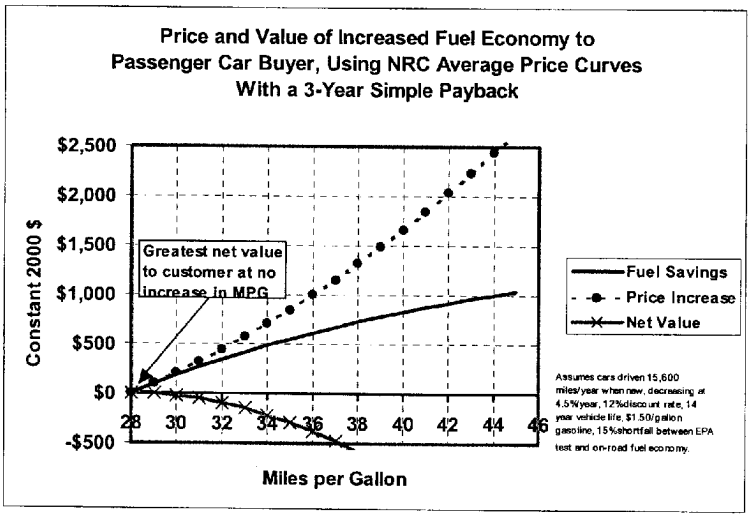

Figure 3. Net Value of Fuel Economy if only First Three Years of Fuel Savings Are Counted

2. CAN THE GOVERNMENT ENCOURAGE THE ADOPTION OF TECHNOLOGIES TO IMPROVE FUEL ECONOMY WITHOUT LEADING AUTOMAKERS TO MAKE VEHICLES LESS SAFE?

The government can encourage the adoption of technologies to improve fuel economy without leading automakers to make vehicles less safe. First, there are many

technologies that can be used to improve fuel economy that should have no impact on vehicle safety. Technologies such as variable valve timing and lift control, displacement on demand, reduced aerodynamic drag, continuously variable transmissions, and engine friction reduction should be independent of vehicle safety. Several reports have developed lists of such technologies and estimate their likely impacts on vehicle costs and fuel economy. The 2002 NRC study of the CAFE standards provides an extensive analysis of how such technologies could be used to cost-effectively increase passenger car and light truck fuel economy. Given the availability of such technologies, manufacturers should be able to respond to the demands of a higher fuel economy standard without compromising safety.

The argument that fuel economy improvement inevitably leads to weight reduction which inevitably leads to increased fatalities and injuries is not correct. The role of weight reduction versus technology in achieving the fuel economy improvements of the past thirty years has been greatly exaggerated. Weight reduction was indeed an early strategy for increasing fuel economy. Vehicle weight reduction began before the CAFE standards went into effect, probably a response to the fuel shortages and higher prices caused by the first oil crisis of 1973–74. It continued after fuel economy standards went into effect in 1978 but ended in 1981. Fuel economy continued to improve through 1987 while weight increased. Since then, weight has increased while the average fuel economy of new light-duty vehicles has gradually declined, in large part due to the increasing market share of light trucks. According to data published by the Environmental Protection Agency, the average 2004 model year light-duty vehicle actually weighed six pounds more than the average light-duty vehicle sold in 1975. The average fuel economy of a new light-duty vehicle sold in 2004 was 58 percent higher than in 1975 (Figure 4). Clearly, none of this increase can be attributed to weight reduction since today's new light-duty vehicles are actually slightly heavier than their 1975 counterparts.

It has been argued, however, that further increases in fuel economy standards would inevitably lead to downsized or down-weighted vehicles and that smaller, lighter vehicles are inherently less safe. By and large, this objection has focused on weight reduction as the principal threat to safety. Reducing vehicle mass is certainly one way, though by no means the only way or even the most effective way, to increase fuel economy.[1] In a dissent to the 2002 NRC CAFE report, Marianne Keller and I pointed out that the evidence for a causal link from fuel economy to weight reduction to increase traffic fatalities and injuries was highly dubious. Since that report, our position has been strengthened by four scientific studies. With the support of Honda, Van Auken and Zellner (2002) attempted to replicate Kahane's (1997) path-breaking analysis of the relationship between vehicle weight and crash fatalities using more recent data from a somewhat different subset of states. They found that a reduction in the weight of passenger cars and light trucks of 100 pounds would not increase net highway fatalities. In an extension of this study in which they separately estimated the impacts of weight versus size (wheelbase and track width), Van Auken and Zellner (2003) found that reducing weight while holding vehicle size constant would improve safety somewhat, while increasing weight at constant size would be harmful to safety. Kahane (2003) has since published a new study using a modified methodology that contradicts the findings of the first Van Auken and Zellner study and concludes that weight reduction accompanied by size reduction would be harmful to safety, but Kahane's new study still does not distinguish between the effects of size and weight.

[1] In general, a one percent reduction in vehicle weight at constant performance can produce a 0.6 percent to 0.7 percent increase in fuel economy on the U.S. test cycle.

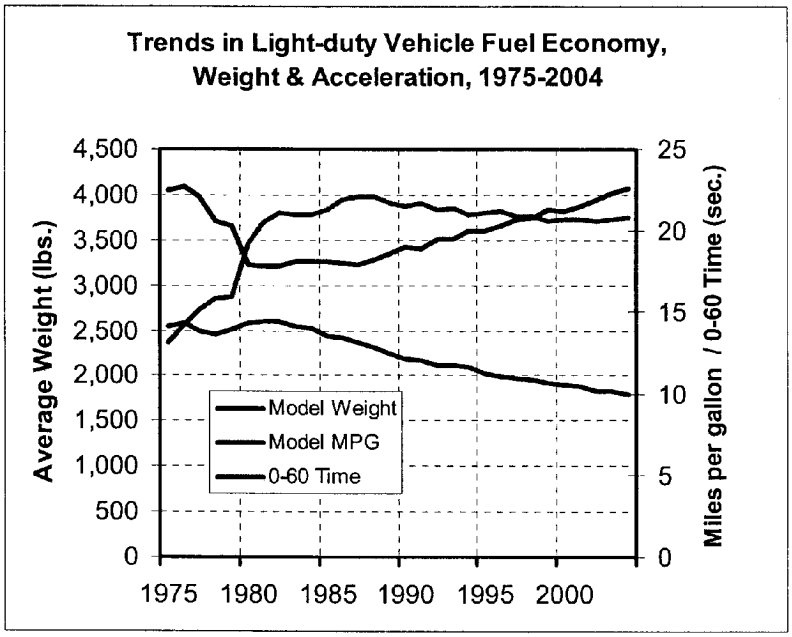

Figure 4. Trends in Light-duty Vehicle Fuel Economy, Weight & Acceleration, 1975-2004

In a paper forthcoming in *Accident Analysis and Prevention,* Wenzel and Ross (2005) demonstrate two key points. First, they show that, in a crash between vehicles, heavier vehicles may provide additional protection to their own occupants but this comes at the expense of the occupants of the vehicles with which they collide. This is important because it is consistent with the simple physics of elastic collisions which imply that increasing the weight of one vehicle in a crash is a zero sum game: the heavier vehicle gains safety at the expense of the lighter vehicle.[2] Wenzel and Ross (2005) also show that light trucks with chassis-on-frame construction tend to be exceedingly aggressive in collisions with other vehicles and that the harm they do to other vehicles outweighs the benefit of their additional weight to their occupants. These vehicles and roll-over-prone SUVs turned out, on net, to be harmful to overall traffic safety.[3]

Perhaps the seminal study linking fuel economy, weight and safety was that of Crandall and Graham (1989). This study, however, was based on the very limited experience with significant fuel economy changes that was available at the time the analysis was carried out. It included data from 1947 to 1981, but the CAFE law was not passed until 1975, took effect in the 1978 model year, and affected only new vehicles and not the entire fleet. More recently, Noland (2004) examined the relationship between fuel economy, fatalities and injuries using a time series of data for states covering the period 1975 to 1998. Instead of regressing fatalities or injuries against vehicle weight, he regressed directly against fuel economy. This is significant because, as pointed out above, weight reduction is far from the only means of raising vehicle fuel economy. For example, reducing engine power is also beneficial

[2] These same simple laws of physics imply that a proportional down-weighting of both vehicles would have no effect on the outcome of the crash. The predictions of Kahane's 1997 analysis were also consistent with these simple laws, as Keller and I demonstrated in our dissent to the NRC 2002 report.

[3] The fact that heavier vehicles benefit their occupants in a collision at the expense of occupants of the vehicles with which they collide creates what economists call an externality. The implication is that individuals will buy heavier vehicles than they would if they considered the impacts on others.

to fuel economy.[4] By using fuel economy instead of weight as an independent variable, Noland was able to reflect all the possible paths by which fuel economy improvements might have influenced vehicle design and thereby safety. What Noland found was that the relationship between fuel economy and safety was not stable over time. It appeared that in the 1970s fuel economy was positively related to (increased) traffic fatalities, but that in later years there was no statistically significant relationship. Indeed, Noland found that, unless the years 1975 to 1977 were included in the analysis, no statistically significant relationship could be found.

At the 2005 Transportation Research Board Meetings, I presented the results of a statistical analysis of the relationship between national average passenger car and light truck fuel economy and total U.S. traffic fatalities for the period 1966 to 2002 (Ahmad and Greene, 2005) (see Figure 5). Testing a wide array of possible models and other contributing factors, our analysis demonstrated that the only statistically significant relationships between fuel economy and traffic fatalities indicated that increasing fuel economy was associated with lower traffic fatalities, not higher. For a number of reasons we cover in detail in the paper, we do not conclude that increasing fuel economy will reduce traffic fatalities. Rather we conclude that the aggregate national traffic fatality and fuel economy statistics provide no support for the hypothesis that increasing fuel economy led to increased traffic fatalities over the period 1966 to 2002. While these results contradict the earlier findings of Crandall and Graham (1982), we believe this is because of the longer record of experience available to us today.

Major improvements in light-duty vehicle fuel economy will require major vehicle design changes. Safety is always an issue when vehicle designs change. This strongly argues for insuring that manufacturers have sufficient time to carry out redesigns with the usual level of care and attention to detail. There need be no compromise in safety, provided that fuel economy targets are set at levels close to what can be achieved with approximately cost-effective technologies.

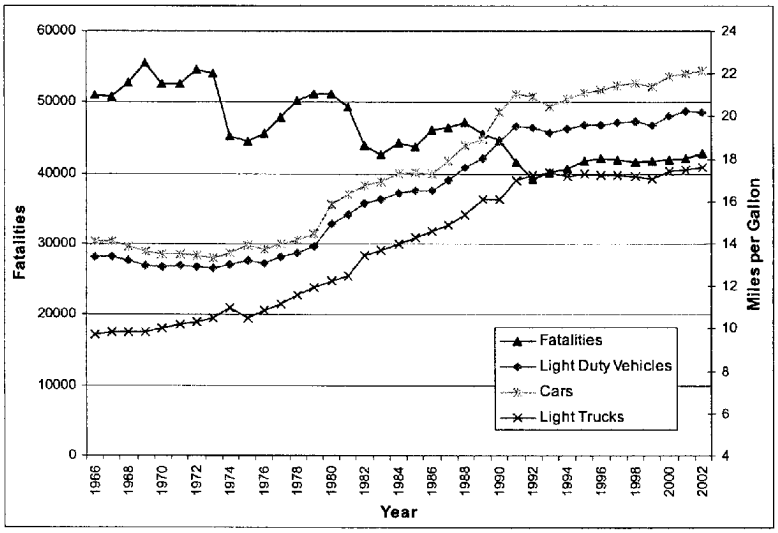

Figure 5. On-Road Passenger Car and Light Truck Fuel Economy and Traffic Fatalities in the United States, 1966-2002

3. CAN THE GOVERNMENT ENCOURAGE THE ADOPTION OF TECHNOLOGIES TO IMPROVE FUEL ECONOMY WITHOUT GIVING ANY INDIVIDUAL AUTOMAKER A SIGNIFICANT ADVANTAGE?

[4] A one percent reduction in horsepower, all else equal, would produce a 0.2 percent to 0.3 percent increase in fuel economy.

While it is possible for the government to encourage the adoption of technologies to improve fuel economy without giving any individual automaker a significant advantage, most of the policies described above will be more easily complied with by some manufacturers than others. However, there are ways to reduce competitive impacts and improve the fairness of fuel economy policies.

What makes a system fair from a competitive perspective? This question could be answered in many ways. I suggest the following definition. A fair policy is one that (1) requires each manufacturer to spend the same amount at the margin to reduce the fuel consumption of each car by one gallon per mile and (2) does not otherwise redistribute revenues among manufacturers.[5] A CAFE system with tradable credits could satisfy the first criterion, as would other market-based mechanisms such as a feebate system or gasoline tax, but they could satisfy the second only with a complex and probably controversial redistribution of revenue.[6]

In my opinion, the EU–ACEA voluntary fuel economy agreement probably comes closest to meeting both criteria. It appears to me that manufacturers have allocated the responsibility for meeting the industry target to individual firms in such a way as to equalize the marginal costs per liters/100 kilometers, and there appear to be no inter-firm transfer payments. However, this is no more than my opinion since the firms have not disclosed the details of their agreement.

Four main factors give different firms different capabilities to increase fleet average fuel economy:

1. The technological capability of the firm
2. The firm's current adoption of fuel economy technology in its products
3. The preferences of the customers served by the firm
4. The firm's product mix

There are differences in the ability of firms to use specific fuel economy technologies, but in general, technology is a fungible commodity in the automotive market place. Firms can buy technology from suppliers and from other firms, generally, but not always at competitive prices. Since being technically capable is essential to being able to compete in today's marketplace, it is probably best not to attempt to address this issue in creating a fair fuel economy policy.

Some firms make greater use of technologies to increase fuel economy than others. This has special relevance if fuel economy metrics such as the uniform percentage increase are being considered. A UPI system would make achieving fuel economy goals more costly for those firms currently making the greatest use of technologies to increase fuel economy. Their marginal costs per gallon saved would therefore be higher than those of firms using less fuel economy technology. Firms may make greater use of fuel economy technologies as a matter of corporate policy or because they serve a segment of the market that places a higher value on fuel economy. In the latter case, a CAFE system would disadvantage manufacturers who served consumers less interested in fuel economy. There appears to be little publicly available research on this subject.

Finally, fuel economy policies can have different impacts on firms that specialize in large or small, high or low power vehicles. Although there has been substantial convergence over time in the product offerings of major manufacturers, differences still remain. Systems like CAFE, UPI, and feebates will have differential impacts on manufacturers. Setting individual targets for vehicle types (e.g., passenger cars vs. trucks) and size classes can mitigate these differential impacts, but at the cost of creating opportunities for "gaming" by shifting vehicles from one class to another to acquire a less stringent standard. A reasonable but not perfect balance can be achieved with these systems. Steps that can be taken to minimize differential competitive impacts are listed below.

1. Give adequate lead time
    a. Time to first possible redesign
    b. Time for orderly redesign and retooling
2. Allow for differences in the mix of vehicles sold
    a. Vehicle classes

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[5] Assuming that every car travels the same number of miles, this would ensure that manufacturers and consumers were spending the same marginal cost for each gallon of gasoline saved.

[6] There is also good reason to doubt that the market in tradable credits would be an open and competitive one. In all likelihood, there would be two to three large buyers facing two to three large sellers, an oligopsony facing an oligopoly. Rubin et al., however, have shown that even in this situation most of the potential efficiency benefits of credit trading would probably be realized.

b. Attribute-based formulas

3. Build in flexibility
   a. Carry-forward, carry-back windows
   b. Credit trading with caps on credit prices
   c. Administrative review
4. Insure that goals are feasible with approximately cost-effective, fungible technologies
   a. Technical analysis
   b. Review other regulations for compatibility

As has been noted above, it is possible but not certain that a voluntary agreement that allows manufacturers to allocate fuel economy improvement responsibilities can achieve equal marginal costs of compliance and no revenue transfers among firms. With a feebate system or tradable credit CAFE system, it is also possible to allocate initial credits in such a way as to mitigate the differential financial impacts that would otherwise occur. Such allocations are likely to be controversial, however, since they will amount to substantial payments to some firms and not others.

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BIOGRAPHY FOR DAVID L. GREENE

A Corporate Fellow of Oak Ridge National Laboratory (ORNL), David Greene has spent 25 years researching transportation energy and environmental policy issues. Dr. Greene received a B.A. degree from Columbia University in 1971, an M.A. from the University of Oregon in 1973, and a Ph.D. in Geography and Environmental Engineering from The Johns Hopkins University in 1978. After Joining ORNL in 1977, he founded the Transportation Energy Group in 1980 and later established the Transportation Research Section in 1987. Dr. Greene spent 1988–89 in Washington, DC, as a Senior Research Analyst in the Office of Domestic and International Energy Policy, U.S. Department of Energy (DOE). He has published more than one hundred seventy-five articles in professional journals, contributions to books and technical reports, and has authored or edited three books *(Transportation and Energy, Transportation and Global Climate Change,* and *The Full Costs and Benefits of Transportation).* Dr. Greene served as the first Editor-in-Chief of the *Journal of Transportation and Statistics,* and currently serves on the editorial boards of *Transportation Research D, Energy Policy, Transportation Quarterly,* and the *Journal of Transportation and Statistics.* Dr. Greene has been active in the Transportation Research Board (TRB) and National Research Council (NRC) for over 25 years, serving on several standing and ad hoc committees dealing with energy and environmental issues and research needs. He is past Chairman and member emeritus of the TRB's Energy Committee, past Chair of the Section on Environmental and Energy Concerns and a recipient of the TRB's Pyke Johnson Award. In recognition of his service to the National Academy of Science and National Research Council, Dr. Greene has been designated a lifetime National Associate of the National Academies.

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February 3, 2005

Chairman Sherwood Boehlert,
Science Committee
2318 Rayburn Building
Washington, DC

Dear Chairman Boehlert:

I am a full-time employee of UT-Battelle, which operates the Oak Ridge National Laboratory for the U.S. Department of Energy. The vast majority of my funding comes from the Department of Energy and supports research in the area in which I will be testifying and related areas dealing with transportation and energy. From time to time I receive funding from other government agencies, for example, the U.S. Department of Transportation. I also occasionally do consulting work with the approval of UT-Battelle.

Sincerely,

David L. Greene
Corporate Research Fellow

DISCUSSION

Chairman BOEHLERT. Thank you very much. And thank all of you for your outstanding testimony.

Let us address something right off the bat that I think is very important. We have all been through this drill before. We know the arguments pro and con. I am going to make a statement and ask each of the witnesses if they agree or disagree with this statement. And the statement is this: the only way to increase CAFE standards is to make vehicles lighter and therefore less safe. Do you agree or disagree with that statement?

Mr. Reilly.

Mr. REILLY. You mean the only way to improve fuel economy, right?

Chairman BOEHLERT. Exactly.

Mr. REILLY. Right. No, I disagree with that.

Chairman BOEHLERT. Dr. Duleep.

Mr. DULEEP. I disagree.

Chairman BOEHLERT. Mr. Stanton.

Mr. STANTON. I am confused. Could you tell me one more time?

Chairman BOEHLERT. All right. The only way to increase fuel efficiency, using increased CAFE standards, is to make vehicles lighter and therefore less safe.

Mr. STANTON. Disagree.

Chairman BOEHLERT. Thank you.

Dr. Greene.

Dr. GREENE. Disagree.

Chairman BOEHLERT. Thank you very much.

All right. Mr. Portney and—Dr. Portney and Mr. Duleep, you both state the percentages by which fuel economy could safely be improved by deploying a number of technologies ranging from more efficient transmissions to diesel and hybrid engines, and incidentally, try to buy a hybrid today, and they will tell you to stand in line. But presumably, those are percentages by which an individual model, or even a class of vehicles, could be improved. Tell me how those figures would translate into fleet-wide averages. By how much would it be possible for Congress, should it choose to do so, raise the CAFE standards, and in what time frame?

Dr. Portney.

Mr. PORTNEY. I will let Mr. Duleep go first.

Mr. DULEEP. Mr. Chairman, the key assumption would be what happens with the consumer demand. In other words, are consumers buying the same kinds of cars today and in 2015 and how—what would you assume on that? And if you make the assumption that people buy the same mix of vehicles and the same kind of horsepower and the same features, then I believe that, just with conventional technology on cars, you can get up to about 32 or 33 miles per gallon with just conventional, no hybrids or diesels, and for the light trucks, you would get up in the neighborhood of 23½ or 24 miles per gallon.

Unfortunately, as I mentioned, that is—people are buying more and more attributes. That is they want four-wheel-drive, and they want cars that ride high and more cup holders and a bigger stereo and so on. And so that is going to take away from these numbers. And clearly, I would expect that about half of the improvement would go away, and perhaps even more. It might go away and consumers are just buying more vehicle. If you add in, say, the diesel and hybrid, with reasonable market penetrations, like the kinds that Dr. Greene computed, which is about 20 percent of the market, then they can do another two or three miles per gallon.

So some number in the neighborhood of 35 or 36 miles per gallon for cars and some number like 26 or 27 miles per gallon may be possible. But again, the backsliding issue is, like, a major one.

Chairman BOEHLERT. In using existing technology?

Mr. DULEEP. No, sir; the—this would use hybrid and diesel, perhaps diesels for the trucks and——

Chairman BOEHLERT. That is existing technology, right?

Mr. DULEEP. That is all—yeah.

Chairman BOEHLERT. Dr. Portney.

Mr. PORTNEY. Well, I am going to espouse an unpopular view. I think several of my colleagues on the panel have disagreed with it, and I realize it is a particularly difficult view for those of you in Congress. But I want to say that there is a problem with using CAFE standards as a way to improve fuel economy in contrast to increasing, say, the federal excise tax on gasoline. And it is important for everybody to understand this distinction. If I have a car that gets 50 miles per gallon, but I drive that car 50,000 miles per

year, I use more gasoline than if I have a car that gets 10,000—or 10 miles per gallon that I only drive 5,000 miles per year.

So it is not just the fuel economy of the car, it is also the number of vehicle miles traveled that the—that determine how much gasoline we use, and therefore how much we are contributing to the greenhouse gas burden in the atmosphere or how insecure our energy supply is becoming. And so, while no one likes to vote for tax increases, I mean, you need to keep in mind that just requiring that cars be more fuel-efficient only gets at part of this. And when cars become more fuel efficient, it becomes cheaper to drive each mile, so you lose a little bit, because people cheat and drive more miles, because they have more fuel-efficient cars.

Now I notice you shaking your head——

Chairman BOEHLERT. Well, no, that would be the subject of considerable debate, and I—you know, a good, healthy, honest debate——

Mr. PORTNEY. Well, and——

Chairman BOEHLERT.—because, you know, I think most people just don't go out, like we used to when I was a kid, for a Sunday drive. People drive from their home to their place of work, or if they have a limited time off home to recreate someplace, I don't think people just go out and drive a lot depending upon the price of gasoline.

So we—I mean, the desire is to make the automobiles more fuel-efficient. That is to the advantage of consumers. That is in our national security interests.

And let me go to Mr. Stanton. You know, I watched the Super Bowl, and I must confess, a lot of people did. I will tell you, when you talk about consumer demand, I would say I have to commend your industry, one member of it, that ad that Ford put on for the new Mustang was one of the stars of the whole commercials. And I think a lot of people watch the Super Bowl just to watch the commercials, and they don't give a darn about the Patriots or the Eagles. But it seems to me that the industry, if—you can help drive consumer demand by your marketing and advertising approach. And I don't know if there are any examples of members of your Alliance selling safety or selling fuel efficiency. But I will tell you this, I have been around this town long enough to remember when a hot shot young vice president from Ford came to town and told the Congress, and I was on the staff at that time, "If you mandate seat belts, that will have a devastating negative impact on the industry I represent." Fast forward several years, that guy then was chairman of the board of another automobile company and was on saying, you know, "Buy our product. We have got airbags to protect you, and no one requires it, but we are concerned for your safety." So I would suggest that a lot of this has to do with your marketing approach.

And we all have to be sensitive to your industry. It is a very vital part of our overall economy. And for us to put undue burdens on the auto industry is counterproductive. But I think to impose some reasonable burdens and work cooperatively with you, not say we need something by 8:30 tonight, but you know, with a lead time frame, as Mr. Reilly has testified, as Dr. Portney has emphasized

in the report, I think is a reasonable approach. I could—I am on my high horse, and I have got the advantage of the microphone——

Mr. STANTON. Could I have it for a minute?

Chairman BOEHLERT. Sure, by all means, Mr. Stanton. Yeah.

Mr. STANTON. For someone who spent 5½ lobbying the States for mandatory safety belt use laws, our industry has changed a lot. There is just absolutely no question about it. I can't tell you how proud I am to say that we have got national safety belt usage up to 85 percent. We have got a long ways to go still, but at least we are making progress.

I was also very pleased to watch the Super Bowl, and I noticed that three of our members had three drastically different commercials. One of the members had, in addition to Ford, a commercial on power and acceleration. And then another, which you probably really recognize, had a commercial about the Prius. So we had three very different target audiences, and that is I think the—what I heard in all of the testimony today is how complex an issue it is to get what we all want, and I really want to emphasize this. We all want to reduce our dependence on foreign oil. The only difference of opinion, I think, is how to go about doing it.

Chairman BOEHLERT. Thank you very much.

With that, Mr. Gordon.

Mr. GORDON. Mr. Reilly, you said that your Commission recommended that there be significantly higher CAFE standards, but you also said that you I guess intentionally did not try to say what those standards would be. You know, having worked with this group and what you know, what would you say would be the minimum of a higher standard?

You need to—you——

Mr. REILLY. I don't want to go beyond where the Commission itself has come out. This was one of the——

Mr. GORDON. Well, that is why I was asking you, as an individual who has assimilated all of this information. What would be the minimum?

Mr. REILLY. Well, let me just say that this was a particularly contentious and concerning issue that our Commission addressed. We looked at a lot of options. We looked at their advantages, their costs. We did propose these consumer incentives as well as manufacturer incentives to encourage more fuel efficient, advanced diesel and hybrids. The consultant studies on which we relied strongly suggested that a 10- to 20-mile-per-gallon increase in CAFE would be cost effective and a desirable policy. When I say "significant," when the Commission said a "significant increase," I think it is reasonable to infer from those studies and from the language of our report that that is the range that most of us were contemplating.

Mr. GORDON. So when you say "range," would 10 be a minimum then?

Mr. REILLY. Ten would be a number that I believe most——

Mr. GORDON. That most folks would——

Mr. REILLY.—members of the Commission would endorse.

Mr. GORDON. Okay. And Mr. Stanton, what is your opinion as to how long it would take the automobile industry and how feasible is it to obtain a 10 percent—or a 10-mile CAFE increase?

Mr. STANTON. A lot of it would depend upon market forces, obviously. I think that we have just seen the biggest increase in light truck fuel efficiency standards, which was between 2005 and 2007. And that was a 7½ percent increase. That was supposedly determined by NHTSA with the congressional criteria of looking at all of the factors that are important, including employment and production cycles, et cetera.

One of the problems that we have with looking forward to whatever the time frame is that a substantial time frame builds uncertainty into the standard—into the process for us. We don't know where consumers are going to be. We don't know where the demands are going to be. We are—we do not, and would not, recommend that we set standards separate from where—or different from where our customer base is. And this goes back to the comments that were made here, too. We need to get the consumer somehow in the equation, because right now, just as we were talking about with the Super Bowl ads, we have got customers out there that want power. And if we want to sell vehicles, we will sell power. And that—you see that in the marketplace. But we are also doing an awful lot on the advanced technology side of it in an effort to maintain those attributes that our customers want and, at the same time, get a major increase in fuel efficiency.

Mr. GORDON. But I am talking more of the technology. You know, I mean—you know, in terms of you have to have a reasonable time to come out with new models and so to get a 10-mile increase, what kind of lead time—again, is that possible, and if so, what kind of lead time is necessary to keep it in that—and I guess the question is what is a reasonable, you know, increase. So what kind of—are we talking five years, 20 years?

Mr. STANTON. The dilemma that I face is I just really don't know the answer if that is the right number in a given period of time. If we could make some certain assumptions that, you know, 50 percent of the vehicles would be hybrids or gas prices would be some place else, then we could chart a path that would make sense to get there. But I don't know how to answer those questions.

Mr. GORDON. Well, let me ask you this. Is the Alliance—have you taken a position on tradable CAFE compliance credit programs?

Mr. STANTON. Actually, we like the idea of increased flexibility in the program. And in preparation for the hearing, we tried to figure out what exactly was meant by the tradable credits program that had been espoused by a number of my colleagues here. And we found out that we didn't fully understand all of the ramifications of it, but it is something we certainly would be willing to do.

Mr. GORDON. What do you think it will take to help you to understand that better?

Mr. STANTON. Some pretty healthy discussions, I think.

Mr. GORDON. Is there a forum for that?

Mr. STANTON. No, sir.

Mr. GORDON. And does anyone here have a suggestion on what would be a necessary forum? And also, I think in that discussion, the statistic that you pointed out that was a 17 percent reduction in the costs by having this, what would be an appropriate forum for that discussion? Anyone? Go right ahead.

Mr. PORTNEY. I would be happy to convene a group of auto makers and analysts who have floated this idea of tradable credits at Resources for the Future any time to have a talk about this and try to explain the idea in more detail so that even the analysts could better understand what the pros and cons are. I would be happy to do that.

Mr. GORDON. I think that would be helpful for us if there could be some groundwork laid on something like that. I mean, hopefully—that might be very well an area of consensus within the—between the industry and those folks that are, you know, want an increase in the fuel efficiency.

Thank you, Mr. Chairman.

Chairman BOEHLERT. Thank you very much.

Ms. Biggert.

Ms. BIGGERT. Thank you, Mr. Chairman.

The National Highway and Traffic Safety Administration is considering ways to reform the CAFE system, and one of the—one method is the weight-based standard. In my District, we have a company that is just newly developing a process—a reactor in process to produce titanium. It is called International Titanium Powder, in a very useful forum, and they are actually working with the military now and looking at the weight of tanks and the weight of Humvees. Is NHTSA considering advances in materials, like I have just described with respect to titanium as it contemplates reform to the CAFE program? Mr. Stanton? Or is this something that you would see in—rather than just looking at the CAFE standards and the weight to look at advanced materials in deciding how to raise those standards? Dr. Greene.

Dr. GREENE. One thing about weight-based standard can be formulated in any number of ways. It can be formulated to encourage weight increasing in cars. It can be formulated to discourage it. And so if it were formulated to discourage increasing the weight of cars, that would encourage material substitution of the kind you are describing. I think this gets at the real issue in auto safety and weight, which is the energy that has to be absorbed in a crash in order to minimize the maximum deceleration that is experienced by the people in the car, and the ability of the materials to handle that. The heavier the car, the more energy has to be absorbed, and so there is a trade-off there. But advanced materials ought to be able to play a role in making safer and lighter cars.

Ms. BIGGERT. Because if this material is lighter and yet it is just as strong, it is—it would reduce the fuel consumption. And you talked about the cars' size versus weight and said that there can be lighter cars, which are just as safe, depending on the size.

Dr. GREENE. Yeah, on—the study done by—sponsored by Honda essentially took the same approach as the National Highway Traffic Safety Administration and Dr. Kahain did in his study, but tried to separate the effect of size from the effect of weight, which Dr. Kahain did not try to do, and came to the conclusion that making cars the same size but a bit lighter would be beneficial to safety.

Ms. BIGGERT. Thank you.

Mr. Stanton.

Mr. STANTON. Yeah. Just to follow up on one—well, two points, actually. One is that, by all means, we are always into advanced technologies, and if you have someone in your District, then we would love to talk to them if they have got a promising technology, and by all means, we can make that happen.

The second point is on the size and mass. We are still learning an awful lot on safety. But basically, it is our opinion anyway, that at the present time that it is a function of both mass and volume or size. We have got to remember that we are talking about a whole fleet out there. And the question—the public policy question we are trying to struggle with is how do we increase the safety for all of the driving public? We can't sacrifice some safety for someone to improve safety for someone else. We can do that, but we don't think that is the right public policy.

Ms. BIGGERT. With regard to NHTSA, the regulatory process, and they have had the process for raising CAFE standards for light trucks, and it seems to have been working. It was going up. It went unimpeded by Congress. Is—do you agree that—well, particularly Mr. Stanton, do you agree that this would continue if we hadn't put a hold on the raising of those standards?

Mr. STANTON. Not only would I agree, it would have to, under the law that Congress has passed, that NHTSA has to set the maximum feasible standard for light trucks for each and every year. I think you are absolutely correct. And we anticipate that it will continue.

Ms. BIGGERT. Thank you. Thank you, Mr. Chairman.

Chairman BOEHLERT. Mr. Lipinski.

Mr. LIPINSKI. Thank you.

A number of you had touched upon this, but I don't know if you really wanted—it is a little bit off of the question exactly of technology, but I want to see if anyone wanted to just take a stab at this. What do we really know about consumers' habits in regard to purchasing vehicles, their driving habits? I have heard, you know, different things, suggestions about what may—what changes may occur in the vehicles purchased or, you know, how they drive. They get better mileage, are they going to drive differently? Or perhaps even, you know, if they got feedback on what their mileage is that they are getting, do people actually respond to that. And so what do we know? You know, if we are working at this, you know, through a free market, what can we do in that regard? Go ahead.

Dr. GREENE. Given the importance of this subject of fuel economy and car purchases, there has been remarkably little research on this subject. There has been, however, recently completed by the University of California Davis, in-depth interviews of households, their complete history of automobile purchase decisions, and getting at where fuel economy came into those decisions, and when they did consider it, how did they go about doing it. And what those researchers found is that a small minority of the people considered fuel economy at all in making their car-buying decisions. And of those who did, none of them made any explicit calculations about what the value the fuel saving would be worth and what the car would cost. And nobody thought in terms of paying more to get a more fuel-efficient car. They thought in terms of paying less to get a smaller, lighter, less-efficient car. So this idea of adding tech-

nology to improve efficiency is not in the consumer's mind when he goes to buy the car. That is something that happens on the manufacturer's side in designing the vehicle.

Now a great deal is known about travel behavior, and we have entire Transportation Research Board meetings every January in which there are thousands of papers presented, half of them or so on subjects related to that. But is it well understood? Well, I think most of them would say no, it is not. There are still, sort of, some mysteries there.

But one of the things that has been studied fairly carefully is this rebound effect. And we know that if you look back historically, the rebound effect is probably somewhere in the range of 10 to 20 percent, meaning if you improve the fuel economy of the vehicle by 50 percent, then people will drive, maybe, five to 10 percent more in the long run. And we—I suspect that the rebound effect decreases over time, as the cost of fuel becomes less and less and less important in the monetary costs of operating a vehicle and including, also, the value of a person's time.

So I think the rebound effect is a small effect, but it is real, and it is probably decreasing over time, as people's time becomes more valuable. This was confirmed by a recent study from the University of California, again out of Irvine, Professor Kent Small.

Mr. STANTON. Briefly that—and I was looking in my briefcase to see if we—if I had brought it with me, but there are a number of polls that are out there on what consumers value when they search for a new vehicle. Usually the first item is reliability and then it goes down to cost and other attributes. I think verifying what the panel is saying here is in the past, fuel efficiency wasn't even on the list, and it is there now as number 13 on the 2004 poll that I had seen.

Mr. LIPINSKI. And does this mean that, in essence, have to forget about the consumer side when we are, you know, trying to, you know, save fuel? Does it all have to then come from, you know, the manufacturer side and, you know, are they going to the people? If consumers don't care about it, then, you know, what incentive do they have to be—you know, make more fuel-efficient vehicles, and does that come down to incentives that the government may have to give them to be more fuel efficient, such as the CAFE standards and that is the only thing that is going to move them?

Mr. REILLY. Well, sir, the National Commission on Energy Policy considered that incentives are necessary, incentives both to the manufacturers and the parts suppliers to them and also incentives to the consumers themselves. There is currently a tax deduction of up to $2,000. It is worth between $400 and $600 to the average taxpayer, and that is provided to consumers who purchase new hybrid electric vehicles. That starts phasing out—expires after 2006. The Commission supports extending that tax incentive for five years, 2007 to 2011, but altering the mechanism from a simple deduction to a variable credit of up to $3,000 based on vehicle fuel economy, and also expanding the scope of the allowance of the program to include advanced diesel vehicles, from which we expect quite a lot of fuel efficiency in the years to come.

Chairman BOEHLERT. Thank you. The gentleman's time is expired.

Mr. Sodrel.

Mr. SODREL. I think you have answered a lot of my questions as I sit here. I am a free market person. I mean, I believe in the marketplace. I believe it produces products that consumers want. And my question really went to what marketing—and maybe it is best for Mr. Stanton. What marketing—we talked a little bit about the Super Bowl and the convertible with the frozen guy sitting at the wheel. What kind of marketing programs have the automobile manufacturers undertaken to try to sell fuel economy to their customers and to the marketplace?

Mr. STANTON. Well, I think that the best, and probably the most efficient program, as you look at the most fuel-efficient vehicles, and they are also the least expensive, so I mean, it is—other than pricing, and I think it is pretty well known that on a lot of the smaller vehicles, the manufacturers are pretty much giving them away. It is very difficult to make—to compete successfully in that marketplace.

Mr. SODREL. Yes, sir.

Mr. PORTNEY. If I can weigh in on this, first of all, I am glad we are staying away from BigDaddy.com commercials here. I—on this—the issue of the free market in all of this, I absolutely agree with you: we all benefit from a free market that produces shoes and pencils and everything else, and I think it is for—goods and services for which all of the costs are borne by the producers and the consumers, it is, by far, the best way to organize an economic system. The one justification you can make for having the government involved in this particular case, either through higher taxes or through mandated fuel economy standards, is that when I go buy a car, typically I count in the cost of that thing how much the purchase price of the car is and what it will cost me over my lifetime. Typically, people don't take into account the fact that the gasoline that they use is contributing to the atmospheric burden of carbon dioxide. They don't take into account, in their own purchase decisions, this dependence on imported oil, and that is why, in a case where you wouldn't get involved if there weren't these external costs, that there is a good reason for economic efficiency that you can justify some form of government involvement in the fuel economy—in the case of fuel economy. We can certainly argue about what is the best way to do it, but I think there is a case there that, because there is a form of market failure, that you need some kind of government intervention.

Chairman BOEHLERT. Mr. Miller.

Mr. MILLER. Thank you, Mr. Chairman.

Just a couple questions. Mr. Stanton, you mentioned that your association supports the President's hydrogen fuel cell proposal. This committee had hearings in the last Congress on that proposal, and there seemed to be a great deal of skepticism that there is not an ample supply of hydrogen out there, we just need to find a way to use it, that, in fact, the hydrogen has to come from other fossil fuels, has to be stripped out, that it is not a particularly clean process to do that. It doesn't really free us from our dependency on foreign—on fossil fuels. We seem to be pursuing that to the exclusion of other alternative fuels, and we have some massive amount of money tied up in a liquid fuel in transporting liquid fuels and hav-

ing it available. My question to you is have things changed in the last couple of years on that proposal? Do we—where would the hydrogen come from if we really dramatically changed from a fossil to a hydrogen economy?

Mr. STANTON. Well, I think we all believe that somewhere down the line it has got to come from renewables if we are going to work our way out of this. It is really the goal, I think, that we would like to see, and we recognize that. And I hope everybody understands that. As the industry, we agree that dependence on foreign oil is a national issue. And the question is what is the best path out of that. And we are struggling with exactly what is the best path. Certainly research—additional research and development, the things that this committee has done in the past or things that we have supported, part of our members are involved in FutureCar and FreedomCAR. I personally was involved in the PNGV program. Those kinds of programs are the kind of research and development that we are going to need to solve this conundrum that we find ourselves in.

Mr. MILLER. Mr. Portney, you seemed to be nodding your head to that question, so did you have anything you wanted to add or——

Mr. PORTNEY. Just that, you know, I think everyone is optimistic about anything that has the potential technological promise of hydrogen of being a completely clean energy source, but I think we need to do something sooner than the time frame in which hydrogen will become the major propulsion for motor vehicles. I mean, I think that is really 15 or 20 years off. I would love to be more optimistic than that. I think we can't wait 15 or 20 years before we try to do something, regardless of what it might be, to try to improve the fuel economy of the overall fleet, whether it is through higher taxes or technological fuel economy requirements or whatever. I would hate to just put all of our eggs in the hydrogen basket and not do anything for 20 years in the hopes that that will be available and to solve the problem.

Mr. MILLER. Mr. Stanton, you seemed to describe a two-step process: figure out, one, how to make hydrogen work, then, two, figure out where we are going to get the hydrogen. How long—Mr. Portney—Dr. Portney suggested that that would be a 15- or 20-year proposal. Do you see it as being substantially more than that or less than that?

Mr. STANTON. Yeah, actually, we have some members that are very high on bringing fuel cell vehicles to the fleet now, but the question is what are the numbers and what is the impact going to be. And we certainly agree with Paul that we need something in between, and that is why we are supporting and working hard on the hybrid vehicles and the clean diesel, because that is the interim path that we see to getting us to the hydrogen——

Mr. MILLER. One of the criticisms in the hearings that we held in the last Congress was that the proposal—President's proposal, I believe it was $3 billion, was to the exclusion of other alliterative fuels. But from what you have just described, we obviously need to be doing both. Do you think we are doing enough to develop other alternative fuels from which we would get hydrogen, as well as having those alternative fuels to use in the meantime?

Mr. STANTON. Mr. Miller, you are beyond my expertise on all——
Mr. MILLER. Okay.
Mr. STANTON. I think we, generally, as an industry, are looking at all of the paths, and we are just trying to find what is the right one and work with the right people to get there.
Mr. MILLER. Okay. Dr. Portney, I think I saw you nodding again. Did you have anything to——
Mr. PORTNEY. I am going to hold my head——
Mr. MILLER. You may just have a tick, I don't know.
Mr. PORTNEY.—very still in the future here. I—let me just say, I am always worried when the government or the private sector or anybody puts all of its eggs in one basket. And I think what we ought to do is have a goal for a fuel economy for the fleet without specifying the technology, whether it is diesel or hybrid or hydrogen or improved internal combustion engines. I always worry where we sort of anoint a winner and put all of our R&D dollars and other efforts into that.
Mr. MILLER. So Mr. Reilly, you did more than nod.
Mr. REILLY. If I might add to that, thank you.
Our Commission, in that opening statement I gave about the crunch that is coming in liquid fuels need versus production capacity over the coming years and the current shortfall, a very limited capacity that exists of less than two percent of excess capacity, we looked at the need for a whole range of new interventions and of new efficiencies, fuel sources, and the rest, but strongly supported ethanol as a fuel derived primarily from cellulosic material, corn stover, switch grass, forest cuttings, and things of that sort as an important solution to part of our problem. The oil industry has tended to regard ethanol as an additive over the years past. It is only two percent of our gas supply now. And I think that is 2.8 billion gallons a year. We see the need to boost that considerably and offer a number of incentives to do that, but that has got to be part of our future, I think, and particularly, with the phase-out, the banning of MTBE as an oxygenate in many of our states, including my own State of California.
Chairman BOEHLERT. The gentleman's time has expired.
Mr. Gilchrest.
Mr. GILCHREST. Thank you, Mr. Chairman.
First, I want to welcome the person who, on the Eastern Shore, is affectionately known as Bill "Wetlands" Reilly. Back in the late '80s, early '90s, we had a full range of issues dealing with wetlands, and as EPA Administrator, Mr. Reilly was a friend of the State of Maryland, especially the Eastern Shore, and I just wanted to make those comments, Bill.
It is—Mr. Chairman, it seems to me that we have an issue that we have been dealing with for a number of decades that is environmental, it deals with energy security, it deals with safety, and it deals with economics. And when we look at that, and we hear the information that has been given to us, both from your testimony, from the NRC report, Bill, from what you have done with your research. I am looking at this either from a global marketplace or an international marketplace issue. If we look at it from a global marketplace issue, this is free market, do what you want, the bottom line, the top line is the profit margin. But I think this has to be

an international. This has to be an issue with the marketplace, which gives us most of our ingenuity and our initiative, on new technologies, and the government's understanding, and you might want to comment on this, that there is a factor with CO_2 and global warming. There is a factor with our security and energy dependence, especially with countries like China moving to create a huge demand on energy. And can we resolve the issue of safety? And can we do it economically feasibly so we have a dynamic economy that continues to be prosperous?

So I sort of frame that issue to ask just four quick questions. One is, Bill, and a number of you, mentioned increase production as part of a whole package. Is that looking both foreign and domestic or just domestic? Number two, Mr. Stanton, you said something interesting about petroleum-dependent transportation sector, or I think I heard you say you are moving away from the petroleum-dependent transportation sector. And that sounds like it is pretty good news. How long do you think that will take, and what can we do to speed that up? And then, Mr. Greene—Dr. Greene and a number of people have mentioned the idea of CAFE standards versus a number of new technologies, weight-based standard versus CAFE standard. So where are we on that, and is that a recommendation specific to us? The last one is, Bill, you mentioned, you know, burning corn and those kinds of things, ethanol. Where are we, and can we move in certain sectors of our country, especially in the rural areas, to add more soy oil to diesel fuel?

Those are my questions, Mr. Chairman.

Chairman BOEHLERT. Who are you directing your question to, or do you want to provide the answer, also?

Mr. GILCHREST. I don't have my—I don't have the answers. I am just—if anybody would like to comment on that, or any of those——

Mr. REILLY. I would just comment quickly, first of all to say I know nothing about the capacity of soy oil to be a fuel, but I have been impressed in the course of our research over the past 2½ years that even turkey parts are being used in Carthage, Missouri to create liquid fuels. I think you can make alcohol out of virtually anything, and we are beginning to find more imaginative ways and cheaper ways and more—ways that are more efficient in the use of energy and manufacturing, and that is what some of these ethanol possibilities are, I think.

You mentioned China. That first question you had, is it a U.S. or is it a worldwide number? The number that I began with is an excess—in excess of 50 percent of new production will be required over the next 20 years. It is, I think, 43 percent for the United States in liquid fuels, in oil and in gas, basically, gasoline. That compares with a 20 percent increase in production worldwide over the period 1980 to 2000. Those contrasting numbers, a very significant difference, suggests to me that we are not going to make it. We really do need virtually all of the possibilities that we can explore and bring on with some degree of cost effectiveness.

Mr. DULEEP. On the issue of soy-based diesel, I—there has been a lot of research on that, and it does look like a relatively expensive option, so it is a tough sell at $1.50 or $2.00 a gallon for diesel fuel, but it——

Mr. GILCHREST. It is a tough sell because of——

Mr. DULEEP. The cost of production.

Mr. GILCHREST.—the cost of production, even though you might be in an area where soybean production is large? It would still—the cost of production to turn soybeans into soy oil is still not competitive with traditional fossil fuels?

Mr. DULEEP. Relative to what you can sell the soybeans in the market for, it would be a difficult—it is just a hard thing to do. But I understand there are other types of agricultural products they are looking at to make diesel fuel from. Now ethanol is a completely different animal.

Chairman BOEHLERT. The gentleman's time has expired.

Ms. Lofgren.

Ms. WOOLSEY. Woolsey is my name.

Chairman BOEHLERT. Lofgren. Woolsey. I am looking here, and then I am looking there, and I am seeing two different things.

Ms. Woolsey.

Ms. WOOLSEY. Well, first of all, I would like to welcome Mr. Gilchrest to this committee. I am glad you are here, except for now you have made my questions seem simplistic.

I want to talk about consumers and getting consumers into the equation. And I will start with Mr. Stanton. I mean, we talked about a target audience on the Super Bowl ads, but there is something about supply and demand, so we know that consumers are actually waiting for hybrid cars. So if we don't—and we also know that Americans don't like to wait for anything, but they are actually waiting for these cars, and more would buy them, I believe, if there—it was more convenient for them to just get one off the lot, like other automobiles. So why do you think when these cars are popular that there aren't enough of them yet?

Mr. STANTON. Well, I think there are a couple of reasons, and I want to give credit to one of my members, particularly Toyota, because they are just going gangbusters on this, and they have just announced that they are going to double production again. And I think that is wonderful. We are finding out that things like single occupant HOV use in Virginia or California seems to be a great incentive for these things, and we are generally for incentives to encourage the production and then, of course, the purchase of these advanced-technology vehicles.

If I look at our membership in the Alliance, we have some members who, right now, are going very strong on hybrids, and other members are going very hard on clean diesel. And I think it was Mr. Portney who said it earlier, I mean, we don't think Congress ought to try to pick winners and losers in technologies, but the race is there. That is the point.

Who is going to win the race? I—we don't know. I mean, hybrids are inherently more expensive, because they have got two power plants. You have got the internal combustion engine, and then you have got the battery. So clean diesel has some emission challenges. Thanks to Congress, we are going to have 15 parts per million sulfur-fueled beginning in 2006. We hope that is an enabler that will allow us to put the after-treatment on the diesel—on the clean diesels so that we will be able to certify those vehicles and they will meet the stringent tier two emission standards to—that come into effect or being phased in now.

So who wins? The consumer wins eventually. What we have proposed, and what we would like to see, is very complex. I mean, as we talk about how to do this, Mr. Camp's bill or the consumer credits that were in the Energy Bill last year, I mean, it was an attempt to balance the degree of technology, the fuel economy increase, and the gallons saved for hybrids versus diesel and come up with a package where everyone thought that that was relatively neutral in supporting both technologies. And that is what we would like to see happen. And then the consumer becomes the big winner.

Ms. WOOLSEY. Well, and the industry becomes a winner.

Mr. STANTON. Absolutely.

Ms. WOOLSEY. It doesn't cost—I mean, the automobile industry doesn't lose money on hybrid cars, do they?

Mr. STANTON. They sure do in the beginning.

Ms. WOOLSEY. Well——

Mr. STANTON. There is no question that—you know, our industry is spending $18 billion on research a year. I don't want to say long lead time, but lead time extremely important. There are major investments in new technology. And you tend to, you know, want to go a little slower than faster unless you know that you have a winner. And I think you are seeing in the marketplace now that the hybrid turns out to be a winner. I have got an article on my desk that shows that we are going to have 50 hybrid models by 2010. This is phenomenal.

Ms. WOOLSEY. So how does—how do R&D credits work into that? I mean——

Mr. STANTON. Well, the tax credits work in, because the incremental cost increase is going to be less than the tax credit, but we need a way to get the new technology into the marketplace. And if we want to accelerate the introduction—and we all recognize that there is going to be a cost differential. If we can get the cost differential down to where it is—the purchase price is roughly similar to a comparable internal combustion engine, then we will get the volumes up, and with the volumes up, the price comes down.

Ms. WOOLSEY. Well, thank you.

And you did say that consumers don't really care that much. I represent Marin and Sonoma Counties, just north of the Golden Gate Bridge, if it matters.

Mr. STANTON. Not all consumers, how about—we will put the qualification there.

Ms. WOOLSEY. Thank you very much.

Chairman BOEHLERT. Thank you very much.

Mr. Schwarz. Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman.

Several comments before I get to questions. First of all, on the issue of hydrogen, everyone assumes when you are talking hydrogen that it has to be fuel cell, and I agree with Mr. Portney: they will leave the options open. Those are two separate issues, and there are other ways of using hydrogen besides fuel cell. The—but the main factor there with hydrogen is simply don't get it from fossil fuels. There are abundant sources. H_2O happens to be fairly abundant. Unfortunately, it is a very tight chemical bond, but again, that may be an appropriate place for high-temperature nuclear reactors and getting away from fossil fuels.

I would also like to comment about the statement about market forces. A number of people have talked about this as if somehow these are some magic, independent things that automatically lead to good results. And that assumes—that kind of model assumes that people genuinely react to these market forces. But that ignores certain things, and I have always had a—I have had a bone to pick with the auto industry for a long time. In fact, I am the only Member of Congress from Michigan who has consistently voted against the freezing CAFE standards, not that I am that enamored of higher CAFE standards, but we have to face this issue. And the auto companies simply refuse to face it. And my bone with them was they kept talking about market forces. "We are just making what the people want." And I simply remind them of their advertising budget. How much do you spend advertising SUVs compared to how much do you spend advertising low-cost, high fuel economy vehicles? It is very disproportionate. And we are not talking peanuts here. If I buy a new car, I am paying about $400 for the advertising that they bought to persuade me to buy the car.

And so market forces don't operate in a vacuum. I think the auto industry has taken a pass on that. They can greatly influence the choices consumers make through education, through advertising. A part of the problem, and part of the reason market forces don't work very well is the public simply does not understand energy. They can't see it, they can't touch it, they can't taste it, they can't feel it, and it is frustrating to me, as a physicist, because that is one thing I do understand. But I have often said I wish energy were purple. If energy were purple and people could see it and they are driving down the highway and a Toyota Prius comes by with just a little purple around it, and it is followed by an SUV with a big purple cloud, people are going to say, "Hey, you know, I am going to get one of those Prius," because they could see it. They could see the impact. As it is, their only tie to reality, in terms of the energy, is the price at the gas pump. And that is a little too ephemeral to directly affect their purchases.

I—now enough ranting for a while, except that I wish the automobile companies would try to influence purchases.

I—Mr. Stanton, in your testimony, you state their approaches to restructuring the CAFE program, that would—can help address competitiveness concerns. And as I told you, I am not enamorant of the CAFE program, but I would be interested in what you meant by that. What ideas do you have? What mechanisms are available to more—to affect consumer choices so that they are more likely to choose energy-efficient vehicles? I would appreciate your comments on that, and then I am going to ask the rest of the panel, too.

Mr. STANTON. Mr. Ehlers, thank you.

Yeah, I think that there are ways to improve the program. I think that it was referenced earlier that, certainly, we have had 30 years of experience, and we all recognize that it is less than perfect. NHTSA is currently looking at an attribute-based system. The NAS is looking at an attribute-based system. There are certain pluses and certain minuses. Those are ways to do it. The complexity of the program, and from Michigan, you understand, certainly, that issues like two fleet credit and credit trading and some people like that very much and other people don't like that very

much, depending upon which side of the fence you sit. But we are looking for ways to further the fuel efficiency, and I hear you on the advertising—the advertisement, as you and I have discussed before.

Mr. EHLERS. I would like other comments. What alternatives are there to CAFE standards that you really think would be workable in today's marketplace that would really affect consumer choices? Dr. Greene.

Dr. GREENE. I think that a leading contender to fuel economy standards are these feebate systems in which we have, at present, a gas-guzzler tax, which is kind of a half of a feebate system. It is just a tax. And that gas-guzzler tax is quite steep. It is so expensive that there virtually aren't any gas-guzzler passenger cars sold. There is no comparable tax on light trucks, so we have a strange asymmetrical situation there. But it is very, very likely that a feebate system would work well, encouraging both consumers to buy more efficient cars and light trucks, and encouraging manufacturers to adopt the technology to avoid fees and gain rebates. And so I think as a market-based incentive, that deserves a careful look as an alternative to CAFE standards.

Mr. EHLERS. Would you—are you saying you should—that we should try to apply something like that across the whole market spectrum?

Dr. GREENE. Well, there are two components of a feebate system. One is the pivot point. That is, what MPG level defines whether you get charged a fee or you get a rebate? You can have a pivot point for cars and a different one for trucks. You could have one for smaller cars or larger cars, smaller trucks. You can have as many as you like. What provides the incentive to the manufacturers, especially, to adopt technology is the rate. That is usually specified in terms of dollars per 0.01 gallons per mile so that every gallon of gasoline gets the same rate—weight in this incentive. And a feebate system of $500 to $1,000 per 0.01 gallons per mile, that is about the difference between a 20- and a 25-mile-per-gallon vehicle. It would provide a very strong incentive, both to the manufacturers and to the consumers to get a more efficient vehicle. These systems can be designed so the pivot points make the system revenue neutral, that is you take in as much as you pay out.

Chairman BOEHLERT. Thank you very much.

The gentleman's time has expired.

Mr. Schwarz.

Mr. SCHWARZ. We have talked about—first, let me say that my District is right next to Congressman Ehlers' District. And my District—in my District, General Motors is building the largest plant that they have built in the last 20 years, and I am delighted to have them there. It is the Delta Township plant, the Delta plant just outside of Lansing, Michigan. You have talked about methyltertiary butylether gone away. You can't use that anymore. Ethanol is expensive stuff, not generally accepted by the population, by the motoring population yet. Biodiesel is a great idea. There are some places—where I live in Michigan, they are actually using it and selling it, the B20 with biodiesel from soy and some of it from restaurant grease and other things of that nature. At

some point, the industry has got to get from petrofuels to the hydrogen society, the hydrogen environment.

So my question is briefly this, as someone who has thousands of people in his District working in the automotive industry, and someone from the State of Michigan, what is the best policy that the Federal Government should develop or maintain toward the industry that gets you from petrofuels to hydrogen the most quickly that it possibly can? Less regulation? More regulation? Change the rules? Leave CAFE standards the way—what gets us there quickest?

Mr. STANTON. Well, I will take the first stab at that. Certainly the research and development that this committee has been supportive of in the past, and we need to continue that and increase that. We think that the tax credits for advanced-technology vehicles is certainly a good way to go, too. We are not saying no increases in CAFE. We are just saying make sure we do the CAFE increases right so we don't divert resources from our main goal to having to meet incremental increases, which is not going to be the big bang for the buck at the end of the day.

Mr. PORTNEY. If I could, Mr. Schwarz, thank you.

I agree with Mike that there are two pieces to this puzzle to hasten the onset of the hydrogen economy, if it turns out that that really is the energy wave of the future. The first is more investment in research and development, because individual companies don't have a sufficient incentive to invest in new technologies, because other people can then ape the technologies that they invent, and they don't get all of the benefits. So there is underinvestment. But I think there also needs to be some incentive that—something that motivates the consumer to demand more fuel-efficient cars, and that can either take the form of higher gasoline prices or tighter fuel economy standards that the car companies have to meet.

If I could add one more thing, I actually think 2005 will be the most important year for people who pay attention to fuel economy that we have seen, and the reason I say that is that if one looks at the hybrid vehicles that we have had in the past, the Honda Insight, the original version of the Prius, tend to be cars that give you great fuel economy and this hybrid technology but not a lot of other amenities. So you have kind of sacrificed on the amenity side to get improved fuel economy. This year, we will see the Ford Escape SUV. We will see the Toyota or the Lexus HX–400, a very elegant SUV hybrid. We see the Honda Accord now hybridized, and we will see the—both Volkswagen and DaimlerChrysler with advanced diesel engines in much more upscale cars. And if we see this year great consumer acceptance of those vehicles, then I think it will be an unmistakable signal to car makers across the line, both in the passenger car and the light-duty truck segment of the fleet, that this is something that the public is willing to pay for and fuel economy really does have a strong consumer demand. And I think that is going to go a long way toward creating a great incentive for improved fuel economy, even without government intervention, which, I would argue, probably still needs to take place.

Dr. GREENE. Let me endorse both of those recommendations that have been made, and also add that if we want a—if we want hydrogen from renewable sources, then we probably need to have a pol-

icy for controlling carbon emissions, cap and trade system, some kind of way of penalizing vehicles that emit greenhouse gases.

Chairman BOEHLERT. Thank you very much. You are right on time. The gentleman's time has expired.

Excuse me. I think we have pretty well established that we have the technology right now to make cars and trucks get significantly better fuel economy without any detriment to safety. I think that is agreed by all.

The question is still on the table, it seems to me, and there are two of them. First, what are the pros and cons of using CAFE standards to get that technology into the hands of consumers rather than just depending on the markets? And the second one, how can we put CAFE standards into place without disproportionately burdening U.S. manufacturers? A tall order. Who wants to take the first crack at it?

Mr. DULEEP. Let me——

Chairman BOEHLERT. The centrist in the panel.

Mr. DULEEP. Let me just answer the first part of it, which is how can we get these technologies. I think, as I pointed out in my opening statement, and as Mr. Stanton pointed out, a lot of these are going to come in, regardless of any actions by the Congress or not. That—I think that many of these technologies pay for themselves and make sense in the marketplace. I think where there is a market failure in this constantly increasing consumer demand for attributes that are rapidly eroding some of these benefits of the technologies, and there has been reference made to it. And I think that is where there is perhaps more disagreement on how one might capture the technology benefits in terms of fuel economy benefits rather than benefits in acceleration performance or other attributes.

And the second part of it, on the CAFE issue, I am fairly certain, and I think Dr. Greene will back me up on this, is that if the—meeting a single-number target for all companies is definitely—creates distortions in terms of competitive impacts between manufacturers. And any attribute-based standard, we have found in our research, is somewhat better than the current CAFE standard. But we also came to the conclusion that there is no real perfect way to do it, and that almost anything you do involves some degree of compromise. And so I think it is just a matter of defining those compromises and—rather than the fact we are ready to accept them.

Chairman BOEHLERT. Mr. Reilly.

Mr. REILLY. The question of whether or not the onset of hybrids does disadvantage American auto manufacturers is one that we took very seriously. And I must say, coming into that conversation, I was skeptical that it would. We concluded—our consultants concluded that there is a risk of loss of U.S. jobs to American manufacturers and that the reason for that is—in a word is because the technologies that we are talking about here, advanced diesel and hybrids, are German, primarily, and Japanese, primarily. They are—when they are brought to this united—these United States, they are, very often, under contract or franchised with some of those who have developed those technologies.

Chairman BOEHLERT. Is that because they have regulations that require that in Japan and Germany?

Mr. REILLY. It is possible that that has played a role. It certainly has stimulated much more attention to some of these issues on a more urgent basis, I think, particularly in Japan. But for that reason, we did propose significant manufacturer incentives of a billion and a half dollars over 10 years to manufacturers for producing these vehicles in the United States, for all manufacturers, Toyota included to the extent that they manufacture in the U.S. We had those proposals vetted by trade lawyers to determine whether or not these were consistent with international trade agreements, with the World Trade Organization. They concluded that they were, that they are, and that this is an important way to get the introduction of the technologies. And I think they are game changing technologies. I have been involved with this issue for a long time. What is truly new now is we have technologies available to us that can get significant improvements in automobile fuel efficiency that we didn't have 10 years ago. So I think finding a way to get them introduced with the least disadvantage to American manufacturers and workers is the way to go, and that is the reason for the incentives that we proposed. We also had consumer incentives that I mentioned.

Chairman BOEHLERT. What—you know, let me just ask. It is—I think it is a national security imperative to reduce oil demand, and I think we all—can all accept that. Can we just rely on market forces to do that, or is there something more than market forces that we have to engage in? And you are recommending—obviously, you are recommending something more than market forces, and I think Dr. Portney is, too.

Mr. REILLY. Well, I strongly prefer the use of market forces, because that aligns the interests of consumers with the interests of manufacturers.

Chairman BOEHLERT. Well, I understand that, and we all do.

Mr. REILLY. Right.

Chairman BOEHLERT. I mean, I don't think you will get any disagreement there. Everybody raise their hand. We prefer market forces, but if market forces aren't doing what needs to be done, and we have a national security imperative to reduce demand for oil and look at the emerging giants in India and China, the demand, you know—there is not an unlimited supply of oil around the world. And you—well——

Mr. REILLY. Well, if the question is if you could not use higher prices as a way to create demand for more fuel efficient vehicles, do I think that there is an appropriate role for the government, through tightening CAFE standards. I do, but there I would come back to the point that I made before, that I would only do that if I gave up on the use of market forces, which I am not prepared to do, and it is so important that car makers be given sufficient time to do this, rather than be required to get unrealistically high improvements in unrealistically short periods of time, because then we are back to downsizing and downweighting, which was a counterproductive way to go about this, I think, in the first place.

Chairman BOEHLERT. And we established the fact that it is not necessary to downsize and downweight to get the increased fuel efficiency that we are looking for. We have established that fact.

Mr. REILLY. Well, we have established that——

Chairman BOEHLERT. You know, I can remember well.

Mr. REILLY. Yeah, we have established that if the car makers are given a sufficient period of time. If you said we are going to——

Chairman BOEHLERT. And we all agree that they—what they should be given, so, you know——

Mr. REILLY. But in that case, fine——

Chairman BOEHLERT.—a period of time. We can't say, "Do it tomorrow."

Mr. REILLY.—I absolutely—right. Right.

Chairman BOEHLERT. I mean, what—you know, I applauded the President last January 14 when he announced his space exploration initiative, and you know, he took an agency where they are still wearing black arm bands in the aftermath of the demise of the Columbia, and they were in a collective funk, and he said, you know—he inspired them, you know, for future space exploration. But to his credit, he said, "We are not going to do it tomorrow, and don't write me a blank check." And I am very mindful of the people that Mr. Stanton represents. I don't want to just shove something down the throat of the industry and say, "We have got to do it right away." We have got to be sensitive to their very legitimate concerns. But what comforts me today is the positive approach saying that we have got to work together to accomplish something that we agree is a legitimate national security objective. Now we might have some differences on timetable, but we are not focusing from one side of the argument all our energy on fighting something that we all agree is necessary. Now we may have some differences on timetable.

And finally, I would say on customer demand, and everybody keeps talking about customer demand, and I agree, but I will tell you, I think, I feel strongly that customer demand is ignited, in large measure, by what all of us are exposed to in advertising. And I would—and I go back to, once again, the auto industry came forward with airbags before they were mandated by the government. And a lot of the captains of industry were on television selling safety. And you know what, in my house, like a lot of houses across the country, my wife said, "Boy, that is something I want for me and for our kids and grandkids."

So I think we are all in this together. I hope that—Dr. Portney, I am going to take you up on your offer. We will follow it up in writing. You said you would be glad to convene something and maybe we can get, you know—from people in the auto industry and the Alliance to sit down and sort of talk together to try to sort this thing out. It is very, very important. And I know one of the things you are including in your market forces is increasing taxes, and I will tell you this, we are very skittish about that, and with legitimate reason, because there are ways to accomplish the same objective without increasing taxes. So—but I understand that is one of the market forces that is an option that you would suggest we take a look at. And let me say we should look at all options.

But with that, let me say thank you very much. You know, we will follow up, probably, with a few questions for each of you, and we would appreciate a timely response. But this has been a very good panel. Not everyone has been in agreement. We have had some good back and forth—good participation from up here. I really appreciate it. We did something worthy of note here today.

The hearing is adjourned.

[Whereupon, at 4:30 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

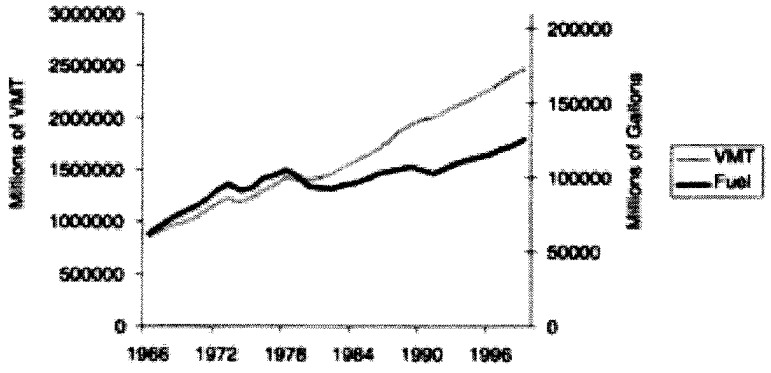
Responses by Hon. William K. Reilly, Aqua International Partners

Questions submitted by Representative W. Todd Akin

Q1. If the CAFE program has been successful, could you please explain why we are more dependent on foreign oil today and consuming more gasoline in our vehicles than we were when the program was originally put into place? And if that is the case, how will increasing the CAFE requirements to higher levels reverse this trend and accomplish the original goals of CAFE?

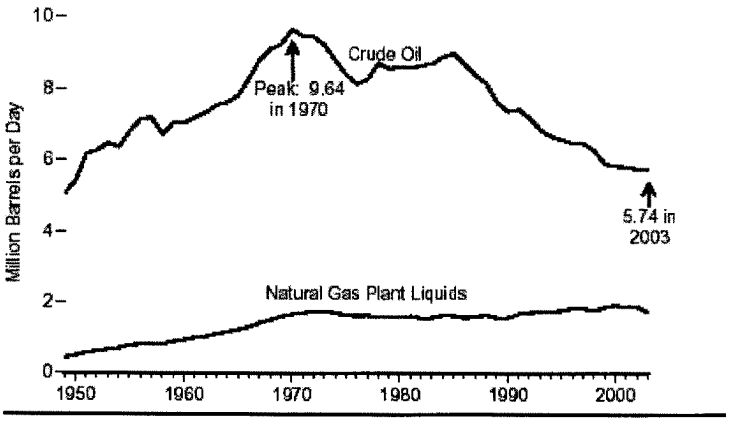
A1. Was CAFE successful? In a study published in 2002 entitled "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards," the National Academy of Sciences found that fuel use by passenger vehicles is roughly one-third lower today than it would have been had fuel economy not improved since 1975. CAFE was identified as a "major reason" for the fuel economy improvement. The NAS estimated a 2.8 million barrel per day savings between 1975 and 2000, or 14 percent of current U.S. consumption (?20 million barrels per day).

If CAFE was successful, why are we consuming more oil? We are consuming more oil because vehicle miles traveled (a function of increasing numbers of vehicles on U.S. roadways and the trend towards driving greater distances each year) have outstripped the oil savings achieved by improved fuel economy in the late 1970s and 1980s. The figure to the right from the NAS report shows vehicle miles traveled (VMT) increasing steadily since 1966. Fuel use declined between 1978 and 1983 due to improved vehicle fuel economy and a decline in the use of oil by electric utilities, but has risen steadily since then as passenger vehicle fuel economy levels have stagnated. Source of Figure: NAS CAFE report at page 19.



If CAFE was successful, why are oil imports increasing? Oil imports are increasing because domestic production has declined steadily since 1970, and domestic consumption has continued to grow, although at slower rate than what might have been given CAFE and other factors. The figure to the right is from EIA's Annual Energy Review (2003) which provides statistics on petroleum production, consumption by sector, trade, storage, prices, refinery activities and the Strategic Petroleum Reserve. Since the peak of U.S. crude oil production in 1970 of 9.6 MBD, domestic production has declined 40 percent and now rests at 5.7 MBD. Over the next twenty years, the Energy Information Administration in its Annual Energy Outlook 2005 forecasts a slight increase in U.S. oil production over the next five years, followed by a slow but steady decline until 2025.

Crude Oil and Natural Gas Plant Liquids Production, 1949-2003



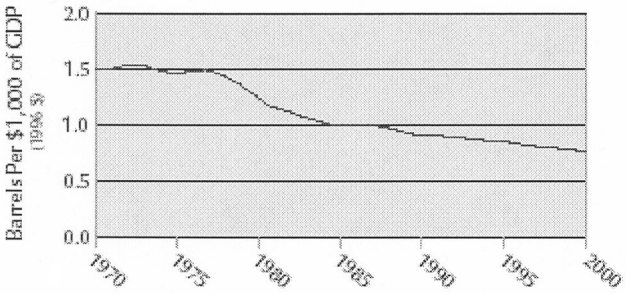
[1] Approximate representation of petroleum consumption.
[2] Crude oil and natural gas plant liquids production; refinery processing gains; and field production of other hydrocarbons, hydrogen, oxygenates (ethers and alcohols), gasoline blending components, and finished petroleum products.

How will increasing CAFE reverse the trend of increasing consumption and rising oil imports and thus accomplish its original goals? The fact that the U.S. economy has not gone into a recession despite $50 for a barrel of crude oil is in part because efforts over the last thirty years to begin to wean our economy off oil have been successful. The figure to the left excerpted from the Commission's report shows that the oil economic intensity of the U.S. economy (that is, the amount of oil needed to produce a dollar of GDP) was halved over the last 30 years. Increasing CAFE can reverse the trends of increasing consumption and rising imports, but the increase would have to be larger than two percent per year to offset the annual rise in VMT. But the point here is that even a more modest increase in CAFE can help insulate the economy from future oil price shocks and generally high oil prices.

Figure 1-2

Oil and the Economy

The ability of the U.S. economy to weather oil price shocks improves as oil's share of GDP decreases. This share has declined over the past several decades, although the rate of decline has slowed in recent years.



Resources for the Future, 2004

ANSWERS TO POST-HEARING QUESTIONS

Responses by Paul R. Portney, President, Resources for the Future

Questions submitted by Chairman Sherwood L. Boehlert

Q1. In your testimony you said that recent research by your colleagues suggests that the "rebound" effect—people driving more because improvements in fuel economy make it cheaper to do so—might cancel out the economic and environmental benefits of improving fuel economy. To what extent were the energy security benefits of improving fuel economy taken into account?

A1. The rebound effect has only to do with how much gasoline will be saved by tighter standards—it does not bear on the question of the good that is done by reducing consumption. If people drive a little more because their cars get better fuel economy (and hence the cost of driving an additional mile are reduced), that just means that we'll save less gasoline through tighter CAFE standards than appears at first blush.

The NAS committee indeed took into account energy security benefits—assigning them a "shadow value" of $5/barrel of oil consumed, which at the time was about 20 percent of the price of a barrel of oil (more like 10 percent now). This is a very important question, of course, but it is unrelated to the debate over the rebound effect.

Q2. In discussing the potential of technology to reduce fuel consumption, you emphasized the importance of the ability of the individual consumer to recoup the additional costs of fuel efficient technology through gasoline savings. But if reducing the Nation's dependence on oil is a public good, why not emphasize the level of fuel savings that maximizes the benefit to the public as a whole? Why not think of fuel economy standards as similar to pollution emissions requirements, in which individual consumer repayment is not as important a consideration?

A2. In fact, the right way to think about the benefits of improved fuel economy is to combine the benefits to the consumer from reduced gasoline consumption with the social benefits from internalizing the climate change and oil import dependence externalities. The NAS Committee thought it was worthwhile, though, to analyze the effects of tighter standards purely from the standpoint of the car buyer. Depending upon the period over which gasoline savings are calculated, and upon the discount rate used to compare future savings with present outlays, tighter standards look attractive purely on economic grounds alone.

This is somewhat deceiving, however, because a rational car buyer might think to herself, "Fine, I'll save more gasoline over the life of this car than I'll have to shell out in a higher purchase price. But what if the car companies could use the money they are required to spend on tighter fuel economy instead on developing other conveniences for me? It's at least possible that I'd like those new features even more than the fuel economy savings I'll be getting now."

This isn't an unrealistic scenario, though it gets more and more unrealistic as gasoline gets more and more expensive. In other words, the higher the cost of gasoline, the less likely it is that car buyers will prefer heated cup-holders or whatever other options might be invented to improved fuel economy.

Questions submitted by Representative W. Todd Akin

Q1. You served as Chair of the NAS panel that reviewed the CAFE program in 2001. Did your panel recommend any specific CAFE standards? Could you explain some of the complexities and policy tradeoffs that must be considered in taking information on future technologies and assessing the increases in vehicle and fleet fuel economy that may be possible from implementing those technologies?

A1. The NAS Committee did not recommend any specific CAFE standards. Determining those standards involves a set of complicated tradeoffs that can only be made by elected or appointed officials of the Federal Government.

The complicated tradeoffs include such things as the safety of vehicle occupants, the cost and reliability of new vehicles, the fuel savings that would result from tighter standards, the reduced emissions of greenhouse gases associated with improved fuel economy and many other factors that are spelled out clearly in the report.

Q2. If the CAFE program has been successful, could you please explain why we are more dependent on foreign oil today and consuming more gasoline in our vehi-

cles than we were when the program was originally put into place? And if that is the case, how will increasing the CAFE requirements to higher levels reverse this trend and accomplish the original goals of CAFE?

A2. This is an easy one. The fact that we consume more gas today than we did before the CAFE standards were put in place does NOT necessarily indicate that the program was unsuccessful. That depends on how much gasoline we consume today compared to the level that would exist had we not implemented CAFE standards in the late 1970s. It was very clear to the NAS panel that while fuel consumption has gone up significantly since then, it would have gone up by much more had the CAFE program not been put in place—particularly after the fall in gas prices during the 1980s.

While there are clearly pros and cons to even tighter standards—again, all spelled out in some detail in the NAS report, no one doubts that they would reduce the amount of gasoline used. Some believe that the savings wouldn't be worth the costs, while others have a different view. But NO ONE argues that tighter CAFE standards in the future will fail to reduce gasoline consumption relative to the current baseline.

ANSWERS TO POST-HEARING QUESTIONS

Responses by K.G. Duleep, Managing Director of Transportation, Energy and Environmental Analysis, Inc.

Questions submitted by Chairman Sherwood L. Boehlert

Q1. In your testimony you called the demand for 400, 500 and 600 horsepower engines "astounding" since the speed limit in this country rarely exceeds 70 miles per hour. What effect do you believe this increase in horsepower will have on fuel economy? On safety?

A1. Large increases in horsepower do affect fuel economy and safety if vehicles. Typically a 10 percent increase in horsepower decreases fuel economy by 2.5 percent if the vehicle technology level is unchanged and the horsepower gain is achieved by engine upsizing. Larger increases in horsepower of 20 percent or more also require improvements to the brakes, tires and the drive line, thereby increasing vehicle weight and causing additional losses in fuel economy over and above the effect of engine upsizing. The doubling of horsepower that has occurred over the last 20 years has led to an implied loss in fuel economy of about 30 to 35 percent.

It is more difficult to provide a quantitative estimate on safety effects, since the vehicle safety statistics are profoundly influenced by driver behavior. In the past, high horsepower engines were typically associated with sports cars, which have a poor safety record. Now, very powerful engines are being offered in many conventional cars but it is not clear if their accident and fatality rates will be similar to those of sports cars with similar engines, due to differences in the types of consumers who drive these vehicles. I would still expect some increase in accident and injury rates since it is much easier to drive these powerful vehicles aggressively.

Q2. You have emphasized the importance of the ability of the individual consumer to recoup the additional costs of fuel efficient technology through gasoline savings. But if the government chose to improve fuel economy to benefit the Nation by reducing our dependence on oil, why shouldn't it approach the issue more like it does the setting of requirements to control pollution emissions, in which consumer repayment is not a consideration?

A2. My testimony did emphasize the ability of consumers to recoup the costs of technology through savings from reduced fuel consumption, and I do not believe the situation is the same as setting emission standards for criteria pollutants. The committee appeared most interested in achieving increased fuel economy by setting fuel economy standards that auto manufacturers must comply with, but have no direct effect on consumer demand. Moreover, there appears to be little appetite in Congress for restricting consumer choice of vehicle size and power. Hence, manufacturers faced with consumer demand for larger, more powerful cars and lack of consumer interest in fuel economy will have considerable

difficulty in selling technology that is perceived by the consumer to cost-ineffective. In contrast, emissions of criteria pollutants are not a function of vehicle size and power (due to the catalyst cleaning up 99 percent of engine-out emissions) and meeting emission standards is effectively de-coupled from the issue of consumer choice of vehicle attributes. The California zero-emissions vehicle mandate departs from historical emission standards by requiring a certain percentage of vehicles sold by each manufacturer to be a hybrid or electric vehicle. This regulation presents problems similar to those posed by fuel economy regulations, especially if hybrids are perceived as cost-ineffective by a majority of consumers.

Questions submitted by Representative W. Todd Akin

Q1. Since all of the automakers are in different places in terms of the current use, potential use and even applicability of the various technologies you have identified to their products, can you explain how you are able to evaluate the potential for increasing the fleet fuel economy levels? Aren't there going to be "winners" and "losers" in the process of dramatically increasing CAFE standards as some have suggested?

A1. We recognize that different manufacturers are in different positions with regard to technology deployment and vehicle sales mix, but we *do* track technology and fuel economy at the vehicle make and model level and can derive fuel economy potential for each manufacturer. The fleet fuel economy improvements cited in my testimony are simply a sales-weighted average of individual manufacturer capability but my testimony also makes the point that a single fuel economy standard for all manufac-

turers could disadvantage many manufacturers. The current CAFE standard imposes a single standard for cars and another for all light trucks, regardless of the mix of cars or trucks sold by any specific manufacturer. Historically, this single standard approach has created problems for GM, Ford, Chrysler and European luxury car manufacturers. This could continue to be true in the future, but the magnitude of the effect is declining due to mergers and acquisitions in the industry. In addition, the Japanese and Korean manufacturers are gradually entering all market segments including low fuel economy segments like fullsize pickup trucks and SUV, where no imports were offered in the past. Dr. Greene of Oak Ridge National Laboratory and I have explored other types of standards such as size class or weight specific fuel economy standards, and these appear to be better than the single standard approach used in the historical period.

Q2. If the CAFE program has been successful, could you please explain why we are more dependent on foreign oil today and consuming more gasoline in our vehicles than we were when the program was originally put into place? And if that is the case, how will increasing the CAFE requirements to higher levels reverse this trend and accomplish the original goals of CAFE?

A2. Many detailed analyses of the CAFE standard conducted by the government conclude that it was effective in reducing gasoline consumption during the 1980–1990 period. Of course, the CAFE standards for cars set in 1975 by Congress are still in force today at the same level of 27.5 mpg while light-truck CAFE standards have also continued for the last 20 years with almost no change. Hence, the benefits of these standards have long since been swamped by population growth, increases in car ownership, and increased driving per car. Future increases in CAFE standards will also have only a short-term effect if the standards are left unchanged for decades. It is also possible that historical increases in car ownership will not occur as we approach saturation, and future increases in travel per vehicle may be much lower due to increasing congestion and traffic. If historical growth rates of these parameters are reduced in the future, then the benefits of CAFE standards may be more durable.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Michael J. Stanton, Vice President of Government Affairs, Alliance of Automobile Manufacturers

Questions submitted by Chairman Sherwood L. Boehlert

Q1. You suggest in your testimony that to advance the adoption of new technologies to improve fuel economy, the government should enact tax credits for the purchase of advanced technology vehicles. However, if CAFE standards were to remain constant, since they are based on a fleet-wide average, the purchase of advanced high efficiency vehicles could be off-set by the sale of more fuel inefficient vehicles or the deployment of these technologies for greater power or size, resulting in little or no change in the overall consumption of fuel by the fleet. How do we avoid this outcome when supporting incentives for the purchase of advanced vehicles?

A1. Your question gets to the heart of one of the problems of the CAFE program. There is nothing that says the consumer must purchase "fuel economy." The CAFE program only says that vehicle manufacturers must produce a fleet that averages a certain fuel economy level regardless of what consumers want or choose to purchase. The auto industry today makes over 100 models that achieve 30 or better miles per gallon on the highway, yet the sales of these vehicles are very low.

The purpose of the incentives is to make it economical for the manufacturer to offer these advanced technology vehicles, since there is a premium to produce these vehicles. The proposed consumer tax incentives are for a very limited time. They will help increase production volumes and consequently reduce costs, enabling manufacturers to provide highly fuel-efficient vehicles with the attributes consumer's value.

We can't change consumer-purchasing habits, but we can make some of these advanced technology vehicles in the most popular vehicle lines. There are already two hybrid-electric SUVs available and more are planned for production. There is also a diesel-powered SUV available. It is the manufacturers task to introduce advanced technologies in vehicles that consumers want to purchase.

Q2. You have emphasized the importance of the ability of the individual consumer to recoup the additional costs of fuel-efficient technology through gasoline savings. But, if the government chose to improve fuel economy to benefit the Nation by reducing our dependence on oil, why shouldn't it approach the issue more like it does the setting of requirements to control pollutant emissions, in which consumer repayment is not a consideration?

A2. There are two important distinctions between the national program to control tailpipe emissions and the CAFE program. Over the past four decades, manufacturers developed and implemented very effective emission control technology. In fact, today's vehicles have 99 percent fewer smog-forming pollutants than vehicles of the 1970s.

These emission reductions were achieved in a way that was invisible to the consumer.

Unlike smog-forming pollutants, there are no "catalysts" that can be put on a vehicle to improve its fuel economy. Although several technologies to improve fuel efficiency have been introduced in the fleet, it can take 20 years to develop and implement a single new technology.

The other main way to improve fuel economy is to make vehicles lighter. This involves either making vehicles smaller or using advanced materials for constructing the vehicle, which may not be cost-effective. Unfortunately, history shows that consumers do not value or purchase in large numbers small cars with good fuel economy.

Once consumers purchase these vehicles and get some experience, Consumer incentives to purchase advanced technology vehicles will spur the sale of these vehicles resulting in greater consumer acceptance and greater consumer willingness to invest in these technologies.

Questions submitted by Representative W. Todd Akin

Q1. The House has considered amendments to legislatively increase the CAFE standards during consideration of each of the past two energy bills. Does the Auto Alliance support such legislative attempts to increase CAFE standards? Are legislative changes necessary? What would you recommend instead?

A1. No, the Alliance does not support legislative increases to CAFE standards. Congress clearly assigned the task of setting CAFE standards to NHTSA. NHTSA has the expertise and a great deal of experience in carrying out its statutory obligation to set maximum feasible standards considering technological feasibility, economic practicability, the effect of other motor vehicle standards, and the need of the U.S. to conserve energy. NHTSA enacted the largest increase ever for light trucks when it set standards for the 2005–2007 model years. Now, NHTSA is working on a proposal that will set standards and revamp the CAFE program for 2008 and later models years.

Q2. If the CAFE program has been successful, could you please explain why we are more dependent on foreign oil today and consuming more gasoline in our vehicles than we were when the program was originally put into place? And if that is the case, how will increasing the CAFE requirements to higher levels reverse this trend and accomplish the original goals of CAFE?

A2. The CAFE program has been successful—the average fuel economy of the passenger car fleet doubled from around 13 mpg in the mid 1970s to 27.5 mpg in 1985. However, programs that succeed in reducing oil demand have always increased, in percentage terms, the world's dependence on the most insecure sources of supply. As demand falls, the market share of high-cost non-OPEC producers falls, and the market share of low-cost Middle Eastern OPEC producers rises.

In terms of overall fuel consumption, there are many unintended consequences of the CAFE program. When consumers are able to buy cars that get better mileage, in a low fuel price environment, consumers will drive more miles. Vehicle miles traveled have been increasing exponentially over the last decade or more. Since the enactment of the original CAFE standards, consumers have purchased more light trucks, which are now over 50 percent of the market. These vehicles are generally less efficient than passenger cars, but they provide greater carrying capacity and the ability to tow heavy loads, which most passenger cars today can't.

Increasing the CAFE standards as they are currently structured will not reverse this trend, because the same unintended consequences will occur. The CAFE standards are a requirement for manufacturers to make more fuel-efficient cars and light trucks, but there is nothing that says consumers have to buy more fuel-efficient vehicles. The auto industry today makes over 100 models that achieve 30 mpg or more on the highway, but sales of these vehicles are relatively low compared to the overall fleet. NHTSA should be left with the job of weighing all of the competing demands placed on the industry and setting a standard that takes all of that into account.

ANSWERS TO POST-HEARING QUESTIONS

Responses by David L. Greene, Oak Ridge National Laboratory, Center for Transportation Analysis, National Transportation Research Center

Questions submitted by Chairman Sherwood L. Boehlert

Q1. In his testimony, Dr. Portney said that recent research by his colleagues suggests that the "rebound" effect—people driving more because improvements in fuel economy make it cheaper to do so—might cancel out the economic and environmental benefits of improving fuel economy. Do you agree? Would consideration of the energy security benefits of improving fuel economy affect your answer?

A1. I do not agree that the rebound effect would cancel the benefits of fuel economy improvements brought about by higher fuel economy standards set at an appropriate level.

In general, a reduction in the cost of operating a car brought about by improving fuel economy will be partially to entirely offset by an increase in the price of the vehicle. *This is an extremely important point that is generally overlooked in analyses of the rebound effect.* The premise of the rebound effect is that increasing fuel economy reduces the cost of operating a vehicle by reducing the amount of fuel required per mile of travel. Estimates of the rebound effect published in the economics literature measure the effect of reduced fuel cost per mile of travel (price per gallon divided by miles per gallon) on the amount of travel, *other things equal.* However, when manufacturers raise fuel economy in response to higher standards they do so primarily by adding more expensive fuel economy technology, thereby increasing the cost of the vehicle. Whether the increased cost of this technology will be less than or greater than the value of fuel saved is usually a subject of heated debate, and in any case will depend on how high the standards are set. Regardless, in the long run the cost of operating a vehicle depends on the cost of the vehicle as well as the cost of fuel (plus other costs such as insurance, maintenance, etc., some of which may increase with vehicle price). Thus, in the long run, the rebound effect due to lower fuel costs will be at least partially and possibly entirely offset by the increased cost of fuel economy technology. I will provide a simple illustration below to show how important this effect can be.

Second, when fuel economy increases significantly, motor fuel tax revenues drop dramatically. Since motor fuel taxes are overwhelmingly user fees that finance the construction and maintenance of highways, Federal and State governments must find some way to replace the lost revenue. Historically, they have done this by raising motor fuel tax rates. Current federal and State motor fuel taxes average $0.38 per gallon (excl. sales taxes). If fuel economy standards were raised by 50 percent, for example, the increase in fuel economy would eventually cause tax revenues to drop by $\frac{1}{3}$. To restore the lost revenue the total tax would have to increase to $0.57, an increase of $0.19 or about 10 percent of the price of gasoline (at $2/gallon). Such a tax increase would further erode the rebound effect, as I will illustrate below.

Finally, while historical estimates of the rebound effect (the elasticity of travel with respect to fuel cost per mile) are in the vicinity of -0.2, the rebound effect has been decreasing over time, (1) as fuel costs have decreased as a share of total vehicle operating costs, and (2) as consumers' incomes rise. In 1985, fuel costs comprised 20 percent of total vehicle operating costs; in 2003, fuel accounted for only 12 percent of operating costs. As fuel becomes a smaller share of the cost of driving, motorists become less sensitive to both fuel prices and fuel economy. In addition, as consumers' incomes rise, they become less sensitive to fuel costs. The most recent analysis of the rebound effect by Professors Kenneth Small and Kurt Van Derider of the University of California at Irvine found a long-run rebound elasticity for the U.S. of -0.24 for the period 1966–2001. This is quite similar to my 1999 study of this subject which found a long-run elasticity of -0.23. However, for the most recent five-year period using values of income for the State of California Small and Van Dender found the long-run rebound effect had fallen to -0.09. Projecting future income growth in California, they calculated expected rebound values of -0.08 for 2005 and -0.04 for 2020. The current value of the long-run rebound elasticity is therefore probably close to -0.1, with smaller values appropriate for evaluating future fuel economy impacts.

It is instructive to combine these elements in a sample calculation. Suppose fuel economy regulations require a 50 percent increase in light-duty vehicle fuel economy. This will produce a 33 percent decrease (1/1.5 = 0.67) in fuel cost per mile. Evaluated using alternative rebound elasticity values of -0.2 and -0.1, this would imply a 6.7 percent or a 3.3 percent increase in vehicle travel, respectively. If we

assume that the increase in vehicle price for technologies to achieve these fuel economy gains will be two thirds of the value of fuel saved, then the net decrease in long-run vehicle operating costs would be only 11 percent. This would produce an increase in vehicle travel between 1.1 percent and 2.2 percent. If we add to this the assumption that motor fuel taxes will increase by $0.19 per gallon, and that this amounts to 9.5 percent of the cost of gasoline at $2.00/gallon, then the total long-run decrease in the operating cost of a vehicle is 1.5 percent, for which we would estimate a rebound effect of between 0.3 percent and 0.15 percent. Obviously, the numbers used in this example are approximations. Nevertheless, taking into account the fact that increased fuel economy will increase the price of vehicles together with the likelihood that governments will respond to losses in highway revenues by raising motor fuel taxes can reduce the rebound effect to a truly negligible factor.

From the above example it is clear that the smaller the price increase caused by higher fuel economy standards is relative to the fuel savings they produce, the larger the rebound effect will be. If the price increase is larger than the value of fuel savings, the rebound effect could be negative (i.e., an increase in vehicle operating costs and a decrease in miles traveled). My point is that one cannot have it both ways. Either fuel economy standards cause a net decrease in vehicle operating costs, in which case there is a rebound effect but also a substantial economic benefit to car buyers, or there is a net increase in operating costs, in which case there should be no rebound effect. *If the fuel economy standards are set near the point at which the value of fuel savings equals the price increase, the rebound effect should be negligible.*

Finally, I believe that Dr. Portney was referring to not just the environmental impacts of the rebound effect, but to the full range of potential external costs of vehicle travel, which in previous studies by RFF have included congestion and safety externalities, among others. According to Harrington and McConnell (2003) non-environmental external costs may be several times the environmental external costs. In my view, we should not let the existence of safety, congestion and air pollution problems prevent us from addressing our oil dependence problem. Instead, we should address all these problems with appropriate and well targeted solutions.

Q2. In discussing the potential of technology to reduce fuel consumption, you emphasized the importance of the ability of the individual consumer to recoup the additional costs of fuel efficient technology through gasoline savings. But if reducing the Nation's dependence on oil is a public good, why not emphasize the level of fuel savings that maximizes the benefit to the public as a whole? Why not think of fuel economy standards as similar to pollution emissions requirements, in which individual consumer repayment is not as important a consideration?

A2. Thank you for the opportunity to clarify my view on this subject. I entirely agree that reducing oil dependence is a public good and that the value to the Nation of reducing oil dependence should be a key factor in determining the appropriate level of vehicle fuel economy. However, in studying the costs of improving light-duty vehicle fuel economy I have observed two relevant phenomena. First, it appears that technology costs increase rapidly beyond the point at which the *total* cost of an increase in fuel economy exceeds the total present value of fuel savings. This is usually significantly above the fuel economy level at which the marginal value of fuel savings equals the marginal cost. Second, trying to increase fuel economy by using pricing to shift vehicle sales in favor of higher mpg configurations (rather than using fuel economy technology) appears to be a very expensive strategy. My intent in making the observation that the level of fuel economy standards should be set *close to* the level at which the total value of fuel saved equals the total cost of technology used to achieve those savings was to suggest a reasonable range in which the socially optimal level of fuel economy is likely to be found. In my opinion, this will be above the point at which the marginal cost of improving fuel economy equals the marginal value of fuel saved but below the point at which the total value of fuel saved equals the total cost of improving fuel economy. Of course, technology is constantly changing and therefore the most beneficial level of fuel economy from a societal perspective will change, as well.

Questions submitted by Representative W. Todd Akin

Q1. If the CAFE program has been successful, could you please explain why we are more dependent on foreign oil today and consuming more gasoline in our vehicles than we were when the program was originally put into place? And if that is the case, how will increasing the CAFE requirements to higher levels reverse this trend and accomplish the original goals of CAFE?

A1. Establishing fuel economy standards was effective in raising fleet average fuel economy, reducing U.S. petroleum consumption, and reducing our oil dependence. During the years in which we required continuous increases in light-duty vehicle fuel economy (from 1978 to 1985) our oil dependence steadily decreased. When oil prices (not coincidentally) collapsed in 1986, we abandoned that successful strategy. By leaving the fuel economy standards essentially constant for the past 20 years we have allowed growing travel demand to overtake the new vehicle fuel economy gains achieved by 1985. The principal factors driving the growth of travel demand have been increasing population, increasing levels of income and economic activity, and the continuing geographical dispersion of both people and the built environment.

Our oil dependence problem has worsened considerably since 1985 because we stopped requiring fuel economy to increase while at the same time our ability to produce petroleum domestically continued to decline. The amount of oil we import equals the amount we consume minus what we produce. U.S. production has been falling since 1970 due to depletion of our oil resources. In 1970, the U.S. produced 11.3 million barrels per day of petroleum (crude oil plus natural gas liquids); in 2003 we produced only 7.5 million barrels per day.[1] U.S. petroleum consumption in 1970 was 14.7 million barrels per day. Petroleum use increased to 18.8 million barrels per day in 1978, the first year in which the CAFE standards were in force. From that level, U.S. petroleum consumption *decreased* to 15.7 million barrels per day in 1985, for practical purposes the last year in which the CAFE standards increased. The reduction in petroleum consumption from 1978 to 1985 was achieved despite a 15 percent increase in miles traveled by light-duty vehicles over the same period (from 1,426 billion vehicle miles in 1978 to 1,637 billion in 1985).[2] Because it takes more than 10 years to turn over most of the stock of light-duty vehicles, the benefits of higher new vehicle fuel economy persisted beyond 1985 even though the rate of growth in vehicle travel exceeded the rate of increase in fuel economy. By 1992, the turnover of the stock of vehicles was nearly complete and on-road light-duty vehicle fuel economy reached a plateau of approximately 19.5 miles per gallon. Had light-duty vehicle fuel economy remained at the 1978 level of 13.6 mpg, the 2,078 billion miles traveled by passenger cars and light trucks in 1992 would have required 46 billion gallons (three million barrels per day) more petroleum than it did.

Depending on the fuel economy standards chosen, raising fuel economy standards alone may or may not be sufficient to reverse the trend of increasing oil dependence. In general, increasing energy efficiency alone is not a complete strategy for addressing oil dependence. Increasing domestic petroleum and alternative fuel supplies is equally important, and harnessing market forces to promote both efficiency of energy use and increased energy supply is key. Equally important to these strategies is continuously expanding the technological potential to increase energy efficiency and substitute alternative energy sources for petroleum through research. In my opinion, raising the fuel economy standards is an essential part of an effective energy security strategy but not a sufficient strategy by itself.

References

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2. Greene, D.L., J. Kahn and R. Gibson. 1999. "Fuel Economy Rebound Effect for U.S. Household Vehicles," *The Energy Journal,* Vol. 20, No. 3, pp. 1–31.
3. Harrington, W. and V. McConnell. 2003. "Motor Vehicles and the Environment," RFF Report, Resources for the Future, Washington, DC, April.

[1] U.S. Department of Energy, Energy Information Administration, "Annual Energy Review 2003," DOE/EIA–0384 (2003), Table 5.1, September 2004, Washington, DC.

[2] U.S. Department of Transportation, Federal Highway Administration, "Highway Statistics 2002," Table VM–1, Washington, DC.

Appendix 2:

Additional Material for the Record

PREPARED STATEMENT OF DR. DAVID L. BODDE

Professor and Director of Innovation and Public Policy, International Center for Automotive Research, Clemson University

Thank you, Mr. Chairman, for the opportunity to comment on Corporate Average Fuel Economy (CAFE) standards and their capacity to encourage fuel-saving innovation in automobiles and light trucks. The thoughts that follow are my own and not necessarily the views of Clemson University or its International Center for Automotive Research.

In summary, my thesis rests on three points:

- Near-term improvements in fuel economy can most likely be achieved through more stringent CAFE standards. But these gains will soon dissipate unless efficiency-enhancing innovation becomes an ongoing process.
- CAFE standards, by themselves, cannot move light vehicles from mere compliance to continuous improvement. This is true for two reasons:
  - CAFE standards operate on the supply side of the market. They do nothing to promote consumer demand for more fuel-efficient vehicles.
  - CAFE standards take no cognizance of the entrepreneurial sector of the economy. Therefore they are irrelevant to the most dynamic force for change in a free society, the wellspring of "creative destruction" that has led technological revolutions in fields as diverse as telecommunications, computing, and medicine.
- If more aggressive CAFE standards are authorized, then I would suggest consideration be given to policies that could supplement regulation with incentives for continuous innovation.

In what follows, I will set out the evidence that supports this thesis.

The Limits of Standards in Promoting Ongoing Fuel Efficiency Innovation

The balance of evidence supports two premises as true. The first is that the original CAFE standards contributed to the sharp increase in vehicle fuel efficiency that occurred in the decade from 1975 to 1985. To be sure, analysis cannot clearly distinguish the effects of the regulation from the effects of the fuel price increase over that same period. But at the very least, the CAFE standards *contributed* to the improvement—and they surely prevented a decline in efficiency as fuel prices fell in the late 1980s.

Second, the evidence strongly supports a conclusion that the technology required for meaningful improvement is readily at hand. For example, the 2002 report of the National Research Council[1] found that technologies capable of meaningful improvements in fuel efficiency now exist but are not applied to passenger cars and light duty vehicles. Other statements presented to this Committee corroborate this view.[2] And yet, if this Committee were to hold these hearings 10 years from now, the same would be said—the ongoing advance of science in many fields will ensure that the frontier of the possible remains well ahead of what is actually achieved. The key issue then concerns how to achieve rapid and continuous application of these results.

These premises hold important implications. The current situation does not differ markedly from that of 1975, when the *Energy Policy and Conservation Act* first put fuel efficiency standards in place. Then, as now, the public need for fuel efficiency was far stronger than could be expressed by price in the marketplace. Then, as now, technologies offering potential improvement were available, but not in use. Then as now, the evidence suggested some differential impact on auto manufacturers. Thus, we can reasonably expect that a new, more aggressive set of standards would achieve similar results: a onetime, marked improvement in vehicle fuel performance, followed by a period of much diminished gains.

If that outcome is satisfactory, then CAFE alone would be satisfactory. But if the aim of energy policy is to achieve something more, then consideration should also be given to ways of nurturing fuel-saving innovation as an ongoing process. And to that subject that we now must turn.

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[1] U.S. National Research Council, Committee on the Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,* National Academies Press, 2002.

[2] For example, Duleep, K.G. Testimony of Mr. K.G. Duleep at the Hearing on *Improving the Nation's Energy Security: Can Cars and Trucks Be Made More Efficient?* Committee on Science, U.S. House of Representatives, 9 February, 2005.

The Process of Innovation: Implications for Fuel Efficiency

At the beginning, it might be helpful to review some general principles regarding technological innovation and how it advances performance throughout the economy. We should begin by understanding technology from the customer perspective—not as a "thing," but as a service.

Technology Viewed as a Service: Fuels and vehicles have little value in themselves, but enormous utility as providers of mobility services. For road transportation, these valued services include performance vectors like:

- time saving: will the vehicle travel far enough that the driver does not waste time with frequent refueling?
- safety: how well does the vehicle protect its occupants, both by its ability to avoid accidents and by its ability to survive them?
- comfort: can the vehicle mitigate the stress and hassles of road travel for the driver and passengers?
- image: what does driving this particular vehicle say about its occupants?
- ancillary services: does the vehicle have enough generating capacity to meet the growing demand for on-board, electricity-based services?

At any time, consumers emphasize some of these performance dimensions while sacrificing along others. Consider the consumer preferences revealed by an EPA analysis of automobile performance from 1981 to 2003. Over this period, average horsepower nearly doubled (from 102 to 197 horsepower), weight increased markedly (from 3201 to 3974 lbs.), and the time required to accelerate from zero to 60 mph dropped by nearly 30 percent. One task of policy should be the addition of fuel efficiency to the competitive performance dimensions for road transportation.

Technology-based Innovation: Accumulating Technological innovations can be grouped into two general classes: those that advance performance by *accumulating* incremental improvements, and those that offer *discontinuous* leaps in performance. The term *accumulating* applies to technologies that advance performance along dimensions already recognized and accepted by customers. Each improvement might be incremental, but the cumulative effect compounds to yield markedly improved performance—consider the improvements in processor speed for computers, for example. Auto manufacturers are accustomed to competing along these dimensions, and the cumulative effect can lead to important advances—but only if the technology competition continues long enough for the gains to accumulate. Most of the fuel saving technologies discussed at this hearing are incremental in nature, and so nurturing this kind of innovation could become an important policy goal.

Technology-based Innovation: Discontinuous: In contrast, *discontinuous* technologies introduce performance dimensions quite distinct from what the mainstream customers have come to value, sometimes offering inferior performance along the accustomed dimensions. Because of their inferior mainstream performance, these technologies initially gain traction only in niche markets. With continued use and improvement, however, discontinuous technologies gain adequacy along the original dimensions and then enter the mainstream markets.

Consider the electric car, for example. Many analysts have written off electric vehicles because of their inferior performance in mainstream auto markets—acceleration, range, and recharge time. Yet electric vehicle technologies are emerging in an important niche: the market for personal transportation. This includes golf carts, all-terrain vehicles, touring vehicles for resorts, transportation within gated communities, and so forth. In that market, the chief performance dimensions are convenient access, economy, and ease of use—and style. The current state of electric vehicle technology is adequate for the limited range and acceleration requirements of this niche. But, could electric vehicle technology advance to the point of entry into mainstream markets? Or, could it compete effectively in personal transportation markets in developing countries—say Thailand or China? That is, of course, unknowable. But, please recall that the personal computer was once considered a hobbyists toy, inherently without enough power to enter mainstream applications.

Discontinuous innovation tends to be the province of the *entrepreneur,* and the companies that such persons found become platforms for the innovations that radically change all markets. Yet entrepreneurs often have low visibility relative to the market incumbents in policy discussions, and their companies are far from household words.[3] This is because the entrepreneurs' story is about the future, not the

[3] Consider, for example, *Zap!,* a company founded 10 years ago in response to the zero-emissions vehicle market emerging in California. A description can be found at: *http://www.zapworld.com/index.asp*

present; about what could be and not about what is. For that reason, policies that encourage entrepreneurship in technologies relevant to reducing fuel use should become part of the energy policy conversation.

Policy Options to Promote Fuel Saving Innovations

Two general strategies could be considered to supplement the CAFE approach by encouraging ongoing innovation in fuel-efficient technologies: building market demand for these innovations, and nurturing the entrepreneurial sector to supply them.

Building Market Demand: The price of the fuel offers most obvious way to encourage fuel saving innovations, and motor fuel taxes provide the most direct leverage if this component of policy is to be considered. We must, however, distinguish among short-term and long-term effects, and include consideration of consumer expectations.

For the short-term, consumers can respond to increased motor fuel prices in only two ways: by changing their driving patterns, or by paying more for fuel and reducing their consumption in other areas. The evidence suggests some mix of these responses. For the longer-term, consumers can exchange their capital stock—the vehicles they drive—for more fuel efficient models. In both cases, this adaptive behavior will depend upon consumer expectations for the magnitude and duration of the fuel price increase. Adaptive behavior diminishes to the extent that consumers believe the price increase will prove impermanent. We should observe also that every country relying on fuel economy standards also matches them with meaningful motor fuel taxes.

The so-called "freebates" program offers an alternative to taxes. This has been capably discussed elsewhere,[4] and needs no further comment here. The effectiveness of income tax deductions for the purchase of fuel-efficient vehicles will depend upon the tax status of the individual purchaser. The incentive is further blunted by the complexities of the tax code and by the delay in receipt of the benefit.

In general, any policy that increases consumer incentives to purchase fuel efficient vehicles will provide an incentive for ongoing innovation—provided that the policy is perceived as permanent. Entrepreneurs and innovators respond primarily to opportunity; but that opportunity must be durable for the 10-year cycle required to establish a new high-growth company.

Nurturing an Entrepreneurial Culture in Fuel Saving: Policies to build the market for fuel saving technologies operate on the "demand" side of entrepreneurship and innovation. In addition, several policies could be considered to build an entrepreneurial climate on the "supply" side. These include:

- Special tax consideration for investors in new ventures offering products relevant to fuel savings. The intent would be to increase the amount of venture capital available to startup companies.
- Commercialization programs might enable more entrepreneurs to bring their nascent technologies up to investment grade. For example, an enhanced and focused *Small Business Innovation Research* (SBIR) program might increase the number of participating entrepreneurs participating in fuel-relevant markets. A portion of the *Advanced Technology Program* (ATP) could be focused in like manner.
- Outreach from the National Laboratories to entrepreneurs might be improved. Some laboratories, the National Renewable Energy Laboratory (NREL) for example, offer small, but effective programs. But more systematic outreach, not to business in general, but to entrepreneurial business, would also increase the supply of market-ready innovations.

[4] Greene, Dr. David L. Hearing on *Improving the Nation's Energy Security: Can Cars and Trucks Be Made More Efficient?* Committee on Science, U.S. House of Representatives, 9 February, 2005.

PREPARED STATEMENT OF DR. GAL LUFT

Executive Director, Institute for the Analysis of Global Security (IAGS)

Mr. Chairman, Members of the Committee:

It is an honor to be invited to submit this testimony to this distinguished Committee on the important issue of improving the fuel efficiency of America's vehicle fleet. I currently serve as executive director of the Institute for the Analysis of Global Security (IAGS), an energy security research institution. I'm also representing the Set America Free coalition, a coalition of national security, foreign policy and environmental groups dedicated to promote a blueprint for energy security which focuses on reduction of U.S. oil demand in the transportation sector. Among the groups involved in the coalition are IAGS, the National Defense Council Foundation, the Hudson Institute, the Foundation for the Defense of Democracies, the Center for Security Policy, and the Natural Resources Defense Council.

I would like to address the strategic context of our current dependence on imported oil and its implications on national security and offer new approaches to the fuel efficiency debate.

The Strategic Impact of Our Oil Dependence

In 2004 oil prices have grown by close to 40 percent. As a result, the United States spent more than $18 million per hour on foreign oil. In the same period of time, OPEC's oil export revenues grew by 42 percent to $338 billion. According to the U.S. Energy Information Administration (EIA) throughout 2005 oil prices will continue to stay high and OPEC will rake $345 billion in revenue. This transfer of wealth of historical proportions is not only exacting a hidden tax on the American economy but is also undermining our national security and the security of the world at large. It is unfortunate that most major oil producing countries are either politically unstable and/or at odds with the U.S. Some of the world's largest oil producing nations are sponsors of or allied with radical Islamists who foment hatred against the U.S. The petrodollars we provide such nations contribute materially to the terrorist threats we face. In time of war, it is imperative that our national expenditures on energy be redirected away from those who use them against us.

Beyond the underwriting of terror, our present dependency creates unacceptable vulnerabilities. As we have learned from Osama bin Ladin's messages, al Qaeda terrorists know that oil is the Achilles heel of the world economy and disrupting the world's oil supply is central to their efforts to defeat the U.S. and its democratic allies. In Iraq and Saudi Arabia, America's enemies have demonstrated that they can advance their strategic objective by attacking critical oil infrastructure and personnel. In Iraq alone there have been more than 200 attacks against pipelines and oil installations in the past 20 months. These targets are readily found not only in the Mid East but also in other regions to which Islamists have ready access such as the Caspian Basin and Africa. Over time, these attacks are sure to become more sophisticated and their destructive effects could be difficult, costly and time-consuming to undo.

In the longer run America's national security can be adversely influenced by China's growing demand for oil. Chinese oil consumption is increasing seven times faster than that of the U.S. and its imports have grown by over 35 percent per year for two consecutive years. All signs indicate that China's appetite for oil will continue to grow in the years to come. According to the International Energy Agency, by 2030 China will import more oil than the U.S. does today. There is no doubt that China's robust economic growth has already been felt on the global energy scene and has been a major contributor to last year's spike in prices. More importantly, China's demand for energy and other raw materials and its hunt for steady oil supplies in areas where the U.S. has strategic interests could undermine Sino-American relations. The U.S.–China Economic and Security Review Commission, a group created by Congress to examine the national security implications of the bilateral trade and economic relationship between the two countries, warned in its 2004 report that China's growing dependence on imported oil is a key driver of its relations with terrorist-sponsoring governments. The report said: "China's approach to securing its imported petroleum supplies through bilateral arrangements is an impetus for non-market reciprocity deals with Iran, Sudan, and other states of concern, including arms sales and WMD-related technology transfers that pose security challenges to the United States." There is growing recognition within the oil industry that the rise of China will bring about a bidding war for Middle East supply between East and West. Dave O'Reilly, chief executive of ChevronTexaco warned recently against alliances formed between Asian countries and Middle East entities, calling for the U.S. Government to recognize and understand the implications of such a geopolitical

shift. Without a comprehensive strategy designed to prevent China from becoming an oil consumer on par with the U.S., the U.S. might find itself in the future facing aggressive competition from China over access to Middle East oil with grave implications for global security.

U.S. Approach to Oil Dependence

In light of intensifying military involvement in the Middle East, terrorist attacks on oil infrastructure, persistently high global oil prices, and the rise of China, oil dependence has become an incipient national security emergency. To address the problem of our dependence on volatile suppliers, the U.S. has pursued a three-part strategy:

- Diversifying sources;
- Managing inventory in a strategic reserve;
- Increasing the transportation sector's energy-consumption efficiency

The first pillar of our strategy is no more than a stopgap solution. In May 2001, when the Bush administration released its National Energy Policy, it proposed to reduce dependence on Middle East oil dependence by targeting alternative oil-supplying nations for government investment and closer alliances, including Angola, Azerbaijan, Colombia, Kazakhstan, Nigeria, Russia, and Venezuela. All of these nations are undemocratic, vulnerable to global terrorism and face significant political and social instability. Increasing U.S. reliance on these states would do little to address U.S. security and economic threats stemming from oil dependency. Given the integrated nature of the world economy we accomplish nothing if we merely shift our own purchases of oil from one of the world's regions to another. An oil crisis will affect all our economies, regardless of the source of our own imports. Furthermore, non-OPEC reserves are being depleted almost twice as fast as OPEC's. This will ensure that our dependence on OPEC will only grow as time goes by. With OPEC countries sitting in the driver's seat with respect to the world's oil supply and oil prices, the world's economic and political future will be compromised.

Inventories are a critical element of energy security. But they are limited in scale and only useful to address a short term supply disruption. However, at this moment most major oil consuming nations do not have significant strategic petroleum reserves. This means that a supply disruption will still send international oil prices to the roof regardless of how much stock is kept in the U.S. Though over time it would be advisable to see more countries developing robust strategic petroleum reserves, such action at the point of high oil prices would only create additional demand and hence drive prices up even further.

Since the Arab oil embargo in 1973 several sectors of the economy significantly reduced their dependence on oil. The power sector is a particular example: today, only two percent of U.S. electricity is generated from oil. The transportation sector accounts for ⅔ of U.S. oil consumption, about ⅔ of that being gasoline and most of the rest diesel. Improving fuel efficiency in U.S. vehicles is the only course of action which carries no negative consequences. On the contrary, studies show that by reducing demand for oil in the transportation sector and transitioning the economy into an economy based on next generation fuels and automobiles, the U.S. could generate millions of new jobs and billions of dollars worth of investment opportunities.

New Approach to Fuel Efficiency

In the past three decades the debate on improving fuel efficiency has focused mainly on the tension between auto manufacturers, consumers and the government. Though everybody agrees that the U.S. should reduce its oil bill neither Detroit nor the American consumer is willing to do so for the greater good. The U.S. auto industry shies away from embarking on revolutionary changes in its designs and production lines and by and large resists significant rise in CAFE standards. The American consumer is growingly minded to the need to reduce oil dependence but is still unwilling to accept compromise on cost, comfort, power or performance. To end the stalemate in the fuel efficiency issue we need to change the terms of the debate. Today when it comes to CAFE the auto industry shoulders the entire burden. But long-term security and economic prosperity depends on technological transformation not only at the vehicle level but also in the fuel that powers it. In other words, to get people to travel more miles per gallon of gas one need not focus only on redesigning the car, making it lighter or improving its engine. We should think in terms of gallon stretchers—making our fuel more efficient. For example, a number of commercially available fuel additives can enhance combustion efficiency by up to 20 percent. Most of these additives are made from organic materials and are environmentally friendly. By reducing the size of the oil droplets they bring to more effi-

cient combustion. Such additives can be blended into gasoline, diesel and bunker fuel.

An even better way of reducing the content of gasoline in the fuel tank can be done by mixing gasoline with alternative fuels and using the blend in *flexible fuel vehicles (FFVs)* that can be readily available at low marginal cost and that require no change in auto design. FFVs are designed to burn on alcohol, gasoline, or any mixture of the two. About four million FFVs have been manufactured since 1996. The only difference between a conventional car and a flexible fuel vehicle is that the latter is equipped with a different control chip and some different fittings in the fuel line to accommodate the characteristics of alcohol. The marginal additional cost associated with such FFV-associated changes is currently under $150 per vehicle. That cost would be reduced further as volume of FFVs increases, particularly if flexible fuel designs were to become the industry standard.

Alcohol fuels that can be used in FFVs:

- *Ethanol* is currently produced in the U.S. from corn. In 2004, the U.S. produced over 3.2 billion gallons of ethanol, and the market has increased on the average of 25 percent per year over the past three years. Almost all our ethanol comes from corn and is being used either as an additive to gasoline or as E–85. Upping production of ethanol would be achieved by continuing to advance the corn-based ethanol industry but, more importantly, by commercializing the production of ethanol from agricultural and municipal waste and dedicated energy crops. Progress has been made on a process that produces ethanol from biomass using genetically modified biocatalysts and a Canadian company, Iogen, has just entered commercial production.
- *P–Series* fuel (approved by the Department of Energy in 1999) is an energy-efficient blend of ethanol, natural gas liquids and ether made from biomass waste. About 20 percent of the blend is MeTHF, an ether derived from lignocelullosic biomass—paper sludge, wastepaper, food waste, yard and wood waste, agricultural waste, and so on. P–Series fuels can help solve a problem all municipalities are facing today: waste disposal. Using feedstock with a negative cost—that means waste that municipalities would otherwise pay to have hauled away—allows the fuel's selling price to be about the same as mid-grade gasoline.
- *Methanol* (also known as wood alcohol) is today for the most part produced from natural gas. Expanding domestic production can be achieved by producing methanol from coal, a resource with which the U.S. is abundantly endowed. The commercial feasibility of coal-to-methanol technology was demonstrated as part of the DOE's "clean coal" technology effort. For almost a decade, a commercial scale demonstration plant in Kingsport, Tennessee has been producing methanol from coal at under $0.50 a gallon. Methanol can also be produced from biomass using gasification technology.

Alcohol fuels are relatively easy to introduce to the market because of the low infrastructure costs involved. It only costs about $20,000 to enable an existing gasoline or diesel tank at a gas station to accommodate one of the above fuels and about $60,000 to add a new fuel pump to an existing refueling station. By introducing a fleet of FFVs and actually fueling them with blends of say 20 percent alcohol and 80 percent gasoline we can save more oil than through the entire CAFE program. For example, a hybrid car like the Toyota Prius that is also an FFV running on a blend of 85 percent ethanol and 15 percent gasoline can get nearly 300 miles per gallon of gasoline.

Electricity as a Fuel

Electricity is seldom referred to as a transportation fuel, but it is. Less than two percent of U.S. electricity is generated from oil, so using electricity as a transportation fuel would greatly reduce dependence on imported petroleum. Tens of thousands of *hybrid electric vehicles* are already on America's roads combining hybrid engines powered in an integrated fashion by liquid fuel-powered motors and battery-powered ones. Such vehicles increase gas-consumption efficiency by 30–40 percent. While hybrids gather charge to their batteries by capturing breaking energy, their only external source of energy is liquid fuel. *"Plug-in" hybrid electric vehicles* take the concept one step further, by allowing us to draw charge not only from the engine and captured braking energy, but also directly from the electrical grid by being plugged into standard electric outlets when not in use. They have liquid fuel tanks and internal combustion engines, so they do not face the range limitation posed by electric-only cars. Since fifty percent of cars on the road in the United States are driven 20 miles a day or less, a plug-in with a 20-mile range battery would reduce

fuel consumption by, on average, 85 percent. Plug-in hybrid electric vehicles can reach fuel economy levels of 100 miles per gallon of gasoline consumed. Overall, plug-ins can reduce gasoline use by 85 percent. This is so dramatic a reduction that a plug-in SUV actually would consume less gasoline than a standard compact car. Plug-in hybrid vehicles would be charged at night in home garages—a time-interval during which electric utilities have significant excess capacity. The Electric Power Research Institute estimates that up to 30 percent of market penetration for plug-in hybrid electric vehicles with 20-mile electric range can be achieved without a need to install additional electricity-generating capacity. Plug-ins will soon make their debut. DaimlerChrysler is currently introducing a plug in version of its Sprinter van. Though a plug-in would be initially more expensive up front than an ordinary car, the total cost over the life of the vehicle would be less due to lower operating costs and gasoline saving. As battery technologies improve the cost of plug-ins will drop further.

If a vehicle combines hybrid technology with a flexible fuel internal combustion engine, the effect of next generation fuels can be multiplied with substantial fuel efficiency gains. A plug-in hybrid vehicle that is also a flexible fuel vehicle can be powered by blends of alcohol fuels, gasoline, and electricity. If fueled by a blend of 80 percent alcohol, 20 percent gasoline, and electricity, fuel economy could reach 500 miles per gallon of gasoline.

According to the Set America Free Coalition if by 2025, all cars on the road are hybrids and half are plug-in hybrid vehicles, U.S. oil imports would drop by eight million barrels per day (mbd). Today, the United States imports 10 mbd and it is projected to import almost 20 mbd by 2025. If all of these cars were also flexible fuel vehicles, U.S. oil imports would drop by as much as 12 mbd.

Recommendations for Congress:

Provide incentives to auto manufacturers to produce and consumers to purchase, hybrid vehicles, plug-in hybrid electric vehicles and FFVs across all vehicle models. Producing fuel-efficient, advanced technology vehicles will requires automakers and their suppliers to retool their factories. Hybrid vehicles rely on advanced equipment such as battery packs, electric motors and generators, and electronic power controllers. Advanced diesel drivetrains require sophisticated fuel injection systems, turbochargers and after treatment systems.

Provide incentives for auto manufacturers to increase fuel efficiency of existing, non-FFV auto models. Many off-the-shelf technologies exist to improve today's cars, including variable valve engine timing, continuously variable transmissions, and lightweight, high strength materials.

Call for substantial incorporation of plug-ins hybrids, standard hybrids, and FFVs into federal, State, municipal and covered fleets, and ensure that these FFVs are actually fueled with alcohol blends.

Provide investment tax incentives for corporate fleets and taxi fleets to switch to plug-ins, hybrids and FFVs.

Encourage gasoline distributors to blend combustion enhancers into the fuel.

Provide incentives for existing fueling stations to install alternative fuel pumps and mandate that all new gas stations be so equipped with such pumps.

Encourage new players, such as utilities, to enter the transportation fuel market. Utility companies have traditionally viewed themselves as providers of "power" for lighting homes or powering computers. Using electricity as a fuel can allow them to become key players in the transportation energy sector and introduce much needed competition in the fuel market.

Provide incentives for the construction of commercial scale demonstration plants to produce non-petroleum based liquid fuels from domestic energy resources, particularly from waste. Two billion dollars in federal funding utilizing public-private cost sharing partnerships could build roughly 25 demonstration plants. Such program would spur innovation, development, and demonstration projects aimed at making non-petroleum fuels cost-effective for consumers while weeding out unfeasible technologies.

Apply efficiency standards for heavy-duty trucks. Most of our effort to improve fuel efficiency is focused on light-duty vehicles. But improving the fuel economy of heavy-duty trucks offers no smaller opportunity for oil savings. The heavy-duty trucks sector is responsible for the consumption of close to three million barrels per day of oil. Over two-thirds of this energy is consumed by the heaviest trucks, such as tractor-trailers weighing over 33,000 lbs. Technology assessments by the American Council for an Energy-Efficient Economy (ACEEE) found that conventional technology improvements including enhancements to aerodynamics, weight

reduction, improved engine fuel injection and the introduction of hybrid gasoline-electric or diesel-electric drive trains can achieve truck fuel-efficiency advances of 26 to 70 percent at cost-effectiveness. Congress should therefore begin to apply some of the standards for the small cars to the larger vehicle classes especially heavy trucks from 8,500 to 10,000 lbs. Tremendous amounts of fuel are used by truck drivers during idling. Drivers idle their trucks for days in a row to heat or cool their sleeping cabin and run electrical appliances. This practice is extremely wasteful since large diesel engines are designed to move heavy loads, not run auxiliary systems. Idling can be reduced by installing auxiliary power units and providing electricity in rest areas.

Invest in Public Education. Consumers still rank fuel efficiency way below power, performance, cost and safety in their car buying considerations. As a result the Nation's fuel efficiency standards have remained stagnant while our oil dependence continues to grow. Barring a catastrophic oil disruption this could only change if the public is to become more aware of the huge impact oil dependence has on our national security. Reduction of our oil bill should be viewed by consumers as a patriotic duty, not pure economic calculation. There is clear need for public education program to connect the dots between our behavior on the road and our national security, between the number of Hummers on the road and the number of Humvees in the Persian Gulf. Another issue on which public education is desirable is the true cost of oil. The most recent estimates suggest that in a non-war year the United States spends $20 to $40 billion in military costs to secure access to Middle East oil supplies, which means that the American taxpayer is paying at least an additional $4 to $5 a barrel for crude oil above market price. These extra dollars are being paid by consumers through their income tax but are not reflected at the price at the gas station. If Americans were more aware of what they pay outside the gas station it would be politically easier to introduce legislative efforts to transfer that tax burden from an indirect mechanism such as income tax to a direct pay-as-you-go tax at the pump.

In sum

America takes pride in offering choice in every aspect of our lives. Yet, when it comes to transportation fuels we are offered nothing but petroleum products. We must embark on an effort to diversify our fuel market by introducing domestically produced fuels that are made from waste products or other resources the U.S. is rich in, and that are clean and affordable. The U.S. is no longer rich in oil or natural gas. It has, however, a wealth of other energy sources from which transportation fuel can be safely, affordably and cleanly generated. Among them: hundreds of years worth of coal reserves, 25 percent of the world's total (especially promising with Integrated Gasification and Combined Cycle technologies); billions of tons a year of biomass, and further billions of tons of agricultural and municipal waste. Vehicles that meet consumer needs like "plug-in" hybrids can tap America's electrical grid to supply energy for transportation, making more efficient use of such clean sources of electricity as solar, wind, geothermal, hydroelectric and nuclear power.

Because of the national security imperative we have no time to wait for commercialization of immature technologies such as fuel cells. I believe that automotive fuel cells hold great potential and should definitely be pursued. But far too much focus is being placed on them at the expense of more quickly available solutions. We should focus on real world solutions and implement technologies that exist today and are ready for widespread use. We also don't have the time and money to embark on massive infrastructure changes. The focus should be on utilizing competitive technologies that do not require prohibitive or, if possible, even significant investment in changing our transportation sector's infrastructure. Instead, we should permit the maximum possible use of the existing refueling and automotive infrastructure. Finally, we need to remember that oil dependence is a global issue which should be addressed internationally. Even if the U.S. was no longer dependent on foreign oil, if the rest of the world still remains beholden to the small club of oil producers the national security problems discussed before will not go away. Only a global effort led by the U.S. to reduce demand for petroleum by distributing the above-mentioned technologies will bring about prosperity and strengthen global security.

AIAM

February 23, 2005

The Honorable Sherwood Boehlert
Chairman, House Committee on Science
2320 Rayburn House Office Building
Washington, D.C. 20515

Subject: *Improving the Nation's Energy Security: Can Cars and Trucks Be Made More Fuel Efficient?*

Dear Chairman Boehlert:

Following the February 9, 2005 hearing by the House Committee on Science, the Association of International Automobile Manufacturers (AIAM) would like to take this opportunity to offer its views regarding motor vehicle fuel economy and ask that they be included as part of the record of these proceedings. AIAM is a trade association representing 14 international motor vehicle manufacturers who account for 40 percent of all passenger cars and 20 percent of all light trucks sold annually in the United States. AIAM members have invested over $26 billion in U.S.-based production facilities, have a combined domestic production capacity of 2.8 million vehicles, directly employ 75,000 Americans, and generate an additional 500,000 U.S. jobs in dealerships and supplier industries nationwide. AIAM members include Aston Martin, Ferrari, Honda, Hyundai, Isuzu, Kia, Maserati, Mitsubishi, Nissan, Peugeot, Renault, Subaru, Suzuki and Toyota. AIAM also represents original equipment suppliers and other automotive-related trade associations.

AIAM member companies have for many years been leaders in offering fuel-efficient vehicles for the U.S. market. Historically, vehicles produced by our member companies have headed EPA's annual list of most fuel-efficient vehicles. Indeed, these companies have achieved success in the U.S. market to a significant extent through the offering of high quality, fuel-efficient vehicles. AIAM member companies have achieved this fuel economy leadership to a significant degree by pioneering the introduction of advanced automotive technology.

AIAM members believe there are several key principles that should guide any effort to raise fuel economy standards or revise the current CAFE structure. Most basic and obvious is that the structure of any CAFE program should provide incentives for the achievement of real world energy savings. Despite the fundamental nature of this principle, some of the alternative structures that have been proposed in the past do not guarantee the achievement of energy savings.

Another guiding principle should be that the structure is competitively neutral, so that all manufacturers are treated equally under the standards system, with whatever standards that are established being equivalently applicable to all

ASSOCIATION OF INTERNATIONAL AUTOMOBILE MANUFACTURERS, INC.
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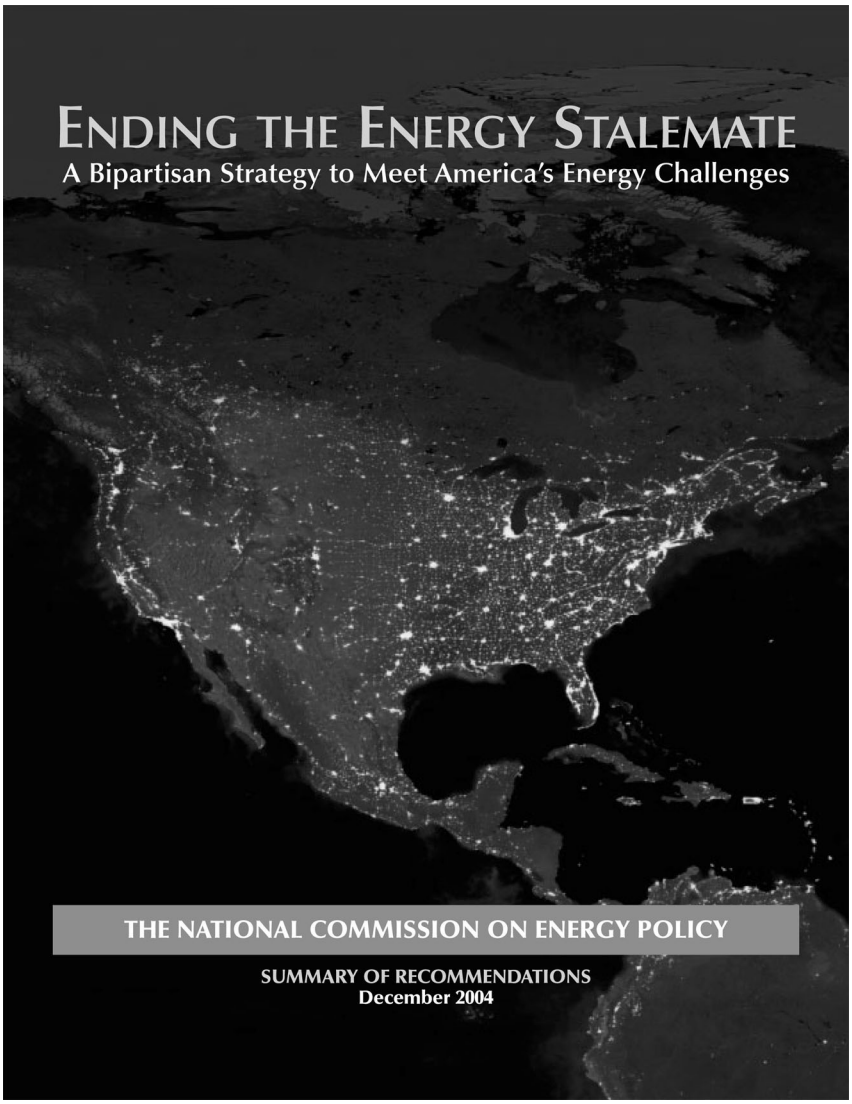
manufacturers. One alternative structure that has been frequently proposed, the uniform percentage improvement (UPI) structure, fails this test, since it establishes manufacturer-specific standards that penalize companies that have produced fuel-efficient vehicles in the past. Other structures, such as the fixed attribute system, have been proposed that have similar defects. In addition, under any structure, the specific requirements of the standards must be technologically feasible, economically practicable and must provide adequate lead-time.

Thank you for allowing us the opportunity to present our views on the important subject. Should you or your staff have any questions, please do not hesitate to contact me.

Sincerely,

Timothy C. MacCarthy
President and CEO


ENDING THE ENERGY STALEMATE
A Bipartisan Strategy to Meet America's Energy Challenges
THE NATIONAL COMMISSION ON ENERGY POLICY
SUMMARY OF RECOMMENDATIONS
December 2004

PREAMBLE

This report is a product of a bipartisan Commission of 16 members of diverse expertise and affiliations, addressing many complex and contentious topics. It is inevitable that arriving at a consensus document in these circumstances entailed innumerable compromises. Accordingly, it should not be assumed that every member is entirely satisfied with every formulation in the report, or even that all of us would agree with any given recommendation if it were taken in isolation. Rather, we have reached consensus on the report and its recommendations *as a package,* which taken as a whole offers a balanced and comprehensive approach to the economic, national security, and environmental challenges that the energy issue presents to our nation.

ACKNOWLEDGEMENTS

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Cover: U.S. Government Satellite Images: Western Hemisphere at Night

ENDING THE ENERGY STALEMATE

A Bipartisan Strategy to Meet America's Energy Challenges

THE NATIONAL COMMISSION ON ENERGY POLICY

SUMMARY OF RECOMMENDATIONS
December 2004

NATIONAL COMMISSION ON ENERGY POLICY

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KEY RECOMMENDATIONS

1. ENHANCING OIL SECURITY

- Increase and diversify world oil production and expand global network of strategic petroleum reserves.
- Reform and significantly strengthen vehicle efficiency standards.
- Provide $3 billion over ten years in manufacturer and consumer incentives for domestic production and purchase of efficient hybrid-electric and advanced diesel vehicles.

2. REDUCING RISKS FROM CLIMATE CHANGE

- Establish a mandatory, economy-wide tradable-permits program to limit greenhouse gas emissions while capping initial costs at $7 per metric ton of CO_2-equivalent reduction.
- Link further U.S. action to developed and developing nation commitments.

3. INCREASING ENERGY EFFICIENCY

- Update and expand efficiency standards for new appliances, equipment, and buildings to capture additional cost-effective energy-saving opportunities.
- Integrate improvements in efficiency standards with targeted technology incentives, R&D, consumer information, and programs sponsored by electric and gas utilities.
- Pursue cost-effective efficiency improvements in the industrial sector.

4. ENSURING AFFORDABLE, RELIABLE ENERGY SUPPLIES

- Natural Gas: expand and diversify supplies of this critical resource
  - Adopt effective public incentives for the construction of an Alaska natural gas pipeline.
  - Encourage the siting and construction of liquefied natural gas (LNG) infrastructure.
- Advanced Coal Technologies: ensure a future for the nation's most plentiful energy resource
  - Provide $4 billion over ten years in public incentives for integrated gasification combined cycle (IGCC) coal technology and for carbon capture and sequestration.
  - Provide $3 billion over ten years in public incentives to demonstrate commercial-scale carbon capture and geologic sequestration at a variety of sites.
- Nuclear Energy: address the obstacles
  - Fulfill existing federal commitments on nuclear waste management.
  - Provide $2 billion over ten years from federal energy research, development, demonstration, and deployment budgets for demonstration of one to two new advanced nuclear facilities.
  - Significantly strengthen the international non-proliferation regime.

- **Renewable Energy Sources: tap America's technological potential**
  - **Increase federal R&D funding for renewable electricity technologies by $360 million annually.**
  - **Expand and extend from 2006 through 2009 the federal tax credit for electricity production from non-carbon energy resources.**
  - **Support efforts by the Federal Energy Regulatory Commission (FERC) to address the need for better integration of intermittent renewable resources (such as wind and solar power) into the interstate grid system.**
  - **Establish a $1.5 billion program over ten years to increase domestic production of non-petroleum renewable transportation fuels.**

5. STRENGTHENING ESSENTIAL ENERGY SYSTEMS

- **Reduce barriers to the siting of critical energy infrastructure.**
- **Protect critical infrastructure from accidental failure and terrorist threats.**
- **Support a variety of generation resources — including both large-scale power plants, small-scale "distributed" and/or renewable generation — and demand reduction (for both electricity and natural gas) to ensure affordable and reliable energy service for consumers.**
- **Encourage increased transmission investment and deployment of new technologies to enhance the availability and reliability of the grid, in part by clarifying rules for cost-recovery.**
- **Enhance consumer protections in the electricity sector and establish an integrated, multi-pollutant program to reduce power plant emissions.**

6. DEVELOPING ENERGY TECHNOLOGIES FOR THE FUTURE

- **Double federal government funding for energy research and development, while improving the management of these efforts and promoting effective public-private partnerships.**
- **Increase incentives for private sector energy research, development, demonstration, and early deployment (ERD[3]).**
- **Expand investment in cooperative international ERD[3] initiatives and improve coordination among relevant federal agencies.**
- **Provide incentives for early deployment of (1) coal gasification and carbon sequestration; (2) domestically produced efficient vehicles; (3) domestically produced alternative transportation fuels; and (4) advanced nuclear reactors.**

INTRODUCTION

This report recommends a revenue-neutral package of measures designed to ensure affordable and reliable supplies of energy for the twenty-first century while responding to growing concern about energy security and the risks of global climate change driven by energy-related greenhouse gas emissions. Through these recommendations and associated analysis, the Commission seeks to establish a constructive center in the often polarized debate over national energy policy.

This report presents key findings from an intensive, three-year effort to develop consensus recommendations for future U.S. energy policy. Bringing together a diverse and bi-partisan group of leaders from business, government, academia, and the non-profit community, the National Commission on Energy Policy has sought to establish a constructive center in the often polarized debate about energy and to advance a coherent strategy for meeting the energy challenges of the 21st century that has the economic, environmental, and political integrity to overcome the current stalemate in national energy policy.

KEY CHALLENGES

The challenges that must be addressed are at once familiar and new. Long-standing anxieties about the nation's underlying energy security have resurfaced at a time of record high oil and gas prices and in the wake of the largest cascading power outage in U.S. history. Recent developments in world oil markets, including rapid growth in global demand and the emergence of terrorist threats to oil facilities, are bringing new urgency to perennial concerns about the nation's exposure to oil price shocks and supply disruptions. Similar price and supply concerns increasingly apply to natural gas markets where sustained price increases and extreme volatility have begun to signal a steadily widening gap between domestic supply and demand for this economically and environmentally valuable fuel. At the same time, the uncertain state of restructuring efforts in the nation's electric industry is prompting urgent questions about the prospects for needed investment in an infrastructure that is essential to nearly every facet of modern life.

All of these issues present formidable challenges in their own right, even as the inability of the 108th Congress to pass comprehensive energy legislation in 2003 and 2004 demonstrated the political difficulty of addressing them. Meanwhile, the overall picture is vastly complicated by the inescapable linkages between energy production and use and the environment. In particular, the risk of global climate change from emissions released by fossil fuel combustion will exert a profound influence on the world's energy options and choices over the decades ahead. In this context, the old notion of energy security acquires new dimensions. Reliable access to the energy resources needed to support a healthy economy remains the core imperative, but in the 21st century energy security also means reducing the macroeconomic and terrorism-related vulnerabilities inherent in the current geopolitical distribution of oil supply and demand and coming to grips with the environmental impacts of the current energy system.

GOALS

The pages that follow set forth the Commission's specific recommendations for addressing these linked objectives, beginning with oil security and climate change risks — arguably two of the most difficult issues for U.S. energy policy. Thus, the first chapter of this report describes a package of measures designed to ***improve U.S. oil security*** by increasing global oil supply and reducing growth in domestic demand. The next chapter proposes a mandatory, economy-wide tradable-permits system for ***limiting emissions of carbon dioxide and***

other greenhouse gases. The third and fourth chapters describe a set of complementary proposals for, on the one hand, substantially ***improving energy efficiency*** throughout the economy (i.e., in buildings, equipment, industry, and transportation) and, at the same time, ***promoting energy supply*** options that advance a number of cross-cutting policy objectives, from reducing the nation's exposure to resource constraints and supply disruptions to reducing climate change risks.

Specifically, Chapter IV recommends a number of policies to help ***ensure adequate supplies of natural gas and to promote the expanded deployment of low-carbon energy alternatives*** — including advanced coal technologies with carbon sequestration, next-generation nuclear technology, and renewable sources for electricity production and transportation fuels. Recognizing that a robust and resilient energy infrastructure and healthy markets provide the necessary foundation for ensuring continued access to needed energy resources, Chapter V addresses the need to ***site critical infrastructure, protect key energy facilities from terrorist attack, and improve the performance and reliability of the nation's electricity system.*** Finally, the Commission recognizes that continued technological advances are essential to ensure that clean, secure, and affordable energy will be available in the quantities required to sustain long-term economic growth for the United States and the world. In Chapter VI, the Commission therefore recommends that the federal government promote technology innovation in both the public and private sectors by ***significantly expanding and refocusing federal energy research and development programs.***

POLICIES THAT WORK TOGETHER

It is important to emphasize that the Commission's various recommendations were designed to be mutually reinforcing and are intended to function as a package. Each component of that package is the product of extensive discussions and rigorous analysis, informed by many of the nation's top energy experts. The resulting consensus is a product of detailed technical exploration, substantive debate, and principled compromise. Early on, Commissioners agreed that a strong economy, affordable energy, and adequate energy supplies were essential prerequisites for tackling all other policy objectives; that markets — appropriately regulated — should be relied upon wherever possible to produce the most efficient solutions; that policies must be designed and implemented with great care and due appreciation for the law of unintended consequences; and that gradual adjustments are generally preferable to dramatic interventions.

REJECTING MYTHS ON THE LEFT AND RIGHT

Equally important, Commissioners found common ground in rejecting certain persistent myths — on the left and on the right — that have often served to polarize and paralyze the national energy debate. These include, for example, the notion that energy independence can be readily achieved through conservation measures and renewable energy sources alone, or that limiting greenhouse gas emissions is either costless or so costly as to wreck the economy if it were tried at all. Most of all, Commissioners rejected the proposition that uncertainty justifies inaction in the face of significant risks.

Given current trends, the consequences of inaction are all too clear. Under business-as-usual assumptions, the United States will consume 43 percent more oil and emit 42 percent more greenhouse gas emissions by 2025.[1] At the global level, oil consumption and emissions will grow 57 and 55 percent respectively over the same timeframe[2] and the Earth will be heading rapidly — perhaps inexorably — past a doubling and toward a tripling of atmospheric greenhouse gas concentrations. In the Commission's view, this is not a scenario that should inspire complacency, nor is it consistent with the goal of reducing the nation's exposure to potentially serious economic, environmental, and security risks.

POLICY CRITERIA

In choosing among a large number of potential policy options, the Commission applied several general criteria, including: economic efficiency; cost-effectiveness and consumer impacts; ability to provide appropriate incentives for future action; flexibility for adjustment in response to further experience, new information, and changed conditions; equity; political viability; and ease of implementation, monitoring, and measurement.

REVENUE NEUTRALITY

Another important consideration was impact on the U.S. Treasury. Here the Commission sought to ensure that, as a package, its proposed policies achieved revenue neutrality; that is, they are expected to roughly pay for themselves (see Table 1).[3] Commission estimates suggest that implementing these recommendations will require additional federal outlays of approximately $36 billion over ten years. To cover those outlays, the Commission outlines proposals that would raise about the same amount between 2010 and 2020 from the sale of a small portion of emission allowances under the proposed tradable-permits system for greenhouse gases.

Taken together, the Commission's recommendations aim to achieve a gradual but nevertheless decisive shift in the nation's energy policy. Their near-term impacts, by design, will be modest, and some will undoubtedly find them grossly inadequate to the challenges at hand. Others will criticize the same recommendations for going too far, precisely because they initiate a process of long-term change with consequences that no one can fully predict. These refrains are familiar. They characterize the stalemate in views that has too long resulted either in outright gridlock or in a piecemeal, special interest-driven approach to energy policy. These outcomes are no longer acceptable. It is time for the stalemate to end.

Notes:

1. United States Department of Energy, Energy Information Administration, *Annual Energy Outlook 2004 with Projections to 2025* DOE/EIA-0383 (Washington, DC: Energy Information Administration, 2004), 8, 95, http://www.eia.doe.gov/oiaf/aeo/index.html.

2. United States Department of Energy, Energy Information Administration, *International Energy Outlook 2004* DOE/EIA-0484 (Washington, DC: Energy Information Administration, 2004), 28, 137, Fig. 72, http://www.eia.doe.gov/oiaf/ieo/index.html.

3. Expected auction revenue over the first decade of program implementation (i.e., from the begining of 2010 to the begining of 2020) amounts to a discounted and annualized value of $2.6 billion per year. Expected safety valve revenues contribute an additional $1.0 billion per year. Over ten years, the total revenue generated is projected to equal roughly $36 billion.

SUMMARY OF KEY RECOMMENDATIONS

IMPROVING OIL SECURITY

To enhance the nation's energy security and reduce its vulnerability to oil supply disruptions and price shocks, the Commission recommends:

- Increasing and diversifying world oil production while expanding the global network of strategic petroleum reserves.
- Significantly raising federal fuel economy standards for cars and light trucks while reforming the 30-year-old Corporate Average Fuel Economy (CAFE) program to allow more flexibility and reduce compliance costs. New standards should be phased in over a five-year period beginning no later than 2010.
- Providing $3 billion over ten years in manufacturer and consumer incentives to encourage domestic production and boost sales of efficient hybrid and advanced diesel vehicles.

Today's combination of tight oil supplies and high and volatile prices is likely to continue, given trends in global consumption (expected to grow by more than 50 percent over the next two decades), continuing instability in the Middle East and other major oil-producing regions, and a global decline in spare production capacity.

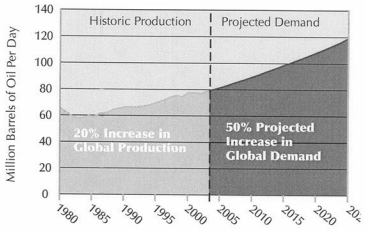
Oil production in the United States peaked in the 1970s and has been flat or declining since. Although highly important to the nation's economy and energy security, it cannot compensate for anticipated growth in domestic demand, which is expected to reach 29 million barrels per day by 2025 — a more than 40 percent increase over current consumption levels.

Improving the nation's energy security and reducing its vulnerability to high oil prices and supply disruptions are more meaningful and ultimately achievable policy goals than a misplaced focus on energy independence *per se*. Achieving these goals requires focusing in equal measure on expanding and diversifying oil supplies and improving efficiency, especially in the transportation sector. Additional Commission recommendations aim to expand transportation fuel supplies by enabling production of unconventional oil and alternative fuels.

The Commission's recommendations for improving passenger vehicle fuel economy, increasing the contribution from alternative fuels, and improving the efficiency of the heavy-duty truck fleet and passenger vehicle replacement tires, could reduce U.S. oil consumption in 2025 by 10–15 percent or 3–5 million barrels per day. These demand reductions, in concert with increased oil production, would significantly improve domestic oil security.

Trends in Global Oil Production and Future Demand

Future demand for oil is projected to grow at more than double the historical rate since 1980.



Data Source: Energy Information Administration, 2004

REDUCING RISKS FROM CLIMATE CHANGE

To address the risks of climate change resulting from energy-related greenhouse gas emissions without disrupting the nation's economy, the Commission recommends:

- Implementing in 2010 a mandatory, economy-wide tradable-permits system designed to curb future growth in the nation's emissions of greenhouse gases while capping initial costs to the U.S. economy at $7 per metric ton of carbon dioxide-equivalent.
- Linking subsequent action to reduce U.S. emissions with comparable efforts by other developed and developing nations to achieve emissions reductions via a review of program efficacy and international progress in 2015.

The Commission believes the United States must take responsibility for addressing its contribution to the risks of climate change, but must do so in a manner that recognizes the global nature of this challenge and does not harm the competitive position of U.S. businesses internationally.

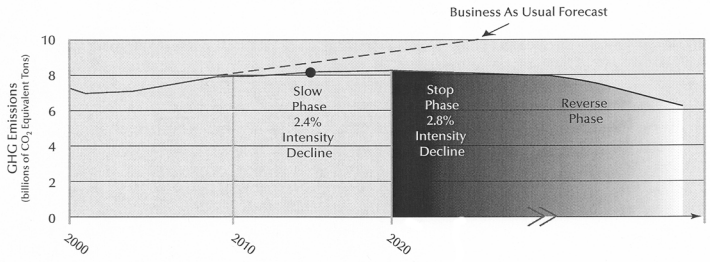
The Commission proposes a flexible, market-based strategy designed to slow projected growth in domestic greenhouse gas emissions as a first step toward later stabilizing and ultimately reversing current emissions trends if comparable actions by other countries are forthcoming and as scientific understanding warrants.

Under the Commission's proposal, the U.S. government in 2010 would begin issuing permits for greenhouse gas emissions based on an annual emissions target that reflects a 2.4 percent per year reduction in the average greenhouse gas emissions intensity of the economy (where intensity is measured in tons of emissions per dollar of GDP).

Most permits would be issued at no cost to existing emitters, but a small pool, 5 percent at the

Commission Climate Proposal Timeline

The Commission recommendation is to slow, stop, and eventually reverse emissions growth, through an intensity-based target, contingent on action by other countries.



NCEP

outset, would be auctioned to accommodate new entrants, stimulate the market in emission permits, and fund research and development of new technologies. Starting in 2013, the amount of permits auctioned would increase by one-half of one percent each year (i.e., to 5.5 percent in 2013; 6 percent in 2014, and so on) up to a limit of 10 percent of the total permit pool.

The Commission's proposal also includes a safety valve mechanism that allows additional permits to be purchased from the government at an initial price of $7 per metric ton of carbon dioxide (CO_2)-equivalent. The safety valve price would increase by 5 percent per year in nominal terms to generate a gradually stronger market signal for reducing emissions without prematurely displacing existing energy infrastructure.

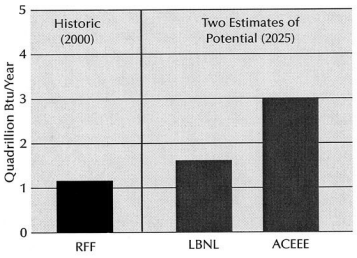
In 2015, and every five years thereafter, Congress would review the tradable-permits program and evaluate whether emissions control progress by major trading partners and competitors (including developing countries such as China and India) supports its continuation. If not, the United States would suspend further escalation of program requirements. Conversely, international progress, together with relevant environmental, scientific, or technological considerations, could lead Congress to strengthen U.S. efforts.

Absent policy action, annual U.S. greenhouse gas emissions are expected to grow from 7.8 billion metric tons of CO_2-equivalent in 2010 to 9.1 billion metric tons by 2020 — a roughly 1.3 billion metric ton increase. Modeling analyses suggest that the Commission's proposal would reduce emissions in 2020 by approximately 540 million metric tons. If the technological innovations and efficiency initiatives proposed elsewhere in this report further reduce abatement costs, then fewer permits will be purchased under the safety valve mechanism and actual reductions could roughly double to as much as 1.0 billion metric tons in 2020, and prices could fall below the $7 safety valve level.

The impact of the Commission's proposed greenhouse gas tradeable-permits program on future energy prices would be modest. Modeling indicates that relative to business-as-usual projections for 2020, average electricity prices would be expected to rise by 5–8 percent (or half a cent per kilowatt-hour); natural gas prices would rise by about 7 percent (or $0.40 per mmBtu); and gasoline prices would increase 4 percent (or 6 cents per gallon). Coal use would decline by 9 percent below current forecasts, yet would still increase in absolute terms by 16 percent relative to today's levels, while renewable energy production would grow more substantially; natural gas use and overall energy consumption, meanwhile, would change only minimally (1.5 percent or less) relative to business-as-usual projections.

Overall, the Commission's greenhouse gas recommendations are estimated to cost the typical U.S. household the welfare equivalent of $33 per year in 2020 (2004 dollars) and to result in a slight reduction in expected GDP growth, from 63.5 percent to 63.2 percent, between 2005 and 2020.

Energy Savings from Appliance Standards



Data Source: Resources for the Future 2004, Lawrence Berkeley National Laboratory 2004, American Council for an Energy Efficient Economy 2004

IMPROVING ENERGY EFFICIENCY

To improve the energy efficiency of the U.S. economy, the Commission — in addition to an increase in vehicle fuel economy standards — recommends:

- Updating and expanding efficiency standards for new appliances, equipment, and buildings to capture additional cost-effective energy-saving opportunities.
- Integrating improvements in efficiency standards with targeted technology incentives, R&D, consumer information, and programs sponsored by electric and gas utilities.[1]
- Pursuing cost-effective efficiency improvements in the industrial sector.

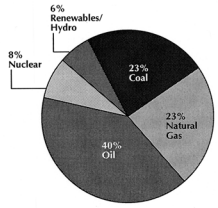
In addition, efforts should be made to address efficiency opportunities in the heavy-duty truck fleet, which is responsible for roughly 20 percent of transportation energy consumption, but is not subject to fuel economy regulation, and in the existing vehicle fleet where a substantial opportunity exists to improve efficiency by, for example, mandating that replacement tires have rolling-resistance characteristics equivalent to the original equipment tires used on new vehicles.

In updating and implementing efficiency standards, policy makers should seek to exploit potentially productive synergies with targeted technology incentives, research and development initiatives, information programs (such as the federal ENERGY STAR label), and efficiency programs sponsored by both electricity and natural gas utilities.

Energy efficiency advances all of the critical policy objectives identified elsewhere in this report and is therefore essential to successfully managing the nation's, and the world's, short- and long-term energy challenges. Absent substantial gains in the energy efficiency of motor vehicles, buildings, appliances, and equipment, it becomes difficult to construct credible scenarios in which secure, low-carbon energy supplies can keep pace with increased demand. As a nation that consumes more energy than any other in the world, improving domestic energy efficiency can have a notable effect on global energy demand.

Total Domestic Energy Use by Source

The U.S. relies upon fossil fuels to meet over 85% of its total energy needs (2003).



Data Source: Energy Information Administration, 2004

EXPANDING ENERGY SUPPLIES

The United States and the world will require substantially increased quantities of electricity, natural gas, and transportation fuels over the next 20 years. In addition to the measures discussed previously for improving oil security, the Commission's recommendations for assuring ample, secure, clean, and affordable supplies of energy address established fuels and technologies (such as natural gas and nuclear power), as well as not-yet-commercialized options, such as coal gasification and advanced biomass (including waste-derived) alternative transportation fuels.

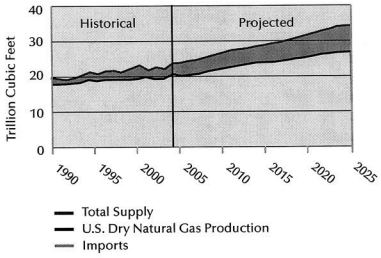
Natural Gas:

To diversify and expand the nation's access to natural gas supplies, the Commission recommends:

- Adopting effective public incentives for the construction of an Alaska natural gas pipeline.
- Addressing obstacles to the siting and construction of infrastructure needed to support increased imports of liquefied natural gas (LNG).

U.S. Natural Gas Supply

Even with construction of the Alaska pipeline, the United States will need more natural gas imports in the years to come.



Data Source: Energy Information Administration, 2004

Other Commission recommendations aim to: (1) improve the ability of agencies like the Bureau of Land Management to evaluate and manage access to natural gas resources on public lands and (2) increase R&D efforts to develop technologies for tapping non-conventional natural gas supplies, such as natural gas hydrates, which hold tremendous promise.

The above recommendations are intended to address growing stresses on North American natural gas markets that have already resulted in sharply higher and more volatile gas prices, and created substantial costs for consumers and gas-intensive industries. Construction of a pipeline would provide access to significant natural gas resources in Alaska's already-developed oilfields (potentially lowering gas prices by at least 10 percent over the pipeline's first decade). Support for a pipeline in the form of loan guarantees, accelerated depreciation, and tax credits was included in legislation passed by Congress late in 2004, but the Commission believes that additional incentives are likely to be necessary given the high cost, lengthy construction period, uncertainty about future gas prices, and other siting and financing hurdles associated with the project.

In addition to the Alaska pipeline, expanded LNG infrastructure would further increase the nation's ability to access abundant global supplies of natural gas, providing important benefits in terms of lower and less volatile gas prices and more reliable supplies for electricity generators and for other gas-intensive industries. Accordingly, the Commission recommends concerted efforts to overcome current siting obstacles, including improved federal-state cooperation in reviewing and approving new LNG facilities and efforts to educate the public regarding related safety issues.

Advanced Coal Technologies:

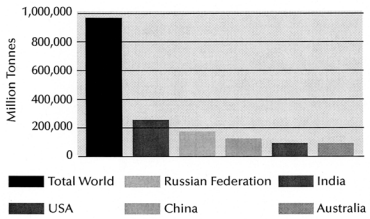
To enable the nation to continue to rely upon secure, domestic supplies of coal to meet future energy needs while addressing the risks of global climate change due to energy-related greenhouse gas emissions, the Commission recommends:

- Providing $4 billion over ten years in early deployment incentives for integrated gasification combined cycle (IGCC) coal technology.
- Providing $3 billion over ten years in public incentives to demonstrate commercial-scale carbon capture and geologic sequestration at a variety of sites.

Coal is an abundant and relatively inexpensive fuel that is widely used to produce electricity in the United States and around the world. Finding ways to use coal in a manner that is both cost-effective and compatible with sound environmental stewardship is

Proved Coal Reserves

The United States has the largest proved coal reserves of any nation in the world (the top five nations are shown here).



Data Source: BP, 2004

imperative to ensure a continued role for this important resource.

IGCC technology — in which coal is first gasified using a chemical process and the resulting synthetic gas is used to fuel a combustion turbine — has the potential to be significantly cleaner and more efficient than today's conventional steam boilers. Moreover, it can assist in effectively controlling pollutants such as mercury and can open the door to economic carbon capture and storage. The gasification process itself is already commonly used in the manufacture of chemicals, but — with the exception of a handful of demonstration facilities — has not yet been widely applied to producing power on a commercial scale.

Nuclear Power:

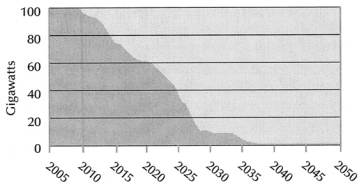
To help enable nuclear power to continue to play a meaningful role in meeting future energy needs, the Commission recommends:

- Fulfilling existing federal commitments on nuclear waste management
- Providing $2 billion over ten years from federal research, development, demonstration, and deployment (RDD&D) budgets for the demonstration of one to two new advanced nuclear power plants.
- Significantly strengthening the international non-proliferation regime.

Worldwide, some 440 nuclear power plants account for about one-sixth of total electricity supplies and about half of all non-carbon electricity generation. In the United States, 103 operating nuclear power plants supply about 20 percent of the nation's electricity and

Total U.S. Nuclear Power Plant Capacity (by License Expiration Date)

Today's existing nuclear fleet will gradually be retired over the next 50 years – if current licenses expire – depriving the nation of one of its key non-carbon electricity sources.



Data Source: Energy Information Administration, 2003

almost 70 percent of its non-carbon electricity. The contribution of nuclear energy to the nation's power needs will decline in the future absent concerted efforts to address concerns about cost, susceptibility to accidents and terrorist attacks, management of radioactive wastes, and proliferation risks.

Government intervention to address these issues and to improve prospects for an expanded, rather than diminished, role for nuclear energy is warranted by several important policy objectives, including reducing greenhouse gas emissions, enhancing energy security, and alleviating pressure on natural gas supplies from the electric-generation sector.

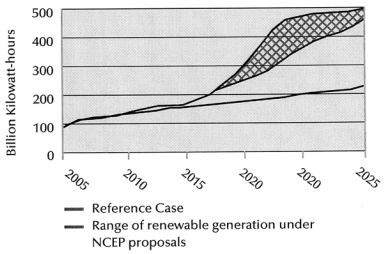
Renewable Energy:

To expand the contribution of clean, domestic, renewable energy sources to meeting future energy needs, the Commission recommends:

- Increasing federal funding for renewable technology research and development by $360 million annually. Federal efforts should be targeted at overcoming key hurdles in cost competitiveness and early deployment.
- Extending the federal production tax credit for a further four years (i.e., from 2006 through 2009), and expanding eligibility to all non-carbon energy sources, including solar, geothermal, new hydro-power generation, next generation nuclear, and advanced fossil fuel generation with carbon capture and sequestration. (This is in addition to the extension recently passed by Congress for 2004-2005.)
- Supporting ongoing efforts by the Federal Energy Regulatory Commission (FERC) to promote market-based approaches to integrating intermittent resources into the interstate grid system, while ensuring that costs are allocated appropriately and arbitrary penalties for over- and under-production are eliminated.
- Establishing a $1.5 billion program over ten years to increase domestic production of advanced non-petroleum transportation fuels from biomass (including waste).

Projected Renewable Electricity Generation

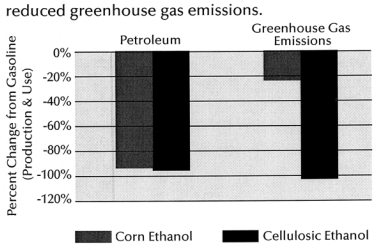
Non-hydro renewable electricity generation is expected to more than double in 2025 compared to forecasted business-as-usual levels as a result of the Commission's proposed greenhouse gas emissions trading program and other policy recommendations.



Data Source: NCEP NEMS Modeling

The Attributes of Corn Ethanol and Cellulosic Ethanol

While both corn and cellulosic ethanol are effective at offsetting petroleum consumption, cellulosic ethanol has the added benefit of substantially reduced greenhouse gas emissions.



Data Source: Lynd, Greene, and Sheehan, 2004

Renewable energy already plays an important role in the nation's energy supply, primarily in the form of hydropower for electricity production and corn-based ethanol as a transportation fuel. Other renewable options — including wind, solar, and advanced biomass technologies for power generation together with alternative transportation fuels from woody or fibrous (cellulosic) biomass and organic wastes — have made considerable progress in recent years, but still face substantial cost or technology hurdles as well as, in some cases, siting challenges.

The Commission's recommendations aim to improve the performance and cost-competitiveness of renewable energy technologies while also addressing deployment hurdles by providing more planning certainty in terms of federal tax credits, boosting R&D investments, and addressing issues related to the integration of renewable resources with the interstate transmission grid.

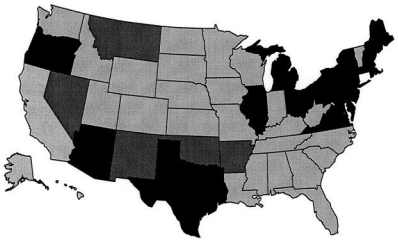
STRENGTHENING ENERGY SUPPLY INFRASTRUCTURE

To sustain access to the essential energy supplies and services on which the economy depends, the Commission recommends:

- Reducing barriers to the siting of critical energy infrastructure.
- Protecting critical infrastructure from accidental failure and terrorist threats.
- Supporting a variety of generation resources — including both large scale power plants and small scale "distributed" and/or renewable generation — and demand reduction (for both electricity and natural gas), to ensure affordable and reliable energy service for consumers.
- Encouraging increased transmission investment and deployment of new technologies to enhance the availability and reliability of the grid, in part by clarifying rules for cost-recovery.

The State of Electricity Restructuring

Roughly half of the states in the United States have taken action on electricity restucturing, although several chose to suspend or delay retail competition as a result of the California power crisis in 2001. The remaining states have chosen instead to maintain traditional state-regulated monopolies.



Restructuring Active
Restructuring Suspended
Restructuring Delayed
Restructuring Not Active

Energy Information Administration, 2003

- Enhancing consumer protections in the electricity sector and establishing an integrated, multi-pollutant program to reduce power plant emissions.

The Commission believes there is a national imperative to strengthen the systems that deliver secure, reliable, and affordable energy. Priorities include: siting reforms to enable the expansion and construction of needed energy facilities; greater efforts to protect the nation's energy systems from terrorist attack; and reforms to improve the reliability and performance of the electricity sector.

DEVELOPING ENERGY TECHNOLOGIES FOR THE FUTURE

To ensure that technologies capable of providing clean, secure, and affordable energy become available in the timeframe and on the scale needed, the Commission recommends:

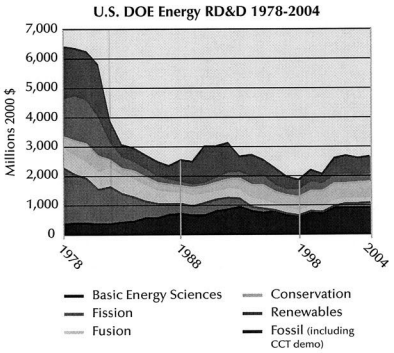
- Doubling federal government funding for energy research and development, while improving the management of these efforts and promoting effective public-private partnerships.
- Increasing incentives for private sector energy research, development, demonstration, and early deployment (ERD^3).
- Expanding investment in cooperative international ERD^3 initiatives and improving coordination among relevant federal agencies.
- Providing incentives for early deployment of (1) coal gasification and carbon sequestration; (2) domestically-produced efficient vehicles; (3) domestically-produced alternative transportation fuels; and (4) advanced nuclear reactors.

Overcoming the energy challenges faced by the United States and the rest of the world requires technologies superior to those available today. To accelerate the development of these technologies, the federal government must increase its collaboration with the private sector, with states, and with other nations to develop and deploy technologies that will not be pursued absent greater federal support.

Investments by both the private and public sectors in energy research, development, demonstration, and early deployment have been falling short of what is likely to be needed to meet the energy challenges confronting the nation and the world in the 21st century. This insufficiency of investment is compounded by shortcomings in the government's management of its energy-technology-innovation portfolio and in the coordination and cooperation among relevant efforts in state and federal government, industry, and academia.

Declining Public Support for ERD&D in the United States

Analysis of DOE data shows that, over the 25 years from FY1978 to FY2004, US government appropriations for ERD&D fell from $6.4 billion to $2.75 billion in constant year-2000 dollars, a nearly 60-percent reduction. The part of these appropriations devoted to applied-energy-technology RD&D fell from $6.08 billion to $1.80 billion.



Gallagher and Sagar, 2004

The Commission proposes that the nation devote the resources generated by the sale of greenhouse gas emissions permits to enhance the development and deployment of improved energy technologies. The approximately $36 billion that Commission analysis indicates will be generated over ten years by the proposed greenhouse gas tradeable-permits program — most of which will come from auctioning a small portion of the overall permit pool — will offset the specific additional public investments summarized below.

A Revenue Neutral Strategy for Investing in Energy Technology Development

The Commission proposes to double current federal spending on energy innovation, substantially expand early deployment efforts for advanced energy technologies, and triple investment in cooperative international energy research. To offset additional costs to the Treasury, the Commission proposes that the federal government each year auction a small percentage of greenhouse gas emissions permits.

Additional Expenditures		**Annual**	**10 Year Total**
RD&D	Double current investment	$1.7 billion	$17 billion
Incentives for Early Deployment	Coal IGCC, biofuels, advanced nuclear, non-carbon production tax credit (PTC), manufacturer and consumer auto efficiency incentives, Alaska pipeline	$1.4 billion	$14 billion
International Cooperation	Triple Current Investment	$500 million	$5 billion
Total			**$36 billion**
Additional Revenues			
Greenhouse Gas Permit Sales	• 5 percent permit auction in 2010 with 0.5 percent annual increase starting in 2013 • Revenue from expected permit sales under the safety valve		$26 billion $10 billion
Total			**$36 billion**

Notes:

1. See, e.g., the constructive joint proposal on these issues to the National Association of Regulatory Utility Commissioners by the American Gas Association and the Natural Resources Defense Council (July 2004); available at www.aga.org.

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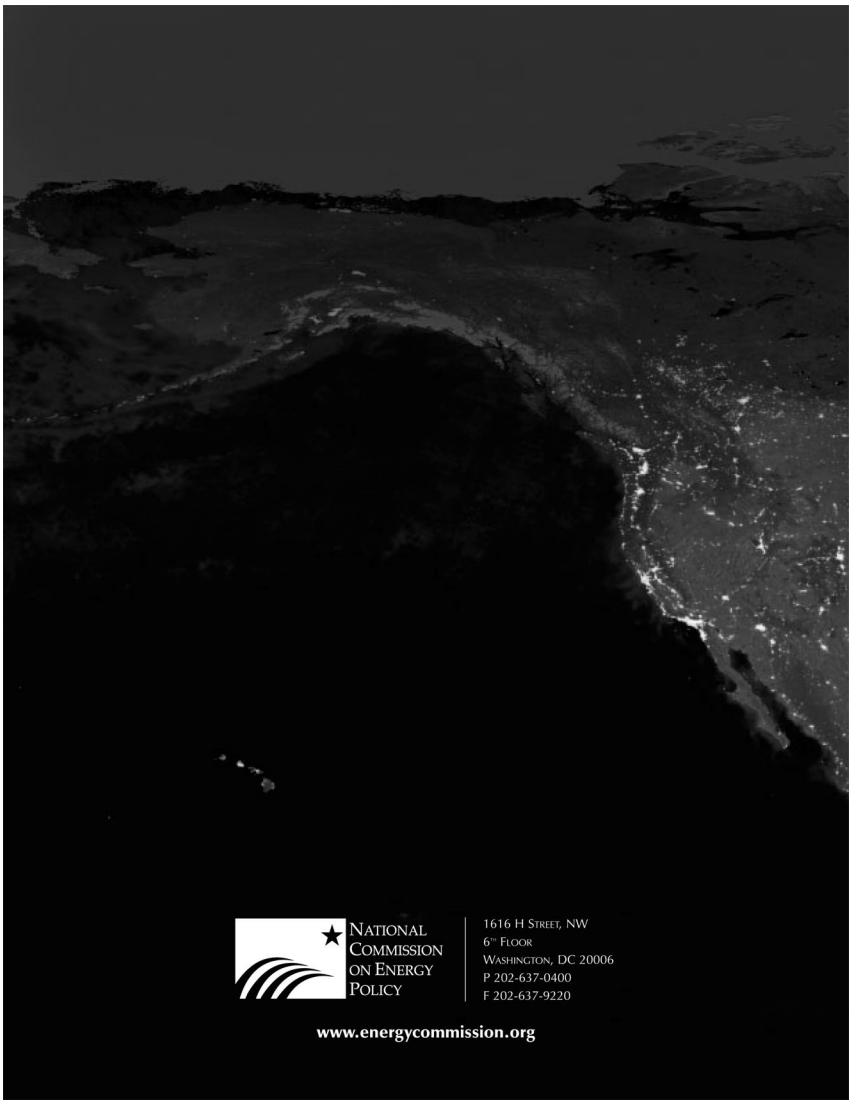
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Executive Summary

In the wake of the 1973 oil crisis, the U.S. Congress passed the Energy Policy and Conservation Act of 1975, with the goal of reducing the country's dependence on foreign oil. Among other things, the act established the Corporate Average Fuel Economy (CAFE) program, which required automobile manufacturers to increase the sales-weighted average fuel economy of the passenger car and light-duty truck fleets sold in the United States. Today, the light-duty truck fleet includes minivans, pickups, and sport utility vehicles. Congress itself set the standards for passenger cars, which rose from 18 miles per gallon (mpg) in automobile model year (MY) 1978 to 27.5 mpg in MY 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 bills since fiscal year 1996 have prohibited the agency from changing or even studying CAFE standards.

In legislation for fiscal year 2001, Congress requested that the National Academy of Sciences, in consultation with the Department of Transportation, conduct a study to evaluate the effectiveness and impacts of CAFE standards.[1] In particular, it asked that the study examine the following, among other factors:

1. The statutory criteria (economic practicability, technological feasibility, need for the United States to conserve energy, the classification definitions used to distinguish passenger cars from light trucks, and the effect of other regulations);
2. The impact of CAFE standards on motor vehicle safety;
3. Disparate impacts on the U.S. automotive sector;
4. The effect on U.S. employment in the automotive sector;
5. The effect on the automotive consumer; and
6. The effect of requiring separate CAFE calculations for domestic and nondomestic fleets.

In response to this request, the National Research Council (NRC) established the Committee on the Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards. In consultation with DOT, the NRC developed a statement of work for the committee. The committee's work was to emphasize recent experience with CAFE standards, the impact of possible changes, and the stringency and/or structure of the CAFE program in future years. The committee held its first meeting in early February 2001. In effect, since the congressional appropriations language asked for the report by July 1, 2001, the committee had less than 5 months (from February to late June) to complete its analysis and prepare a report for the National Research Council's external report review process. In its findings and recommendations, the committee has noted where analysis is limited and further study is needed.

Following the release of the prepublication copy of this report in July 2001, the committee reviewed its technical and economic analyses. Several changes were made to the results, as reported in a letter report released in January 2002, which is reprinted in Appendix F below. These changes have been incorporated in this report also.

The CAFE program has been controversial since its inception. Sharp disagreements exist regarding the effects of the program on the fuel economy of the U.S. vehicle fleet, the current mix of vehicles in that fleet, the overall safety of passenger vehicles, the health of the domestic automobile industry, employment in that industry, and the well-being of consumers. It is this set of concerns that the committee was asked to address.

These concerns are also very much dependent on one another. For example, if fuel economy standards were raised,

[1] Conference Report on H.R. 4475, Department of Transportation and Related Agencies Appropriations Act, 2001. Report 106-940, as published in the *Congressional Record*, October 5, 2000, pp. H8892-H9004.

the manner in which automotive manufacturers respond would affect the purchase price, attributes, and performance of their vehicles. For this reason, the mix of vehicles that a given manufacturer sells could change, perhaps resulting in a greater proportion of smaller and lighter vehicles; this, in turn, could have safety implications, depending on the eventual mix of vehicles that ended up on the road. If consumers are not satisfied with the more fuel-efficient vehicles, that in turn could affect vehicle sales, profits, and employment in the industry. Future effects would also depend greatly on the real price of gasoline; if it is low, consumers would have little interest in fuel-efficient vehicles. High fuel prices would have just the opposite effect. In addition, depending on the level at which fuel economy targets are set and the time the companies have to implement changes, differential impacts across manufacturers would probably occur depending on the types of vehicles they sell and their competitive position in the marketplace. Thus, understanding the impact of potential changes to CAFE standards is, indeed, a difficult and complex task.

In addition to the requirement that companies meet separate fleet averages for the automobiles and light-duty trucks they sell, there are other provisions of the CAFE program that affect manufacturers' decisions. For example, a manufacturer must meet the automobile CAFE standard separately for both its import and its domestic fleet (the two-fleet rule), where a domestic vehicle is defined as one for which at least 75 percent of its parts are manufactured in the United States. Also, CAFE credits can be earned by manufacturers that produce flexible-fuel vehicles, which can run interchangeably on gasoline or an alternative fuel, such as ethanol.

Why care about fuel economy at all? It is tempting to say that improvements in vehicle fuel economy will save money for the vehicle owner in reduced expenditures for gasoline. The extent of the annual saving will depend on the level of improvement in the fuel economy (in miles per gallon of gasoline), the price of gasoline, and the miles traveled per year, as well as on the higher cost of the vehicle attributable to the fuel economy improvement. While a strong argument can be made that such savings or costs are economically relevant, that is not by itself a strong basis for public policy intervention. Consumers have a wide variety of opportunities to exercise their preference for a fuel-efficient vehicle if that is an important attribute to them. Thus, according to this logic, there is no good reason for the government to intervene in the market and require new light-duty vehicles to achieve higher miles per gallon or to take other policy measures designed to improve the fuel economy of the fleet.

There are, however, other reasons for the nation to consider policy interventions of some sort to increase fuel economy. The most important of these, the committee believes, is concern about the accumulation in the atmosphere of so-called greenhouse gases, principally carbon dioxide. Continued increases in carbon dioxide emissions are likely to further global warming. Concerns like those about climate change are not normally reflected in the market for new vehicles. Few consumers take into account the environmental costs that the use of their vehicle may occasion; in the parlance of economics, this is a classic negative externality.

A second concern is that petroleum imports have been steadily rising because of the nation's increasing demand for gasoline without a corresponding increase in domestic supply. The demand for gasoline has been exacerbated by the increasing sales of light trucks, which have lower fuel economy than automobiles. The high cost of oil imports poses two risks: downward pressure on the strength of the dollar (which drives up the costs of goods that Americans import) and an increase in U.S. vulnerability to macroeconomic shocks that cost the economy considerable real output. Some experts argue that these vulnerabilities are another form of externality that vehicle purchasers do not factor into their decisions but that can represent a true and significant cost to society. Other experts take a more skeptical view, arguing instead that the macroeconomic difficulties of the 1970s (high unemployment coupled with very high inflation and interest rates) were due more to unenlightened monetary policy than to the inherent difficulties associated with high oil prices. Most would agree that reducing our nation's oil import bill would have favorable effects on the terms of trade, and that this is a valid consideration in deliberations about fuel economy.

The committee believes it is critically important to be clear about the reasons for considering improved fuel economy. Moreover, and to the extent possible, it is useful to try to think about how much it is worth to society in dollar terms to reduce emissions of greenhouse gases (by 1 ton, say) and reduce dependence on imported oil (say, by 1 barrel). If it is possible to assign dollar values to these favorable effects (no mean feat, the committee acknowledges), it becomes possible to make at least crude comparisons between the beneficial effects of measures to improve fuel economy on the one hand, and the costs (both out-of-pocket and more subtle) on the other.

In conducting its study, the committee first assessed the impact of the current CAFE system on reductions in fuel consumption, on emissions of greenhouse gases, on safety, and on impacts on the industry (see Chapters 1 and 2). To assess the potential impacts of modified standards, the committee examined opportunities offered by the application of existing (production-intent) or emerging technologies, estimated the costs of such improvements, and examined the lead times that would typically be required to introduce such vehicle changes (see Chapter 3). The committee reviewed many sources of information on technologies and the costs of improvements in fuel economy; these sources included presentations at its meetings and available reports. It also used consultants under its direction to facilitate its work under the tight time constraints of the study. Some of the consultants' work provided analyses and information that helped the committee better understand the nature of

previous fuel economy analyses. In the end, however, the committee conducted its own analyses, informed by the work of the consultants, the technical literature, and presentations at its meetings, as well as the expertise and judgment of its members, to arrive at its own range of estimates of fuel economy improvements and associated costs. Based on these analyses, the implications of modified CAFE standards are presented in Chapter 4, along with an analysis of what the committee calls cost-efficient fuel economy levels. The committee also examined the stringency and structure of the current CAFE system, and it assessed possible modifications to it, as well as alternative approaches to achieving higher fuel economy for passenger vehicles, which resulted in suggestions for improved policy instruments (see Chapter 5).

FINDINGS

Finding 1. The CAFE program has clearly contributed to increased fuel economy of the nation's light-duty vehicle fleet during the past 22 years. During the 1970s, high fuel prices and a desire on the part of automakers to reduce costs by reducing the weight of vehicles contributed to improved fuel economy. CAFE standards reinforced that effect. Moreover, the CAFE program has been particularly effective in keeping fuel economy above the levels to which it might have fallen when real gasoline prices began their long decline in the early 1980s. Improved fuel economy has reduced dependence on imported oil, improved the nation's terms of trade, and reduced emissions of carbon dioxide, a principal greenhouse gas, relative to what they otherwise would have been. If fuel economy had not improved, gasoline consumption (and crude oil imports) would be about 2.8 million barrels per day greater than it is, or about 14 percent of today's consumption.

Finding 2. Past improvements in the overall fuel economy of the nation's light-duty vehicle fleet have entailed very real, albeit indirect, costs. In particular, all but two members of the committee concluded that the downweighting and downsizing that occurred in the late 1970s and early 1980s, some of which was due to CAFE standards, probably resulted in an additional 1,300 to 2,600 traffic fatalities in 1993.[2] In addition, the diversion of carmakers' efforts to improve fuel economy deprived new-car buyers of some amenities they clearly value, such as faster acceleration, greater carrying or towing capacity, and reliability.

[2]A dissent by committee members David Greene and Maryann Keller on the impact of downweighting and downsizing is contained in Appendix A. They believe that the level of uncertainty is much higher than stated and that the change in the fatality rate due to efforts to improve fuel economy may have been zero. Their dissent is limited to the safety issue alone.

Finding 3. Certain aspects of the CAFE program have not functioned as intended:

- The distinction between a car for personal use and a truck for work use/cargo transport has broken down, initially with minivans and more recently with sport utility vehicles (SUVs) and cross-over vehicles. The car/truck distinction has been stretched well beyond the original purpose.
- The committee could find no evidence that the two-fleet rule distinguishing between domestic and foreign content has had any perceptible effect on total employment in the U.S. automotive industry.
- The provision creating extra credits for multifuel vehicles has had, if any, a negative effect on fuel economy, petroleum consumption, greenhouse gas emissions, and cost. These vehicles seldom use any fuel other than gasoline yet enable automakers to increase their production of less fuel efficient vehicles.

Finding 4. In the period since 1975, manufacturers have made considerable improvements in the basic efficiency of engines, drive trains, and vehicle aerodynamics. These improvements could have been used to improve fuel economy and/or performance. Looking at the entire light-duty fleet, both cars and trucks, between 1975 and 1984, the technology improvements were concentrated on fuel economy: It improved by 62 percent without any loss of performance as measured by 0–60 mph acceleration times. By 1985, light-duty vehicles had improved enough to meet CAFE standards. Thereafter, technology improvements were concentrated principally on performance and other vehicle attributes (including improved occupant protection). Fuel economy remained essentially unchanged while vehicles became 20 percent heavier and 0–60 mph acceleration times became, on average, 25 percent faster.

Finding 5. Technologies exist that, if applied to passenger cars and light-duty trucks, would significantly reduce fuel consumption within 15 years. Auto manufacturers are already offering or introducing many of these technologies in other markets (Europe and Japan, for example), where much higher fuel prices ($4 to $5/gal) have justified their development. However, economic, regulatory, safety, and consumer-preference-related issues will influence the extent to which these technologies are applied in the United States.

Several new technologies such as advanced lean exhaust gas aftertreatment systems for high-speed diesels and direct-injection gasoline engines, which are currently under development, are expected to offer even greater potential for reductions in fuel consumption. However, their development cycles as well as future regulatory requirements will influence if and when these technologies penetrate deeply into the U.S. market.

The committee conducted a detailed assessment of the

technological potential for improving the fuel efficiency of 10 different classes of vehicles, ranging from subcompact and compact cars to SUVs, pickups, and minivans. In addition, it estimated the range in incremental costs to the consumer that would be attributable to the application of these engine, transmission, and vehicle-related technologies.

Chapter 3 presents the results of these analyses as curves that represent the incremental benefit in fuel consumption versus the incremental cost increase over a defined baseline vehicle technology. Projections of both incremental costs and fuel consumption benefits are very uncertain, and the actual results obtained in practice may be significantly higher or lower than shown here. Three potential development paths are chosen as examples of possible product improvement approaches, which illustrate the trade-offs auto manufacturers may consider in future efforts to improve fuel efficiency.

Assessment of currently offered product technologies suggests that light-duty trucks, including SUVs, pickups, and minivans, offer the greatest potential to reduce fuel consumption on a total-gallons-saved basis.

Finding 6. In an attempt to evaluate the economic trade-offs associated with the introduction of existing and emerging technologies to improve fuel economy, the committee conducted what it called cost-efficient analysis. That is, the committee identified packages of existing and emerging technologies that could be introduced over the next 10 to 15 years that would improve fuel economy up to the point where further increases in fuel economy would not be reimbursed by fuel savings. The size, weight, and performance characteristics of the vehicles were held constant. The technologies, fuel consumption estimates, and cost projections described in Chapter 3 were used as inputs to this cost-efficient analysis.

These cost-efficient calculations depend critically on the assumptions one makes about a variety of parameters. For the purpose of calculation, the committee assumed as follows: (1) gasoline is priced at $1.50/gal, (2) a car is driven 15,600 miles in its first year, after which miles driven declines at 4.5 percent annually, (3) on-the-road fuel economy is 15 percent less than the Environmental Protection Agency's test rating, and (4) the added weight of equipment required for future safety and emission regulations will exact a 3.5 percent fuel economy penalty.

One other assumption is required to ascertain cost-efficient technology packages—the horizon over which fuel economy gains ought to be counted. Under one view, car purchasers consider fuel economy over the entire life of a new vehicle; even if they intend to sell it after 5 years, say, they care about fuel economy because it will affect the price they will receive for their used car. Alternatively, consumers may take a shorter-term perspective, not looking beyond, say, 3 years. This latter view, of course, will affect the identification of cost-efficient packages because there will be many fewer years of fuel economy savings to offset the initial purchase price.

The full results of this analysis are presented in Chapter 4. To provide one illustration, however, consider a midsize SUV. The current sales-weighted fleet fuel economy average for this class of vehicle is 21 mpg. If consumers consider only a 3-year payback period, fuel economy of 22.7 mpg would represent the cost-efficient level. If, on the other hand, consumers take the full 14-year average life of a vehicle as their horizon, the cost-efficient level increases to 28 mpg (with fuel savings discounted at 12 percent). The longer the consumer's planning horizon, in other words, the greater are the fuel economy savings against which to balance the higher initial costs of fuel-saving technologies.

The committee cannot emphasize strongly enough that the cost-efficient fuel economy levels identified in Tables 4-2 and 4-3 in Chapter 4 are *not* recommended fuel economy goals. Rather, they are reflections of technological possibilities, economic realities, and assumptions about parameter values and consumer behavior. Given the choice, consumers might well spend their money on other vehicle amenities, such as greater acceleration or towing capacity, rather than on the fuel economy cost-efficient technology packages.

Finding 7. There is a marked inconsistency between pressing automotive manufacturers for improved fuel economy from new vehicles on the one hand and insisting on low real gasoline prices on the other. Higher real prices for gasoline—for instance, through increased gasoline taxes—would create both a demand for fuel-efficient new vehicles and an incentive for owners of existing vehicles to drive them less.

Finding 8. The committee identified externalities of about $0.30/gal of gasoline associated with the combined impacts of fuel consumption on greenhouse gas emissions and on world oil market conditions. These externalities are not necessarily taken into account when consumers purchase new vehicles. Other analysts might produce lower or higher estimates of externalities.

Finding 9. There are significant uncertainties surrounding the societal costs and benefits of raising fuel economy standards for the light-duty fleet. These uncertainties include the cost of implementing existing technologies or developing new ones; the future price of gasoline; the nature of consumer preferences for vehicle type, performance, and other features; and the potential safety consequences of altered standards. The higher the target for average fuel economy, the greater the uncertainty about the cost of reaching that target.

Finding 10. Raising CAFE standards would reduce future fuel consumption below what it otherwise would be; however, other policies could accomplish the same end at lower cost, provide more flexibility to manufacturers, or address

inequities arising from the present system. Possible alternatives that appear to the committee to be superior to the current CAFE structure include tradable credits for fuel economy improvements, feebates,[3] higher fuel taxes, standards based on vehicle attributes (for example, vehicle weight, size, or payload), or some combination of these.

Finding 11. Changing the current CAFE system to one featuring tradable fuel economy credits and a cap on the price of these credits appears to be particularly attractive. It would provide incentives for all manufacturers, including those that exceed the fuel economy targets, to continually increase fuel economy, while allowing manufacturers flexibility to meet consumer preferences. Such a system would also limit costs imposed on manufacturers and consumers if standards turn out to be more difficult to meet than expected. It would also reveal information about the costs of fuel economy improvements and thus promote better-informed policy decisions.

Finding 12. The CAFE program might be improved significantly by converting it to a system in which fuel economy targets depend on vehicle attributes. One such system would make the fuel economy target dependent on vehicle weight, with lower fuel consumption targets set for lighter vehicles and higher targets for heavier vehicles, up to some maximum weight, above which the target would be weight-independent. Such a system would create incentives to reduce the variance in vehicle weights between large and small vehicles, thus providing for overall vehicle safety. It has the potential to increase fuel economy with fewer negative effects on both safety and consumer choice. Above the maximum weight, vehicles would need additional advanced fuel economy technology to meet the targets. The committee believes that although such a change is promising, it requires more investigation than was possible in this study.

Finding 13. If an increase in fuel economy is effected by a system that encourages either downweighting or the production and sale of more small cars, some additional traffic fatalities would be expected. However, the actual effects would be uncertain, and any adverse safety impact could be minimized, or even reversed, if weight and size reductions were limited to heavier vehicles (particularly those over 4,000 lb). Larger vehicles would then be less damaging (aggressive) in crashes with all other vehicles and thus pose less risk to other drivers on the road.

Finding 14. Advanced technologies—including direct-injection, lean-burn gasoline engines; direct-injection compression-ignition (diesel) engines; and hybrid electric vehicles—have the potential to improve vehicle fuel economy by 20 to 40 percent or more, although at a significantly higher cost. However, lean-burn gasoline engines and diesel engines, the latter of which are already producing large fuel economy gains in Europe, face significant technical challenges to meet the Tier 2 emission standards established by the Environmental Protection Agency under the 1990 amendments to the Clean Air Act and California's low-emission-vehicle (LEV II) standards. The major problems are the Tier 2 emissions standards for nitrogen oxides and particulates and the requirement that emission control systems be certified for a 120,000-mile lifetime. If direct-injection gasoline and diesel engines are to be used extensively to improve light-duty vehicle fuel economy, significant technical developments concerning emissions control will have to occur or some adjustments to the Tier 2 emissions standards will have to be made. Hybrid electric vehicles face significant cost hurdles, and fuel-cell vehicles face significant technological, economic, and fueling infrastructure barriers.

Finding 15. Technology changes require very long lead times to be introduced into the manufacturers' product lines. Any policy that is implemented too aggressively (that is, in too short a period of time) has the potential to adversely affect manufacturers, their suppliers, their employees, and consumers. Little can be done to improve the fuel economy of the new vehicle fleet for several years because production plans already are in place. The widespread penetration of even existing technologies will probably require 4 to 8 years. For emerging technologies that require additional research and development, this time lag can be considerably longer. In addition, considerably more time is required to replace the existing vehicle fleet (on the order of 200 million vehicles) with new, more efficient vehicles. Thus, while there would be incremental gains each year as improved vehicles enter the fleet, major changes in the transportation sector's fuel consumption will require decades.

RECOMMENDATIONS

Recommendation 1. Because of concerns about greenhouse gas emissions and the level of oil imports, it is appropriate for the federal government to ensure fuel economy levels beyond those expected to result from market forces alone. Selection of fuel economy targets will require uncertain and difficult trade-offs among environmental benefits, vehicle safety, cost, oil import dependence, and consumer preferences. The committee believes that these trade-offs rightfully reside with elected officials.

Recommendation 2. The CAFE system, or any alternative regulatory system, should include broad trading of fuel

[3]Feebates are taxes on vehicles achieving less than the average fuel economy coupled with rebates to vehicles achieving better than average fuel economy.

economy credits. The committee believes a trading system would be less costly than the current CAFE system; provide more flexibility and options to the automotive companies; give better information on the cost of fuel economy changes to the private sector, public interest groups, and regulators; and provide incentives to all manufacturers to improve fuel economy. Importantly, trading of fuel economy credits would allow for more ambitious fuel economy goals than exist under the current CAFE system, while simultaneously reducing the economic cost of the program.

Recommendation 3. Consideration should be given to designing and evaluating an approach with fuel economy targets that are dependent on vehicle attributes, such as vehicle weight, that inherently influence fuel use. Any such system should be designed to have minimal adverse safety consequences.

Recommendation 4. Under any system of fuel economy targets, the two-fleet rule for domestic and foreign content should be eliminated.

Recommendation 5. CAFE credits for dual-fuel vehicles should be eliminated, with a long enough lead time to limit adverse financial impacts on the automotive industry.

Recommendation 6. To promote the development of longer-range, breakthrough technologies, the government should continue to fund, in cooperation with the automotive industry, precompetitive research aimed at technologies to improve vehicle fuel economy, safety, and emissions. It is only through such breakthrough technologies that dramatic increases in fuel economy will become possible.

Recommendation 7. Because of its importance to the fuel economy debate, the relationship between fuel economy and safety should be clarified. The committee urges the National Highway Traffic Safety Administration to undertake additional research on this subject, including (but not limited to) a replication, using current field data, of its 1997 analysis of the relationship between vehicle size and fatality risk.