

February 2000

ENERGY POLICY ACT OF 1992

Limited Progress in Acquiring Alternative Fuel Vehicles and Reaching Fuel Goals



G A O

Accountability * Integrity * Reliability

Contents

Letter		3
Appendixes		
	Appendix I: General Characteristics of Alternative Fuels	28
	Appendix II: Acquisitions of Alternative Fuel Vehicles by Mandated Federal Agencies, State Governments and Fuel Providers	29
	Appendix III: Listing of Stakeholders Contacted During Our Review	31
	Appendix IV: Comments From the Department of Energy	33
	Appendix V: GAO Contacts and Staff Acknowledgments	37
Related GAO Reports		38
Tables		
	Table 1: Alternative Fuel Vehicle Acquisition Mandates for Centrally Fueled Fleets of Federal Agencies, State Governments, and Alternative Fuel Providers	6
Figures		
	Figure 1: Percentage of Total Alternative Fuel Vehicles Used by Federal Agencies, State and Local Governments, and Private Entities, 1998	11
	Figure 2: Purchases of Alternative Fuel Vehicles Necessary to Meet the Act's Fuel Replacement Goals	12
	Figure 3: Density of Refueling Stations for Gasoline and Alternative Fuels, 1999	14



B-284298

February 11, 2000

Congressional Requesters

The effects of the nation's petroleum consumption in the transportation sector on our energy security and environment have long been national concerns. The transportation sector currently accounts for about 67 percent of all petroleum use in the United States and roughly 25 percent of total energy consumption. Each day, vehicles in the United States consume about 10 million barrels of petroleum fuels, primarily gasoline and diesel. The Department of Energy's (DOE) Energy Information Administration projects that this figure will rise to about 15 million barrels by 2010 and that much of this consumption will be met by importing oil. Over the past 25 years, a number of steps have been taken to reduce petroleum consumption in the transportation sector. Numerous laws and policies have been implemented, including encouraging the use of mass transit and high-occupancy vehicles (e.g., carpooling), improving auto efficiency, and developing alternative fuels—either by themselves or as a blend with gasoline.

In 1992, Congress passed the Energy Policy Act (the act) with the objective, among others, of reducing petroleum use in transportation by encouraging the use of alternative fuels in light-duty vehicles (cars and light trucks). Alternative fuels include ethanol, methanol, natural gas, propane, electricity, and biodiesel, among others. Alternative fuel vehicles operate on these fuels, although some of them can also consume gasoline. The act established goals of having alternative fuels replace at least 10 percent of the petroleum fuels projected to be consumed in 2000 and at least 30 percent of projected consumption in 2010. To help reach these goals, it also mandated that a portion of the new vehicles acquired for fleets operated by federal agencies, state governments, and alternative fuel providers must be alternative fuel vehicles.¹ DOE was tasked with a number of responsibilities related to these activities, including monitoring the

¹Alternative fuel providers, as defined by the act, are businesses that are involved in (1) producing, refining, storing, processing, transporting, distributing, importing, or selling at the wholesale or retail level alternative fuels other than electricity; (2) generating, transmitting, importing, or selling wholesale or retail electricity; or (3) producing or importing an average of 50,000 barrels per day of petroleum.

progress towards the fuel replacement goals and collecting data to measure compliance with the act's fleet mandates.

With the first deadline approaching for the act's petroleum replacement goals, you asked that we review progress towards achieving these goals through the use of alternative fuel vehicles. More specifically, you asked that we determine (1) the progress made in acquiring alternative fuel vehicles and using alternative fuels to meet the act's fuel replacement goals, (2) the impediments to using alternative fuel vehicles, and (3) the measures that can be taken to address those impediments to using alternative fuel vehicles and alternative fuels to help reach the act's replacement goals.

Results in Brief

Since the passage of the Energy Policy Act of 1992, some, albeit limited, progress has been made in acquiring alternative fuel vehicles and reducing the consumption of petroleum fuels in transportation. DOE estimates about 1 million alternative fuel vehicles were on the road in 1999, about 0.4 percent of all vehicles. It also estimates that, in 1998, alternative fuels used in alternative fuel vehicles replaced about 334 million gallons of gasoline, which represents about 0.3 percent of the total gasoline consumed during that year. In addition, about 3.9 billion gallons of alternative fuels (e.g., ethanol and methanol) were blended with gasoline and used in conventional vehicles in 1998.² Thus, in total, about 4.23 billion gallons of gasoline were replaced by alternative fuels or approximately 3.6 percent of all highway gasoline use—considerably less than the act's goal of 10 percent in 2000. Consistent with this data, in a 1999 draft report required by the act for the Congress, DOE concluded that the act's goals for replacing petroleum fuels with alternative fuels would not be achieved under current conditions.

The goals in the act for fuel replacement are not being met principally because alternative fuel vehicles have significant economic disadvantages compared to conventional gasoline vehicles. Fundamental economic impediments—such as the relatively low price of gasoline, the lack of refueling stations for alternative fuels, and the additional cost to purchase

²This blend is known as oxygenated gasoline, which consists primarily of gasoline with small additional quantities of oxygenated compounds derived from ethanol or methanol. The act recognizes these compounds as counting towards the fuel replacement goals. This fuel is currently available in a number of states.

these vehicles—explain much of why both mandated fleets and the general public are disinclined to acquire alternative fuel vehicles and use alternative fuels. In addition, aspects of the act's approach do not directly address its goal to replace petroleum fuels. For example, because the act mandated federal and state agencies and alternative fuel providers to meet certain acquisition targets for alternative fuel vehicles rather than establish targets for alternative fuel use, some alternative fuel vehicles acquired under the fleet mandate are being fueled with gasoline—thereby making no contribution to the fuel replacement goals. The act also limits its focus to light-duty vehicles and does not include other ways to reduce petroleum consumption, such as increasing the use of alternative fuels in heavy-duty vehicles or mandating the use of vehicles that consume gasoline more efficiently.

Any efforts to significantly expand the use of alternative fuel vehicles will need to address their current cost disadvantages relative to vehicles that use gasoline. In general, the economic disadvantages of alternative fuel vehicles relative to conventional fuel vehicles are substantial. According to a DOE analysis performed at our request, using a well-established econometric model, even if crude oil prices doubled from current levels of about \$20 per barrel, alternative fuels' share of the market would not increase. While tax credits or other financial incentives could be used to reduce the cost of alternative fuel vehicles and encourage their use, both of these measures would involve very large costs to drivers or taxpayers and, as such, are unlikely to be acceptable. While such dramatic measures would be necessary to meet the act's goals with alternative fuel vehicles, some modest increases in the use of alternative fuels and/or reductions in the use of gasoline could occur if limitations in the act's approach were addressed. For example, the focus of the act's mandates could shift from acquiring alternative fuel vehicles to using alternative fuels. The act's scope could broaden from exclusively promoting alternative fuels to include other ways to reduce the use of petroleum fuels, such as using more efficient gasoline vehicles. The act could also target its promotion of alternative fuels to specific areas where a particular fuel might be plentiful or applications in which the fuels will make better economic sense.

Background

The Energy Policy Act of 1992 contained provisions designed to help reduce the nation's use of petroleum fuels in the transportation sector through the use of alternative fuel vehicles. The act set goals for replacing the use of petroleum fuels by 10 percent by the year 2000 and by 30 percent by the year 2010. A major component of these goals was mandating the acquisition of light-duty alternative fuel vehicles, such as cars and light trucks, for centrally fueled light-duty vehicle fleets used by federal agencies and state governments as well as fleets used by alternative fuel providers. As shown in table 1, the act required that a certain percentage of the vehicles acquired each year by fleet operators be alternative fuel vehicles. These percentages differed across groups and increased over time. The act designated the type of fuels recognized as alternative or replacement fuels.³

Table 1: Alternative Fuel Vehicle Acquisition Mandates for Centrally Fueled Fleets of Federal Agencies, State Governments, and Alternative Fuel Providers

Year	Percentage of all acquisitions for groups mandated to acquire vehicles		
	Federal agencies	State Governments	Alternative fuel providers
1996	25	N/A	N/A
1997	33	10	30
1998	50	15	50
1999	75	25	70
2000	75	50	90
2001 and beyond	75	75	90

Note: The act mandated that the federal government had to acquire 5,000 alternative fuel vehicles in 1993, 7,500 vehicles in 1994, and 10,000 vehicles in 1995. It did not require state governments and alternative fuel providers to acquire alternative fuel vehicles during these years. In addition, the states' and fuel providers' acquisition mandates for 1996 were postponed for 1 year.

Source: Energy Policy Act of 1992 and DOE.

³The act made a distinction between these fuels. Alternative fuels were alternatives to gasoline and diesel, and replacement fuels were portions of alternative fuels that would be added to gasoline to displace a certain amount of gasoline per gallon of fuel.

The act also identified alternative fuels as methanol, denatured ethanol, and other alcohols; mixtures (85 percent)⁴ of these components with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels derived from biological materials; electricity, and any other fuels that are substantially not petroleum and that are determined to be acceptable by the Secretary of Energy. Appendix I provides information on some general characteristics of the primary alternative fuels. The act also gave the Secretary of Energy the authority to adjust the act's fuel replacement goals as well as to include other fuels that might meet the purposes of the act. DOE expanded the definition of alternative fuels through a rule-making to include, "neat" fuels or 100 percent by volume biodiesel and "P-series" fuels derived from ethanol and other chemicals from plant materials.

The act also established a variety of other authorities and requirements to promote the use of alternative fuel vehicles. Specifically, the act required DOE to establish a program to promote the replacement of petroleum fuels to the maximum extent possible and to determine the technical and economic feasibility of achieving the act's petroleum replacement goals. DOE's efforts have included activities to promote the use of alternative fuels and alternative fuel vehicles; collect and analyze data on related issues and concerns; establish rules and regulations; and develop voluntary partnerships to advance the use of alternative fuel vehicles, such as the Clean Cities Program.⁵ For example, Section 506 of the act required that DOE assess the progress made in achieving the act's goals and the role and the availability of alternative fuels and alternative fuel vehicles in reducing the demand for imported petroleum fuels. DOE is currently undertaking these assessments and considering potential changes, such as lowering or delaying the goal or mandating that private sector and local government fleets acquire alternative fuel vehicles.

To help implement the act, on April 21, 1993, the President issued Executive Order 12844, Federal Use of Alternative Fueled Vehicles. This

⁴DOE has statutory authority to issue a rule to designate alcohol mixtures below 85 percent, but above 70 percent, as alternative fuels for cold start purposes. DOE has not utilized this authority.

⁵The Clean Cities Program was established to stimulate voluntary commitments at the municipality level to develop alternative fuel markets through acquiring alternative fuel vehicles, developing alternative fuel infrastructures, and communicating information on the merits of using these vehicles and alternative fuels.

order is based on the premise that the federal government would provide a significant impetus for developing and manufacturing alternative fuel vehicles and for expanding the fueling infrastructure necessary to support large numbers of privately owned alternative fuel vehicles. To supercede this order, a new Executive Order, 13031, Federal Alternative Fueled Vehicle Leadership, was issued in December 1996. The new order directed agencies to implement aggressive plans to fulfill the act's requirements for the acquisition of alternative fuel vehicles and establish reporting requirements.

Over the last 20 years, GAO has issued many reports on a number of alternative fuel vehicles, including those that use ethanol, methanol, propane, and electricity. These reports discussed the potential for some of these fuels and the importance of their cost-effectiveness compared to gasoline vehicles. Furthermore, we reported that federal and state incentives have played an important role in expanding the use of these fuels. More recently, after the act's passage, we issued a report *Alternative Fueled Vehicles: Progress Made in Accelerating Federal Purchases, but Benefits and Costs Remain Uncertain* (GAO/RCED-94-161, July 15, 1994). In this report, we noted that the net benefits of alternative fuels would depend heavily on expanding the use of these fuels beyond mandated fleets to the much larger private vehicle market. We also pointed out that this expansion would depend on how alternative fuels compare with gasoline in cost, performance, and convenience. A list of some of our most recent related reports is provided in the back of this report.

Limited Progress Has Been Made Towards Act's Fuel Replacement Goals and Achievement of the Alternative Fuel Vehicle Mandate Is Uncertain

To date, limited progress has been made towards achieving the act's goals of replacing petroleum fuels with alternative fuels. Also, acquisitions of alternative fuel vehicles by the mandated fleets of federal agencies, state governments, and fuel providers have been mixed, and it is difficult to determine if all mandated fleets have been meeting their acquisition targets.

**Fuel Replacement Goals
Will Not Be Met**

Limited progress has been made in reaching the act's goals to replace 10 percent of petroleum fuels in 2000, and it is unlikely the 30-percent goal for 2010 will be met. According to the Energy Information Administration, about 1 million alternative fuel vehicles were on the road in 1999. However, the number of alternative fuel vehicles represented only about 0.4 percent of the estimated 212 million vehicles in the United States in 1998.

DOE estimates that, in 1998, alternative fuels replaced about 334 million gallons of gasoline, which represents 0.3 percent of the total gasoline consumed during that year. DOE also estimates that about 3.9 billion gallons of alternative fuels (e.g., ethanol and methanol) were blended with gasoline and used in conventional vehicles in 1998. Thus, in total, about 4.23 billion gallons were replaced by alternative fuels or approximately 3.6 percent of all highway gasoline use—considerably less than the act's goal of 10 percent in 2000. Consistent with this data, in a 1999 draft report, *Replacement Fuel and Alternative Fuel Technical and Policy Analysis*, required by the act for the Congress, DOE concluded that the act's goals for replacing petroleum fuels with alternative fuels would not be achieved under current conditions.

**Progress Towards Meeting
Acquisition Mandates Is
Uncertain**

The act requires that a certain percentage of vehicles in fleets operated by each federal agency, state government, and alternative fuel provider be alternative fuel vehicles. (See appendix II for information on the acquisition of alternative fuel vehicles by these groups.) DOE officials said that there are mixed results among the federal agencies, with some agencies exceeding their mandates, while others are acquiring very few or no alternative fuel vehicles. For example, in 1998, the U.S. Postal Service acquired 10,000 ethanol alternative fuel vehicles for mail delivery vehicles. This purchase played a major role in the federal government's collectively meeting the federal mandate for that year. DOE officials believed that most states are in compliance with the mandate. However, they said that the progress of fuel providers is uncertain because of the limited amount of information they currently have on this group.

DOE acknowledged that it does not have a complete inventory of all fleets for each group that would be subject to the act's mandates. DOE believed, however, that it has a good understanding of the fleet inventory of federal agencies and state governments, but has less certainty with the fleets of fuel providers. As a result, a complete and accurate determination of compliance with the mandates is impossible. DOE officials acknowledged that they do not audit or survey the mandated groups to determine whether

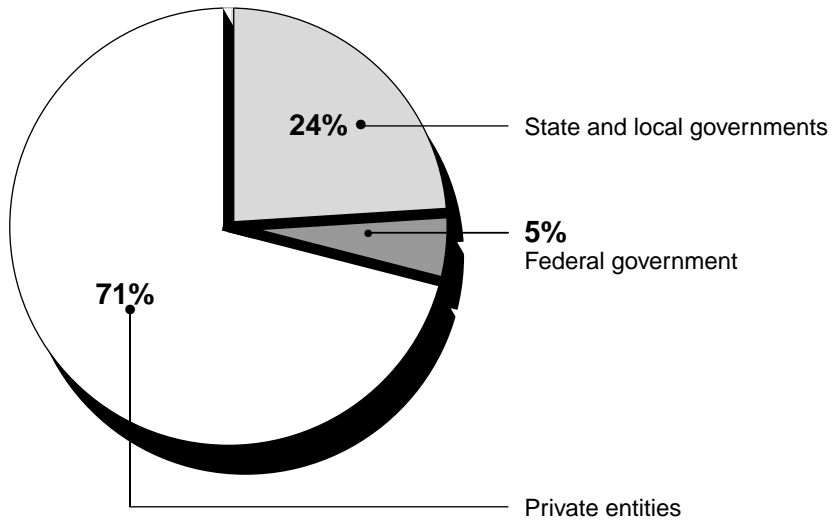
each of their fleets subject to the mandate is reporting its acquisitions of alternative fuel vehicles.

However, it is important to recognize that even if all the mandated fleets operated by these groups would fully comply with their acquisition targets, the goals for petroleum fuel replacement would not be met. The number of vehicles in these fleets and their total use of alternative fuels has been relatively small compared to the number of vehicles that would be needed to meet the act's fuel replacement goals. DOE estimated that, if federal agencies, state governments, and alternative fuel providers fully complied with the act's mandates, the vehicles in their fleets would replace less than 1 percent of petroleum fuels in 2010. This amount is far below the act's goals of 10 and 30 percent replacement in 2000 and 2010, respectively.⁶

DOE officials acknowledged that the act's mandates were not designed, by themselves, to replace enough petroleum fuel to reach its goals. They stated that the vehicle acquisition mandates were intended to demonstrate the use of alternative fuels and stimulate the acquisition of alternative fuel vehicles by the general public. Two federal officials also told us that some of the act's supporters believed that the demand for alternative fuel vehicles by the fleets specified in the act would be large enough to create a general market for these vehicles. Representatives from auto manufacturers also stated that the fleets subject to the act are too small to significantly affect the market. They made this assertion because the mandated fleets represent a relatively small share of the current market for alternative fuel vehicles. As shown in figure 1, federal, state, and local governments together operated less than 30 percent of the alternative fuel vehicles in 1998.

⁶DOE had estimated that if an acquisition mandate were established for the private sector and local governments, their compliance would increase the fuel replacement percentage to about 2 percent.

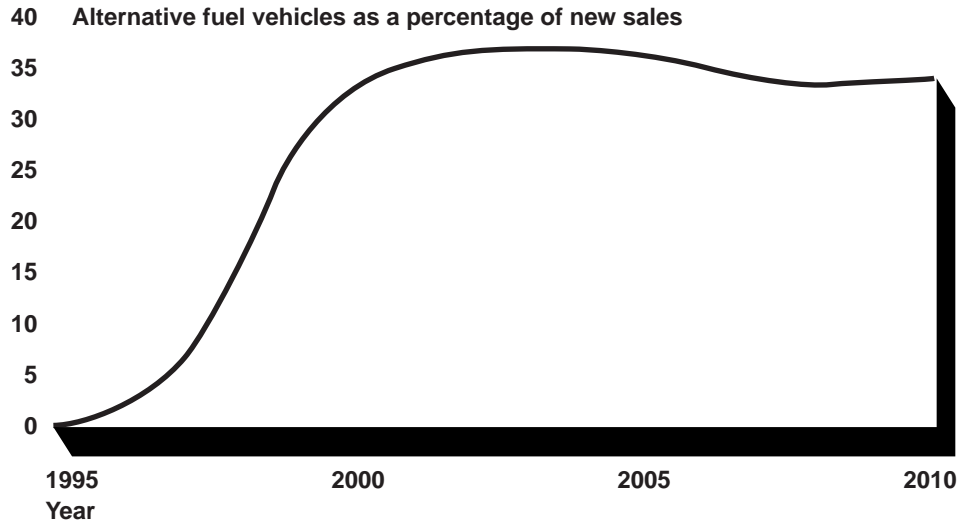
Figure 1: Percentage of Total Alternative Fuel Vehicles Used by Federal Agencies, State and Local Governments, and Private Entities, 1998



Source: Energy Information Administration.

To reach the act's goals of 10 percent and 30 percent replacement in 2000 and 2010, respectively, the general public would have to purchase a very large number of alternative fuel vehicles. For instance, to reach the 10-percent goal, DOE estimates that sales of alternative fuel vehicles would have to grow by about 1.5 to 1.9 million vehicles per year. By comparison, the entire production of Ford's passenger cars in 1996 was slightly more than 1.4 million. As shown in figure 2, to reach the 30-percent goal, sales of alternative fuel vehicles would have to represent between 35 and 40 percent of all light-duty vehicle sales in 1999, then stay at between 30 and 38 percent of all sales from 2000 to 2010. This rapid market penetration is beyond the auto industry's typical pattern for introducing a conventional model or technology into the marketplace. As a result, DOE concluded in a recent draft report that, under current circumstances, the act's fuel replacement goals will not be met.

Figure 2: Purchases of Alternative Fuel Vehicles Necessary to Meet the Act's Fuel Replacement Goals



Source: DOE.

Economic Impediments Hamper Use of Alternative Fuel Vehicles

Limited progress has been made towards reaching the Energy Policy Act's goals for fuel replacement principally because alternative fuel vehicles have significant economic disadvantages compared with conventional gasoline vehicles. These economic disadvantages explain much of the general public's reluctance to buy the vehicles and the difficulties that fleets subject to the act have in using them. Although our review identified a variety of factors that hinder the acceptance of these vehicles, several economic impediments appear to be fundamental.

First, the cost of gasoline is not high enough to entice consumers to switch to alternative fuel vehicles. The historically low cost of gasoline has sustained an entire refueling infrastructure and auto-manufacturing system dedicated to this fuel. This system has become more developed and entrenched over time. Even if the price of gasoline rose above the price of an alternative fuel, few consumers would switch to alternative fuel vehicles. To induce the general public to discard their conventional vehicles, the price of gasoline would have to reach a level high enough that consumers' increased spending on gasoline also surpassed the other costs associated with alternative fuel vehicles, such as longer trips to refuel

because of the limited number of refueling stations, higher vehicle purchase price, maintenance, limitations in vehicle performance, and consumers unfamiliarity with the vehicles. In addition, because fuel constitutes a relatively small percentage of the total cost of driving, the price of gasoline would have to increase substantially for consumers to discard conventional vehicles for those that run on alternative fuels.

Second, the lack of refueling stations that provide alternative fuels has been a major impediment to using alternative fuel vehicles. Officials from federal agencies and state governments who administer vehicle fleets cited the lack of a refueling infrastructure more than any other impediment to using alternative fuels. Because of the lack of demand for alternative fuel vehicles, owners of refueling stations are reluctant to provide facilities to refuel them. In addition, the high cost of providing some alternative fuels at existing refueling stations reduces station owners' willingness to provide the facilities. For example, building facilities to provide compressed natural gas cost approximately \$300,000—significantly more than the cost of refueling stations for gasoline, ethanol, or methanol. Conversely, the lack of refueling stations for alternative fuels makes it less convenient for the general public to obtain the fuels, and, thus, deters the general public from buying the vehicles.

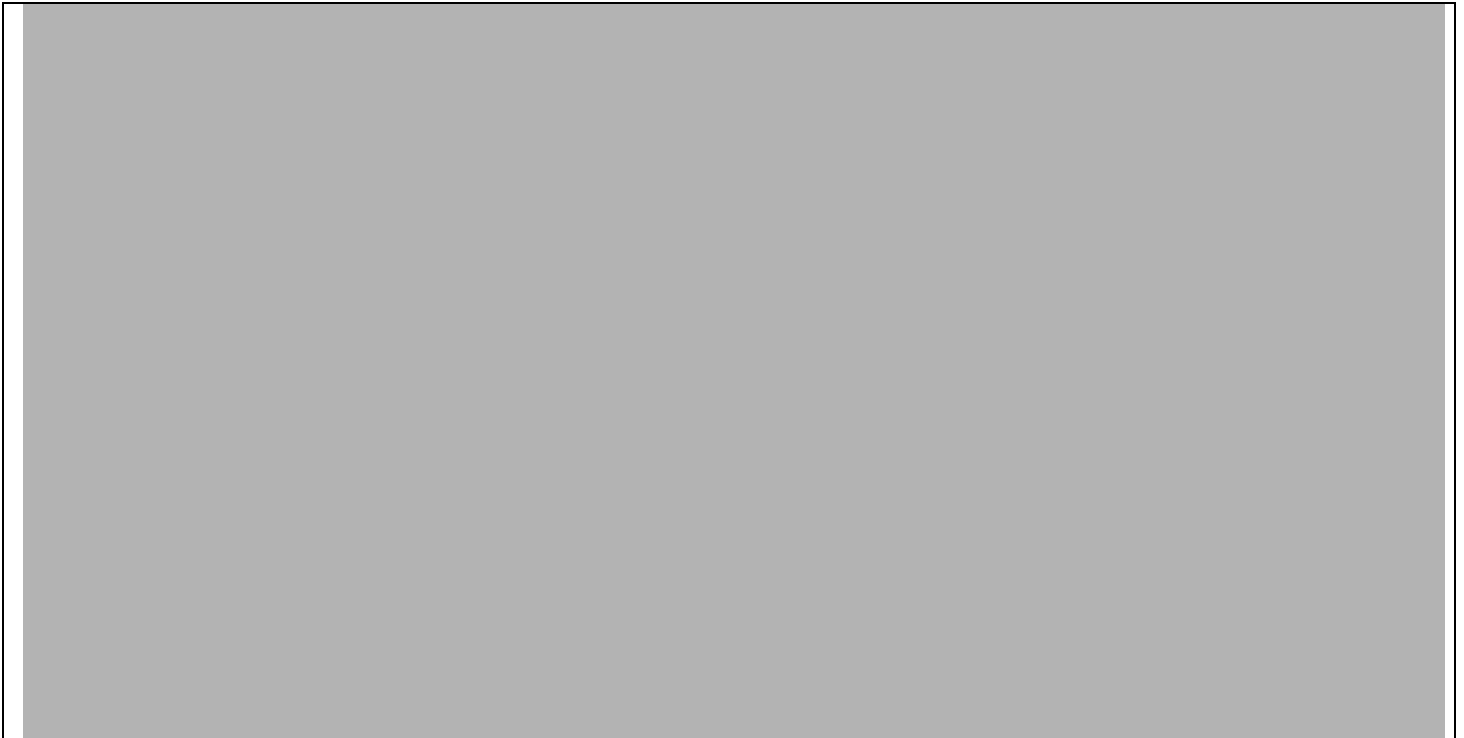
The number of refueling stations for alternative fuels in the United States is far below the level that would be necessary to support the act's goals for fuel replacement. In the past, DOE has estimated the number of refueling stations that would be necessary if alternative fuel use increased significantly. Under three scenarios provided to GAO that used an alternative fuel model, DOE estimated that the number of alternative fuel refueling stations necessary to reach the act's 30-percent goal by 2010 ranges from 60,000 to 69,300.⁷ This represents more than 10 times the number of refueling stations for alternative fuels that were available in 1999.

⁷The three scenarios were as follows: (1) World crude oil prices equal those projected in the "high" case by DOE in its 1999 Annual Energy Outlook, and liquid petroleum gas prices are relatively low; (2) world crude oil prices are \$16 above the base case prices projected in the 1999 Annual Energy Outlook, and the prices of alternative fuels contain a subsidy for greenhouse gases avoided; (3) World crude oil prices are \$18 above the base case prices projected in the 1999 Annual Energy Outlook, and DOE mandates that private and local fleets acquire alternative fuel vehicles and requires these fleets to run them with at least 50 percent alternative fuels. GAO did not make a detailed review of DOE's modeling of these scenarios.

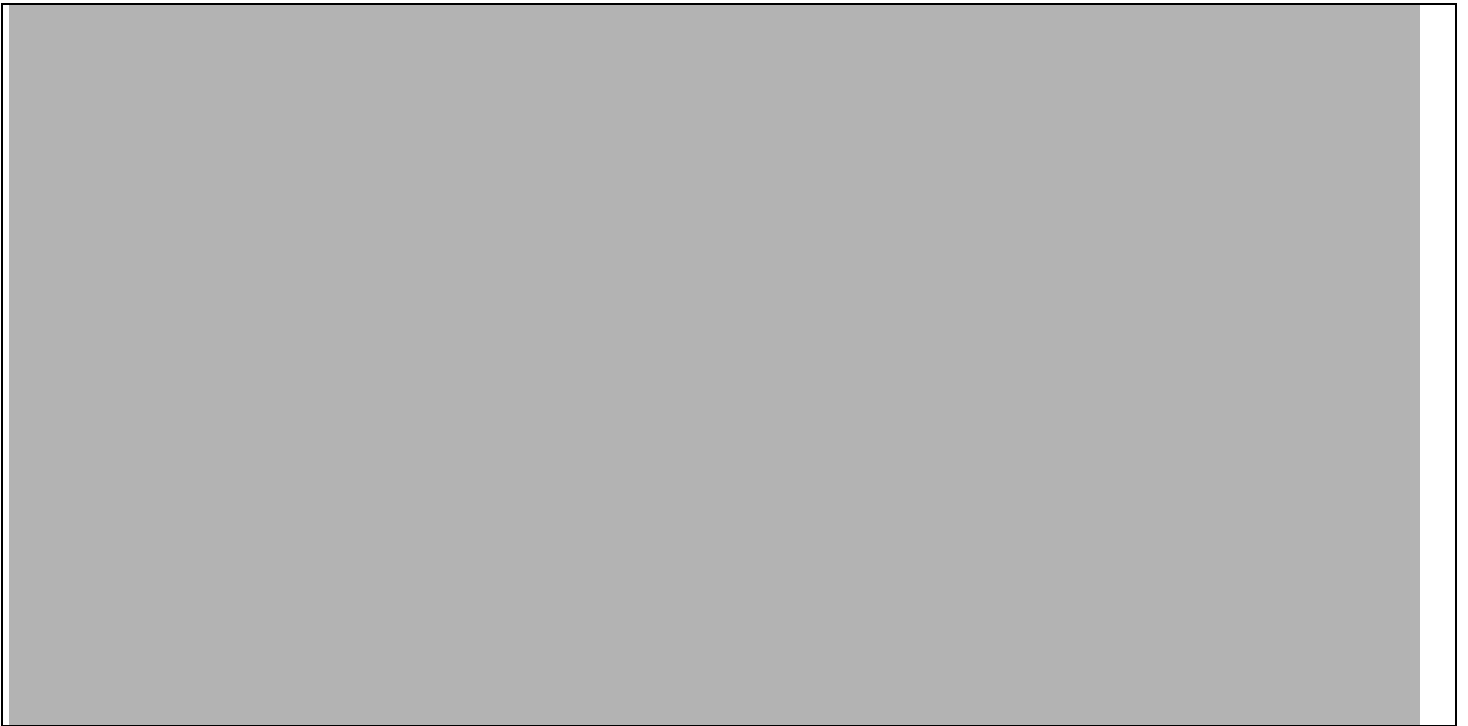
The number of alternative fuel refueling stations currently available is far less than the approximately 180,000 gasoline refueling stations available in 1999. As shown in figure 3, refueling stations for gasoline are numerous and densely configured throughout the United States. As a result, the general public usually has to travel short distances to refuel their vehicles. By comparison, the number of refueling stations for alternative fuel vehicles is generally sparse.

Figure 3: Density of Refueling Stations for Gasoline and Alternative Fuels, 1999

Gasoline Stations



Alternative Fuel Stations



Source: Energy Information Administration.

Note: Each dot represents 10 refueling stations in the state, rounded up to the next highest 10 (e.g., a state with 11 stations would receive 2 dots). The dots in each state do not correspond to the geographic location of stations in the state.

The refueling stations for some alternative fuels are more numerous in specific areas, such as methanol in the West. Refueling stations are more evenly distributed around the country for compressed natural gas. While liquefied petroleum gas has more refueling sites around the U.S. than any other alternative fuel, many of them are designed for other fuel uses, such as heating or recreation, and are located on campgrounds or other remote locations.⁸ Because there are significantly fewer refueling stations for alternative fuels compared to gasoline, many owners of alternative fuel vehicles would have to incur significantly higher costs in convenience, limitations in range, and distance traveled to obtain fuel.

Third, according to most stakeholders, the higher costs to purchase alternative fuel vehicles have deterred buyers, although these costs vary by type of vehicle. For example, vehicles that can run on ethanol alone or a mixture of it with gasoline have prices that are often very close to the price of a conventional version of the same vehicle. Conversely, a vehicle that runs on compressed natural gas generally costs from \$3,000 to \$5,000 more than the conventional version of the same vehicle. In addition, the current price of an electric vehicle generally ranges from the low \$30,000s to the mid \$40,000s, according to the Electric Vehicle Association of the Americas. Because of the high price, most of the estimated 3,500 electric vehicles they identified as operating today are leased.

The costs for alternative fuel vehicles are often higher because consumer demand for them is not large enough to achieve economies of scale in production. These higher costs pose problems for both the general public and fleets subject to the act. According to several federal officials, the higher cost of these vehicles makes it difficult for an agency's fleet managers to satisfy the act's mandates within their limited budgets. Several fleet managers told us their primary responsibility is to acquire the number of vehicles that will satisfy their agency's mission. Buying alternative fuel vehicles has a lower priority. Thus, when budget constraints make it impossible to satisfy both the agency's mission and the act's mandates to acquire alternative fuel vehicles, fleet managers obtain conventional vehicles.

⁸Liquefied petroleum gas is primarily propane. According to a previous GAO report (Energy Policy Act: Including Propane as an Alternative Motor Fuel Will Have Little Impact on Propane Market, (GAO/RCED-98-260, Sept. 28, 1998), officials in the propane industry do not believe the industry has the internal cohesion necessary to promote the use of propane as an alternative fuel.

In addition to these economic impediments, aspects of the Energy Policy Act's approach have hindered the replacement of petroleum fuels with alternative fuels. For example, the act mandates targets for the acquisition of alternative fuel vehicles for fleets operated by federal agencies, state governments, and fuel providers. However, the act does not establish targets for alternative fuel use for these vehicles. As a result, according to some federal officials, fleet managers or drivers often run their alternative fuel vehicles on gasoline. In some cases, fleet managers have had to run the vehicles on gasoline because there were no refueling stations for alternative fuels in the area. In other cases, fleet managers used gasoline because they had concerns about the safety or reliability of alternative fuels or did not realize a vehicle could run on an alternative fuel. Some of these officials also believed that DOE should require all entities covered by the act to use alternative fuels whenever possible in vehicles that can run on them.

The act also limits its mandates by specifying the acquisition of light-duty passenger vehicles. State officials from Maryland and officials from the Natural Gas Vehicle Coalition thought use of heavy-duty vehicles, such as buses or trucks that use alternative fuels, should be included under the mandates. These officials believe that many uses of heavy-duty vehicles are well suited to using alternative fuels because the vehicles use more fuel per vehicle than a light-duty vehicle.⁹

Finally, the act seeks to enhance the nation's energy security by substituting petroleum fuels with alternative fuels. Reducing the consumption of petroleum fuels would also support the act's goals, but the act only requires that fleets subject to its mandates acquire alternative fuel vehicles, not that the fleets reduce gasoline consumption. As a result, fleets subject to the act's mandates could not satisfy their requirements by using emerging technologies, such as hybrid electric vehicles, that may also run on gasoline or diesel, but will be very efficient. Honda and Toyota recently have each introduced a hybrid electric vehicle for sale in the United States.¹⁰ Reportedly, these vehicles can achieve fuel efficiencies ranging from 50 to 70 miles per gallon.

⁹This assumes the heavy-duty vehicle and light-duty vehicle are travelling the same distance.

¹⁰A hybrid electric vehicle operates on gasoline, diesel, fuel cells, or other fuels in combination with an electric battery. These vehicles are designed to be much more energy efficient than a conventional vehicle and produce much lower emissions.

Increasing Alternative Fuel Use Significantly Will be Costly and May Require Changes in Approach

To reach the act's goals for fuel replacement, a large proportion of the general public would have to use alternative fuel vehicles and alternative fuels. However, the economic impediments that deter the public from buying alternative fuel vehicles are significant and fundamental, and the costs of ameliorating them will be high.

Consumers will purchase alternative fuel vehicles only if gasoline prices became so high that the increased spending on gasoline surpassed all the added costs of using an alternative fuel vehicle. In an analysis conducted for GAO, DOE estimated that even if crude oil prices doubled from the current level of about \$20 per barrel, alternative fuels' share of the market among transportation fuels would not increase. According to DOE's analysis, the use of alternative fuels would approach the act's goals only if current world oil prices increase substantially (e. g., to a sustained level that is \$18 per barrel above the prices currently projected by DOE) in combination with specific policy initiatives, such as adopting mandates that the fleets of local government and private sector fleets acquire alternative fuel vehicles.¹¹ Alternatively, tax or other financial incentives could be used to reduce the cost of alternative fuel vehicles and encourage their use. However, given the extent of the economic disadvantages of alternative fuel vehicles compared to gasoline vehicles and the magnitude of the act's goals, the incentives would most likely have to be very large and sustained, making them unlikely to be acceptable.

Overcoming the lack of refueling stations would also be costly. DOE estimated the cost of building these refueling stations. For example, in an analysis provided to GAO, DOE estimated that the nationwide cost of constructing the refueling facilities necessary to reach the act's fuel replacement goal in 2010 would range from \$2.7 billion to \$10.5 billion, depending on the alternative fuels used.

Changes in the act's approach may also increase the use of alternative fuels. For fleets subject to the act, several agency officials suggested that shifting the act's focus from acquiring alternative fuel vehicles to using alternative fuels would address the problem of acquiring alternative fuel vehicles and operating them with gasoline. Alternatively, the act's focus could be expanded from exclusively promoting alternative fuels to

¹¹Under this scenario, the mandate would also require that local government and private sector fleets use at least 50 percent alternative fuel in their alternative fuel vehicles.

including other strategies to decrease the use of petroleum fuels in transportation, such as increased fuel efficiency. Currently, the act does not allow for reductions in petroleum consumption to count towards its goals. For example, the act could include vehicles that operate on gasoline or diesel but are very efficient. The act does not allow fleets to satisfy its mandates by acquiring emerging technologies, such as hybrid electric vehicles, because they run on petroleum fuels. Some representatives of the automobile manufacturing industry believe that alternative fuel vehicles may be transitional until these hybrid vehicles become established in the marketplace. Others believe that the role of alternative fuel vehicles will diminish and may never evolve beyond small niche markets.

In addition, the act could target its promotion of specific alternative fuels to areas where they are plentiful or to those applications that make more economic sense. For instance, in the Midwest, ethanol probably has the advantage over other alternative fuels because it is produced there. Some applications, particularly those involving heavy-duty vehicles that do not drive long distances, may make better use of alternative fuels than others. For example, according to state officials, Maryland has successfully used shuttle buses at Baltimore-Washington International Airport that run on compressed natural gas.

Any policies designed to help reach the act's goals will have a greater chance for success if they involve a larger section of the driving public. Currently, if the fleets subject to the act comply fully with its mandates, only 2 percent of gasoline and diesel consumption would be replaced in 2010, according to DOE. Several fleet managers and representatives of the automobile industry acknowledge it is unlikely that usage of alternative fuel vehicles by these fleets will convince the general public to buy them. Furthermore, many federal and state initiatives, primarily tax incentives, currently exist to encourage the general public to purchase alternative fuel vehicles, but purchases by the general public remain small, primarily because of economic disadvantages.

It is important to note that, even with changes in the act's approach, the specific policies (e.g., higher gas taxes, subsidies, or tax incentives) to encourage the significant use of alternative fuels or the conservation of petroleum fuels by the general public will be costly to government and consumers.

Finally, if the act's mandates shift towards a greater focus on using alternative fuels or conserving petroleum fuels, monitoring compliance

would require a shift in performance measures from counting the number of alternative fuel vehicles an agency acquires to monitoring an agency's fuel use. According to agency officials, this shift will not be easy. For example, several federal officials told us that the credit cards the federal government currently uses for refueling cannot be used to track the type of alternative fuel that a driver purchases. According to program officials from the General Services Administration, steps are being taken to address this problem. Officials from the Department of Defense stated that its compressed natural gas vehicles often refuel at the facilities on military bases. Because the fuel from these facilities are used for a variety of applications, determining how much natural gas has been used by these vehicles is difficult.

Conclusions

The Energy Policy Act's goals to replace at least 10 percent of petroleum fuel with alternative fuels in 2000 and 30 percent in 2010 will not be achieved under current economic conditions. Widespread acceptance of alternative fuels will be primarily determined by economics, not by provisions in the act. The general public would shift significantly towards alternative fuels only if there are (1) dramatic and sustained increases in the price of gasoline and/or (2) very large incentives to reduce the cost of alternative fuel vehicles and encourage their use. Both of these measures would involve high costs, making them unlikely to be acceptable. While such significant measures would be necessary to meet the act's goals with alternative fuel vehicles, some modest increases in the use of alternative fuels and/or reductions in the use of gasoline could occur if limitations in the act's approach were addressed. Given current authority, the Secretary of Energy can initiate actions to bring about these modest increases in the use of alternative fuels. However, making more substantial progress toward the overall goal of reducing petroleum use by 30 percent in transportation will require the Secretary and the Congress to consider and choose among broader policy alternatives.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for its review and comment. (See App. IV.) In general, DOE agreed with the key findings and conclusions in our report. DOE also said that, overall, the report provides an objective review of the progress that has been made in implementing the act's alternative fuel provisions. However, DOE provided additional perspectives on the results of our work in the following four areas: (1) whether the act's fuel replacement goals can be met and the cost to do so, (2) the

acceptability of incentives with significant costs, (3) the act's structural limitations, and (4) the extent to which the economic disadvantages and performance limitations of alternative fuel vehicles deter consumers from acquiring them. In addition, DOE suggested that we point out that U.S. dependence on imported oil is increasing and that this trend is likely to make the economy more vulnerable to disruptions in the supply of oil.

Regarding the act's fuel replacement goals and the cost to reach them, DOE agreed with our conclusion that, under current economic conditions, the act's goal to replace 30 percent of petroleum fuels used for transportation by 2010 will not be achieved. DOE said that this conclusion was consistent with its own analyses. However, DOE noted that some of its analyses also suggest that these goals could be met if the transitional impediments, such as the high cost and low-volume production of alternative fuel vehicles and the limited number of refueling stations, could be overcome. In its comments, DOE mentioned a scenario under which higher oil prices, in combination with policy initiatives, such as fuel tax incentives to address these impediments, would achieve the act's goals. We agree that there are scenarios under which the act's goals could be met and have provided such an example in this report. While we agree that higher oil prices in concert with other measures—if large enough—have the potential to increase the use of alternative fuels, the basic message is the same. Changing a transportation system, which has evolved over many years to take maximum advantage of relatively inexpensive gasoline, is likely to come at a substantial cost. We made no changes to our report for this comment.

Regarding the acceptability of incentives, DOE agreed that large incentives would be required to meet the act's goals with alternative fuel vehicles, but differed with our view that the costs of these measures are unlikely to be acceptable. As an example, DOE cited the estimated cost of building enough alternative fuel refueling stations to reach the act's goals—between \$2.7 and \$10.5 billion—as small relative to the public expenditures made for national defense, public roads, and transit. While DOE believes the cost to build refueling stations may be small compared to other major federal expenditures, this cost represents only one of the costs to society of transitioning to alternative fuel vehicles. As we mention in our report, other costs to using alternative fuel vehicles, such as higher vehicle prices, maintenance costs, performance limitations, and consumers' unfamiliarity with these vehicles, may be significant. Consumers consider all these costs when deciding whether to buy an alternative fuel vehicle. We made no changes in our report for this comment.

With regard to the structural limitations in the act, DOE agreed with our statement that modest increases in the use of alternative fuels and/or reductions in gasoline use could occur if some of these limitations were addressed. For example, DOE believed that, if mandated fleets were required to use alternative fuels, the number of alternative fuel stations available to the public would significantly increase. As we state in our report, mandated fleets are not large enough to substantially increase the market for alternative fuel vehicles nor result in large increases in alternative fuels' share of the market. Thus, although we agree that a requirement that mandated fleets use alternative fuels would slightly increase the use of these fuels, this increase would not be large enough to significantly increase the number of alternative fuel stations. We made no changes in our report for this comment.

Regarding the economic disadvantages of alternative fuel vehicles, DOE agreed with our assessment that consumers will generally choose conventional vehicles because of the economic disadvantages of alternative fuels. However, DOE suggested that these economic disadvantages would be ameliorated if higher volumes of alternative fuel vehicles are used and more alternative fuel stations were available. We agree that overcoming these two significant disadvantages would reduce the cost of using alternative fuel vehicles but these disadvantages are real and the cost to do so would be considerable. Thus, we did not change the report. In another point related to the economics of alternative fuel vehicles, DOE asserted that, with the exception of range, performance limitations—one of the reasons we provide as to why consumers are reluctant to use alternative fuel vehicles—have been remedied over the last 10 years. DOE suggests it is more accurate to state that there is a perception of performance problems. While perception may be a problem, representatives of auto manufacturers told us alternative fuel vehicles still have some performance limitations when compared to conventional vehicles. We, therefore, made no change to this report.

In addition, DOE suggested that we provide greater context for the report by noting that U.S. dependence on imported oil is growing and that this trend makes the nation's economy and its transportation sector more vulnerable to the economic effects of supply disruptions. We have added language to reflect that projected increases in consumption, particularly in the transportation sector, will be met by imported oil, according to the Energy Information Administration. However, as we have noted in previous reports, vulnerability to the effects of these disruptions depends on a number of factors, including dependence on oil, the oil intensity of the U.S.

economy, the availability of strategic stocks, excess worldwide oil production capacity, as well as the likelihood of a supply disruption.

Finally, DOE said that it believes a dialogue with the Congress would be helpful to clarify federal policy and programs to displace and/or reduce our use of petroleum based fuels in the transportation sector. We agree with DOE that early engagement in such a dialogue is important. DOE also provided technical and other editorial comments, which we incorporated as appropriate.

Scope and Methodology

Our methodology included (1) interviews of numerous federal and state officials as well as officials from alternative fuel providers, industry groups, trade associations, and automobile manufacturers; (2) reviews of reports and information generated by DOE, other federal agencies, and private sector organizations representing various facets of the industry; (3) a review of the act's Titles III, IV, and V that contained the direction for activities on alternative fuel vehicles and alternative fuels; and (4) previous GAO reports concerning alternative fuels.

To address the progress achieved in meeting the fuel replacement goals and acquiring alternative fuel vehicles, we examined data and reports assembled by DOE and its Energy Information Administration on alternative fuel usage, the availability and the consumption of alternative and replacement fuels, and the mandated and voluntary acquisitions of alternative fuel vehicles. This review was supplemented by interviews with stakeholder groups associated with the issues, including federal officials, fleet program managers, state and municipal government representatives, private sector associations and organizations, and representatives of the automobile industry. Appendix III lists the 8 federal agencies, 11 state governments, 9 Clean Cities Program Participants, and 28 associations we contacted.

To identify impediments to acquiring alternative fuel vehicles and using alternative fuels, we interviewed officials who manage fleets that are subject to the act. We also reviewed reports by DOE, state governments, and industry groups concerning alternative fuels and alternative fuel vehicles. We also reviewed previous GAO reports issued since the act was passed in 1992 (see Related GAO Products). Because of the large number of groups involved with alternative fuels or alternative fuel vehicles, we judgmentally selected groups that represent a cross section of the issue.

To identify potential solutions to the impediments of acquiring alternative fuel vehicles and reducing petroleum fuel consumption, we interviewed various stakeholder groups to obtain their views and reviewed various documents and reports related to the alternative fuel vehicles acquisition program and the use of alternative fuels. In addition, we asked DOE to use its Transitional Alternative Fuel Vehicle model to estimate how much the alternative fuels' share in the marketplace would increase if the price of gasoline increased substantially. Using this model, DOE also estimated the number of alternative fuel stations that would be necessary for alternative fuels, as a group, to meet the act's 2010 goal for replacing petroleum fuels in transportation. In addition, the model projected the cost of providing these refueling stations nationwide. GAO examined the technical documentation of DOE's model, and, in a series of discussions, reviewed the model's characteristics and performance with its authors. Engineering economics estimates are an important component of the model, given the absence of plentiful historical data on alternative fuel vehicles. The limited empirical content of the model makes it difficult to determine how well it forecasts. We conducted this review from March 1999 through January 2000 in accordance with generally accepted government auditing standards.

Copies of this report are being sent to House and Senate Committees with jurisdiction and oversight for energy issues and the Honorable Bill Richardson, Secretary of Energy. Copies will also be made available to others upon request. Please call me at (202) 512-3841 if you or your staff have any questions about this report. Key contributors to this report are listed in Appendix V.



Jim Wells
Director, Energy, Resources,
and Science Issues

List of Congressional Requesters

The Honorable John D. Rockefeller
United States Senate

The Honorable Tim Johnson
United States Senate

The Honorable Jeff Bingaman
United States Senate

The Honorable Barbara Boxer
United States Senate

The Honorable Kent Conrad
United States Senate

The Honorable Tom Daschle
United States Senate

The Honorable Byron L. Dorgan
United States Senate

The Honorable Bob Graham
United States Senate

The Honorable Charles E. Grassley
United States Senate

The Honorable Jim Jeffords
United States Senate

The Honorable Mary L. Landrieu
United States Senate

The Honorable Carl Levin
United States Senate

The Honorable Daniel P. Moynihan
United States Senate

The Honorable Sanford Bishop
House of Representatives

The Honorable Edward J. Markey
House of Representatives

The Honorable John Shimkus
House of Representatives

General Characteristics of Alternative Fuels

This table provides the following general characteristics of several alternative fuels: (1) the components, (2) the source, (3) the chemical state, (4) British thermal units (Btu) per gallon, (5) the energy ratio compared to gasoline, and (6) the estimated cost. We did not attempt to compare emissions information because considerable variation exists in testing procedures and conditions, as well as vehicles used that affects outcomes.

Characteristic	Gasoline	Liquified Petroleum Gas	Compressed Natural Gas	Liquified Natural Gas	Ethanol (E85)	Methanol (M85)	Electricity
Component	Petroleum	Propane	Methane	Methane	Denatured Ethanol	Methanol	Electric battery
Source	Petroleum	Petroleum fuel refining and natural gas processing	Underground reserves and crude oil refining	Natural gas production and crude oil refining	Corn, grains, and agriculture waste	Natural gas, coal, and woody biomass	Electricity power plants
Chemical State	Liquid	Liquid	Gas	Liquid	Liquid	Liquid	N/A
Btus (per gallon)	115,400	82,450 to 84,000	19,760 to 29,000	73,500	81,000 to 82,500	64,600 to 66,100	N/A
Energy ratio	1	1.36 to 1	3.00 to 1	1.55 to 1	1.41 to 1	1.77 to 1	N/A
Price (per gallon) ^a	\$1.35	1.38	.58 to 1.05	.58 to 1.05	1.3 to 1.38	1.73 to 2.10	4 cents per kwh (15 cents less than gasoline)

Notes: According to DOE, fleet tests of E85 and M85 have produced energy ratios lower than reported because both fuels are more efficient in combustion than gasoline. Some of the current prices for alternative fuels are higher than what they would be if the fuels were produced in greater quantities with economies of scale in production, distribution, and storage.

^aPrices as of January 1, 2000.

Source: DOE.

Acquisitions of Alternative Fuel Vehicles by Mandated Federal Agencies, State Governments and Fuel Providers

Mandated group	Year	Minimum mandated target (1)	Theoretical universe of vehicles in mandated fleets (2)	Fleet vehicles reported to DOE (3)	Vehicles required to meet mandates (4)	Reported acquisitions of vehicles
Federal fleets	1993	5000			5000	4500
	1994	7500			7500	8000
	1995	10000			10000	4000
	1996	25%			0	6000
	1997	33%	15153	15153	5000	3624
	1998	50%	24723	24723	12362	14205
	1999	75%	26124	26124	19593	18345
	2000	75%	20345	20345	15259	15000
	2001	75%	20000	20000	15000	15000
	2002	75%	20000	20000	15000	15000
State fleets ^a	1993	0%				695
	1994	0%				1178
	1995	0%				1555
	1996	0%				2110
	1997	10%	31207	14320	1432	2817
	1998	15%	31588	13482	2022	3307
	1999	25%	31974			
	2000	50%	32365			
	2001	75%	32760			
	2002	75%	33160			
Fuel provider fleets ^a	1993	0%				1729
	1994	0%				2957
	1995	0%				3759
	1996	0%				2381
	1997	30%	13268	4146	1244	2986
	1998	50%	13268	5692	2846	2663
	1999	70%	13268			
	2000	90%	13268			
	2001	90%	13268			
	2002	90%	13268			

^aThe mandates for states and fuel providers were delayed until 1997. (1)Mandated quantity or percent targets. (2) This represents the estimated number of mandated fleet vehicles subject to the act from which alternative fuel vehicle acquisition achievements could be

Appendix II
Acquisitions of Alternative Fuel Vehicles by
Mandated Federal Agencies, State
Governments and Fuel Providers

measured. (3) This represents the number of light-duty fleet vehicles reported to DOE. They are less than the estimated number of fleet vehicles subject to the act. (4) This represents the number of light-duty alternative fuel vehicles necessary to meet the mandated acquisition targets. It is calculated on the fleet vehicles reported to DOE, not the estimated number of mandated fleet vehicles.

Source: DOE's Office of Technology Utilization

Listing of Stakeholders Contacted During Our Review

Federal Departments and Agencies

Department of Energy
General Services Administration
Environmental Protection Agency
Department of Defense
Department of Agriculture
Department of Transportation
U.S. Postal Service
Office of Management and Budget

State Governments

Alaska
Arizona
California
Colorado
Georgia
Maryland
Michigan
New York
North Dakota
Texas
Washington

Clean Cities Program Participants

Atlanta, GA
Chicago, IL
Denver, CO
Detroit, MI
Florida Gold Coast, FL
Phoenix, AZ
Puget Sound, WA
Sacramento, CA
Wisconsin Southeast Area, WI

Associations and Organizations

Alliance of Automobile Manufacturers
American Coalition for Ethanol
American Methanol Institute
American Petroleum Institute
American Public Power Association
American Public Transit Association

**Appendix III
Listing of Stakeholders Contacted During
Our Review**

American Soybean Association
BP Amoco Oil
Clean Fuels Development Coalition
Daimler-Chrysler Corporation
Edison Electric Institute
Electric Vehicle Association of Greater Washington
Electric Vehicle Association of the Americas
Environmental and Energy Study Institute
Equilon Enterprises
Ford Motor Company
General Motors Corporation
Natural Gas Vehicle Coalition
National Association of Fleet Administrators
National Biodiesel Board
National Ethanol Vehicle Coalition
National Hydrogen Association
New World Energy Systems
Pacific Gas and Electric Company
Propane Vehicle Council
Renewable Fuels Association
Union of Concerned Scientists
West Virginia University

Comments From the Department of Energy

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001



JAN 20 2000

Mr. Allen Li
Associate Director
Defense Acquisition Issues
National Security and
International Affairs Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Li:

I have reviewed the GAO Draft Report – Aviation and the Environment: Aviation's Effect on the Global Atmosphere Is Small but Potentially Significant and Expected to Grow.

The following comments are provided:

- Page 7: The assumption that aviation's contribution would only increase to 5% assumes a robust contribution from technology that increases fuel efficiency and NOX reductions. Achievement of these assumptions will require a significant level of technology improvement that is not currently funded.
- Page 12: The UEET program is 6 years long, not 5, running from 2000 to 2005
- Page 12: Through this program, NASA will develop technology to reduce turbine engine carbon dioxide emissions by 15% below today's emissions. NASA will not reduce the emissions, but rather provide the technology to do so.

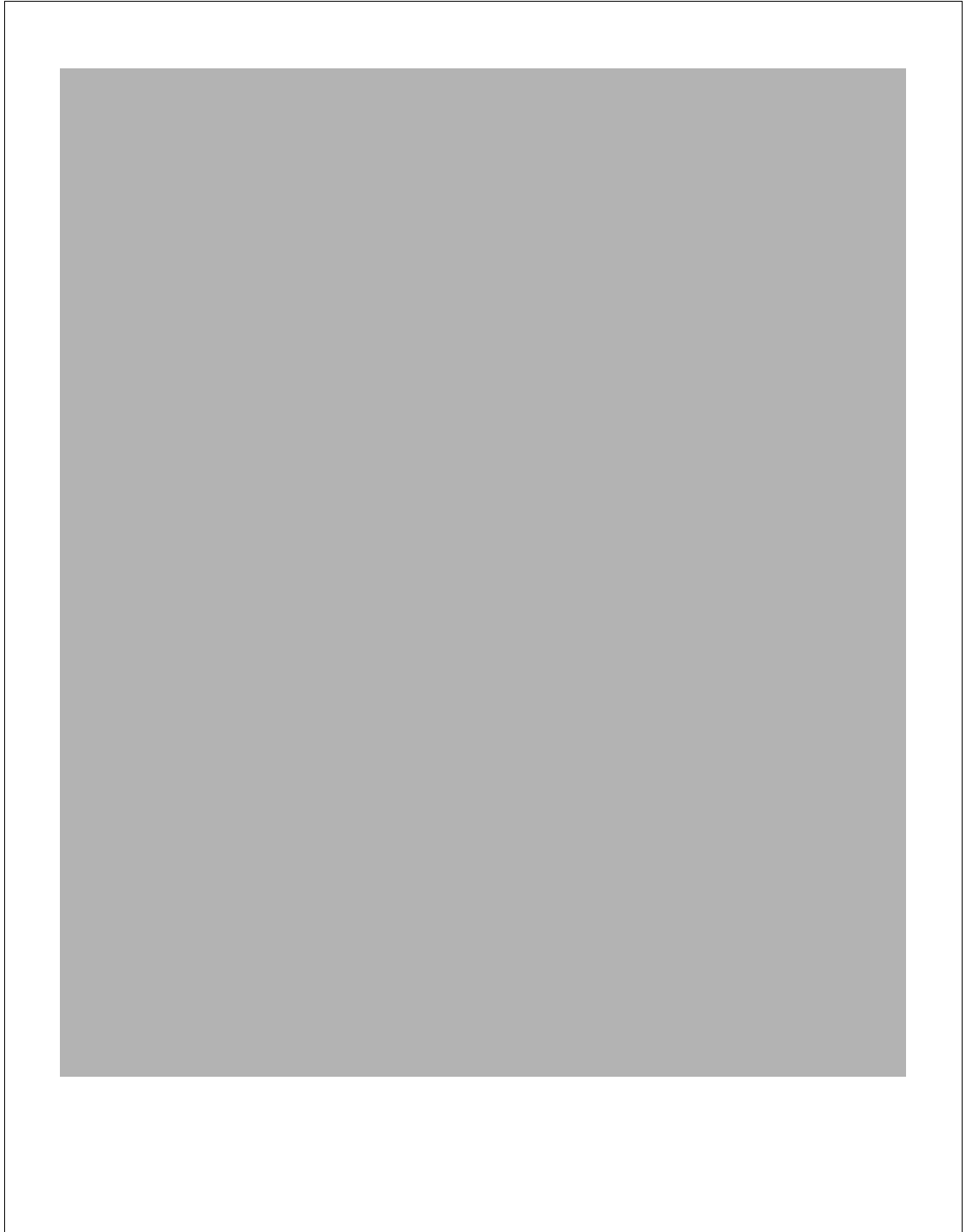
Robert A. Pearce, who can be reached at (202) 358-4595, will contact you to set up a meeting to answer any questions you may have on our review. In response to this letter, a total of 7.5 hours were required.

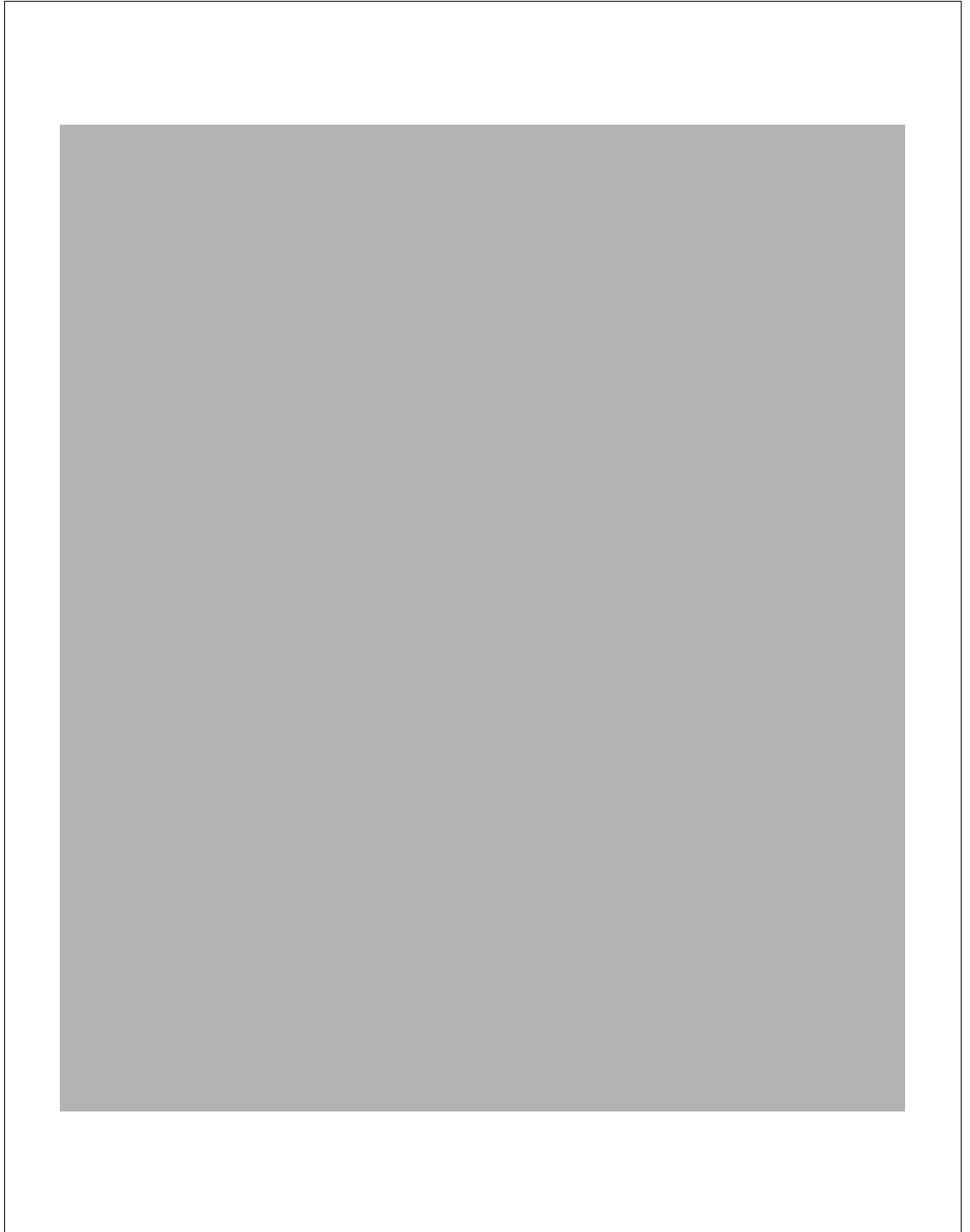
Sincerely,

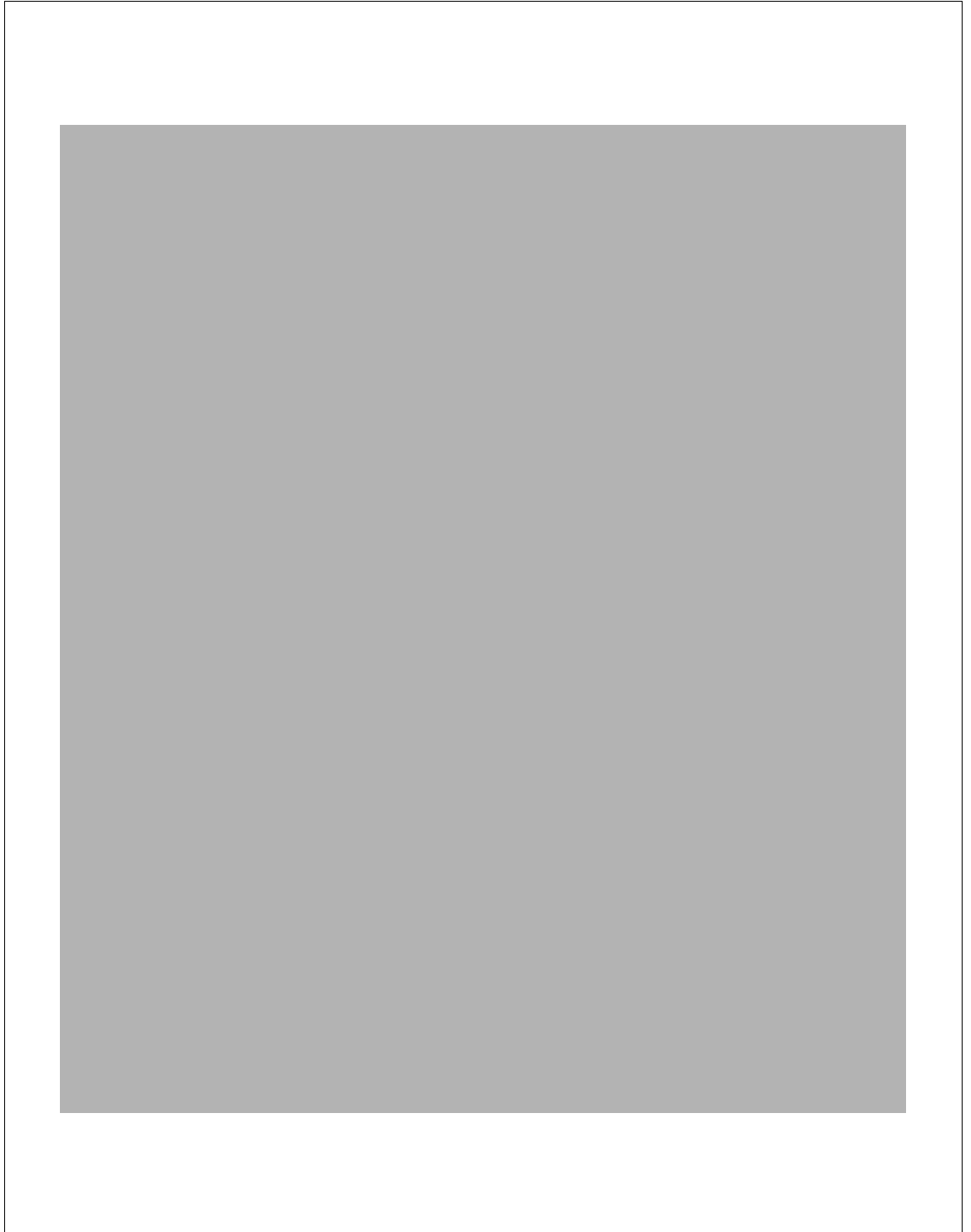
A handwritten signature in black ink that reads "Daniel R. Mulville".

Daniel R. Mulville
Associate Deputy Administrator

Appendix IV
Comments From the Department of Energy







GAO Contacts and Staff Acknowledgments

GAO Contacts

Jim Wells (202) 512-3841
Daniel Haas (202) 512-9828

Acknowledgments

In addition to those named above, Richard Iager, Daren Sweeney, Charles Bausell, Phil Amon, Gene Barnes, Daniel Williams, Joseph Kile, and Doreen Feldman made key contributions to this report.

Related GAO Reports

Energy Policy Act: Including Propane as an Alternative Motor Fuel Will Have Little Impact on Propane Market (GAO/RCED-98-260, Sept. 24, 1998).

Energy Policy: Propane Price Increases During the Winter of 1996-97 (GAO/RCED-98-52R, Dec. 16, 1997).

Energy Security: Evaluating U.S. Vulnerability to Oil Supply Disruptions and Options for Mitigating Their Effects (GAO/RCED-97-6, Dec. 12, 1996).

Tax Policy: Effects of Alcohol Fuels Tax Incentives (GAO/GGD-97-41, Mar. 6, 1997).

Motor Fuels: Issues Related to Reformulated Gasoline, Oxygenated Fuels, and Biofuels (GAO/RCED-96-121, June 27, 1996).

Electric Vehicles: Efforts to Complete Advanced Battery Development Will Require More Time and Funding (GAO/RCED-95-234, Aug. 17, 1995).

Electric Vehicles: Likely Consequences of U.S. and Other Nations' Programs and Policies (GAO/RCED-95-7, Dec. 30, 1994).

Gasohol: Federal Agencies' Use of Gasohol Limited by High Prices and Other Factors (GAO/RCED-95-41, Dec. 13, 1994).

Alternative Fueled Vehicles: Progress Made in Accelerating Federal Purchases, but Benefits and Costs Remain Uncertain (GAO/RCED-94-161, July 15, 1994).

Ordering Information

The first copy of each GAO report and testimony is free. Additional copies are \$2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary, VISA and MasterCard credit cards are accepted, also.

Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

Orders by mail:

**U.S. General Accounting Office
P.O. Box 37050
Washington, DC 20013**

or visit:

**Room 1100
700 4th St. NW (corner of 4th and G Sts. NW)
U.S. General Accounting Office
Washington, DC**

**Orders may also be placed by calling (202) 512-6000
or by using fax number (202) 512-6061, or TDD (202) 512-2537.**

Each day, GAO issues a list of newly available reports and testimony. To receive facsimile copies of the daily list or any list from the past 30 days, please call (202) 512-6000 using a touchtone phone. A recorded menu will provide information on how to obtain these lists.

**For information on how to access GAO reports on the INTERNET,
send an e-mail message with "info" in the body to:**

info@www.gao.gov

or visit GAO's World Wide Web Home Page at:

<http://www.gao.gov>

Related GAO Reports

**United States
General Accounting Office
Washington, D.C. 20548-0001**

**Official Business
Penalty for Private Use \$300**

Address Correction Requested

<p>Bulk Rate Postage & Fees Paid GAO Permit No. GI00</p>

