

September 1998

# ENERGY POLICY ACT

## Including Propane as an Alternative Motor Fuel Will Have Little Impact on Propane Market



19981016 046

**DISTRIBUTION STATEMENT A**  
Approved for public release;  
Distribution Unlimited

DTIC QUALITY INSPECTED 4

Resources, Community, and  
Economic Development Division

B-280779

September 24, 1998

The Honorable Dale Bumpers  
The Honorable Tom Daschle  
United States Senate

The Honorable Marion Berry  
House of Representatives

The transportation sector is projected to consume about 70 percent of the petroleum to be used by the United States in 2010, up from about 66 percent in 1996, according to estimates by the Department of Energy's (DOE) Energy Information Administration (EIA).<sup>1</sup> Furthermore, EIA projects that imports will supply 60 percent of the total U.S. oil consumption in 2010, up from about 46 percent in 1996. In part, to help reduce the nation's oil dependence and oil imports, the Congress passed the Energy Policy Act of 1992 (EPACT). Title V of EPACT requires the Secretary of Energy to establish a program to promote the development and use of domestically produced replacement fuels in light-duty vehicles.<sup>2</sup> A major goal of EPACT is to replace a portion of the motor fuel (conventional fuel) used by light-duty vehicles in the United States with what are termed replacement fuels.<sup>3</sup> The act also stipulates that at least half of the replacement fuels should be produced in the United States. Included among the fuels defined by EPACT as alternative or replacement fuels<sup>4</sup> is liquified petroleum gas, or propane.<sup>5</sup>

Propane is widely used for other purposes. The petrochemical industry, for example, by far the largest propane consumer, uses propane in its manufacturing processes, and the residential sector uses propane for heating and other household purposes. Some of these traditional users of propane have expressed concern that the achievement of EPACT's

---

<sup>1</sup>In its *Annual Energy Outlook 1998*, EIA projects that almost 23 million barrels per day of petroleum will be used by the United States in 2010.

<sup>2</sup>Light-duty vehicles include cars and light trucks.

<sup>3</sup>In this report, conventional fuel refers to gasoline and diesel fuel.

<sup>4</sup>As defined by EPACT, replacement fuels are the portion of any motor fuel that is methanol, ethanol, or other alcohols; natural gas; liquified petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; electricity (including electricity from solar energy); ethers; or any other fuel that DOE determines, by rule, is substantially not petroleum and would yield substantial energy security and environmental benefits.

<sup>5</sup>Liquified petroleum gas is mainly propane but includes some butane as well. In this report, we refer to liquified petroleum gas simply as propane.

---

fuel-replacement goal could lead to rapid future growth in the demand for propane, resulting in higher propane prices. This report responds to your request that we determine whether and how including propane as an alternative fuel under EPACT will affect existing propane consumers as well as the supply and price. Specifically, this report addresses the following questions: (1) How likely is it that EPACT's goal of replacing at least 10 percent of the conventional fuel used in light-duty vehicles by 2000 and at least 30 percent by 2010 with replacement fuels will be achieved? (2) To what extent will the use of propane as a motor fuel increase as a result of EPACT? (3) What impact will the use of propane as a motor fuel under EPACT have on the supply and price of propane? (4) What impact will the use of propane as a motor fuel under EPACT have on existing users of propane? In order to respond to these questions, we asked EIA to use its National Energy Modeling System to estimate the likelihood of achieving EPACT's fuel-replacement goal and to estimate the potential impacts.<sup>6</sup>

---

## Results in Brief

It is unlikely that the goal of the Energy Policy Act of 1992 of replacing at least 10 percent of the conventional fuel used by light-duty vehicles in the United States by 2000 and at least 30 percent by 2010 with replacement fuels will be achieved. We estimate, based on the Energy Information Administration's modeling, that alternative fuels will account for less than 1 percent in 2000 and about 3.4 percent in 2010 of the total motor fuel projected to be consumed by light-duty vehicles.<sup>7</sup> The act's focus on the acquisition of "alternative-fueled" vehicles rather than on the use of alternative fuels, high alternative-fueled vehicle costs, low gasoline prices, and an inadequate refueling infrastructure for these vehicles are factors hindering the increased use of alternative fuels for transportation.

The Energy Policy Act can be expected to lead to a small increase in the use of propane as an alternative fuel in the transportation sector. We estimate that after the vehicle acquisition mandates in the act are factored in, consumption of propane as a motor fuel will account for about

---

<sup>6</sup>The National Energy Modeling System is a large-scale computerized model designed by EIA to assist policymakers and the public in assessing the impact of various policy initiatives.

<sup>7</sup>According to a projection by EIA cited in a 1997 DOE report, replacement fuels in the form of oxygenates could contribute an additional 4.8 to 6.7 percent of light-duty vehicle motor fuel by 2010. See Replacement Fuel and Alternative Fuel Vehicle Technical and Policy Analysis, DOE, Energy Efficiency and Renewable Energy, Office of Transportation Technologies (July 1997).

---

1.5 percent of the total propane used in the United States in 2000 and about 5.1 percent in 2010.<sup>8</sup>

The effects of the Energy Policy Act on the supply and price of propane will be minimal. Incremental domestic production of propane as a result of the act will be about 7,000 barrels per day in 2000 and 85,000 in 2010. According to EIA, these levels of domestic production will satisfy most of the estimated additional propane demand caused by the act. We estimate that the increase in the overall price of propane attributable to the act will be a negligible 0.17 cent per gallon in 2000 and 3.28 cents per gallon in 2010.<sup>9</sup>

Similarly, the Energy Policy Act will have little impact on the existing consumers of propane because the price increases will be so small. We estimate that propane prices paid by residential and industrial consumers will increase by an average of just 0.10 cent per gallon in 2000, while the prices paid by transportation consumers will increase by about 0.43 cent per gallon.<sup>10</sup> We project that in 2010, price increases due to the act will be, on average, 1.50 cents per gallon for the residential sector, 1.70 cents per gallon for the industrial sector, and 2.33 cents per gallon for the transportation sector.

---

## Background

To help meet its goal of replacing a portion of the conventional fuel used by light-duty vehicles in the United States with replacement fuels, EPACT established mandates, to be implemented by the Secretary of Energy, that require certain fleet operators to include alternative-fueled vehicles (AFV) in their fleets. Specifically, EPACT required that federal fleets acquire AFVs beginning in fiscal year 1993 and that state fleets and alternative fuel providers acquire AFVs beginning in model-year 1996.<sup>11</sup> The federal AFV fleet program went into effect in 1993, but the mandates for state and alternative fuel provider fleets were delayed until 1997 because, according to a DOE official, the Department did not issue the rulemaking, as required by EPACT, early enough for the mandates to take effect in 1996. Also, under

---

<sup>8</sup>The use of propane by the transportation sector is projected to increase by only about 0.01 quadrillion Btu in 2000 and by 0.10 quadrillion Btu in 2010 as a result of EPACT. A British thermal unit, or Btu, is the heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

<sup>9</sup>All prices cited are in 1996 dollars.

<sup>10</sup>The petrochemical industry consumes most of the propane used in the industrial sector.

<sup>11</sup>EPACT covers federal fleets of 20 or more vehicles that can be centrally fueled and are located in a metropolitan statistical area with a 1980 population of more than 250,000. For other than federal fleets, EPACT covers fleets of 50 or more vehicles, of which at least 20 vehicles can be centrally fueled and are used primarily in a metropolitan statistical area with a 1980 population of more than 250,000.

EPACT, the Secretary of Energy may require municipal and private (business) fleets to purchase an increasing percentage of AFVs to help meet the fuel-replacement goal. Under EPACT, DOE published an advance notice of proposed rulemaking in April 1998 and held public hearings in May and June 1998 to determine whether the establishment of the municipal and private fleet mandate is necessary and whether such a mandate will help attain EPACT's fuel-replacement goal. EPACT does not require that the goal be achieved and authorizes the Secretary of Energy to modify the goal or the target years if he or she determines that they are not achievable. Table 1 presents a summary of EPACT's AFV acquisition mandates for the fleets covered by the act.

**Table 1: EPACT Mandates**

EPACT section	Sector affected	Mandates for new light-duty AFV acquisitions
Section 303(a)	Federal	Acquisitions must total at least 5,000 AFVs in fiscal year (FY) 1993, 7,500 in FY 1994, and 10,000 in FY 1995. <sup>a</sup>
Section 303(b)	Federal	Acquisitions must total at least 25% in FY 1996, 33% in 1997, 50% in FY 1998, and 75% in FY 1999 and thereafter. <sup>b</sup>
Section 501(a)	Alternative fuel providers	Acquisitions must be 30% for model year (MY) 1996, 50% for MY 1997, 70% for MY 1998, and 90% for MY 1999 and thereafter. <sup>c,d</sup>
Section 507(o)	State	Acquisitions must be 10% for MY 1996, 15% for MY 1997, 25% for MY 1998, 50% for MY 1999, and 75% for MY 2000 and thereafter. <sup>e</sup>
<b>Proposed mandate</b>		
Section 507(g)	Municipal and private (other than fuel providers)	Pending rulemaking determination of need and feasibility, acquisitions must be 20% of the AFVs for MY 2002, 40% for MY 2003, 60% for MY 2004, and 70% for MY 2005 and thereafter. <sup>f</sup>

<sup>a</sup>In April 1993, the President signed Executive Order 12844, which increased light-duty AFV acquisition requirements by 50 percent for 1993-95. Thus, vehicle acquisition targets were changed to 7,500 AFVs for FY 1993, 11,250 for FY 1994, and 15,000 for FY 1995. Executive Order 12844 was superseded by Executive Order 13031 of December 13, 1996.

<sup>b</sup>A federal fleet operator can acquire a smaller percentage than mandated as long as the aggregate percentage of all federal fleets is at least equal to the required percentage.

<sup>c</sup>For model year 1997 and thereafter, the required percentages can be reduced to no less than 20 percent in any one year. DOE also has the option of rescheduling acquisition requirements up to 2 model years.

<sup>d</sup>Electric utilities that are covered by alternative fuel provider mandates are excluded from the vehicle purchase mandates until after December 31, 1997, with respect to electric motor vehicles.

<sup>e</sup>Local and private fleets can voluntarily join with state fleets to attain the mandated number of AFVs.

<sup>f</sup>The required percentages can be reduced for any model year. DOE also has the option of starting the acquisition schedule later than model year 2002.

## EPACT's Replacement Goal Is Not Likely to Be Achieved

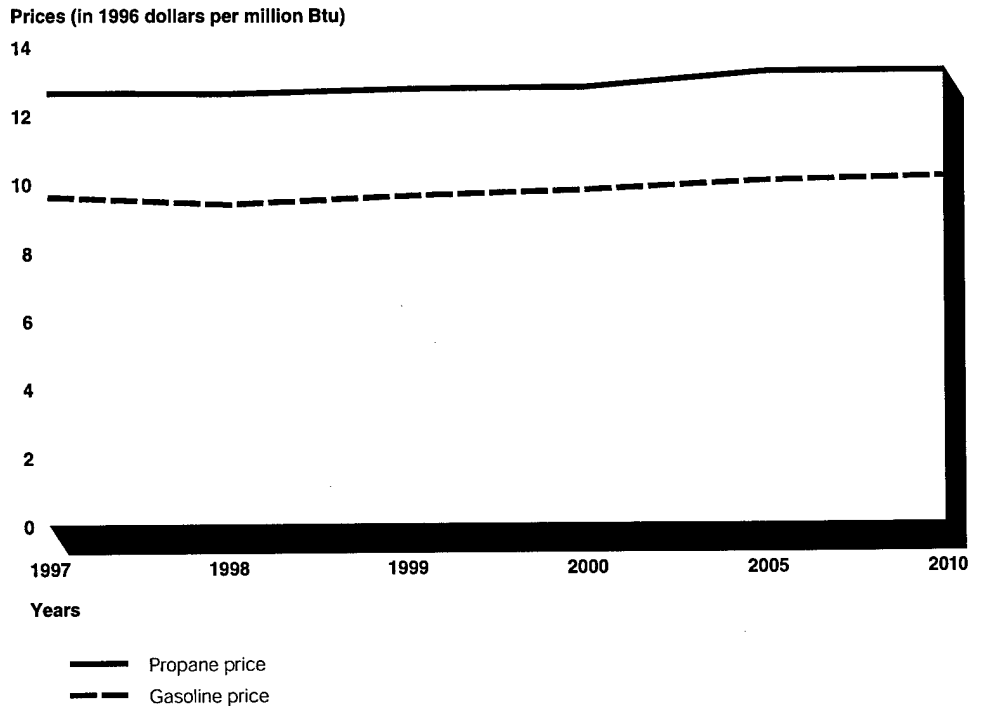
The goal of EPACT to replace 10 percent of the conventional fuel consumed by light-duty vehicles by 2000 and 30 percent by 2010 with replacement fuels is unlikely to be achieved. On the basis of EIA's modeling analysis, we estimate that alternative fuels will account for less than 1 percent of the total fuel to be consumed by light-duty vehicles in 2000 and about 3.4 percent in 2010, even after accounting for EPACT's provisions mandating that fleets acquire AFVs.<sup>12</sup> Previous studies by DOE have also concluded that EPACT's goal is unlikely to be achieved after implementing the fleet acquisition mandates. Appendix I summarizes the results of several previous studies by DOE and Oak Ridge National Laboratory.

Industry and DOE officials we talked with gave several reasons why the consumption of alternative fuels by light-duty vehicles will fall short of EPACT's replacement goal. First, EPACT mandates that fleets acquire AFVs but does not explicitly require that those vehicles use alternative fuels.<sup>13</sup> Consequently, according to industry officials, some fleets meet their AFV requirements by purchasing vehicles capable of using both gasoline and an alternative fuel (called dual-fueled vehicles), but these vehicles are usually run on gasoline. Moreover, both DOE and industry officials believe that achieving EPACT's goal will require greater use of alternative fuels by vehicles beyond those in the fleets covered by the act, a development they believe is unlikely. For one thing, the high price of AFVs discourages their use. For example, according to one industry official, converting a conventional vehicle to run on propane can cost over \$3,500, while a manufacturer's AFV that runs on propane can cost about \$6,000 more than a conventional gasoline-powered vehicle. In addition, the lower price of gasoline discourages increased use of the higher priced alternative fuels. Both DOE and industry officials said that the price of gasoline is simply too low for the transportation sector to purchase significant quantities of alternative fuels. (See fig. 1 for a comparison of gasoline and propane prices, adjusted for inflation.) Finally, the infrastructure needed to keep AFVs refueled is currently inadequate to support the wide-scale use of AFVs that are not operated as centrally fueled fleet vehicles. Industry officials told us that the consumption of alternative fuels for transportation is too small to justify any large-scale investment in this infrastructure.

<sup>12</sup>EIA projected that light-duty vehicles will consume a total of about 15 quadrillion Btu (quads) in 2000 and about 17.8 quads in 2010. See footnote 7.

<sup>13</sup>Only alternative fuel providers are required to operate their AFVs with alternative fuels, except when operating in areas where the appropriate alternative fuel is unavailable.

**Figure 1: Propane and Gasoline Prices for the Transportation Sector, (With EPACT) 1997 Through 2010**



Source: Annual Energy Outlook 1998, EIA.

## EPACT Will Lead to a Small Increase in the Use of Propane as a Transportation Fuel

EPACT is expected to lead to a small increase in the use of propane as a transportation fuel. After EPACT's AFV acquisition requirements are accounted for, the resulting increase in transportation use will represent only 0.4 percent of the total consumption of propane in 2000 and 3.2 percent in 2010.<sup>14</sup> As a result, consumption of propane as a transportation fuel will account for about 1.5 percent of the total propane used in the United States in 2000 and about 5.1 percent in 2010. The effects of EPACT specifically on the consumption of propane fuel by light-duty vehicles are summarized in table 2.

<sup>14</sup>Estimated propane consumption by all sectors increases from 2.70 quads to 2.71 quads in 2000 as a result of EPACT. In 2010, estimated total consumption increases from about 3.03 quads to about 3.13 quads.

**Table 2: Consumption of Propane by Light-Duty Vehicles, 1997 Through 2010**

Quadrillion Btu per year

Year	Propane consumption	
	With EPACT's effects	Without EPACT's effects
1997	0.018	0.018
1998	0.020	0.020
1999	0.023	0.019
2000	0.028	0.018
2005	0.081	0.020
2010	0.140	0.036

Sources: Annual Energy Outlook 1998 and special National Energy Modeling System run, EIA.

Some industry and DOE officials told us that although propane has certain attributes that could make it the alternative fuel of choice, such as permitting a longer driving range than compressed natural gas, the barriers cited previously—the high relative cost of AFVs, the low price of gasoline, and the inadequate infrastructure for refueling—still inhibit its use. In addition, it does not appear that the propane industry will strongly promote the fuel as an alternative vehicle fuel. Propane industry officials and others told us that the industry lacks the internal cohesion necessary to promote the use of propane as a transportation fuel. Some officials pointed out that the history of the industry has been one of small-scale suppliers that primarily serve the heating and other household needs of residential customers. These suppliers do not necessarily want to see propane become a major transportation fuel for fear that that would erode their business. By comparison, DOE and industry officials and other experts told us that the natural gas industry is aggressively promoting compressed natural gas as an alternative transportation fuel. A manufacturer of AFVs also told us that the natural gas industry has been much more aggressive in pushing for the increased manufacture of vehicles that run on its fuel than the propane industry has.

## EPACT Will Have Very Little Impact on the Supply and Price of Propane

Because EPACT is not expected to cause any significant increase in propane demand, it will have very little impact on the supply and price of propane. Any effects of EPACT on the supply and price of propane are indirect, that is, are in response to any higher demand its mandates might cause. Because EPACT will not cause much change in the demand for propane, little change in the supply and price of propane can be expected to result from EPACT's mandates. We estimate that the additional U.S. production of

---

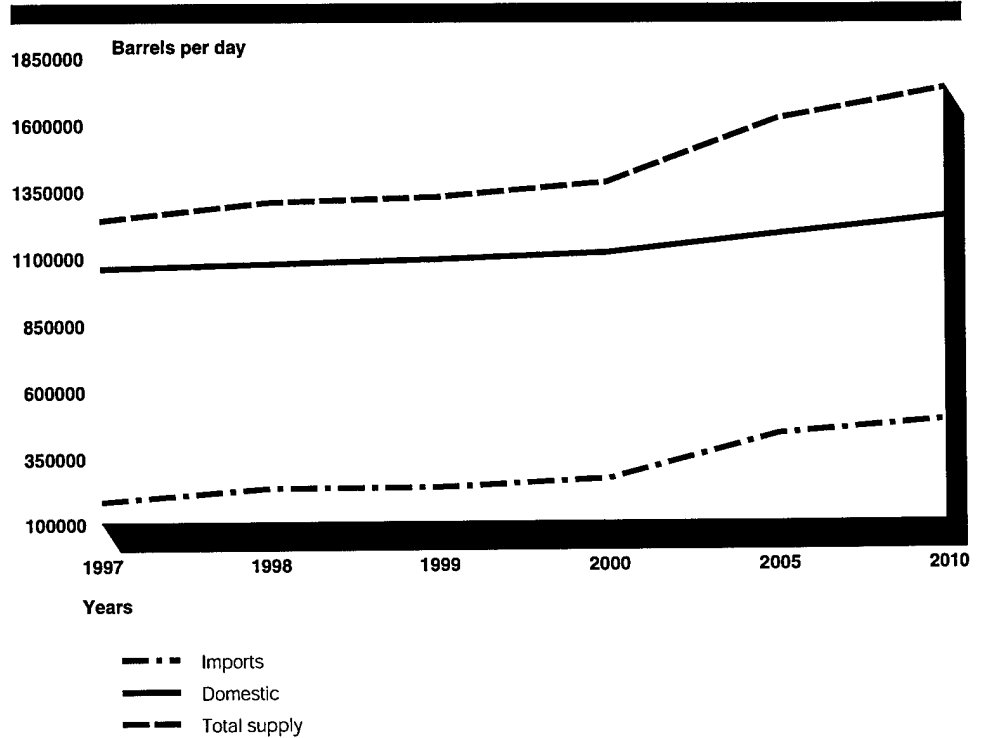
propane that will result from EPACT will be about 7,000 barrels per day in 2000 and 85,000 barrels per day in 2010.<sup>15</sup> According to EIA's modeling results, these levels of domestic production will satisfy most of the additional propane demand or consumption caused by EPACT, while imports will satisfy the rest.

Some propane users have expressed concern that EPACT could cause imports to become a greater proportion of the U.S. propane supply. We found evidence that U.S. propane imports will increase but not because of EPACT. For instance, Purvin and Gertz, Inc., a consulting firm specializing in analyses of the oil and gas industry, projects that U.S. imports of propane will rise from about 179,985 barrels per day in 1997 to about 264,400 barrels in 2000 and almost triple by 2010 to about 483,200 barrels (see fig. 2). As a percentage of the total U.S. propane supply, imports will rise from about 14.5 percent in 1997 to about 19 percent in 2000 and 28 percent in 2010, according to the firm's estimates. However, Purvin and Gertz officials told us that these increases in imports are unrelated to EPACT. The firm's projections of both supply and demand for propane do not account for EPACT because it believes its effects on the propane market will be inconsequential.

---

<sup>15</sup>This projected increase in U.S. propane production is expected to come from refinery production. According to EIA analysts, the effect of EPACT would not be sufficient to cause natural gas processing plants to increase their production because overall natural gas production would likely not be affected. Industry officials and experts believe that in the future, natural gas processing will supply a large share of the propane produced in the United States, even a greater share than that of the propane produced by refineries.

**Figure 2: U.S. Propane Supply From Domestic Production and Imports, 1997 Through 2010**

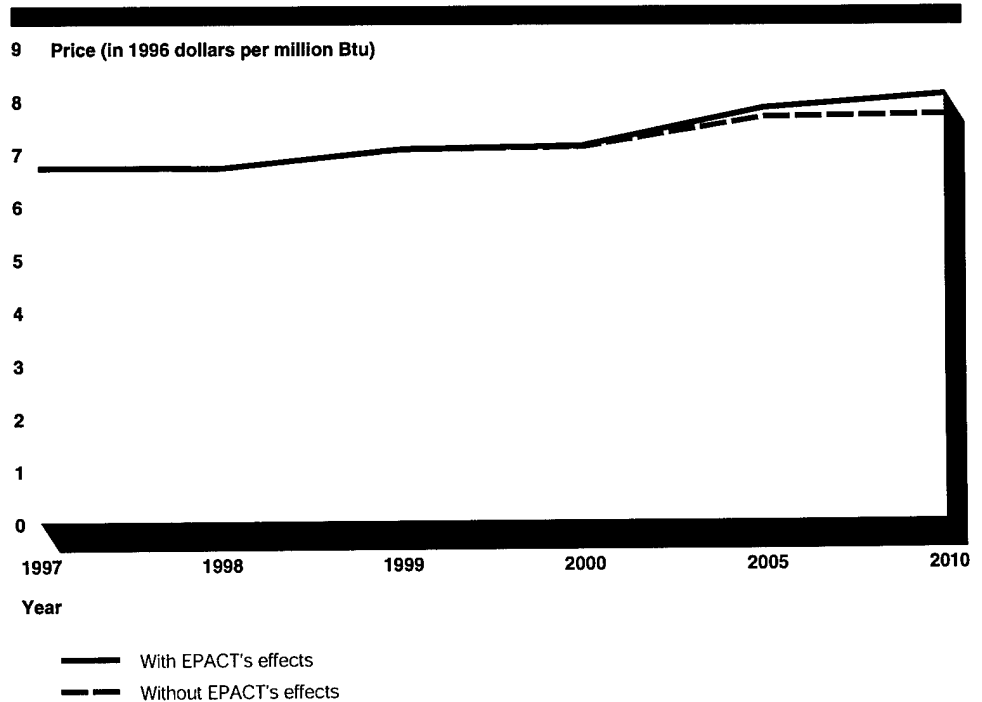


Source: The North American NGL Industry—Opportunities in an Expanding Market, Purvin and Gertz, Inc. (1997).

We estimate, based on EIA’s modeling, that the effect of EPACT on the overall price of propane will be negligible: an increase of 0.17 cent per gallon in 2000 and 3.28 cents per gallon in 2010 (fig. 3 shows the average price of propane, in 1996 dollars per million Btu, with and without EPACT’s effects, from 1997 through 2010). Table 3 presents the estimated price impacts of EPACT on three categories of U.S. consumers. The estimated price increase effects for residential consumers will be only 0.10 cent per gallon in 2000 and 1.50 cents per gallon in 2010; the increase for industrial consumers is estimated to be 0.10 cent per gallon in 2000 and 1.70 cents per gallon in 2010; and the increase for transportation consumers is

estimated at 0.43 cent per gallon in 2000 and 2.33 cents in 2010.<sup>16</sup> In addition, Purvin and Gertz officials believe that the U.S. market will become the destination for a large share of the increased propane production from natural gas fields being discovered in many parts of the world, which could lead to lower prices.

**Figure 3: Average Price of Propane With and Without EPACT's Effects, 1997 Through 2010**



Sources: Annual Energy Outlook 1998 and special National Energy Modeling System run, EIA.

<sup>16</sup>The average U.S. price for propane, with EPACT's effects considered, is projected to be 61.5 cents per gallon in 2000 and 69.8 cents per gallon in 2010. For residential consumers, the projected average price is 99.8 cents in 2000 and \$1.07 in 2010. For industrial consumers, the projected average price is 51.6 cents per gallon in 2000 and 58.4 cents per gallon in 2010, while the projected average price for the transportation sector is \$1.10 per gallon in 2000 and \$1.15 per gallon in 2010. According to an EIA official, the differences in the projected average sectorial prices reflect such factors as taxes for the transportation sector and lower costs for high-volume customers in the industrial sector. The official also pointed out that there may be regional differences in the projected average sectorial prices.

**Table 3: Propane Price Increases Resulting From EPACT, 1997 Through 2010**

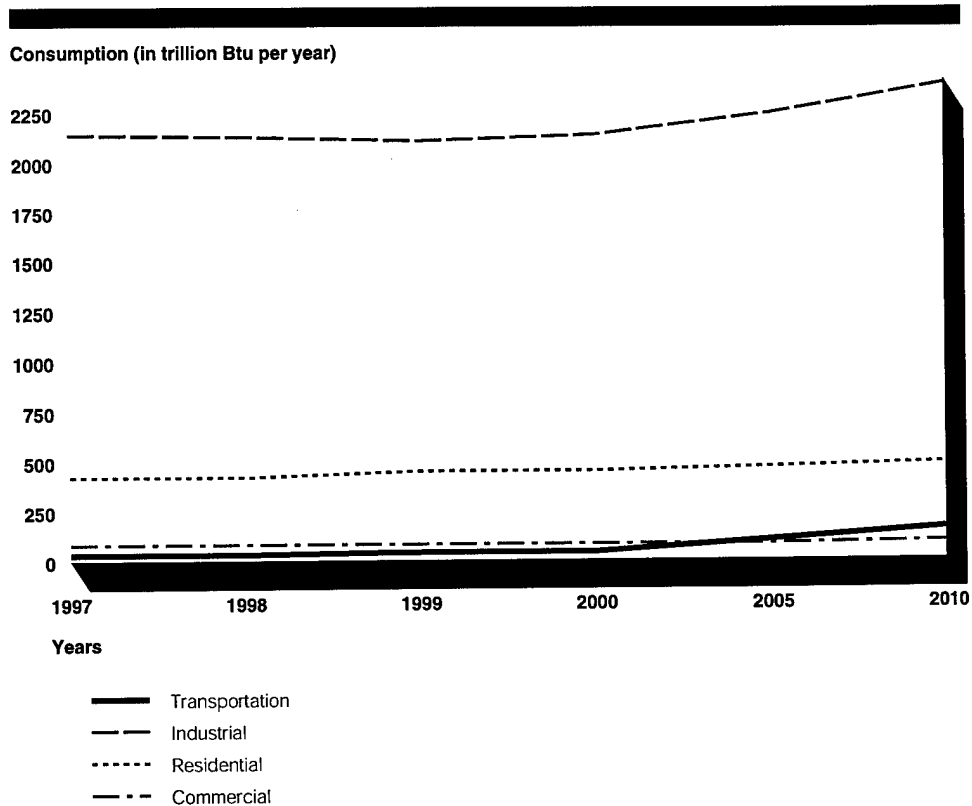
1996 cents per gallon			
Year	Residential	Industrial	Transportation
1997	0.00	0.00	0.00
1998	0.00	0.00	0.00
1999	0.00	0.00	0.17
2000	0.10	0.10	0.43
2001	0.00	0.00	0.52
2002	0.10	0.10	0.78
2003	0.30	0.20	1.12
2004	0.40	0.50	1.29
2005	0.40	0.50	1.47
2010	1.50	1.70	2.33

Source: Special National Energy Modeling System run, EIA.

## EPACT Will Have No Discernible Adverse Effect on Existing Propane Consumers

Existing consumers of propane, such as residential and petrochemical users, are not expected to be adversely affected by EPACT because the act is expected to have a negligible effect on propane prices. EPACT would cause a measurable adverse impact on existing propane consumers if it significantly increased the demand for propane as a transportation fuel and drove up its price. But, as previously discussed, demand and price are not likely to rise significantly given the limited effects of EPACT's mandates for fleets. DOE, EIA, and most of the industry officials and experts we talked with believe that the price effects of EPACT will be negligible and that propane consumption by nontransportation sectors will not be affected by EPACT. Figure 4 presents projections, based on EIA's modeling, for the consumption of propane by various U.S. end-use sectors, including the transportation sector, after factoring in the impact of EPACT.

**Figure 4: U.S. Propane Consumption by Sector With EPACT's Effects, 1997 Through 2010**



Source: Annual Energy Outlook 1998, EIA.

These projections are in contrast to those of a previous DOE study that investigated what might happen if alternative fuels, AFVs, and a refueling infrastructure were available on a widespread basis, a hypothetical scenario different from the questions addressed in our report. Appendix I provides additional detail on that study, which indicated a significant impact on the petrochemical industry if EPACT's replacement goal was met in 2010. According to industry officials and experts, the petrochemical sector is likely to reduce its propane consumption if the price of propane rises because a significant portion of the propane that sector uses can be replaced with other feedstocks, such as naphtha and ethane. However, these officials also told us that switching feedstocks would also lead to increases in the prices of the substitutes, resulting in an increase in the industrial consumers' production costs. These industry officials believe

---

that if EPACT's replacement goal is met, the likely consequences on their industry will be severe.

---

## Agency Comments and Our Evaluation

We provided a draft of this report to DOE for review and comment. DOE agreed with our findings and provided some technical clarifications where appropriate.

---

## Scope and Methodology

To determine whether and how including propane as an alternative fuel under EPACT will affect the supply, price, and existing consumers of propane, we asked EIA to use its National Energy Modeling System to estimate the likelihood of achieving EPACT's fuel replacement goal and to estimate the potential impact. (See app. II for more explanation of the modeling of EPACT's effects.) We asked EIA to include in the analysis all of the mandates in EPACT that require federal and state governments as well as fuel providers to procure AFVs for their fleets, including the mandates for private and municipal fleets that have not gone into effect.<sup>17</sup> We also interviewed officials of the propane and oil industries, manufacturers of AFVs, companies that convert conventional vehicles to AFVs, the alternative fuels infrastructure industry, and relevant DOE and EIA officials for their perspectives on likely effects of EPACT. We also reviewed the EPACT documents as well as studies by DOE and others that deal with EPACT and alternative fuels.

We conducted our review from February through September 1998 in accordance with generally accepted government auditing standards.

---

We will send copies of this report to interested congressional committees and the Secretary of Energy. We will also make copies available to others upon request.

---

<sup>17</sup>As mentioned previously, DOE has until January 1, 2000, to issue a rulemaking on whether private and municipal fleet operators will be required to purchase AFVs.

---

Please call me at (202) 512-3841 if you have any questions. Major contributors to this report are listed in appendix III.



Susan D. Kladiva  
Associate Director, Energy,  
Resources, and Science Issues



# Contents

<b>Letter</b>		1
<b>Appendix I Results From Previous DOE Studies</b>		18
	Replacement of Gasoline With Alternative Fuels Is Likely to Fall Short of EPACT's Goal	18
	The Relative Contribution of Propane in Meeting EPACT's Goal Is Unclear	20
<b>Appendix II Estimating the Effect of EPACT's Fleet Mandates</b>		24
	Estimating EPACT's Effect on Fuel Displacement	24
	Detailed Assumptions and Other EPACT Provisions Incorporated in the Model	25
<b>Appendix III Major Contributors to This Report</b>		28
<b>Tables</b>		
	Table 1: EPACT Mandates	4
	Table 2: Consumption of Propane by Light-Duty Vehicles, 1997 Through 2010	7
	Table 3: Propane Price Increases Resulting From EPACT, 1997 Through 2010	11
	Table I.1: Fuel Shares in 2010 From the 1998 Oak Ridge Study	19
	Table I.2: Light-Duty Vehicle Fuel Use in 2010 From DOE's 1996 Study	21
	Table I.3: Propane Consumption and Supply Estimates in 2010 From DOE's 1996 Study	22
	Table I.4: Price Estimates for 2010 From DOE's 1996 Study	23
	Table II.1: Percentages Used by EIA's NEMS for AFV Purchases by Fleet Type and Year	26
	Table II.2: EPACT Alternative Fuel Fleet Sales Estimates	26
<b>Figures</b>		
	Figure 1: Propane and Gasoline Prices for the Transportation Sector, (With EPACT) 1997 Through 2010	6
	Figure 2: U.S. Propane Supply From Domestic Production and Imports, 1997 Through 2010	9
	Figure 3: Average Price of Propane With and Without EPACT's Effects, 1997 Through 2010	10

---

Figure 4: U.S. Propane Consumption by Sector With EPACT's Effects, 1997 Through 2010

12

---

**Abbreviations**

AFV	alternative-fueled vehicle
DOE	Department of Energy
E85	ethanol 85
EIA	Energy Information Administration
EPACT	Energy Policy Act of 1992
GAO	General Accounting Office
M85	methanol 85
MY	model year
OPEC	Organization of Petroleum Exporting Countries
NEMS	National Energy Modeling System

# Results From Previous DOE Studies

The Department of Energy (DOE) has conducted several studies of the Energy Policy Act of 1992 (EPACT). The scope of these studies is broader than the objectives of our report in that these studies went beyond the mandated fleet measures analyzed in our report. For instance, these studies estimated impacts of actually reaching the EPACT replacement goal, as well as impacts of other policy initiatives. This appendix summarizes some of the information three of these studies provide on the barriers to the widespread use of alternative fuels and on implications for the future use of alternative fuels.

## Replacement of Gasoline With Alternative Fuels Is Likely to Fall Short of EPACT's Goal

“Major transitional impediments” will have to be overcome to reach EPACT's goal of replacing 10 percent of the conventional fuel consumed by light-duty vehicles<sup>18</sup> with alternative fuels by 2000 and replacing 30 percent by 2010, according to a 1997 DOE study.<sup>19</sup> To meet the 2000 goal, 35 to 40 percent of total 1999 sales of new light-duty vehicles would have to be alternative-fueled vehicles, according to that study. To meet the 2010 goal, sales of alternative-fueled vehicles would have to stay in the range of 30 to 38 percent of all new light-duty vehicles sold. A 1998 draft report by DOE's Oak Ridge National Laboratory, however, found that with the implementation of EPACT's fleet requirements, including private fleet mandates, alternative-fueled vehicles would make up less than 1 percent of new vehicle sales in 2000 and only 4 percent by 2010.<sup>20</sup> This study concluded it was unlikely that the 2000 goal will be met, or that the 2010 goal would be met without significant new policy initiatives. The study described the following transitional barriers to the greater use of alternative fuels:

- the lack of scale economies in the production of alternative fuels and alternative-fueled vehicles,
- the consumer costs of the low retail availability of alternative fuels and the limited model diversity of alternative-fueled vehicles, and
- the slow turnover of durable capital equipment and vehicles already on the road.

<sup>18</sup>Light-duty vehicles are automobiles and trucks that have gross weight ratings of less than or equal to 8,500 pounds.

<sup>19</sup>The report to the President and the Congress was prepared pursuant to section 506 of EPACT. See Replacement Fuel and Alternative Fuel Vehicle Technical and Policy Analysis, DOE, Energy Efficiency and Renewable Energy, Office of Transportation Technologies (July 1997).

<sup>20</sup>The Alternative Fuel Transition: Draft Final Results from the TAFV Model of Alternative Fuel Use in Light-Duty Vehicles, 1996-2010, Oak Ridge National Laboratory, (Feb. 27, 1998). (Referred to in this report as the Oak Ridge study.)

Table I.1 summarizes the Oak Ridge study's estimates of what portion of petroleum consumption would be replaced by alternative fuels in 2010 under six different sets of assumptions. In the base case, DOE assumed existing fleet mandates, while in the late rule case DOE assumed a local government and private fleet mandate was added. In either of those cases, alternative fuels would constitute less than 1 percent of light-duty vehicle motor fuel sales in 2010. The assumptions made in the next three cases produced estimated replacement levels between 14 and 22 percent. In the no barriers case, DOE assumed that vehicles and fuels would be produced at large-scale costs and that all fuels would be widely available at retail locations. In the greenhouse gas case, DOE assumed fuel tax reductions in proportion to the reductions in greenhouse gas emissions from a baseline level of emissions for gasoline. In the tax credit case, DOE assumed an ethanol tax credit would continue through 2010. The last of the six cases was the only one in which EPACT's goal of 30-percent replacement was achieved. In this case, called the fuel sales mandate case, DOE assumed that the Congress would require that retail sales of alternative fuel meet EPACT's goal but does not describe how such a result would be mandated.

**Table I.1: Fuel Shares in 2010 From the 1998 Oak Ridge Study**

Percentage of light-duty vehicle motor fuel sales

Type of fuel	Base case	Late rule case	No barriers case	Greenhouse gas subsidy case	Tax credit case	Fuel sales mandate case
Conventional gasoline	70.57	70.58	62.92	58.60	58.40	53.00
Reformulated gasoline	29.24	29.18	22.73	19.80	19.60	17.00
Compressed natural gas	0.10	0.10	5.22	0.10	0.10	0.10
Ethanol (E85)	0.03	0.04	2.96	21.50	21.90	5.10
Methanol (M85)	0.04	0.06	5.81	0.00	0.00	24.80
Propane	0.02	0.02	0.36	0.00	0.00	0.00
Electricity	0.01	0.01	0.01	0.00	0.00	0.00
<b>Alternative fuels total</b>	<b>0.19</b>	<b>0.24</b>	<b>14.36</b>	<b>21.60</b>	<b>22.01</b>	<b>30.00</b>

Note: E85 is a mixture of 85 percent ethanol and 15 percent gasoline. M85 is a mixture of 85 percent methanol and 15 percent gasoline.

Source: The Alternative Fuel Transition: Draft Final Results from the TAFV Model of Alternative Fuel Use in Light-Duty Vehicles, 1996-2010, Oak Ridge National Laboratory, (Feb. 27, 1998) p. 51.

## The Relative Contribution of Propane in Meeting EPACT's Goal Is Unclear

Although the Oak Ridge study suggests only a minimal role for propane in meeting EPACT's goal, in January 1996, DOE issued a report on the feasibility of producing sufficient replacement fuels to meet EPACT's 10- and 30-percent goal. This study indicated a potentially major role for propane.<sup>21</sup> In it, DOE examined two scenarios:

- the low oil price scenario, which assumed that the Organization of Petroleum Exporting Countries (OPEC) was not able to exert monopoly control over crude-oil pricing in 2010 and
- the reference oil price scenario, which assumed that OPEC exerted partial monopoly power over the pricing of crude oil.

Under the low oil price scenario, the world oil price would be \$20.60 per barrel; the U.S. price, \$21.60. Under the reference oil price scenario, the world oil price would be \$25.82 per barrel; the U.S. price, \$26.74 per barrel.<sup>22</sup>

For each scenario, DOE examined various possible cases, including the following four. In the benchmark case, DOE assumed that all fuels would be taxed at the same dollar-per-Btu rate, specifically the gasoline tax rate in 1994. It assumed that no well-developed infrastructure for alternative transportation fuels would exist and that alternative-fueled vehicles would be in use by organizations covered by EPACT's fleet requirements and state mandates, while households would continue to rely on gasoline-fueled vehicles. In the unconstrained case, DOE assumed that a well-developed infrastructure for alternative transportation fuels and vehicles would exist in a long-run situation. In the limited imports case, DOE assumed that at least one-half of alternative fuels used would be produced from within the North American Free Trade Agreement countries. In the letter-of-the-law case, DOE not only assumed limited imports but also assumed that overall petroleum replacement would equal 30 percent. Table I.2 summarizes the results from this study for light-duty vehicle fuel use under the low oil price scenario. Somewhat higher replacement percentages occurred under the unconstrained and limited imports cases in the reference oil price scenario. Propane consumption was higher for the unconstrained and limited imports cases but slightly lower for the letter-of-the-law case under the reference oil price scenario.

<sup>21</sup>The study was prepared pursuant to section 502(a) of EPACT. See *Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector*, (Jan. 1996). (Referred to as the 1996 study.)

<sup>22</sup>All prices are in 1990 dollars.

Appendix I  
Results From Previous DOE Studies

**Table I.2: Light-Duty Vehicle Fuel Use in 2010 From DOE's 1996 Study**

Millions of barrels of gasoline-equivalent per day

Type of fuel	Benchmark case	Unconstrained case	Limited imports case	Letter-of-the-law case
Conventional gasoline	4.029	3.175	3.185	3.343
Reformulated gasoline	3.815	2.711	2.705	2.847
Compressed natural gas	0.041	0.250	0.267	0.220
Ethanol (E85)	0.023	0.023	0.023	0.023
Methanol (M85)	0.035	0.817	0.805	0.740
Propane	0.031	1.059	1.034	0.866
Electricity	0.092	0.092	0.092	0.092
<b>Total</b>	<b>8.066</b>	<b>8.127</b>	<b>8.111</b>	<b>8.131</b>
Replacement percentage	12.4%	33.2%	33.0%	30.0%

Note: E85 is a mixture of 85 percent ethanol and 15 percent gasoline. M85 is a mixture of 85 percent methanol and 15 percent gasoline.

Source: Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, DOE, (Jan. 1996) p. 91.

The importance of propane as an alternative fuel differed in the 1996 study and the Oak Ridge study because of the 1996 study's use of lower cost figures for liquified petroleum gas. According to the authors of the Oak Ridge study, had they also used these lower costs, they would have reported a 28-percent displacement of gasoline by alternative fuels in 2010 versus the 14-percent figure they reported in the no barriers case. Of this 28-percent displacement, propane would have constituted about half. The 1996 study estimated that propane would account for 47 percent of the fuel displaced by alternative fuels.

In its 1996 study, DOE found, under its low oil price scenario, potentially significant impacts on the propane market once all transitional barriers to alternative fuels were overcome. As seen in table I.3, when comparing the benchmark and unconstrained cases, liquified petroleum gas consumption by motor vehicles rises from 0.042 million to 1.450 million barrels per day in 2010. At the same time, consumption by the petrochemical industry falls from 0.333 million barrels per day to 0. The remaining liquified petroleum gas consumption, categorized as "nonvehicle end use" (such as residential heating and cooking), decreases from 1.742 million to 1.710 million barrels per day. Under the benchmark case, propane supplied by refineries and gas processing plants were somewhat lower in the reference oil price scenario than the low oil price scenario, whereas non-Canadian imports

**Appendix I  
Results From Previous DOE Studies**

were higher under the reference oil price scenario. In both the reference and low oil price scenarios, the direction of change in values between the benchmark and the other cases were similar.

**Table I.3: Propane Consumption and Supply Estimates in 2010 From DOE's 1996 Study**

Millions of barrels per day

	<b>Benchmark case</b>	<b>Unconstrained case</b>	<b>Limited imports case</b>	<b>Letter-of-the-law case</b>
<b>Consumption</b>				
Nonvehicle end use	1.742	1.710	1.694	1.714
Petrochemical	0.333	0.000	0.000	0.000
Vehicles	0.042	1.450	1.416	1.186
<b>Supply</b>				
Refineries	0.629	0.776	0.751	0.770
Gas processing	0.950	0.961	0.997	0.961
Canadian imports	0.000	0.216	0.230	0.140
Non-Canadian imports	0.538	1.207	1.132	1.030

Source: Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, DOE, (Jan. 1996).

Table I.4 summarizes the effect of these changes in consumption and supply on propane prices as estimated in the 1996 report. By contrast, the Oak Ridge study reported no increase in propane prices, except in the case of a fuel sales mandate, under which the liquified petroleum gas price rose less than 2 percent.

**Appendix I  
Results From Previous DOE Studies**

**Table I.4: Price Estimates for 2010 From DOE's 1996 Study**

Dollars per gallon of gasoline-equivalent

<b>Type of fuel</b>	<b>Benchmark case</b>	<b>Unconstrained case</b>	<b>Limited imports case</b>	<b>Letter-of-the-law case</b>
<b>Low oil price scenario</b>				
Conventional gasoline	\$1.23	\$1.21	\$1.24	\$1.20
Reformulated gasoline	\$1.32	\$1.31	\$1.35	\$1.30
Propane	\$1.10	\$1.17	\$1.21	\$1.16
<b>Reference oil price scenario</b>				
Conventional gasoline	\$1.35	\$1.33	\$1.37	\$1.29
Reformulated gasoline	\$1.44	\$1.43	\$1.47	\$1.40
Propane	\$1.15	\$1.20	\$1.26	\$1.19

Notes: Fuel consumption in terms of gasoline-equivalent gallons was computed by dividing the adjusted lower heating value of the alternative fuel (thousands of Btu per native unit of fuel) by the lower heating value of gasoline and multiplying this result by the alternative-fueled consumption value.

Reformulated gasoline contains additional oxygen and burns more cleanly than conventional gasoline.

Source: Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, DOE, (Jan. 1996) pp. 77 and 90.

In comparing the overall results of these two studies, the Oak Ridge authors noted that their results were "in marked contrast to DOE's 1996 long-run analysis, which concluded that if the necessary infrastructure for a mature alternative fuel and vehicle industry were present, then alternative fuels, as a group, appear likely to sustain a 30-percent market share under equilibrium conditions." The Oak Ridge report went on to state, "However, the modeling results here suggest that the necessary infrastructure may not evolve smoothly, and fuel and vehicle prices may not benefit from economies of scale in the absence of additional policies . . ." <sup>23</sup>

<sup>23</sup>Oak Ridge study, p. 22.

# Estimating the Effect of EPACT's Fleet Mandates

This appendix describes the Energy Information Administration's (EIA) methodology for estimating the effect of EPACT's purchase mandates for alternative-fueled vehicles (AFV) on the replacement of petroleum fuels used by motor vehicles in the United States and on the demand, supply, price, and existing consumers of propane.

As a starting point, we asked EIA to use its National Energy Modeling System (NEMS) to estimate the likelihood of achieving EPACT's goals of displacing 10 percent of the petroleum motor fuel used in the United States by 2000 and 30 percent by 2010 by implementing all the mandates placed on "covered" fleets (i.e., those bound by the EPACT mandates) to purchase an increasing percentage of AFVs. We also asked EIA to use NEMS to model the effect of including propane as an alternative motor fuel under EPACT on the demand, supply, price, and existing users of propane. EIA developed and maintains NEMS to forecast the effects of energy policies or programs and changing world energy market conditions on the U.S. and world energy markets.<sup>24</sup>

## Estimating EPACT's Effect on Fuel Displacement

To estimate what percentage of petroleum motor fuel will be replaced by alternative fuels in the United States, EIA used the Transportation Demand Module of NEMS to model the effect of AFV acquisitions by the various covered fleets on the consumption of alternative fuels and calculated the percentage of displaced conventional fuel that this represents. EIA assumed that covered fleets will basically meet their legislative requirements for AFVs by purchasing the minimum percentage mandated by law. According to EIA officials, its analysis has found that the economics of AFV purchases do not justify exceeding the minimum percentage. It therefore estimated the impact of the fleet mandates by including in NEMS the minimum percentage required for each fleet category in each year specified. EIA used the reference case in its Annual Energy Outlook 1998 as a projection of the most likely future trends in energy markets and the U.S. economy.<sup>25</sup>

To estimate the impact of EPACT's AFV mandates on the demand, supply, and price as well as on existing consumers of propane, EIA performed a special run of NEMS (otherwise known as the GAO case) that basically removed propane-fueled vehicles from consideration, leaving everything else constant, including the assumption that the minimum required

<sup>24</sup>For more information on NEMS, see The National Energy Modeling System: An Overview, DOE/EIA-0581 (96), (Mar. 1996).

<sup>25</sup>The reference case included 1997 through 2010 figures, all projections.

percentage of AFV purchases would be made in each fleet category. For each variable of interest, the results of the GAO case were then compared with the reference case in the Annual Energy Outlook 1998 and the difference calculated to determine the estimated impact. For example, to estimate the impact of EPACT mandates on propane use, the difference in propane use between the GAO case and the reference case was computed.

---

## Detailed Assumptions and Other EPACT Provisions Incorporated in the Model

In using NEMS to model the effects of EPACT, EIA made the following assumptions concerning how the provisions of EPACT are incorporated in the model. The fleet AFV purchases necessary to meet the EPACT regulations were derived based on the mandates as they currently exist as well as the Commercial Fleet Vehicle Module calculations. The federal AFV program went into effect in fiscal year 1993 but, generally, the mandates for state and alternative fuel provider fleets were delayed until 1997 because, according to a DOE official, DOE did not issue the rulemaking, as required by EPACT, early enough for the mandate to take effect in 1996. Specifically, it is assumed that each fleet category will meet its AFV mandate by purchasing the minimum percentage of AFVs required by EPACT for that fleet category. Table II.1 presents the percentages used by EIA's NEMS for AFV purchases for each fleet category and model year, and the mandates for municipal and private fleets still subject to rulemaking. Table II.2 presents the total projected AFV purchases by fleets.

**Appendix II**  
**Estimating the Effect of EPACT's Fleet**  
**Mandates**

**Table II.1: Percentages Used by EIA's NEMS for AFV Purchases by Fleet Type and Year**

Year	Municipal and private	Federal	State	Fuel providers	Electric utilities <sup>a</sup>
1996	•	25	•	•	•
1997	•	33	10	30	•
1998	•	50	15	50	30
1999	•	75	25	70	50
2000	•	75	50	90	70
2001	•	75	75	90	90
2002	20	75	75	90	90
2003	40	75	75	90	90
2004	60	75	75	90	90
2005 <sup>b</sup>	70	75	75	90	90

<sup>a</sup>Electric utilities fall under EPACT section 501, which provides mandates for fuel providers. However, electric utilities are a separate category for the purposes of this analysis because the Congress stipulated in section 501(c) that electric utilities are excluded from the vehicle purchased mandates until calendar year 1998 with respect to electric motor vehicles. According to DOE officials, the stipulation was made because electric vehicles, which are the most likely choice for the fleets of electric utilities, are 1 to 2 years behind other types of AFVs technologically.

<sup>b</sup>EPACT's AFV percentage requirements remain the same after 2005.

Source: Alternatives to Traditional Transportation Fuels, DOE, EIA (1994).

**Table II.2: EPACT Alternative Fuel Fleet Sales Estimates**

Fleet type	1995	2000	2005	2010
<b>Automobiles</b>				
Government	0	57,065	73,572	73,990
Private	0	0	77,376	76,132
Fuel provider	0	76,614	88,218	88,720
<b>Light trucks</b>				
Government	0	68,021	104,660	106,988
Private	0	0	22,234	22,729
Fuel provider	0	19,304	23,738	24,266

Note: The government fleet figures are a composite of projected AFV purchases by federal, state, and municipal governments, weighted by the respective EPACT-mandated minimum percentage purchase. Similarly, the fuel provider category is the projected aggregate purchase by fuel providers and electric utilities, weighted by their respective minimum percentage purchase for each required by law. The private fleet category comprises only the private fleet component of section 507(g) since the municipal component is captured in the government total.

Sources: Annual Energy Outlook 1998 and special NEMS run, EIA.

---

**Appendix II**  
**Estimating the Effect of EPACT's Fleet**  
**Mandates**

---

Although the mandates for private and municipal fleets (covered by section 507(g) of EPACT) are not in effect yet and are still subject to rulemaking by the Secretary of Energy, the effects of these mandates were included in the model in order to estimate the total effect of all the AFV acquisition provisions in the law. In the model, the private and municipal fleet mandates do not become effective until model year 2002, based on the schedule specified in the law. Only fleets of 50 or more were considered (in accordance with EPACT), and AFV purchases were categorized as cars or light trucks. Because EPACT covers only fleets in the metropolitan statistical areas with 1980 populations of more than 250,000, the model excluded 10 percent of all business and utility fleets and 37 percent of all government fleets. For other than federal fleets, EPACT covers fleets of 50 or more vehicles, of which at least 20 vehicles can be centrally fueled and are used primarily in metropolitan statistical areas with 1980 populations of more than 250,000.

# Major Contributors to This Report

---

**Resources,  
Community, and  
Economic  
Development Division**

Charles W. Bausell, Jr., Assistant Director  
Godwin M. Agbara, Evaluator-in-Charge  
Leslie D. Albin, Communications Analyst

---

**Seattle Field Office**

Araceli Contreras Hutsell, Evaluator