# Chapter 2
# Introduction

The purpose of this report is to assist Congress in evaluating and, if desired, revising a series of legislative initiatives establishing new fuel economy standards for new automobiles sold in the U.S. market. As indicated by the congressional committee requesting this report, the time frame of these initiatives is the coming decade, and OTA's evaluation focuses on this time period–although we do examine, in lesser detail and certainly with less precision, some longer range potential. As a result, we examine the technological potential for improved automotive fuel economy primarily in terms of vehicles similar in type and performance to vehicles in today's fleet. Although we do examine the impact of a shift in consumer tastes towards the smaller and more efficient models in this fleet, we have not examined the potential to design vehicles that are radical departures from today's with different performance, size, and function from vehicles we are familiar with, nor have we tried to rethink the basic nature of our personal transportation system. Both of these are important dimensions of the future of the Nation's transportation that should not be overlooked. OTA will examine these dimensions in an ongoing assessment, ***U.S. Energy Efficiency: Past Trends and Future Opportunities.***

Strategies to reduce fuel use by the U.S. fleet of light-duty highway passenger vehicles —automobiles and light trucks–are at the focal point of debate concerning several important issues affecting the United States. In particular, problems associated with an unstable oil supply and national security, a large trade imbalance aggravated by rising oil imports, and the potential for global warming primarily due to burning of fossil fuels all contribute to congressional interest in reducing light-duty vehicular fuel use. Although a variety of policy measures can address this goal, new automobile fuel economy standards have been at the center of congressional debate. A brief discussion of the national energy security and global warming issues appears in box 2-A.

Trends in U.S. oil consumption, production, and imports have worsened over the past few years, adding to long-standing concerns about U.S. energy security, balance of trade, and environmental quality (see figure 2-l). In 1985, the United States was enjoying substantial success in reining in oil consumption, maintaining domestic production, and thus reducing imports. In that year, we produced nearly 9 million barrels per day (mmbd) of crude oil and 11.4 mmbd of total liquid fuels;[1] consumed 15.7 mmbd, down from 18.4 mmbd in 1977; and imported 4.3 mmbd, only 27 percent of total supply, down from a 1977 high of 8.6 mmbd or 46 percent. At the end of 1985, however, world crude oil prices plunged, drastically reducing incentives for production investments and easing economic restrictions on consumption. Since 1985, domestic crude oil production has fallen well below 8 mmbd; total petroleum consumption has risen back over 17 mmbd; and net oil and product imports have grown to over 7 mmbd in 1990, close to 45 percent of total consumption, and are still rising.[2] In fact, most major forecasts of U.S. energy supply and demand project that, ***without major changes in energy policy,*** oil imports will exceed 50 percent of total oi1[3] consumption within a few years. OTA's previous

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[1]That is, crude oil, lease condensate, natural gas plant liquids, processing gains, alcohols, and other liquids.

[2]U.S. Department of Energy, Energy Information Administration, *Short-term Energy Outlook, 2nd Quarter 1990*, DOE/EIA-0202(90/2Q).

*NOTE:* Figures for oil import percentage vary with the source, and some public figures are quoting values well above 50 percent for the U.S. oil import level. These values almost certainly are based on inappropriate comparisons of total product and crude oil imports to domestic crude oil production without accounting for domestic production of natural gas liquids, which area valuable part of our total petroleum supply.

[3]That is, all liquid fuels, including crude oil, lease condensates, natural gas plant liquids, processing gain, alcohols, etc. Most statements of import dependence refer to imported crude oil and petroleum products as a fraction or percentage of total liquid fuels consumption.

### *Box 2-A—The US. Light-Duty Fleet, Energy Security, and Global Warning*

Efforts to update past fuel economy regulations and boost substantially the efficiency of the U.S. light-duty fleet of automobiles and light trucks are based primarily on two key policy issues facing the United States: the perceived insecurity of U.S. oil supplies and the growing threat of global warming from rising atmospheric concentrations of carbon dioxide and other so-called "greenhouse" gases.

Energy Security. After a decade of quiescence, energy security has once again become a major U.S. concern. The key statistic driving that concern is the level of U.S. oil imports, which had dropped to 27 percent of supply by 1985 but rose to 42 percent in 1989,[1] and continues to rise steadily as U.S. oiI production drops. As in the 1970's, four basic elements underlie the concern: the near-total dependence of the U.S. transportation sector on petroleum; the United States' limited potential to increase oil production; the preponderance of oil reserves in the Middle East/Persian Gulf area; and the basic political instability and considerable hostility to the United States existing there.

In fact, in some ways these elements have grown more severe since the energy crises of the seventies. During the past 10 years (1979-89), the transportation sector's share of total U.S. petroleum use has grown from 53 to 63 percent as transportation has remained almost totally oil-dependent while other sectors have switched to alternate fuels.[2] This is particularly important because the sector's prospect for switching fuel in an emergency is virtually zero. In addition, the boom-and-bust oil price cycle of the post-boycott period, and especially the price drop of 1985-86, may have created a wariness in the oil industry that would substantially delay any major boost in drilling activity in response to another price surge. And, with the passage of time, the industry's infrastructure, including skilled labor, needed for a drilling rebound is being eroded

Despite these problems, OTA believes that, on balance, the United States' energy security is somewhat less at risk today than in the 1970's. Shifts in the oil market that we considers supporting increased energy security include:

- the Strategic Petroleum Reserve and increased levels of strategic storage in Europe and Japan;
- increased diversification of world oil production since the seventies;
- the end of U.S. price controls, allowing quicker market adjustment to price and supply swings;
- advent of the spot market and futures market, making oil trade more flexible;
- increasing interdependence of the world economy, particularly the major investments of OPEC producers in the economies of the Western oil-importing nations and, especially, in their oil-refining and marketing sectors;
- lessening of the strategic importance of the Gulf of Hormuz due to diversification of transport routes out of the Gulf;
- growing importance of natural gas, and its substitutability for oil in key markets; and
- recent political changes in Eastern Bloc nations and the resulting lowering of tensions between East and West.

Iraq's rising military power and recent invasion of Kuwait threatened this trend toward improved security by concentrating control of much of the world's oil resources in one country. The successful war effort liberated Kuwait and seriously weakened Iraq's military capability; but it may also have far-reaching repercussions on power balances, alliances, and attitudes toward the United States and the West. Whatever the outcome, the likelihood of continuing tensions in the Gulf and the considerable enmity

[1] U.S. Department of Energy, Energy Information Administration, *EIA Monthly Energy Review*, DOE/EIA-0035(91/01) January 1991, p. 13; cited hereafter as "*MER* 1/91. " NOTE: "Oil" refers to all crude oil, natural gas liquids, and oil products.

[2] *MER* 1/91, pp. 7,27.

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toward the United States there will create a strong incentive to reduce U.S. dependence on imported oil. In fact, even with the positive outcome in the war, the U.S. effort and the refugee problems created still have the potential to yield new animosities towards the United States that would have negative implications for long-term energy security.

Global Warming. The need to slow and reverse the growth of worldwide emissions of carbon dioxide (C02) and other greenhouse gases has provided new impetus to energy conservation measures.

The greenhouse effect is a warming of the Earth and atmosphere resulting from trapping of the Earth's outgoing infrared radiation by C02, water vapor, methane, nitrous oxide, chlorofluorocarbons, and other gases, both natural and manmade. Although there are respected scientists who remain skeptical that significant greenhouse warming will occur, most scientists believe that growing atmospheric concentrations of the greenhouse gases caused by past and ongoing increases in emissions rates will lead to significant global temperature increases: a widely accepted value is a global average temperature increase of 3 to 8°F. (1.5 to 4.5°C.) from a doubling of $CO_2$ concentrations or the equivalent.[3] Other effects of the warming include an expected rise in sea level, drastic changes in rainfall patterns and increased incidence and severity of storms, and resulting disruptive impacts on agriculture and natural biological systems.

Despite substantial scientific consensus about the likely change in average global temperatures, there is also substantial disagreement and uncertainty associated with regional impacts, effects of various temperature feedback mechanisms such as clouds, the role of the ocean, the relative greenhouse effect of the various gases, and other factors. These uncertainties affect arguments about both the urgency and value of conservation measures such as improving automobile fuel economy.

The U.S. light-duty fleet accounts for about 63 percent of U.S. transport emissions of $C0_2$, 3 percent of world $C0_2$ emissions, and about 1.5 percent of the total greenhouse problem. This last value has been variously interpreted as being a significant percentage of the greenhouse problem, and as proving that focusing on the U.S. fleet to gain consequential greenhouse benefits is a mistake. In OTA's view, few if any sectors of the U.S. economy are large enough, *by themselves,* to significantly alter the course of greenhouse warming. In other words, ignoring the light-duty fleet as "too small a factor" is identical to deciding to do nothing. An effective strategy to mitigate greenhouse warming must address all sectors of the economy. Furthermore, the global nature of the automobile and light-truck market and the economic importance of the U.S. market imply that acceleration of improvements to the fuel economy of the U.S. fleet can have a strong ripple effect on the fuel economy of the worldwide fleet.

[3] Other gases have a warning effect that is some multiple of [the effect of] $CO_2$; so a combination of increases of various gases can be translated into an effective $C0_2$ increase by appropriately weighting the increased concentration of each gas.

review of domestic oil production prospects[4] and its preliminary review of oil demand generally support these projections.

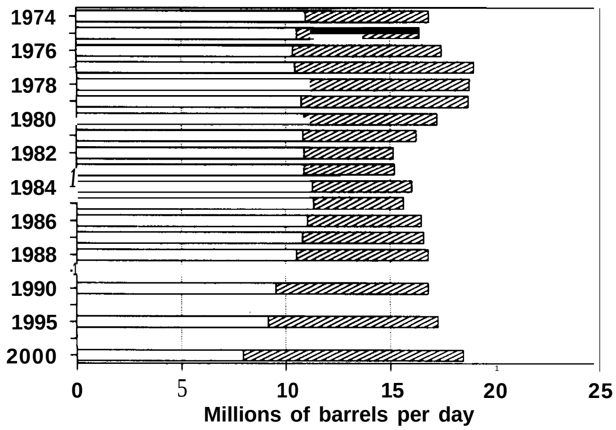
If trends in imports are to be changed, improved efficiency of use is widely expected to be at the head of the list of policy options. During the decade and a half since the first oil price shock, the major factor in reducing U.S. oil imports was the marked reduction in the energy intensity of the U.S. economy, attributable at least in part to dramatic increases in the efficiency of energy use. Many opportunities remain to continue this downward trend in energy intensity.

Because of its importance to U.S. petroleum use, the transportation sector is a main target for further efficiency efforts. In 1988, this sector accounted for approximately 27 percent of total energy consumed by the United States[5] and, more

[4] U.S. Congress, Office of Technology Assessment, U.S. *Oil Production: The Effect of Low Oil Prices-Special Report*, *OTA-E-348 (Washington,* DC: U.S. Government Printing Office, September 1987).

[5] *MER 1/91, p. 21.*

Figure 2-1 –U.S. Oil Balance




SOURCE: Energy Information Administration, Annual Energy Outlook 1991

important ,63 percent of all U.S. petroleum consumption.[6] Furthermore, a substantial portion of the remaining oil use involves consumption of byproducts of refinery production of transportation fuels.[7] Reducing the use of these byproducts would not have a major impact on overall oil supplies unless transportation fuel use were reduced as well.

The light-duty highway fleet-automobiles and light trucks (vans and pickups) used largely for passenger travel–accounts for a very large portion of U.S. transportation energy use and overall oil use. In 1988, this fleet accounted for 38.2 percent of U.S. oil consumption and 15.7 percent of total energy consumption. The automobile fleet alone was responsible for about 26.2 percent of U.S. oil consumption and 10.8 percent of total energy consumption.[8] Consequently, **the** automobile and light truck fleets represent the largest available targets **for reducing** U.S. **petroleum use, and they have in fact become the focal points of recent efforts to involve the Federal Government more actively in energy efficiency efforts.**

This report addresses ***apart*** of what the Federal Government can do to reduce fuel usage by the light-duty highway fleet; it focuses solely on enacting fuel economy regulations governing the efficiency of the fleet. The full range of options open to the Government is much broader, and includes strategies to:

- ***reduce light-duty vehicle travel demand*** by improving other travel modes, reducing the need for travel (e.g., by better urban planning or promotion of video conferencing), or increasing the costs of using light-duty vehicles;
- ***reduce congestion;***
- ***reduce maximum highway speeds;***
- ***increase vehicle occupancy;*** and
- ***improve vehicle efficiency*** through technology and design and through changes in the tradeoffs automakers ***and consumers*** make between fuel economy and other vehicle attributes such as performance and interior space.

The government can influence the efficiency of the fleet by accelerating fleet turnover; increasing gasoline costs (e.g., by a gasoline tax increase); taxing inefficient vehicles or giving rebates on efficient ones; and regulating new-car fuel economy.

Congress enacted the initial Corporate Average Fuel Economy (CAFE) regulations 15 years ago (see box 2-B). Although there appears a widespread public consensus that the CAFE program was a substantial success—in the interim period, average fuel economy of new cars improved by

[6] *MER* 1/91, pp. 7,27.

[7] Data from U.S. Department of Energy, Energy Information Administration, *1989 Annual Energy Outlook*, DOE/EIA-0383(89), January *1989.*

[8] Data *from* Oak Ridge National Laboratory, *Transportation Energy Data Book, Edition 11, ORNL-6649,* January 1991; and Energy Information Administration, *Annual Energy Review 1988,* DOE/EIA-0384(88), May 1989. Different sources of data and different definitions will give somewhat different values. For example, light trucks may include all light trucks, as in table 2.8 in the Oak Ridge document, or light trucks used for personal passenger travel, as in table 2.13 of the same document. For the value shown here, we use total light trucks, primarily because we don't have good data over time for the breakdown of personal light truck travel and freight light truck travel. Otherwise, using the lower figure for personal travel, as in table 2.13, would be preferable. Furthermore, the value for total energy consumption vanes with data source. We use 83.4 quads for 1988, from the Energy Information Administration.

### *Box 2B—Corporate Average Fuel Economy (CAFE) Standards and Measures*

In 1974, world oil prices tripled and the fuel economy of the new U.S. passenger car fleet hit a low point of 14 mpg. Congress responded to these events bypassing the Energy Policy and Conservation Act of 1975 (Public Law-163), which established CAFE standards for each automaker, starting at 18 mpg in 1978 and increasing to 27.5 mpg by 1985. Fleet CAFE values are measured as the sales-weighted harmon-c mean of the individual fuel economies of an automaker's models, with domestically produced and imported vehicles measured as separate fleets.

The Corporate Average Fuel Economy standards and many fuel economy statistics cited in the literature are expressed as the results of the test procedure administered by the Environmental Protection Agency. These values are not equivalent, even approximately, to actual on-road, or in-use, fuel economy values because EPA dynamometer tests do not fully simulate realworld driving conditions, and because the maintenance of the fleet and the driving behavior of the public may be quite different than that experienced during the tests.

EPA analyses conducted in 1984[1] determined that the new car fleet achieved average on-road fuel economy levels about 10 percent and 22 percent less, respectively, than EPA city and highway tests indicated. Using the 55 percent city/45 percent highway split adopted by EPA to simulate average driving, the composite on-road fuel economy would be about 15 percent less than the EPA composite. EPA uses the adjustment factors to calculate an approximate on-road average for each new car model, for reporting to potential purchasers. Also, most estimates of future automotive fuel usage use the same 15 percent adjustment factor applied to estimated future EPA new car fuel economies to calculate the fuel use of each model year's fleet. Consequently, forecasting fuel use by the highway sector depends substantially on the stability of the 15 percent adjustment factor.

[1]K.H. Hellman and J.D. Murrell, "Development of Adjustment Factors for the EPA City and Highway MPG Values," Society of Automotive Engineers technical paper SAE 840496, 1984.

100 percent, from about 14 mpg to roughly 28 mpg—there is strong dissension with this view among automakers and in certain academic and business circles. The dissenters claim most efficiency improvements resulted from market demand driven by rising oil prices and price expectations. Some have even claimed the regulations may actually have ***reduced*** total fleet fuel economy from what it would otherwise have been by slowing vehicle turnover during those periods when oil prices fell and consumers placed a low value on high fuel economy and a high value on those vehicle attributes (performance, vehicle weight) compromised by the need to improve fuel economy. Further, some dissenters claim the regulations, by forcing domestic automakers to increase sales of small cars (generally by lowering prices) and to downsize large cars, degraded overall safety of the fleet.[10] The issue of the relationship among fuel economy regulations, vehicle size, and overall vehicle safety is discussed in chapter 9.

One of the more powerful arguments that CAFE regulations ***did*** play a major role in improving new car fleet fuel economy is that those automakers that were constrained by the standards (primarily those with full car lines or lines tilted towards larger vehicles) exhibited significantly different behavior than those that were relatively unconstrained (those making primarily subcompacts and compacts). As discussed by

[9]As measured by the Federal test administered by the Environmental Protection Agency. Actual on-road fuel economy has been lower than the test values by about 15 percent, on average.

[10]For a cogent summary of these arguments, see R.W. Crandall, "The Changing Rationale for Motor Vehicle Fuel-Economy Regulation," *Regulation,* fall 1990.

Greene,[11] constrained automakers moved their fleet fuel economies upwards almost in lockstep with rising CAFE standards, whereas unconstrained automakers did not improve their fleet fuel economies as fast and tended to level off much earlier. Greene's statistical analysis indicates that the standards were at least twice as important as changes in oil prices as a "driver" of fuel economy.

This report does not attempt to resolve these two points of view; we are not certain any quantitative analysis would prove sufficiently convincing to end the argument. We note, however, that the process of enacting new fuel economy regulations balances important societal and private benefits (lower emissions of carbon dioxide, reductions in oil imports, lower fuel bills) against societal and personal costs (market distortions, potential losses in vehicle safety, increased capital expenditures for car design and manufacture, higher new car prices). At the "right" level, new fuel economy standards should save substantial quantities of oil, though at a cost. On the other hand, there may be some level beyond which further increases in the standards would be damaging to the industry: the standards would raise vehicle prices or degrade vehicle size and performance enough to significantly reduce new car sales. Because retirement of old, inefficient cars and their replacement with new efficient cars are the primary forces driving steady growth in fuel economy of the total on-road automobile fleet, slower turnover caused by overly stringent standards theoretically could produce a net ***increase*** in fuel use compared to more lenient standards. At a lesser extreme, even standards that would save large quantities of oil may have costs that outweigh their benefits; few if any policymakers believe oil savings should be pursued regardless of cost. Members of Congress who favor new fuel economy standards must take care to set standards that are a reasonable compromise between the need to encourage more fuel efficient design and technology, and a range of competing values.

[11] D.L. Greene, Oak Ridge National Laboratory, "CAFE OR PRICE? An Analysis of the Effects of Federal Fuel Economy Regulations and Gasoline Price on New Car MPG, 1978-89," contract paper for Office of Policy Integration, U.S. Department of Energy, revised Nov. 30,1989.