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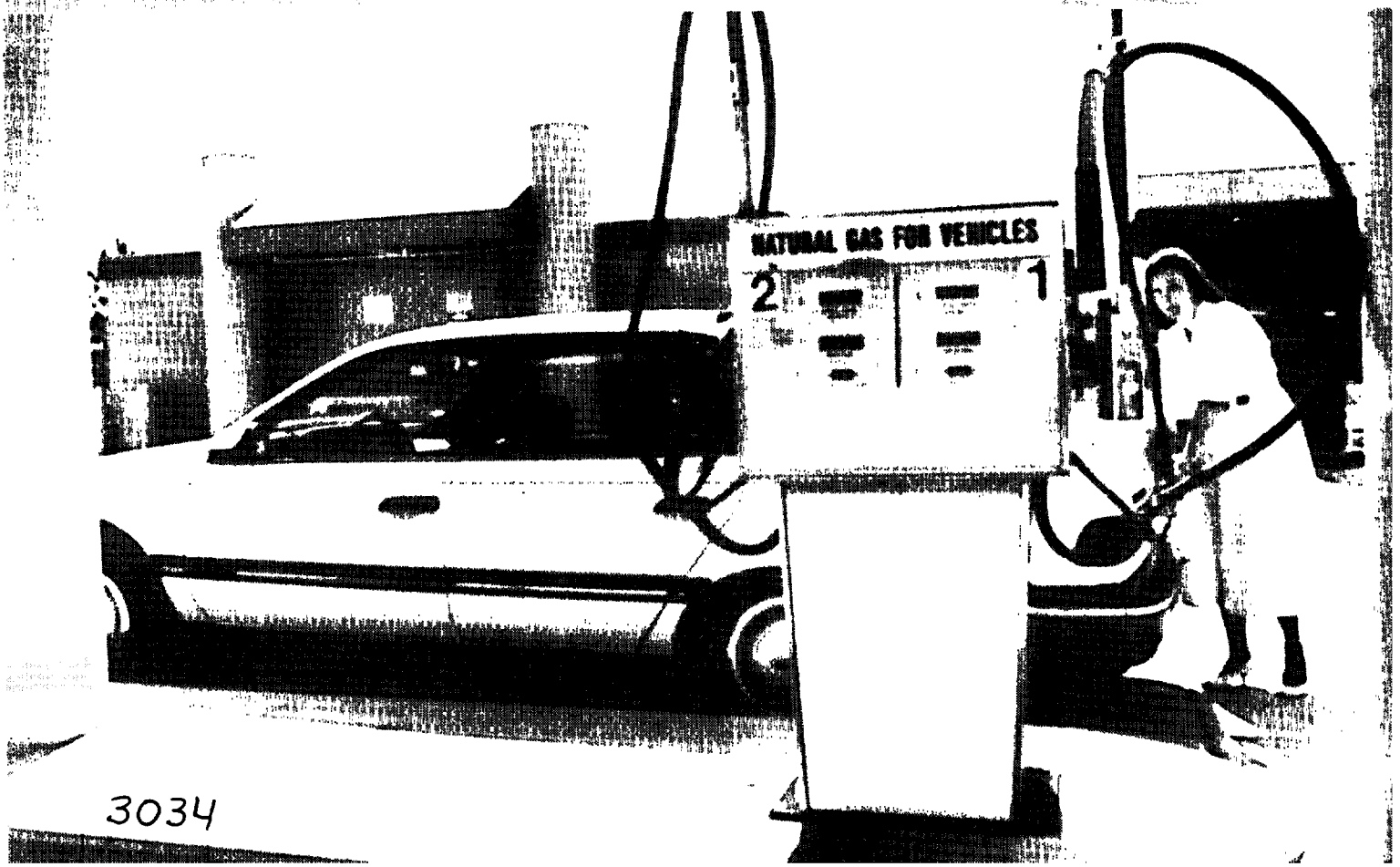
VOLUME 1



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Executive Summary

Petroleum-based gasoline and diesel fuel account for nearly all of the fuel used in onroad vehicles today. Concerns about the environmental effects of fossil fuel use and the Nation's dependence on foreign oil are providing the impetus for increasing use of alternative-fueled vehicles (AFV's) and alternatives to traditional transportation fuels. The Energy Policy Act of 1992 (EPACT) and Presidential Executive Order 12844 mandated minimum AFV purchases for Federal government vehicle fleets beginning in 1993. EPACT mandates for the acquisition of AFV's by State and local government fleets and some private fleets are scheduled to take effect over the next few years.

Alternatives to Traditional Transportation Fuels 1994 is the second in a series of annual reports designed to provide data and information on AFV's and alternative and replacement transportation fuels. Section 503(a) of the EPACT directs the Energy Information Administration (EIA) to estimate annually the number of AFV's in use in the United States, the amount and distribution of replacement fuel, and the greenhouse gas emissions likely to result from replacement fuel use. Section 503(b) directs suppliers of AFV's to report annually the number and type of AFV's made available in the previous year and those that the supplier plans to make available in the following year. Volume 1 of *Alternatives to Traditional Transportation Fuels 1994* includes estimates of the number of AFV's in use (AFV inventory), estimates of alternative and replacement fuel consumption, and data on AFV's made available. The estimates are based on information as of October 1995 (see "Data Availability," page vii). Volume 2, to be published at a later date, will contain estimates and information for greenhouse gas emissions resulting from replacement fuel use.

Alternative-Fueled Vehicle Inventory

The number of AFV's in use in the United States increased by nearly 30 percent from 1992 to 1994 and is expected to increase another 30 percent by 1996, when more than 421,000 AFV's are expected to be in use. About two-thirds of the AFV's in use in 1996 will be vehicles designed to operate on liquefied petroleum gases (LPG). LPG vehicles will continue to comprise the largest portion of AFV's for some time, but their share has declined since 1992, when they made up 88 percent of all AFV's. Meanwhile, vehicles designed to operate on natural gas are becoming a larger portion of AFV's, growing from 9 percent to 20 percent of all AFV's between 1992 and 1996. The remaining AFV's are alcohol-fueled or electric vehicles. The share of methanol vehicles is expected to increase from 2 to 5 percent from 1992 to 1996, while the share of ethanol vehicles will grow from less than 1 to 8 percent. Estimates for 1996 include 30,000 ethanol pickup trucks. General Motors has announced that for the 1997 model year it will produce an entire line of flexible-fuel pickup trucks capable of operating on gasoline or a blend of 85-percent ethanol and 15-percent gasoline (E85). Although many purchasers of these trucks are not expected to use the AFV capability, the vehicles fit the EPACT definition of AFV's and are therefore included in this report.

The largest number of AFV's are located in the South, followed by the West, Midwest, and Northeast. (These Census regions are defined in Appendix B.) The predominance of AFV's in the South and West is primarily due to the large number of States in those regions and to high concentrations of AFV's in Texas and California. California, Texas, Michigan, Illinois, and Ohio are the five States with the largest numbers of AFV's, accounting for about 40 percent of non-Federal AFV's in the United States. California and Texas, however, each have more than twice the number of any other State.

Most (86 percent in 1994 and 81 percent in 1996) AFV's in use are privately owned. The number of federally owned AFV's is expected to reach 36,571, or 9 percent of total AFV's, by 1996.[1] Lack of availability of certain types of AFV's from automakers and reductions in budget appropriations limited the acquisition of Federal

[1]Estimated as of October 1995, based on Federal AFV acquisition requirements (see Appendix A). As of January 1996, lower total Federal vehicle acquisitions, which would decrease the number of AFV's required, are expected.

AFV's in 1995. The number of AFV's owned by State and local governments has increased more rapidly than private ownership, but more slowly than Federal ownership. The percentage of AFV's owned by State and local governments is expected to increase from 7 percent in 1992 to 10 percent in 1996.

Light duty vehicles comprise the majority of AFV's, accounting for 82 percent of AFV's in use in 1994. The share of light duty AFV's is expected to remain high as mandates for increasing acquisitions of light duty AFV's take effect. Federal mandates for AFV acquisitions by fleets do not cover heavy duty vehicles. However, heavy duty vehicles are subject to new emissions requirements that may encourage the use of alternative fuels.

Alternative-Fueled Vehicles Made Available

Preliminary survey results indicate that more than 22,000 onroad AFV's were made available in 1994.[2] AFV suppliers also reported that, in 1995, they plan to make available almost 19,000 additional onroad AFV's.[3] The apparent decrease from 1994 to 1995 is believed to reflect the uncertainty of AFV suppliers about the future.

Sixty-three percent of the AFV's made available in 1994, and 86 percent of those planned to be made available in 1995, are vehicles designed for LPG or natural gas. The remainder are alcohol and electric vehicles. Of the AFV's made available in 1994, 43 percent were automobiles and another 34 percent were vans and pickup trucks. In 1995, 71 percent of the planned AFV's were autos, vans, or pickup trucks. The majority of non-electric AFV's made available are bi-, dual-, or flexible-fuel vehicles. The demand for vehicles that can operate on more than one fuel reflects the absence of a completely developed fueling infrastructure.

The data on vehicles made available were collected by a new survey of AFV suppliers. Survey forms were mailed to respondents in February 1995. Survey respondents included both original equipment manufacturers (OEM's) and entities that perform conversions. Types of organizations that may perform conversions include businesses, Government agencies, quasi-government agencies (such as transit systems, airport authorities, and school bus districts) and research institutions. Subsequent surveys will be conducted annually. The next survey, scheduled to take place in early 1996, will collect data on vehicles made available in 1995 and those planned to be made available in 1996.

Alternative and Replacement Fuel Consumption

Consumption by onroad vehicles of alternative and replacement fuels is increasing much faster than consumption of traditional transportation fuels. As a result, the share of total highway fuel provided by alternative and replacement fuels is increasing. By 1996, alternative and replacement fuels are expected to account for 3.1 percent of the fuel used (on a gasoline-equivalent gallon basis) in highway vehicles, up from 1.6 percent in 1992. Increased demand for oxygenates (ethers and alcohols that are added to gasoline to raise its oxygen content and are defined as replacement fuels by the EPACT) will lead the rise in alternative and replacement fuel consumption. Oxygenate consumption has grown significantly as a result of new specifications for gasoline required by the Clean Air Act Amendments of 1990 (CAAA90). Methyl tertiary butyl ether (MTBE) is the predominant oxygenate and is responsible for most of the total oxygenate growth.

Alternative transportation fuels (ATF's) accounted for 0.17 percent of onroad fuel consumption in 1992. The share is expected to increase to 0.22 percent by 1996. Growth in alternative fuel consumption is being driven by government-mandated AFV acquisition requirements, tax subsidies, and air pollution emission standards.

The consumption of LPG exceeds consumption of all other ATF's combined due to the large number of LPG vehicles in use compared to other AFV's. However, since 1992, consumption of most other ATF's has increased faster than consumption of LPG. LPG consumption accounted for 91 percent of total alternative fuel consumption in 1992, but its share is expected to drop to 81 percent in 1996. Meanwhile, consumption of natural gas is expected to increase from 8 percent to 16 percent of total alternative fuel consumption over the period.

The role of heavy-duty AFV's is much more significant in terms of fuel consumption than their relatively small numbers suggest. In 1996, heavy duty vehicles are expected to comprise 16 percent of total AFV's, but account for 35 percent of total ATF consumption. The

[2]An alternative-fueled vehicle is considered "made available" in the year it is completed and made ready for delivery to dealers or users.

[3]The data for AFV's made available are preliminary, based on a 73-percent survey response rate.

regional distribution of ATF consumption is very similar to the distribution of AFV's.

Data Availability

Data tables showing the estimates presented in this report of AFV's "in use" and "made available," as well as the estimates of alternative transportation fuel consumption were released in October 1995. They are available via modem on the EIA's Electronic Publishing System (EPUB), 202/586-2557. These data tables are also available through the EIA "Home Page" on the Internet. The World Wide Web site address is http://www.eia.doe.gov.

1. Introduction

Petroleum-based gasoline and diesel fuel account for nearly all of the fuel used in onroad vehicles today. These fuels have been identified as significant contributors to urban ozone and carbon monoxide levels and as sources of greenhouse gases. The Clean Air Act Amendments of 1990 focused attention on the environmental impact of transportation fuels by regulating both transportation fuel content and allowable air emissions from transportation fuels. The Persian Gulf War in 1991 emphasized the Nation's high level of dependence on foreign oil; transportation fuels again gained the spotlight. The Energy Policy Act of 1992 (EPACT) established a National goal of replacing 30 percent of the projected U.S. consumption of motor fuels with alternative and replacement fuels by 2010. The Clean Air Act Amendments and the EPACT followed the 1988 Alternative Motor Fuels Act, which directed Federal agencies to administer programs that would encourage the development of alternative transportation fuels (ATF's) and the production of alternative fueled vehicles (AFV's). These three legislative acts, as well as local environmental concerns and the growing interest of fuel suppliers and fleet managers, have provided the motivation for research, development, production, and marketing of AFV's and ATF's.

Alternatives to Traditional Transportation Fuels 1994 is the second in a series of annual reports designed to provide data and information on AFV's and alternative and replacement transportation fuels. It is prepared in accordance with Section 503 of the EPACT, which directs the Energy Information Administration (EIA) to estimate annually for the following calendar year: 1) the number of each type of AFV likely to be in use in the United States; 2) the probable geographic distribution of the vehicles; 3) the amount and distribution of each type of replacement fuel; and 4) the greenhouse gas emissions likely to result from replacement fuel use over the entire fuel cycle. Section 503(b) of the EPACT requires that suppliers of AFV's report annually, to the Department of Energy, the number and type of AFV's "made available." Each supplier must report AFV's that were made available in the previous calendar year and those that the supplier plans to make available in the following calendar year. In 1995, EIA conducted the first survey of AFV suppliers. Volume 1 of *Alternatives to Traditional Transportation Fuels 1994* provides updates of AFV, ATF, and replacement fuel estimates published in January 1995.[4] It also presents preliminary data from the AFV Suppliers' Survey. Volume 2, to be published at a later date, will contain estimates and information for greenhouse gas emissions resulting from replacement fuel use.

Additional information on alternative and replacement fuels can be found in *Alternatives to Traditional Transportation Fuels: An Overview*.[5] The *Overview* report serves as a reference document for the annual reports, because it contains detailed technical information about fuel properties and fuel production processes, vehicle characteristics, legislation, greenhouse gases, and other topics that are not covered in the annual reports.

Report Contents

In this report, alternative and replacement fuels are defined in accordance with the EPACT. Section 301 of the EPACT defines alternative fuels as: methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more (or such other percentage, but not less than 70 percent, as determined by the Secretary of Energy, by rule, to provide for requirements relating to cold start, safety, or vehicle functions) by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; electricity (including electricity from solar energy); and any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits. The EPACT defines replacement fuels as the portion of any motor fuel that is methanol, ethanol, or other alcohols, natural gas, liquefied petroleum gas, hydrogen, coal-derived liquid

[4]Energy Information Administration, *Alternatives to Traditional Transportation Fuels 1993*, DOE/EIA-0585(93) (Washington, DC, January 1995).

[5]Energy Information Administration, *Alternatives to Traditional Transportation Fuels: An Overview*, DOE/EIA-0585(0) (Washington, DC, June 1994).

fuels, fuels (other than alcohol) derived from biological materials, electricity (including electricity from solar energy), ethers, or any other fuel the Secretary of Energy determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits.

To correspond as closely as possible with the definitions in EPACT, the data for alternative fuels in this report include the gasoline portion of alcohol/gasoline mixtures such as 85-percent methanol (M85). The term "alternative and replacement fuels" means all alternative fuels plus alcohols, ethers, and other fuels that meet EPACT requirements and are blended with traditional fuels in smaller amounts than is required to qualify as an alternative fuel. The gasoline or diesel fuel portions of such mixtures are considered to be traditional fuels.

This report covers only those alternative and replacement fuels cited in the EPACT that are currently commercially available or produced in significant quantities for vehicle demonstration purposes. Information about other fuels, such as hydrogen and biodiesel, will be included in later reports as those fuels become more widely used. Annual data are presented for 1992 to 1996. Data for 1996 are based on plans or projections for 1996.

Chapter 2 presents the estimated number of AFV's in use in the United States from 1992 through 1996. AFV's in use represent the entire stock, or inventory, of onroad AFV's at the end of each calendar year. Detailed estimates of AFV's distributed by region, ownership, and vehicle size are shown for 1994 and 1996. Similar detailed estimates for 1992 and 1993 were published in *Alternatives to Traditional Transportation Fuels 1993*. Estimates are included for vehicles designed to operate on the following fuels: liquefied petroleum gases (LPG); natural gas, both compressed (CNG) and liquefied (LNG); alcohols defined as alternative fuels, for example, neat or 100-percent methanol (M100) and mixtures of 85-percent ethanol and 15-percent gasoline (E85); and electricity.

Chapter 2 serves as a means of studying industry growth and the direction of development in AFV's. This chapter presents data for the four U.S. Census regions—Northeast, South, Midwest, and West. Census region information provides a broad picture of where development is occurring. Most AFV's, however, are clustered within specific areas of those regions. To give a better picture of location, estimates of AFV's in use are shown for the five States that have the largest number of AFV's (California, Texas, Michigan, Illinois, and Ohio).

Chapter 3 presents the number of AFV's made available (i.e., additions to stock) in 1994 and those planned to be made available in 1995. This chapter also explains the survey procedure used to collect these data. Coverage by fuel type is the same as for AFV's in use with an added category for other fuels. Other fuels include hydrogen, biodiesel, and other alternative fuels. Data are included for both onroad and nonroad vehicles. Although not all nonroad vehicles are included in the transportation sector, they were included in the AFV Suppliers' Survey because the EPACT has identified the use of alternative fuels in nonroad vehicles as a way of possibly reducing reliance on imported energy. A list of AFV suppliers, compiled from the survey, is included in Appendix C.

Chapter 4 presents estimates of alternative and replacement fuel consumption. This chapter shows the correlation between fuel use and the number of AFV's in use. It can be used as a basis for studying fuel availability and the displacement of petroleum-based transportation fuels. Estimates cover the same time periods as those for AFV's in use. In addition to the alternative fuels covered in Chapter 2, the following replacement fuels are included: methyl tertiary butyl ether (MTBE), ethanol used as a fuel additive, and other oxygenates used as fuel additives. Data are presented in terms of gasoline-equivalent gallons to facilitate comparisons among different fuel types.

Data Sources and Quality

Data and information presented in this report are compiled from the most current available information on AFV's and alternative and replacement fuels.[6] However, the extent and reliability of certain information are limited because of the immature state of alternative transportation fuels markets, regulatory programs, and associated data collection efforts. Detailed descriptions of data estimation methods and quality are presented in Appendix A.

The methods employed for estimating AFV's in use (Chapter 2) vary by fuel type and ownership category (Federal, State and local government, and private). Estimates of vehicles designed for LPG use are subject to much uncertainty. The level of uncertainty varies, but is much less, for other fuel types.

[6]The estimates are based on information as of October 1995.

Data on AFV's made available (Chapter 3) are based on a mail survey of identified AFV suppliers. Because of the difficulty of identifying suppliers in a developing market, the frame of respondents may fall short of the actual number of suppliers. The data in this report are considered preliminary because they are based on a 73-percent survey response rate. The EIA is currently in the process of following up with nonrespondents and is continuing to improve the identification of potential respondents.

Estimates of alternative fuel consumption (Chapter 4) were calculated based on AFV inventories, annual vehicle miles traveled (VMT), and fuel efficiency, measured in miles per gasoline-equivalent gallon. Fuel efficiency and VMT estimates for AFV's were derived from assumptions that were developed to account for differences in fuel type, ownership (private versus government), classification (auto, light duty truck, heavy duty truck, school/transit bus), and fleet type (e.g., rental and service, passenger, and government light duty vehicle pools). Adjustments were made according to the contribution of VMT from alternative and replacement fuels consumed in dedicated versus bi-, dual-, and flexible-fuel vehicles. Lack of actual fuel use and VMT data for AFV's results in a degree of uncertainty for fuel consumption data.

The EIA will continue studying ways to improve data quality. The EIA also plans to expand its AFV and ATF data and information base so that future reports will provide information that can serve as a basis for analyzing AFV and alternative and replacement fuel development. As the fuels develop, *Alternatives to Traditional Transportation Fuels* is intended to provide analysts with data and information to evaluate environmental and energy security issues, to measure progress toward goals, and to track the penetration of replacement fuels into the transportation fuel market. The reports should also be useful for economic studies and many other types of analyses of alternative and replacement fuels.

2. Alternative-Fueled Vehicle Inventory

Although small when compared to the use of all vehicles, the use of alternative-fueled vehicles (AFV's) in the United States continues to grow steadily. Demand for AFV's is driven by AFV acquisition mandates, clean air regulations, government financial incentives, and AFV performance evaluation programs. However, recent Federal legislative proposals to reduce program spending and curb clean air laws, as well as shortages of some AFV models marketed by the major automakers, have slowed market momentum. Technical and economic factors such as refueling facility availability and convenience, fuel tank safety, the extent of air emission benefits, vehicle cost, vehicle resale value, and operating range continue to affect the market. Nevertheless, the prospects for continued increases in AFV market share remain good. Even today, the low cost of some alternative fuels relative to conventional fuels and the decreasing costs for AFV engines and conversion kits are making AFV's economically attractive for a number of fleet vehicle market niches.

Federal laws, particularly the Alternative Motor Fuels Act of 1988, the Clean Air Act Amendments of 1990 (CAAA90), and the Energy Policy Act of 1992 (EPACT), have provided the impetus for government agency and private company investment in AFV's and supporting infrastructure. Many fleet operators are subject to Federal mandates that require the acquisition of AFV's now or in the near future (Table 1). This chapter discusses recent legislative and regulatory actions and other AFV market forces, and provides estimates of the number of AFV's in use.

Legislative, Regulatory, and Other Government Activity

Federal

Recent attention in the Federal sector has focused on the implementation of federally mandated AFV acquisition requirements for fleets, as well as efforts by the U.S. Congress to overhaul regulatory programs and reduce Federal spending.

Sections 501 and 507 of the EPACT require the phase-in of AFV acquisitions by alternative fuel providers (entities that produce, store, refine, process, transport, distribute, import, or sell alternative fuels) and State government fleets beginning September 1, 1995 (the start of the 1996 vehicle model year). On February 28, 1995, the Department of Energy proposed a rule for implementing these requirements.[7] The proposed rule defines which State agencies and fuel providers are covered, sets up the rules for compliance and reporting, and establishes an AFV credit program. The credit program grants credits to fleets that acquire AFV's in excess of the mandate or before the year that the acquisition requirement applies. Credits can be transferred to other fleets. Comments on the proposed rule suggested that the compliance date be delayed.[8] As of December 26, 1995, the final rulemaking is pending.

The Unfunded Mandate Reform Act of 1995 could delay the implementation of Federal AFV acquisition regulations as affected parties consider challenging the proposed regulations. The unfunded mandate law, signed on March 22, 1995, requires Congress and Federal agencies to review the fiscal impact of Federal unfunded mandates. The law also directs an advisory commission to identify and recommend ways to simplify mandate compliance.

In its first session, the 104th Congress introduced 31 bills to amend the Clean Air Act.[9] Proposed amendments include delay or repeal of enhanced motor vehicle inspection and maintenance programs, repeal of certain vehicle emission standards, a moratorium on sanctions for ozone nonattainment areas, suspension or repeal of the Environmental Protection Agency's (EPA's) reformulated gasoline program, and repeal of CAAA90. Changes in the Clean Air Act would probably affect the AFV market, at least indirectly. Repeal

[7]*Federal Register*, Office of Energy Efficiency and Renewable Energy, Department of Energy, 10 CFR Part 490, "Alternative Fuel Transportation Program"; Notice of Proposed Rulemaking (February 28, 1995).

[8]The Department of Energy extended the comment period on the proposed rule through the issuance of two *Federal Register* notices (60 FR 30795, June 12, 1995, and 60 FR 38974, July 31, 1995).

[9]Bill Tracking Report, 104th Congress, 1st Session, LEXIS-NEXIS (Reed Elsevier Inc., July 19, 1995).

Table 1. Federal Mandates for Alternative-Fueled Vehicle Acquisition, by Fleet Type and Year
(Percent of Total Light Duty Vehicle Acquisitions, Unless Otherwise Noted)

	Federal Government		State Government	Alternative Fuel Providers[a]	Electric Utilities[b]	Municipal/ Private
Year	Required Fiscal Year AFV Acquisitions (number)	Required Fiscal Year AFV Acquisitions (percent)	Required Model Year AFV Acquisitions[c]	Required Model Year AFV Acquisitions[c]	Required Model Year AFV Acquisitions	Required Model Year AFV Acquisitions[d]
1993	7,500	--	--	--	--	--
1994	11,250	--	--	--	--	--
1995	15,000	--	--	--	--	--
1996	--	25	10	30	--	--
1997	--	33	15	50	--	--
1998	--	50	25	70	30	--
1999	--	75	50	90	50	20
2000	--	75	75	90	70	20
2001	--	75	75	90	90	20
2002	--	75	75	90	90	30
2003	--	75	75	90	90	40
2004	--	75	75	90	90	50
2005	--	75	75	90	90	60
Thereafter ...	--	75	75	90	90	70

[a]An alternative fuel provider is an entity that produces, stores, refines, processes, transports, distributes, imports, or sells at wholesale or retail any alternative fuel.

[b]An electric utility is an entity that generates, transmits, imports, or sells electricity. Electric utilities may either acquire AFV's under the fuel provider schedule or, upon notifying the Department of Energy before January 1, 1996, fulfill the requirements with electric vehicles according to this schedule.

[c]The final rulemaking that will implement the acquisition mandates for State and alternative fuel provider fleets is pending as of December 26, 1995. As a result, the starting date for those mandates might be delayed.

[d]This requirement can be implemented only if the Secretary of Energy determines it is necessary. A determination of necessity is to be made by December 1996 in accordance with Energy Policy Act criteria.

Note: Fiscal year means the period from October 1 of the previous calendar year through September 30. Model year means the period from September 1 of the previous calendar year through August 31.

Sources: Energy Policy Act of 1992, Public Law 102-486, October 24, 1992; Executive Order 12844, "Federal Use of Alternative Fueled Vehicles"; April 21, 1993, *Federal Register*, Office of Energy Efficiency and Renewable Energy, Department of Energy, 10 CFR part 490, "Alternative Fuel Transportation Program"; Notice of Proposed Rulemaking (February 28, 1995).

of the CAAA90, for instance, would eliminate the Clean Fleet program. A weakening of emission standards could reduce the incentive to purchase and market AFV's.

A number of Federal agency regulations pertaining to AFV's were recently proposed or finalized. These include:

- On March 21, 1995, the Department of Energy (DOE) issued a proposed rule that implements guidelines for the State and Local Incentives Program (Title IV, Section 409 of the EPACT).[10] This program provides grants to States for AFV and alternative fuels projects, contingent on funding availability and DOE approval of State plans.

[10]*Federal Register*, Office of Energy Efficiency and Renewable Energy, Department of Energy, 10 CFR Part 490, "Alternative Fuel Transportation Program"; Notice of Proposed Rulemaking (March 21, 1995).

- The Federal Trade Commission issued a final rule that establishes labeling requirements for nonliquid alternative fuels and AFV's.[11]

- The National Highway Traffic Safety Administration issued a final rule that establishes safety standards for compressed natural gas vehicles (Federal Motor Vehicle Safety Standard No. 303, "Fuel System Integrity of Compressed Natural Gas Vehicles.")

- The Internal Revenue Service (IRS) proposed a regulation that outlines the eligibility criteria for the electric vehicle tax credit mandated by the EPACT. (The credit is for 10 percent of the cost of an electric vehicle, up to $4,000.) Although the IRS excludes from the tax credit program conventional vehicles converted to run as electric vehicles, it will consider the status of converted and hybrid electric vehicles in a future rulemaking.

- In August 1994, the EPA issued a final rule that allows automakers to receive Corporate Average Fuel Economy (CAFE) credits for AFV's. The credits cover light duty vehicles fueled with methanol, ethanol, other alcohols, or natural gas.[12]

- In October 1995, the EPA issued an advanced notice of proposed rulemaking to lower the nitrogen oxide (NO_x) emission ceiling for heavy duty engines by 60 percent over 6 years.

A major effort designed to promote the expansion of AFV's and to establish refueling and maintenance infrastructures is the DOE's Clean Cities Program. This program has expanded at a rapid pace since its inception in 1993. The Clean Cities program encourages local governments and other organizations (fuel suppliers, vehicle manufacturers, consumers, fleet managers, utilities, environmental groups, etc.) to form partnerships to develop AFV markets. It supports coordinated efforts to acquire AFV's in quantity and to increase public awareness. As of October 1995, the program had 41 participating regions, far exceeding the planned participation goal of 25 members.[13] The program plans developed so far indicate that participants intend to operate more than 60,000 AFV's and 700 refueling stations by the end of 1996.

State and Local

As of mid-1995, 16 States had passed laws mandating the acquisition of AFV's for agency fleets, while 27 had established financial incentive programs for AFV conversions.[14] With most States having already established AFV acquisition mandates, incentive programs, or research programs, new activity has been relatively light in the past several months. California recently extended its income tax credit for vehicle conversions to the end of 1995. (The credit is equal to 55 percent of the incremental cost of conversion to a low-emission vehicle.) Colorado devised a rebate program for AFV conversions. New Mexico, Wisconsin, and Florida established local AFV grant programs financed by oil overcharge funds.

In the Northeastern States, the Ozone Transport Commission (OTC) was formed in response to the CAAA90 to address the interstate flow of ozone and its precursor pollutants. The OTC includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and the District of Columbia. In a 1991 Memorandum of Understanding, the OTC members agreed to adopt the California Low-Emission Vehicle (LEV) program. The LEV program requires that vehicles meeting specified emission standards be phased in according to an implementation schedule.[15]

In February 1994, the OTC submitted a proposal requesting the EPA to require all States in the Ozone Transport Region to adopt the OTC LEV program. The

[11]*Federal Register*, Federal Trade Commission, 16 CFR Part 309, "Labelling Requirements for Alternative Fuels and Alternative Fueled Vehicles"; Final Rule (May 19, 1995).

[12]*Federal Register*, Environmental Protection Agency, 40 CFR Part 600, "Fuel Economy Test Procedures, Alternative-Fueled Automobile CAFE Incentives and Fuel Economy Labeling Requirements"; Final Rule (August 3, 1994).

[13]Clean cities, in order of designation date, are Atlanta, GA; Denver, CO; Philadelphia, PA; Wilmington, DE; Las Vegas, NV; Washington, DC; Boston, MA; Austin, TX; Florida Gold Coast; Chicago, IL; Albuquerque, NM; Wisconsin Southeast area; Colorado Springs, CO; Long Beach, CA; Lancaster, CA; Salt Lake City, UT; White Plains, NY; Baltimore, MD; West Virginia (entire State); Louisville, KY; Rogue Valley, OR; Oakland, CA; Sacramento, CA; San Jose, CA; San Francisco, CA; San Joaquin Valley, CA; Western New York; Portland, OR; St. Louis, MO; Waterbury, CT; Norwalk, CT; Norwich, CT; New London, CT; Peoria, IL; Southwest Kansas; Central New York; Dallas/Fort Worth, TX; and Honolulu, HI; Missoula, MT; New Haven, CT; and Central Arkansas.

[14]J.E. Sinor Consultants, Inc., *The Clean Fuels Report*, Vol. 7, No. 3 (Niwot, Co: J.E. Sinor Consultants, Inc., June 1995) pp. 44-46.

[15]In model year 1997, 25 percent of vehicles sold must be certified to meet low-emission vehicle standards. The percentage increases each year to a maximum of 75 percent in the year 2003. There are also emission standards and phased-in schedules for other clean fuel vehicles, namely transitional LEV's, ultra-LEV's, and ZEV's.

proposal was met with resistance from automakers, who contended that California LEV provisions were not appropriate for northeastern States. Of particular concern was the Zero Emission Vehicle (ZEV) mandate of the LEV program, which would require vehicle manufacturers to sell electric vehicles according to a phased-in schedule, beginning in model year 1998. The ZEV mandate has already been adopted by California, Massachusetts, and New York. In February 1995, the EPA issued a rule requiring OTC States to achieve the necessary emission reductions either through adoption of the OTC LEV program (with the ZEV mandates discretionary for each State) or through the establishment of a national LEV-equivalent motor vehicle program.[16] On October 2, 1995, the EPA issued a proposed rule for a voluntary 49-State (all States except California) LEV-equivalent program. The proposed rule retains the option for the Northeast States to implement the ZEV program.

Massachusetts has offered proposals to delay the ZEV requirement and to accept a plan by the automakers to introduce other clean fuel vehicles. California is considering the acceptability of hybrid electric vehicles to meet the ZEV mandate, and has ordered an independent study of battery technology to determine technical barriers to electric vehicle market penetration.

Research, Development, and Marketing Activities

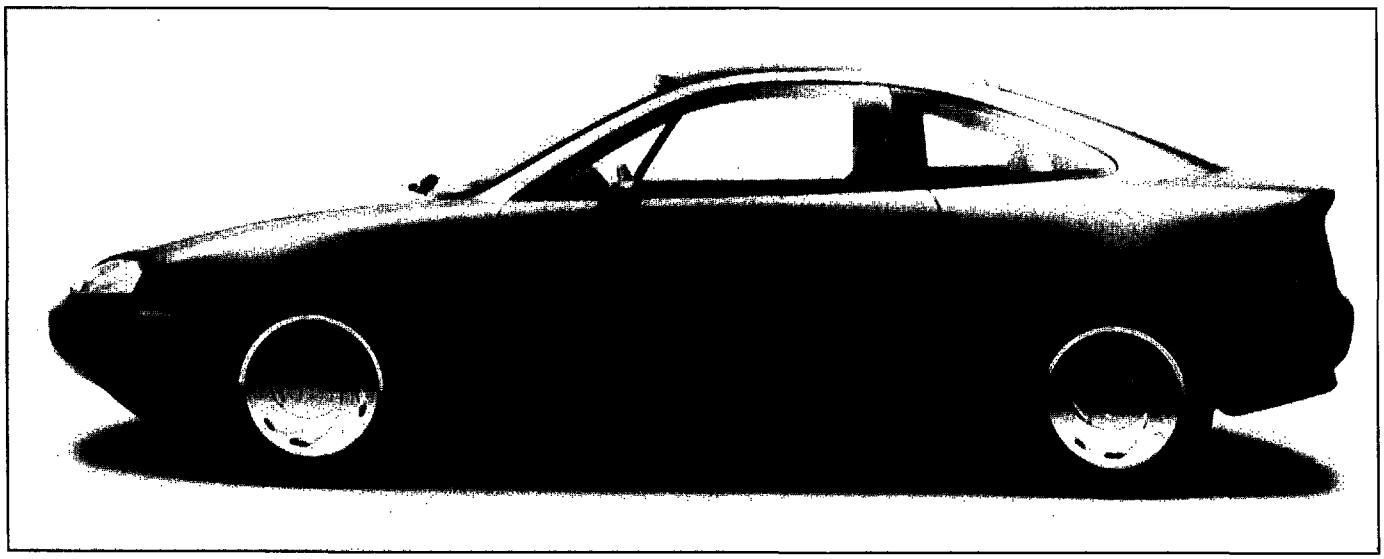
After years of limited field testing of various technologies, the AFV industry has reached the launching point for major commercialization efforts. The best evidence for this is the recent formation of research and marketing consortia. Typically consisting of a mixture of public and private organizations (automakers, vehicle parts suppliers, and energy companies), these groups pool investment funds and manage programs that are designed to advance AFV technologies and accelerate the fall of remaining barriers to AFV marketability. Examples include: the CALSTART advanced transportation consortium, a nonprofit joint venture that has provided matching funds for a number of electric vehicle projects and administered natural gas vehicle research projects; the U.S. Advanced Battery Consortium, established in 1991 to improve battery technology for electric vehicles; the National Fuel Cell Alliance; the Natural Gas Vehicle Technology Partnership; and the U.S. Consortium for Automotive Research (USCAR). USCAR, which consists of General Motors, Ford, and Chrysler, has joined with Federal agencies in the Partnership for a New Generation of Vehicles (PNGV) Program. The PNGV Program, established in September 1993, is a 10-year research and development project aimed at improving national competitiveness in automotive manufacturing, commercializing innovative technologies for conventional vehicles, and developing a "super car" with a fuel economy of at least 80 miles per gallon.

In addition, the fuel industries have begun developing industry strategies to commercialize AFV's and increase ATF markets. For example, the Propane Vehicle Council was formed in 1995, and EVAmerica, an organization for promoting electric vehicles, was established in 1994. In May 1995, the Natural Gas Vehicle Coalition, the American Gas Association, and the Gas Research Institute announced their Natural Gas Vehicle Strategy.

Other endeavors also point to the increased emphasis on market penetration. First, through efforts such as the Federal Clean Cities Program, refueling infrastructure is now being developed on a regional basis. With sufficient infrastructure in place, AFV's will have a wider range of fleet- and personal-use applications. Second, government and industry are moving toward standardization of AFV and refueling system specifications, especially in the electric vehicle industry. Third, major vehicle manufacturers have been expanding their offerings of AFV models. For example, General Motors Corporation will make available a line of ethanol (E85) flexible-fuel light duty trucks in model year 1997. For the 1996 model year, Ford Motor Company will be selling the first U.S. dedicated compressed natural gas (CNG) passenger vehicle. (This vehicle is also the first AFV to be built on a single assembly line.) A number of foreign automakers—Isuzu, Honda, and Volvo—are also planning to enter the U.S. AFV market in the next 2 years.

Major technical barriers to increased use of AFV's include limited driving range, acquisition costs, and safety. The AFV industry has made significant strides in dealing with these barriers. Notable developments have occurred recently in the areas of fuel storage, battery technologies for electric vehicles, diesel-to-gaseous fuel conversion systems, fuel safety systems, hybrid electric vehicles, and fuel injection and control systems. A number of prototype vehicles have shown that driving range and energy efficiency can be significantly improved. Safety problems associated with fuel tanks and refueling nozzles are being addressed. However, manufacturing costs are not expected to be competitive with conventional vehicles for several years.

[16]*Federal Register*, Environmental Protection Agency, 40 CFR Parts 51, 52, and 85, "Final Rule on Ozone Transport Commission; Low Emission Vehicle Program for the Northeast Ozone Transport Region" (February 15, 1995).



California's "CALSTART" showcase electric vehicle.

The fleet market is very important to the development of AFV's. Therefore, identification of fleet characteristics is useful to development of market strategies. In 1994, the EIA conducted the Atlanta fleet survey in response to Section 407 of the EPACT, which requires the development of information for five different U.S. regions that can aid potential marketers and purchasers of AFV's.[17] Survey results indicate that 1 percent of private fleets and 9 percent of municipal fleets in Atlanta contained AFV's in mid-summer 1994. Three percent of the private fleet managers were planning to acquire AFV's in 1995, either through purchases or conversion. The survey also collected information on fleet vehicle characteristics and refueling practices of fleets. Light duty vehicles are predominant in the Atlanta fleets. Most of the private fleets used public service stations, with or without fuel-purchase agreements, for refueling. Only 10 percent of the private fleets with gasoline vehicles and 20 percent of the private fleets with diesel vehicles used onsite fueling facilities. In contrast, 85 percent of the municipal fleets with gasoline vehicles and 80 percent of municipal fleets with diesel vehicles used central, government-owned, refueling sites.

In late 1994, the National Association of Fleet Administrators (NAFA) conducted a survey of members to determine their interest in acquiring AFV's.[18] Of the 305 survey respondents, 32 percent were just beginning to investigate AFV's, while 30 percent currently operated AFV's. Of the members that operated AFV's, 25 percent planned to acquire more within the next 2 years. The fuel of most interest to respondents was CNG, followed by propane, electricity, ethanol, and methanol. About two-thirds of the respondents thought that alternative fuels would be more expensive than conventional gasoline over the vehicle life cycle.

Trends in Alternative-Fueled Vehicle Inventories, 1992-1996

The number of AFV's in use in the United States increased by nearly 30 percent from 1992 to 1994 and is expected to increase another 30 percent by 1996, when more than 421,000 AFV's are expected to be in use (Table 2). Although growth is evident, the exact number of AFV's is uncertain, primarily due to uncertainty about the number of vehicles designed to operate using liquefied petroleum gases (LPG). While LPG vehicles comprise the majority of AFV's in use, their estimates are the most indefinite. The estimates of LPG vehicles in Table 2 are considered to be lower bound estimates.

While growth in LPG vehicles has been somewhat slow, the number of vehicles designed for other alternative fuels has grown rapidly, nearly doubling between

[17]The 1994 Atlanta Vehicle Fleet Survey, Form EIA-890, encompassed approximately 3,600 private fleets with six or more vehicles in the 13-county nonattainment area. Municipal government fleets were also surveyed. Results are published in Energy Information Administration, *Profile of Motor-Vehicle Fleets in Atlanta 1994*, DOE/EIA-0601 (Washington, DC, November 1995). A second survey was conducted in Denver in the summer of 1995. Results will be published in 1996.

[18]National Association of Fleet Administrators, *NAFA Fleet Executive* (Iselin, NJ: January 1995), pp. 18-19.

Table 2. Estimated Number of Alternative-Fueled Vehicles in Use in the United States, by Fuel, 1992-1996

Fuel	1992	1993	1994	1995	1996	Average Annual Growth Rate (percent)
Liquefied Petroleum Gases (LPG)[a]	221,000	269,000	264,000	272,000	*279,000*	6.0
Compressed Natural Gas (CNG) .	23,191	32,714	41,227	65,849	*84,319*	38.1
Liquefied Natural Gas (LNG)	90	299	399	482	*563*	58.1
Methanol, 85 Percent[b] (M85)	4,850	10,263	15,484	20,170	*22,284*	46.4
Methanol, Neat (M100)	404	414	415	413	*411*	0.4
Ethanol, 85 Percent[b] (E85)	172	441	605	894	[c]*32,224*	270.0
Ethanol, 95 Percent[b] (E95)	38	27	33	32	*33*	-3.5
Electricity	1,725	1,847	2,238	2,350	*2,460*	9.3
Fuel Unknown[d]	0	140	0	0	*0*	0
Non-LPG Subtotal	30,470	46,145	60,401	90,190	*142,294*	47.0
Total	**251,470**	**315,145**	**324,401**	**362,190**	***421,294***	**13.8**

[a]Values represent lower bound estimates and are rounded to thousands. Accordingly, these estimates are not equal to the sum of Federal fleet data (for which exact counts are available) and non-Federal fleet estimates (rounded to thousands).

[b]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.

[c]Includes an estimate of pickup trucks expected to be made available by General Motors. According to a recent announcement, one line of 1997 model year Chevrolet pickup trucks will be flexible-fueled vehicles capable of operating on E85 and/or gasoline. The number of these vehicles expected to be in use was estimated by the Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels, based on communication with industry sources. All of these vehicles are assumed to be in the private sector. Only a small portion of these vehicles are actually expected to operate using E85.

[d]Cannot be identified by fuel type; therefore, non-LPG subtotal may include some unidentified LPG vehicles.

Note: Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.

Sources: **Federal:** 1992-1994: U.S. Department of Energy, Office of Alternative Fuels. 1995-1996: Based on projected vehicle acquisitions by the U.S. General Services Administration, Automotive Commodity Center. **Non-Federal:** Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

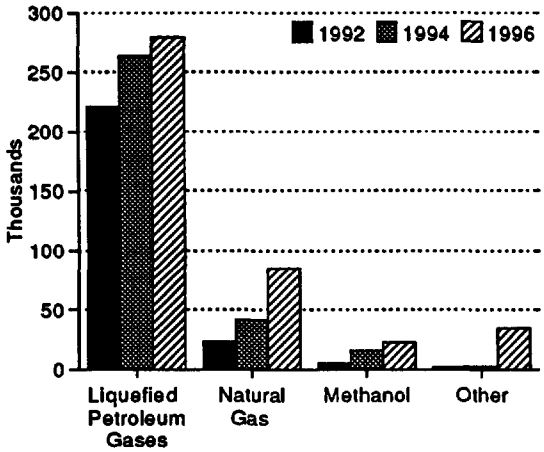
1992 and 1994 (Figure 1). Non-LPG AFV's are expected to more than double again by 1996. Estimates for 1996 include 30,000 E85 pickup trucks. General Motors has announced that it will produce an entire line of flexible-fuel E85 pickup trucks in model year 1997. Although many purchasers of these trucks are not expected to use the AFV capability, the vehicles fit the EPACT definition of AFV's and are therefore included in this report.

LPG vehicles will continue to comprise the largest portion of AFV's for some time, but their share is declining. The number of LPG vehicles in use is expected to decline from 88 percent of total AFV's in 1992 to 66 percent in 1996. During the same period, vehicles designed to operate on natural gas will increase from 9 percent to 20 percent of total AFV's. The share of methanol vehicles is expected to increase from 2 percent to 5 percent, while the share of ethanol vehicles will grow from less than 1 percent to 8 percent. The share of electric vehicles is expected to remain about the same throughout the period.

New data for 1994 and 1996 indicate that the number of AFV's in use is not increasing as fast as had been estimated last year. In 1994, the EIA estimated that the number of AFV's increased by 66 percent from 1992 to 1995. Growth from 1992 to 1995 is now estimated at 44 percent. The revision is nearly all attributable to less-than-expected increases in the number of LPG and CNG vehicles. The revision is most likely due to optimistic assumptions in previous years, incidences of CNG fuel system equipment failure in 1994, and uncertainty surrounding implementation of the EPACT requirements.

The following sections discuss AFV's in use by fuel type, ownership, and vehicle size.

Figure 1. Estimated Number of Alternative-Fueled Vehicles in the United States, by Fuel, 1992, 1994, and 1996



Note: "Other" includes vehicles capable of using ethanol (85 or 95 percent) and electricity.
Source: Table 2.

Liquefied Petroleum Gas (LPG) Vehicles

With estimated average growth of 6 percent per year from 1992 to 1996, the number of LPG vehicles in use is increasing more slowly than the number of most other AFV's. The actual number of LPG vehicles cannot be determined with precision. The estimates in Table 2 are considered minimum estimates because the underlying data from which they were estimated or imputed are likely to be underreported. There is much uncertainty about the accuracy of State AFV records, the definition of onroad LPG vehicles for tax purposes, the identification of vehicles by weight classification, and the imputation of vehicle counts from the small sample of States that track LPG vehicles (see Appendix A).

The expansion in the number of LPG vehicles, unlike most other AFV's, is largely attributable to private sector commercial fleet purchases. In many cases, these acquisitions are encouraged by State government tax incentives. Other reasons for expansion include ease of engine conversion, widespread fuel availability, competitive prices, support from large domestic oil companies, and environmental benefits. LPG enjoys the largest and most widely distributed refueling infrastructure of all the alternative fuels. There are more than 3,300 refueling sites spread across the 50 States.[19] However, refueling sites are not usually located at existing fueling stations, and some are not accessible to the public. LPG engines and vehicles are currently available from producers, but vehicle and engine technology is still under development.

LPG is also widely used for a number of fuel purposes, such as heating and crop drying. Prices tend to fluctuate seasonally. Supplies are occasionally short in certain seasons and locations. This situation creates some uncertainty for those considering acquisition of LPG vehicles.

In March 1994, the Propane Vehicle Council was established to promote the use of propane as a transportation fuel. The Council consists of propane marketers, producers, and vehicle and equipment manufacturers, joined together to further the development of LPG vehicles and infrastructure.

Compressed Natural Gas (CNG) Vehicles

The number of vehicles designed to operate on CNG is expected to grow by more than 60,000 vehicles from 1992 to 1996, a larger increase than for vehicles of any other fuel type. Some of the important factors promoting growth are support from natural gas utilities, relatively greater availability of vehicles and fuels compared to most other alternative fuels, and continued public and private sector enthusiasm for the fuel, despite setbacks caused by fuel cylinder accidents in 1994. Natural gas utilities support the use of natural gas vehicles by sponsoring demonstration programs, subsidizing fuel prices, and conducting other marketing efforts. The natural gas industry is active in increasing and improving the refueling infrastructure as well as informing the public about sites. There have been advances in refueling station design as well as growth in the number of refueling sites. The American Gas Association (AGA) and the Natural Gas Vehicle Coalition (NGVC) have recently published directories of refueling locations.

In early 1994, fuel cylinders on two CNG-fueled General Motors (GM) Sierra pickup trucks ruptured, resulting in explosions and injuries. In response to the accidents, GM offered to buy back the 2,500 CNG Sierra pickups in service, halted its AFV production program for the 1995 model year, and initiated an investigation to determine the cause of the ruptures. Analysis revealed that the cause of the ruptures was acid-induced stress corrosion of the fiberglass cylinder wrapping, stemming from exposure of the cylinders to

[19]National Renewable Energy Laboratory, Alternative Fuels Data Center Database (Extracted April 10, 1995).

acidic liquids trapped in the vehicle underbody. In light of the cylinder failures, the Gas Research Institute initiated an accelerated program to study cylinder failure mechanisms, methods of detecting cylinder degradation, and guidelines for cylinder installations. A key finding was that proper vehicle design and cylinder installation practices can prevent cylinder failures. In particular, cylinders should be protected from exposure to corrosive products and abrasion.

Although the cylinder ruptures represent a short-term setback to the CNG vehicle industry, the long-term outlook for CNG vehicle safety remains bright. The existing stock of CNG vehicles, which includes many relatively old, converted vehicles, has maintained an excellent safety record. Advancements in fuel cylinder technology and testing methods should increase cylinder reliability and reduce the likelihood of accidents caused by cylinder failures. The National Highway Traffic Safety Administration also issued a CNG vehicle safety standard in May of 1995 designed to ensure fuel system integrity under a series of crash tests (Federal Motor Vehicle Safety Standard No. 303, "Fuel System Integrity of Compressed Natural Gas Vehicles").

In May 1995, the AGA, NGVC and Gas Research Institute jointly developed the "Natural Gas Vehicle Industry Strategy" to expand the market for natural gas transportation fuels. For the near term, the strategy focuses on fleet vehicles.

Liquefied Natural Gas (LNG) Vehicles

The number of vehicles designed to operate on LNG, while small, has grown steadily. However, significant uncertainties remain about the future of LNG vehicles. Estimates for 1996 are based largely on orders already in place and expressed intentions by fleets to adopt LNG. In the past, however, expressions of interest have not always resulted in the acquisition of LNG vehicles.

Nearly all of the LNG vehicles in use in the United States are transit buses or heavy duty trucks. Most are transit buses concentrated in a few large programs, so they are not widely distributed by location and few are privately owned. Current LNG vehicle operations are closely watched by a number of potential LNG users for such factors as cost, performance, safety, and maintenance. Operators of the three largest programs (in Houston, Seattle, and Los Angeles) have all realigned or reconsidered their purchase and use strategies over the course of the programs. Seattle Metro, for example, canceled orders in 1994, and the Houston Metropolitan Transit Authority recently canceled an LNG bus contract in favor of buses fueled by low-sulfur diesel.

Low fuel cost is one of the advantages of using LNG, especially for vehicles with high fuel use. Fueling and fuel transfer are among the unresolved technical issues. A new refueling technology was recently developed. Other factors to be resolved include increased fuel system reliability, resolution of outstanding safety and maintenance issues, the development of an LNG infrastructure, and the availability of government subsidies for bus purchases and test programs.

Methanol (M85 and M100) Vehicles

The number of methanol vehicles in use has grown substantially since 1992, but growth appears to be slowing, largely due to increases in methanol prices and some difficulties with vehicle operation. Virtually all of the increase has occurred in the number of M85 vehicles, which increased 219 percent from 1992 to 1994 and is expected to grow 44 percent from 1994 to 1996. There has been very little increase in dedicated methanol (M100) vehicles since 1992, and no increase is expected in 1996. Most of the M100 vehicles currently in operation are buses. No new M100-fueled buses have been ordered since 1993, partly due to the disappointing experience (performance and maintenance) of one of the Nation's largest operators of M100 buses. Therefore, the use of M100 vehicles may decline after 1996.

By far, the largest number of methanol vehicles is located in California, where a number of programs encourage the use of methanol vehicles and the development of a refueling infrastructure. California's South Coast Air Quality Management District, for instance, began a demonstration of heavy duty methanol vehicles in 1987.[20] Today's programs include tax and other financial incentives. Growth in the private sector has been due to the creation and growth of large corporate fleets, including rental car fleets.

In 1994, methanol vehicle programs were greatly affected by fuel supply and cost issues. Increasing demand for reformulated gasoline created a high demand for methyl tertiary butyl ether (MTBE), which, in turn, created high demand for methanol. At the same time, a major plant shutdown and some methanol production problems decreased supplies. The price of methanol nearly tripled between April and November of 1994.

[20]"Southern California Alternative-Fuel Projects," *Automotive Engineering* (Warrendale, PA: Society of Automotive Engineers, Inc., March 1995), p. 64.

A methanol-powered transit bus in Denver, CO.

High prices made California's methanol program uneconomic in the short term.[21] Prices, however, have retreated to more normal levels in 1995.

Ethanol (E85 and E95) Vehicles

Until General Motors announced its plan to produce flexible-fuel ethanol vehicles in significant numbers, ethanol vehicles were expected to remain a very small portion of total AFV's, despite rapid growth in recent years. The number of ethanol vehicles more than quadrupled from 1992 to 1995, although that increase represented only about 700 vehicles. All of the growth was attributable to vehicles designed to use a blend of 85 percent ethanol and 15 percent gasoline (E85). There are estimated to be just 32 E95 vehicles in the United States in 1995, several of which are demonstration vehicles.[22]

In May 1995, General Motors announced that, starting in model year 1997 (summer 1996), all of its Chevrolet S-10 and GMC Sonoma pickup trucks would be flexible-fuel vehicles capable of operating on E85 and/or gasoline. Initial company projections were that over 100,000 of these vehicles would be produced.[23] There is, however, much uncertainty about how many of the vehicles will actually be in use by the end of 1996. The EIA estimate is based on communication with industry sources. There is also much uncertainty about the distribution of these vehicles regionally and by ownership. In this report, all of these vehicles are assumed to be privately owned and to have a regional distribution similar to that of pickup trucks in general. Most purchasers of these trucks are not expected to use the AFV capability. It is unclear whether these trucks can or will be used to meet AFV mandates.

Aside from the GM pickups, expansion of the number of E85 vehicles is mostly due to Midwestern State government programs, Federal programs, and the interest of corn growers. The high cost of ethanol is a major issue. Currently, the transportation use of ethanol

[21]J.E. Sinor, Consultants, Inc., *The Clean Fuels Report.*

[22]E95 includes all blends containing at least 92-percent ethanol (E92). Several buses that use a blend of 92-percent ethanol, 5-percent methanol, and 3-percent kerosene are included.

[23]"E-85 Development Could Give Boost to Ethanol Demand," *Oxy-Fuel News*, (Potomac, MD: Hart Publications Inc., May 15, 1995), p. 9.

EIA Surveys of Alternative-Fuel Provider Fleets

In 1994, the EIA surveyed providers of electricity, natural gas, and propane for information on their fleet vehicles. The surveys were conducted as a partial response to Section 407 of the EPACT. Data were collected as of December 31, 1993. To obtain data on natural gas and electric utility fleets, existing EIA surveys were supplemented.[a] These surveys were sent to the entire population of electric and natural gas providers. A new, one-time survey was conducted to collect information from propane providers. A detailed questionnaire was sent to the 35 largest propane providers (which are estimated to account for about two-thirds of U.S. propane sales). A telephone survey, using a shorter questionnaire, was conducted of a sample of the many small propane providers.

The surveys yielded information on fleet characteristics, such as the size and makeup (vehicle and fuel types) of fleets and refueling practices. Preliminary data show that, in 1993, fleets operated by propane providers included 38,267 AFV's, accounting for 47 percent of all the fleet vehicles operated by propane providers. Most of the AFV's were propane vehicles. Almost 70 percent of the propane vehicles operated by propane providers were medium and heavy duty trucks, and 89 percent of the propane vehicles were dedicated vehicles.

The Natural Gas Supplier Fleet Survey determined that, in 1993, natural gas providers operated 16,049 AFV's, which comprised about 12 percent of their total fleet vehicles. Eighty-seven percent of the AFV's were CNG vehicles. About three-fourths of the CNG vehicles were light duty vans and trucks. About 15 percent of the AFV's operated by natural gas suppliers were medium and heavy duty trucks.

Preliminary estimates from the electric utility fleet survey indicate that electric utility fleets contained 5,595 AFV's, which accounted for 2.8 percent of their total fleet vehicles in 1993. About two-thirds of the AFV's (3,756 vehicles) were CNG vehicles. Only 4.2 percent of the AFV's (237 vehicles) were electric vehicles. Thus, electric vehicles accounted for about 0.1 percent of electric utility fleet vehicles. Eighty-three percent of the AFV's were light duty vehicles; 43 percent were pickup trucks, and 15 percent were full-sized vans.

More information about the fuel provider surveys can be found in the November 1994 and April 1995 issues of the *Monthly Energy Review* (DOE/EIA-0035). Final results of the fuel provider surveys are available electronically via the EIA electronic bulletin board and a report will be published in 1996.[b]

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[a]Electric utility data were collected via Form EIA-861, "Annual Electric Utility Report," Schedule VII. Data from natural gas suppliers were collected via Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition," Schedule B. Companies that operated fewer than 10 vehicles were not required to complete the supplemental fleet surveys.

[b]Interested readers should contact the National Energy Information Center at 202-586-8800 or via Internet E-Mail at infoctr@eia.doe.gov for details on the availability of these products.

is subsidized by an exemption to the Federal excise tax. Several States also offer exemptions to State taxes.

There has been much discussion surrounding the continuation of the Federal tax exemption. In September 1995, the U.S. General Accounting Office (GAO) issued a report finding that elimination of the ethanol tax exemption would result in estimated additional net costs to the Government in farm program payments.[24] GAO also concluded that elimination of the credit would probably cause small ethanol producers to go out of business.[25]

Incompatibility with existing infrastructure is another obstacle for ethanol. Because of its corrosiveness and its propensity to absorb water, ethanol cannot be transported through pipelines. Special storage and dispensing equipment is required at refueling facilities. The ethanol refueling infrastructure is small but growing. In early 1995, there were 36 refueling sites for ethanol vehicles (an increase from 2 in 1992) in 11 States. Nearly all of the refueling sites were in the Midwest. In 1995, the Governors' Ethanol Coalition announced plans to build 40 new ethanol refueling stations in the Midwest. Still, the primary use of ethanol in the transportation

[24]However, the elimination of these farm program payments is also currently under debate.

[25]U.S. General Accounting Office, *Ethanol Tax Exemption*, GAO/RCED-95-273R (Washington, DC, September 14, 1995).

sector is expected to be as a fuel additive to conventional fuels.

Electric Vehicles

The use of electric vehicles is growing slowly. The number of electric vehicles in use increased about 30 percent from 1992 to 1994 and is expected to increase about 10 percent between 1994 and 1996. There is, however, much research and development occurring in anticipation of State government mandates for ZEV's. California's ZEV program, also adopted by Massachusetts and New York, requires that, starting in 1998, 2 percent of vehicles sold in the State be ZEV's. The requirement increases to 5 percent in 2001 and 10 percent in 2003. Presently, only electric vehicles qualify as ZEV's.

It is important to note that many electric vehicles today are operated as part of demonstration programs or are driven sparingly. For instance, a large number of electric vehicles are conversions made by hobbyists and may not be used in the same way as typical onroad vehicles. In that sense, some electric vehicles are not replacing conventional ones. In addition, although all electric vehicles are battery-powered, some may be hybrid (e.g., have a small generator using traditional fuels), have photovoltaic devices to capture solar energy, or rely partially on fuel cells. Because of such definitional differences and the large number of hobbyist owners, estimates of electric vehicles in use are subject to some degree of uncertainty.

Many fleet operators have raised concerns as a result of field tests and demonstrations of electric vehicles. These concerns include limited range, power, reliability, and excessive cost. Encouraging advancements in battery technology (e.g., increased storage capacity, lighter weights, faster recharging, and lower costs) may address these concerns. Five of the DOE national laboratories are working with the U.S. Advanced Battery Consortium (USABC) to develop new battery technologies. The research program, with $30 million in funding, is administered through Cooperative Research and Development Agreements with the laboratories.[26] Research on hybrid vehicles, and on fuel cell development also continues.

The electric utility industry sponsors the EVAmerica program to advance the commercialization of electric vehicles. In November 1994, nine electric vehicles were tested as part of a field evaluation managed by EVAmerica. A second round of testing was conducted in August of 1995. EVAmerica's goal is to place at least 500 electric vehicles into service by the end of 1995 and 5,000 electric vehicles by the end of 1997.

Regional Distribution of AFV's

The regional distribution of AFV's is affected by a number of factors, including State and local laws and incentives, fuel availability (which is usually greater in fuel producing areas), and regional fuel costs. Currently, the largest number of AFV's are located in the South, followed by the West, Midwest, and Northeast (Table 3). (Census regions are defined in Appendix B.) The predominance of these vehicles in the South and West is primarily due to the large number of States in those regions and to high concentrations of AFV's in Texas and California.

Between 1994 and 1996, the number of non-federally owned AFV's is expected to grow most rapidly in the West, where AFV's are expected to increase by 31 percent, compared to nationwide growth of 25 percent (Figure 2). Vehicles designed for fuels that do not have established national transportation networks, particularly LNG and the alcohol fuels, are distributed quite unevenly by region. For example, ethanol vehicles are located mainly in the Midwest where ethanol production is concentrated. The E85 vehicles scheduled to be introduced by General Motors in 1996, however, are expected to be distributed throughout the country as most will not be dependent on ethanol for fuel. Methanol and electric vehicles are found predominantly in the West, particularly in California. CNG and LPG vehicles are more evenly distributed by region. Both fuels have an established nationwide distribution network.

California, Texas, Michigan, Illinois, and Ohio are the five states with the largest numbers of AFV's (Table 4). Together, they account for about 40 percent of the non-Federal AFV's in the United States. However, California and Texas each have more than twice the number of any of the other States. The reliability of the estimates in Table 4 varies depending on State and fuel type (see Appendix A). State counts of alcohol and LNG vehicles, for instance, are considered fairly reliable because these vehicles were enumerated for individual States. For LPG vehicles, data were obtained from Texas, but estimates for the other four States were imputed and are therefore uncertain. General Motors' 1997 model year pickup truck production estimates were not allocated by State.

[26]The national laboratories include the National Renewable Energy Laboratory, Lawrence Berkeley Laboratory, Argonne National Laboratory, Sandia National Laboratory, and Idaho National Engineering Laboratory.

Table 3. Estimated Number of Alternative-Fueled Vehicles in Use by U.S. Non-Federal Entities, by Fuel and Census Region, 1994 and 1996

Fuel	1994					1996				
	Northeast	South	Midwest	West	Total	Northeast	South	Midwest	West	Total
Liquefied Petroleum Gases (LPG)[a]	28,000	103,000	71,000	62,000	**264,000**	*29,000*	*109,000*	*75,000*	*66,000*	***279,000***
Compressed Natural Gas (CNG)	4,741	11,891	7,098	10,475	**34,205**	*7,096*	*19,383*	*14,003*	*20,093*	***60,575***
Liquefied Natural Gas (LNG)	4	371	14	10	**399**	*5*	*507*	*18*	*33*	***563***
Methanol, 85 Percent[b] (M85)	52	68	13	6,060	**6,193**	*52*	*68*	*63*	*11,145*	***11,328***
Methanol, Neat (M100)	18	8	0	389	**415**	*21*	*3*	*0*	*387*	***411***
Ethanol, 85 Percent[b] (E85)	1	2	447	16	**466**	*4,501*	*12,027*	*8,146*	*6,038*	***[c]30,712***
Ethanol, 95 Percent[b] (E95)	0	2	30	1	**33**	*0*	*2*	*30*	*1*	***33***
Electricity	258	223	148	1,479	**2,108**	*338*	*321*	*198*	*1,473*	***2,330***
Total	**33,074**	**115,565**	**78,750**	**80,430**	**307,819**	***41,013***	***141,311***	***97,458***	***105,170***	***384,952***

[a]Values represent lower bound estimates and are rounded to thousands.

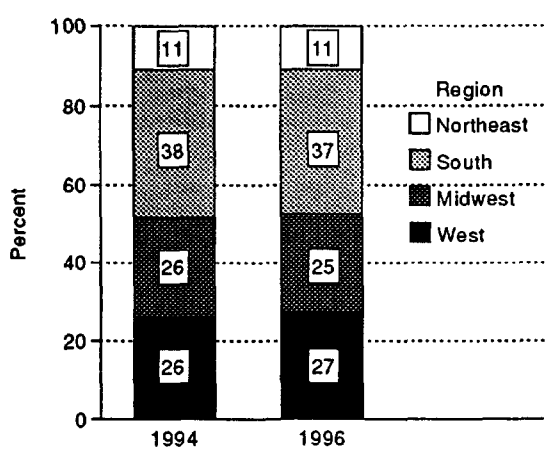
[b]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.

[c]Includes an estimate of pickup trucks expected to be made available by General Motors. According to a recent announcement, one line of 1997 model year Chevrolet pickup trucks will be flexible-fueled vehicles capable of operating on E85 and/or gasoline. The number of these vehicles expected to be in use was estimated by the Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels, based on communication with industry sources. All of these vehicles are assumed to be in the private sector. Only a small portion of these vehicles are actually expected to operate using E85. Regional distribution based on U.S. Bureau of the Census, *Truck Inventory and Use Survey* (Washington, DC, May 1995).

Note: Estimates for 1994 are in roman type; estimates for 1996, based on plans or projections, are in italic.

Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

Figure 2. Estimated Shares of Alternative-Fueled Vehicles in Use by U.S. Non-Federal Entities, by Census Region, 1994 and 1996



Source: Table 3.

Table 4 illustrates the impact of State programs on development of AFV markets. California has a variety of regulations and programs for AFV's prompted in large part by environmental concerns. California Air Resources Board (CARB) regulations, enacted in 1991 to take effect in 1994, require a phase-in of vehicles with increasingly low emissions throughout the State. The California Energy Commission (CEC) has run a number of demonstration and testing programs on different types of fuels and vehicles. California also requires AFV acquisition by State fleets and has offered several types of incentives, such as a tax credit for the incremental cost of purchasing AFV's and fuel tax exemptions. Texas, on the other hand, is a major producer of gaseous fuels and most of the AFV's in the State are LPG or CNG vehicles. A Texas law requires public transit authorities, state agencies with more than 15 vehicles, and school districts with more than 50 vehicles to phase in use of AFV's. The requirement first took effect in 1994, and by 1996, at least 50 percent of such fleets must be converted. Requirements also apply to private fleets of more than 70 vehicles in nonattainment areas. Texas also exempts natural gas and propane sold as motor fuel from sales tax. In 1995, the Texas legislature revised the definition of alternative fuels to include reformulated gasoline, which could have an impact on the use of AFV's in the State.

Table 4. Estimated Number of Alternative-Fueled Vehicles in Use in the United States, by Fuel, Selected States, 1994 and 1996

Fuel	California		Texas		Michigan		Illinois		Ohio	
	1994	1996	1994	1996	1994	1996	1994	1996	1994	1996
Liquefied Petroleum Gases (LPG)	33,200	*35,300*	31,900	*33,800*	13,900	*14,700*	14,200	*15,100*	12,500	*13,200*
Compressed Natural Gas (CNG)	4,208	*10,099*	3,349	*5,319*	1,153	*1,289*	720	*1,871*	2,220	*5,976*
Liquefied Natural Gas (LNG)	10	*14*	367	*486*	0	*1*	0	*0*	10	*10*
Methanol, 85 Percent[a] (M85)	6,009	*11,094*	2	*2*	10	*60*	3	*3*	0	*0*
Methanol, Neat (M100)	387	*387*	0	*0*	0	*0*	0	*0*	0	*0*
Ethanol, 85 Percent[a] [b] (E85)	7	*7*	1	*1*	49	*99*	100	*100*	4	*4*
Ethanol, 95 Percent[a] (E95)	0	*0*	1	*1*	0	*0*	18	*18*	0	*0*
Electricity	890	*817*	53	*48*	56	*82*	16	*18*	14	*17*
Total	**44,711**	***57,718***	**35,673**	***39,657***	**15,168**	***16,231***	**15,057**	***17,110***	**14,748**	***19,207***

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
[b]Estimate for 1996 does not include any of the E85 pickup trucks expected to be made available by General Motors in model year 1997.
Notes: • Federal government vehicles are not included. • Estimates for 1994 are in roman type; estimates for 1996, based on plans or projections, are in italic.
Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished draft report prepared for the Energy Information Administration (McLean, VA, August 1995).

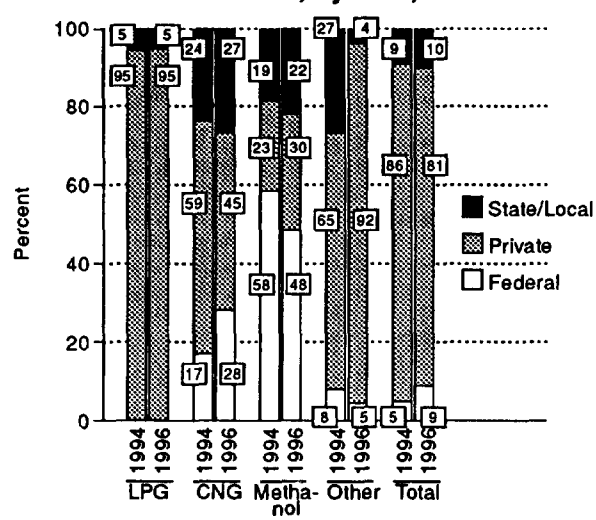
Interestingly, neither Michigan nor Ohio has enacted AFV acquisition mandates. An Illinois law passed in 1993 requires that 75 percent of the State-owned light duty vehicles be capable of running on clean alternative fuels by 2000. Illinois, with a large farm interest, has the largest number of ethanol vehicles of the top five States. A 1987 Executive Order required that State vehicles use ethanol-blended gasoline, and the State also offers a sales tax exemption for ethanol/gasoline blends.

Alternative-Fueled Vehicles by Ownership and Weight Class

As in previous years, the majority (86 percent in 1994 and 81 percent in 1996) of AFV's in use are privately owned (Figure 3). The predominance of privately owned vehicles is primarily due to the large number of privately owned LPG vehicles. The proportion of government ownership is relatively high for CNG and methanol vehicles. In 1994, 41 percent of the CNG vehicles in use and 77 percent of the methanol vehicles in use were owned by Federal, State, or local governments, whereas only 5 percent of LPG vehicles were government owned.

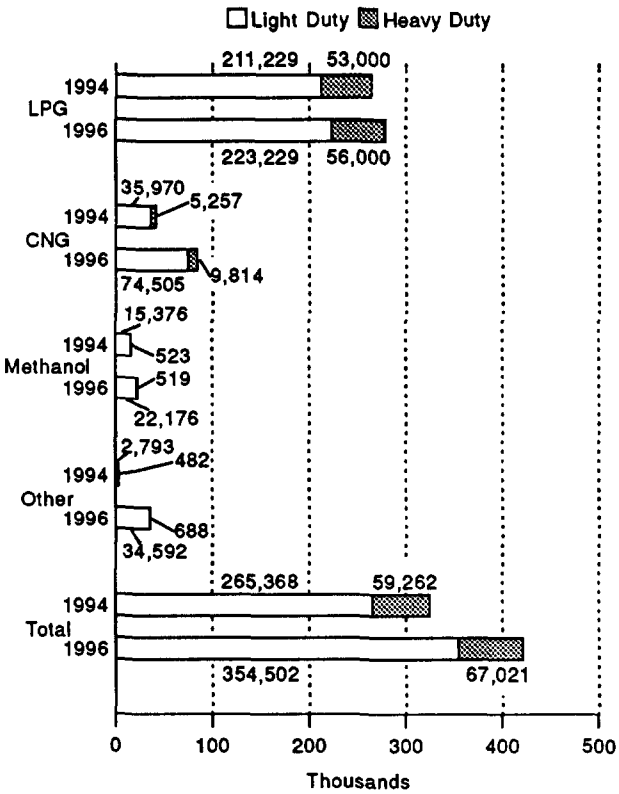
Light duty vehicles comprise the majority of AFV's, accounting for 82 percent of AFV's in use in 1994 (Figure 4). The share of light duty AFV's is expected to remain high as mandates for increasing acquisitions of light duty AFV's take effect.

Figure 3. Ownership Shares of Alternative-Fueled Vehicles in Use, by Fuel, 1994 and 1996



Notes: LPG = liquefied petroleum gases. CNG = compressed natural gas. "Other" includes vehicles capable of using liquefied natural gas, ethanol (85 or 95 percent), and electricity.
Sources: Tables 5, 6, and 7.

Figure 4. Estimated Number of Alternative-Fueled Vehicles In Use In the United States, by Fuel and Weight Category, 1994 and 1996



Notes: LPG = liquefied petroleum gases. CNG = compressed natural gas. Weight classes are based on Environmental Protection Agency definitions: light duty is less than or equal to 8,500 pounds gross vehicle weight; heavy duty is greater than 8,500 pounds gross vehicle weight. "Other" includes vehicles capable of using liquefied natural gas, ethanol (85 or 95 percent), and electricity.

Source: Tables 5, 6, and 7.

Privately Owned Vehicles

The use of AFV's by private entities continues to increase, reflecting preparations for upcoming fleet mandates and promotion by utilities and other fuel providers. Although private vehicles are expected to decline as a proportion of total AFV's, from 92 percent in 1992 to 81 percent in 1996, the number of privately owned AFV's is expected to increase by almost 50 percent over that time period (Table 5).

Use of AFV's in the private sector will be stimulated by Federal mandates in the EPACT. The acquisition of light duty AFV's by alternative fuel providers is required beginning in Model Year 1996 (Table 1). Electric utilities are allowed to delay compliance until 1998 if they intend to acquire electric vehicles, provided they notify the DOE before January 1, 1996. The EPACT also empowers the Secretary of Energy to determine, by rule, that other private fleets must purchase light duty AFV's starting in Model Year 1999. The determination is to be made by December 1996. The percentage of AFV's required increases from 20 percent in 1999 to 70 percent in 2006 and thereafter. Increased use of AFV's may also be stimulated by the CAAA90 Clean-Fuel Fleet program, which requires that an increasing share of the new vehicles purchased by centrally fueled fleets in the worst ozone nonattainment areas use clean fuels and meet more stringent tailpipe standards beginning in 1998. It is expected that reformulated gasoline will be able to meet the lower standards, but some fleets may consider turning to alternative fuels anyway.

State and Local Vehicles

Ownership of AFV's by State and local governments has increased more rapidly than private ownership, but more slowly than Federal ownership. In 1992, State and local governments owned almost 18,000 AFV's. By 1996, they are expected to own almost 43,000 AFV's (Table 6). Thus, the percentage of AFV's that are owned by State and local governments will increase from 7 percent in 1992 to 10 percent in 1996.

State spending on AFV programs continues at a strong pace. The Federal Highway Administration reported that, in 1994, States spent $158 million distributed by the Congestion Mitigation and Air Quality Improvement (CMAQ) program on AFV and alternative fuel projects. (The CMAQ program was mandated as part of Title I of the Intermodal Surface Transportation Efficiency Act of 1991.) At least 25 States offer financial incentives for converting conventional vehicles to AFV's.[27]

Increases in State and local ownership of AFV's are also being driven by Federal and State mandates and financial incentives for vehicle purchases. The EPACT mandate for acquisition of light duty AFV's by State governments takes effect in Model Year 1996. Municipal fleets will be subject to the mandates covering other private fleets if the Secretary of Energy deems it necessary to implement them. The CAAA90 Clean-Fuel Fleet program will also apply to most State and local fleets. In addition, some States and metropolitan areas have their own AFV mandates.

[27]J.E. Sinor Consultants, Inc., *The Clean Fuels Report*, Vol. 7, No. 2 (Niwot, CO: J.E. Sinor Consultants, Inc., April 1995), p. 43.

Table 5. Estimated Number of Alternative-Fueled Vehicles In Use by U.S. Private Entities, by Fuel and Weight Category, 1992, 1994, and 1996

Fuel	1992			1994			1996		
	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total
Liquefied Petroleum Gases (LPG)[a]	168,000	42,000	**210,000**	200,000	50,000	**250,000**	*212,000*	*53,000*	***265,000***
Compressed Natural Gas (CNG)	16,517	1,325	**17,842**	21,496	2,935	**24,431**	*33,379*	*4,677*	***38,056***
Liquefied Natural Gas (LNG)	3	16	**19**	2	12	**14**	*2*	*38*	***40***
Methanol, 85 Percent[b] (M85)	674	3	**677**	3,675	0	**3,675**	*6,784*	*0*	***6,784***
Methanol, Neat (M100)	0	6	**6**	0	1	**1**	*0*	*1*	***1***
Ethanol, 85 Percent[b] (E85)	28	1	**29**	58	0	**58**	*[c]30,080*	*0*	***[c]30,080***
Ethanol, 95 Percent[b] (E95)	9	4	**13**	1	5	**6**	*1*	*5*	***6***
Electricity	1,588	1	**1,589**	2,047	8	**2,055**	*2,224*	*13*	***2,237***
Non-LPG Subtotal	18,819	1,356	**20,175**	27,279	2,961	**30,240**	*72,470*	*4,734*	***77,204***
Total	**186,819**	**43,356**	**230,175**	**227,279**	**52,961**	**280,240**	***284,470***	***57,734***	***342,204***

[a]Values represent lower bound estimates and are rounded to thousands.

[b]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.

[c]Includes an estimate of pickup trucks expected to be made available by General Motors. According to a recent announcement, one line of 1997 model year Chevrolet pickup trucks will be flexible-fueled vehicles capable of operating on E85 and/or gasoline. The number of these vehicles expected to be in use was estimated by the Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels, based on communication with industry sources. All of these vehicles are assumed to be in the private sector. Only a small portion of these vehicles are actually expected to operate using E85.

Note: • Weight classes are based on Environmental Protection Agency definitions: light duty is less than or equal to 8,500 pounds gross vehicle weight; heavy duty is greater than 8,500 pounds gross vehicle weight. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.

Sources: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

State and local governments operate a larger distribution of vehicles by fuel type than the Federal government. Vehicles designed to run on LPG and CNG comprise the largest shares of State and local AFV's, but this sector also owns the largest number of ethanol vehicles. As in the Federal sector, most State and local AFV's are light duty vehicles. Heavy duty AFV programs are primarily transit bus programs.

Federal Vehicles

The number of Federally owned AFV's increased from 3,360 in 1992 to 16,811 in 1994 and is expected to reach 36,571 by 1996 (Table 7). Lack of availability of certain types of AFV's from automakers and reductions in budget appropriations limited the acquisition of AFV's in 1995. Estimates for 1996, as shown in Table 7, are based on the number of vehicle acquisitions needed to meet mandates.[28]

The EPACT provides that the DOE will fund the incremental cost of Federal AFV acquisitions. AFV funding for fiscal year 1995 was uncertain through the first part of 1995. A House-Senate conference committee finalized the 1995 fiscal year Federal AFV funding budget as part of the Congressional budget rescissions bill. The $20 million originally allocated for Federal agency purchases of AFV's was reduced to $10 million.

The Federal AFV fleet comprises mainly methanol and CNG vehicles, with CNG vehicles increasing most rapidly of all fuel types. Most of the Federal AFV's are in the fleets of the General Services Administration (GSA) (which leases vehicles to other agencies through the Interagency Fleet Management System), the Postal Service, and the Department of Defense.

[28]Estimated as of October 1995, based on Federal AFV acquisition requirements (see Appendix A). As of January 1996, lower total Federal vehicle acquisitions, which would decrease the number of AFV's required, are expected.

Table 6. Estimated Number of Alternative-Fueled Vehicles in Use by U.S. State and Local Governments, by Fuel and Weight Category, 1992, 1994, and 1996

Fuel	1992			1994			1996		
	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total
Liquefied Petroleum Gases (LPG)[a]	9,000	2,000	**11,000**	11,000	3,000	**14,000**	*11,000*	*3,000*	***14,000***
Compressed Natural Gas (CNG)	3,665	993	**4,658**	7,452	2,322	**9,774**	*17,382*	*5,137*	***22,519***
Liquefied Natural Gas (LNG)	2	69	**71**	7	378	**385**	*10*	*513*	***523***
Methanol, 85 Percent[b] (M85)	1,452	131	**1,583**	2,410	108	**2,518**	*4,436*	*108*	***4,544***
Methanol, Neat (M100)	37	361	**398**	0	414	**414**	*0*	*410*	***410***
Ethanol, 85 Percent[b] (E85)	117	1	**118**	408	0	**408**	*632*	*0*	***632***
Ethanol, 95 Percent[b] (E95)	1	24	**25**	1	26	**27**	*1*	*26*	***27***
Electricity	92	9	**101**	0	53	**53**	*0*	*93*	***93***
Non-LPG Subtotal	5,366	1,588	**6,954**	10,278	3,301	**13,579**	*22,461*	*6,287*	***28,748***
Total	**14,366**	**3,588**	**17,954**	**21,278**	**6,301**	**27,579**	***33,461***	***9,287***	***42,748***

[a]Values represent lower bound estimates and are rounded to thousands.
[b]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
Notes: • Weight classes are based on Environmental Protection Agency definitions: light duty is less than or equal to 8,500 pounds gross vehicle weight; heavy duty is greater than 8,500 pounds gross vehicle weight. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.
Sources: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

Table 7. Estimated Number of Alternative-Fueled Vehicles in Use by the U.S. Federal Government, by Fuel and Weight Category, 1992, 1994, and 1996

Fuel	1992			1994			1996[a]		
	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total
Liquefied Petroleum Gases (LPG)	19	0	**19**	229	0	**229**	*229*	*0*	***229***
Compressed Natural Gas (CNG)	691	0	**691**	7,022	0	**7,022**	*23,744*	*0*	***23,744***
Liquefied Natural Gas (LNG)	0	0	**0**	0	0	**0**	*0*	*0*	***0***
Methanol, 85 Percent[b] (M85)	2,590	0	**2,590**	9,291	0	**9,291**	*10,956*	*0*	***10,956***
Methanol, Neat (M100)	0	0	**0**	0	0	**0**	*0*	*0*	***0***
Ethanol, 85 Percent[b] (E85)	25	0	**25**	139	0	**139**	*1,512*	*0*	***1,512***
Ethanol, 95 Percent[b] (E95)	0	0	**0**	0	0	**0**	*0*	*0*	***0***
Electricity	35	0	**35**	130	0	**130**	*130*	*0*	***130***
Non-LPG Subtotal	3,341	0	**3,341**	16,582	0	**16,582**	*36,342*	*0*	***36,342***
Total	**3,360**	**0**	**3,360**	**16,811**	**0**	**16,811**	***36,571***	***0***	***36,571***

[a]Estimated as of October 1995, based on Federal AFV acquisition requirements (see Appendix A). As of January 1996, lower total Federal vehicle acquisitions, which would decrease the number of AFV's required, are expected.
[b]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
Notes: • Weight classes are based on Environmental Protection Agency definitions: light duty is less than or equal to 8,500 pounds gross vehicle weight; heavy duty is greater than 8,500 pounds gross vehicle weight. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.
Sources: **1992, 1994:** U.S. Department of Energy, Office of Alternative Fuels. **1996:** Based on projected vehicle acquisitions by the U.S. General Services Administration, Automotive Commodity Center.

Light Duty Vehicles

Federal and State mandates to acquire AFV's, for the most part, apply to light duty vehicles. In addition, vehicle fleets, which are the focus of AFV mandates and marketing efforts, generally contain a high proportion of light duty vehicles. The number of light duty AFV's in use is expected to increase faster than the number of heavy duty AFV's from 1994 to 1996, increasing the share of light duty AFV's from 82 to 84 percent.

Light duty vehicles include automobiles, passenger vans, small and medium pickup trucks, and other vehicles weighing 8,500 pounds or less. Technologically and economically, some fuels lend themselves to either light or heavy duty vehicles. M85, E85, and electric vehicles are nearly all light duty vehicles. Eighty percent of the LPG vehicles and 87 percent of the CNG vehicles in use in 1994 were light duty vehicles.

Heavy Duty Vehicles

Heavy duty vehicles include large trucks, buses, and large cargo vans. Federal mandates for AFV acquisitions by fleets do not cover heavy duty vehicles. However, heavy duty vehicles are subject to new emissions requirements that may encourage the use of alternative fuels. For example, the CAAA90 Clean-Fuel Fleet program applies to both light and heavy duty vehicles. The CAAA90 also sets new pollution reduction requirements for urban buses. If it is found that these standards cannot be met with improved diesel fuel or advanced diesel engine systems, the EPA must require buses operating in designated metropolitan areas to operate exclusively on low-polluting fuels such as ethanol, methanol, propane, or natural gas. There are also a few State mandates, such as the Texas requirement for school buses and transit systems, that apply to heavy duty vehicles. Although light duty vehicles are dominant for most alternative transportation fuel types, a market niche has been established for LNG and M100 heavy duty vehicles.

3. Alternative-Fueled Vehicles Made Available

In 1995, the Energy Information Administration (EIA) initiated a survey of alternative-fueled vehicle (AFV) suppliers. Preliminary survey data indicate that more than 22,000 onroad AFV's were "made available" in 1994.[29] AFV suppliers also reported that, in 1995, they plan to make available almost 19,000 additional onroad AFV's. The number and type of AFV's made available illustrate the direction of AFV market development. However, the apparent decrease from 1994 to 1995 is believed to reflect the uncertainty of AFV suppliers about the future.

The AFV Suppliers' Survey also found that about 34,000 nonroad vehicles (such as forklifts and construction and agricultural vehicles) powered by alternative transportation fuels (ATF's) were made available in 1994. This chapter presents preliminary data on the number and distribution of AFV's made available and explains the data collection process.

Production of Alternative-Fueled Vehicles

AFV's can be produced by original equipment manufacturers (OEM's) or converted from conventionally fueled vehicles. AFV's made available by OEM's are marketed and warranted by the original manufacturer. They are typically produced to fulfill special customer orders for the fleet market. Most AFV acquisitions are arranged directly with the OEM fleet departments, although orders can be placed through dealerships as well.

There are two types of AFV conversions, OEM conversions and after-market conversions (retrofitting). In an OEM conversion, a vehicle is modified to operate on an alternative fuel before delivery to the user. OEM conversions are usually performed by a conversion company under agreement with an OEM. OEM's supply either conventionally fueled vehicles or "gliders" directly to the converters.[30] Warranty coverage is either handled by the OEM or jointly by the OEM and the conversion company. In an after-market conversion, a conventionally fueled vehicle is modified after its delivery to the user. Such conversions may be done by companies that perform these services for others for a fee, or they may be performed by a fleet operator's trained in-house personnel. After-market conversions are usually warranted by converters rather than manufacturers. However, any OEM warranty pertaining to components other than those installed by the conversion company remains in effect.

The Alternative-Fueled Vehicle Suppliers' Survey (Form EIA-886)

Following passage of the Energy Policy Act of 1992 (EPACT), the EIA began a program to gather information on AFV's and ATF's and to fulfill Section 503 requirements. Section 503 (b)(2) of the EPACT requires that suppliers of AFV's report annually to the Department of Energy (DOE) the number and type of AFV's made available. Each supplier must report AFV's that were made available in the previous calendar year and those that the supplier plans to make available in the following calendar year. The EIA-886 survey form, entitled "Alternative Fuel Vehicle Suppliers' Annual Report," was established to collect these data.

On May 23, 1994, a *Federal Register* notice was issued announcing the AFV Suppliers' Survey and inviting interested parties to comment on the proposed form, instructions, and definitions. After incorporation of responses to the *Federal Register* notice, the EIA-886 form was approved for use by the Office of Management and Budget in January 1995. In February 1995, survey forms were mailed to respondents. Subsequent surveys will be conducted annually. The next survey is scheduled to take place in early 1996.

The term "made available" refers to vehicles that are completed and available for delivery. Any conversion underway or in progress as of the end of the year is

[29]An AFV is considered made available in the year it is completed and made ready for delivery to dealers or users.
[30]"Gliders" are partially completed vehicles that are sent to converters for installation of alternative-fuel-compatible components.

counted in the year the conversion is completed or expected to be completed. The AFV Suppliers' Survey applies to AFV's made available for use in the United States only. AFV's intended for export from the United States are not included. AFV's manufactured or converted outside the United States but intended for U.S. registration are included.

The AFV Suppliers' Survey is designed to collect data from all suppliers that made AFV's available the previous calendar year or plan to make them available by the end of the survey year. Survey respondents include both OEM's and entities that perform conversions. Types of organizations that may perform conversions include businesses, Government agencies, quasi-government agencies (such as transit systems, airport authorities, and school bus districts), and research institutions. Survey respondents also include dealers/distributors that assemble vehicles, particularly medium and heavy duty trucks, from components selected to satisfy a specific set of requirements. Such dealers or distributors may not consider themselves OEM's or conversion companies. However, if the dealer/distributor supplies a completed vehicle capable of being fueled by an ATF, it should report in the survey.

To identify the appropriate respondents, the EIA compiled lists of OEM's and converters after researching many types of sources. For example, information came from trade groups that represent vehicle manufacturers and operators, from organizations that promote alternative fuel vehicles, from public documents, and from institutions that train vehicle converters. The set of respondents is intended to include all suppliers of AFV's; however, it is difficult to determine if the universe is covered.

The AFV Suppliers' Survey requests information about onroad and nonroad AFV's. For each vehicle made available in the previous calendar year, AFV suppliers are asked to report the vehicle type, fuel type, and vehicle configuration, as well as other identifying information. Converters are asked to identify both pre- and post-conversion fuel types. For the survey year, respondents are requested to report the total number of each type of vehicle that they plan to make available during the year.

Respondents to the AFV Suppliers' Survey were also requested to indicate if they wanted the EIA to disseminate in a public forum information about their organization, such as company name, address, contact name, telephone number, and type of operation. Appendix C lists this information for companies that indicated a desire to have it published.

The data collected via the AFV Suppliers' Survey are intended to aid in the assessment of the availability of AFV's and to provide measures of the penetration of AFV's into the transportation sector of the economy. The data, scheduled for release in October of each year, will be published annually in this report, *Alternatives to Traditional Transportation Fuels.*

Preliminary Survey Results

For the AFV Suppliers' Survey conducted in 1995, forms were mailed to 1,055 respondents. As of August 31, 1995, 73 percent of those mailed forms had responded. Tables 8 through 12 contain preliminary data reported as of August 31, 1995. The EIA is currently conducting followup telephone contacts with nonrespondents and clarifying responses that require further explanation.

Onroad AFV's

In 1994, 22,463 onroad AFV's were made available (Table 8). The number of onroad vehicles planned to be made available in 1995 is 18,746 (Table 9). Several survey respondents who reported AFV's in 1994 did not report any AFV's planned for 1995, explaining that there was too much uncertainty to make a reasonable estimate. This uncertainty was particularly prevalent among conversion companies. Therefore, the number of AFV's planned to be made available in 1995 is probably understated.

The number of onroad AFV's made available represents additions to AFV's in use. The year-to-year difference in AFV's in use estimated by the EIA (Chapter 2) reflects both additions and retirements from vehicle inventory. No data on AFV retirements are currently available. Furthermore, data collection and estimation procedures are likely to cause inconsistency between the estimates of AFV's in use and AFV's made available. First, the data for AFV's made available are preliminary, based on a 73-percent survey response rate. Second, the frame of identified AFV suppliers may fall short of the actual number of suppliers. Finally, estimates of AFV's in use for some fuel types are not considered highly reliable (see Appendix A).

AFV's Made Available by Fuel and Vehicle Type

The AFV Suppliers' Survey classifies onroad vehicles into 30 vehicle types. These 30 types are grouped into 6 categories: automobiles, passenger vans, cargo vans and pickups, other trucks, buses, and other onroad vehicles.

Table 8. Number of Onroad Alternative-Fueled Vehicles Made Available, by Fuel Type and Vehicle Category, 1994

Fuel Type	Automobiles	Passenger Vans	Cargo Vans/ Pickups	Other Trucks	Buses	Other Onroad Vehicles	Total
Liquefied Petroleum Gases (LPG)	577	W	2,062	3,741	316	W	7,041
Compressed Natural Gas (CNG)	1,091	W	3,648	446	413	W	7,048
Liquefied Natural Gas (LNG)	W	W	W	W	W	0	96
Methanol, 85 percent[a] (M85)	W	0	0	0	W	0	W
Methanol, Neat (M100)	0	0	0	0	0	0	0
Ethanol, 85 percent[a] (E85)	0	0	0	0	0	0	0
Ethanol, 95 percent[a] (E95)	0	0	0	0	0	0	0
Electricity	255	W	W	0	64	W	636
Other[b]	0	0	0	W	0	0	W
Total	**9,563**	**1,546**	**5,998**	**4,265**	**808**	**283**	**22,463**

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
[b]Includes hydrogen, biodiesel, and other alternative fuels.
W = Withheld to avoid disclosure of individual company data.
Notes: • Vehicles made available are vehicles that are completed and made available for delivery to dealers or users in a given year. • Data are based on survey responses as of August 31, 1995, and are considered preliminary.
Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

Table 9. Number of Onroad Alternative-Fueled Vehicles Planned to be Made Available, by Fuel Type and Vehicle Category, 1995

Fuel Type	Automobiles	Passenger Vans	Cargo Vans/ Pickups	Other Trucks	Buses	Other Onroad Vehicles	Total
Liquefied Petroleum Gases (LPG)	279	139	1,000	W	135	W	4,111
Compressed Natural Gas (CNG)	2,354	1,646	5,514	919	W	W	11,835
Liquefied Natural Gas (LNG)	W	W	W	W	W	0	167
Methanol, 85 percent[a] (M85)	W	0	0	0	0	0	W
Methanol, Neat (M100)	0	0	0	0	0	0	0
Ethanol, 85 percent[a] (E85)	0	0	0	0	0	0	0
Ethanol, 95 percent[a] (E95)	0	0	0	0	0	0	0
Electricity	347	W	W	0	W	W	856
Other[b]	0	0	0	0	W	0	W
Total	**4,758**	**1,805**	**6,787**	**3,497**	**767**	**1,132**	**18,746**

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
[b]Includes hydrogen, biodiesel, and other alternative fuels.
W = Withheld to avoid disclosure of individual company data.
Notes: •Vehicles made available are vehicles that are completed and made available for delivery to dealers or users in a given year. •Data are based on survey responses as of August 31, 1995, and are considered preliminary.
Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

Of the 22,463 AFV's made available in 1994, 43 percent were automobiles and another 34 percent were vans and pickup trucks. For 1995, 71 percent of the planned AFV's are autos, vans, or pickup trucks. The large proportion of automobiles, vans, and small trucks is consistent with fleet use and mandates for light duty vehicles. A survey of fleet managers conducted by Runzheimer International in 1993, for instance, produced nearly identical results—43 percent of private business fleet vehicles were automobiles, while an additional 33 percent were full-size vans, pickup trucks, or minivans. The Runzheimer survey also indicated that 52 percent of government and utility fleets were passenger cars, full-size vans, or pickup trucks.[31]

Sixty-three percent of the AFV's made available in 1994, and 85 percent of those planned to be made available in 1995, are vehicles designed for liquefied petroleum gases (LPG) or compressed natural gas (CNG). In terms of vehicle numbers, CNG vehicles are expected to experience the greatest year-to-year increase of all the fuel types.

AFV's Made Available by Vehicle Configuration

In addition to fuel and vehicle type classification, vehicles in the AFV Suppliers' Survey were classified according to fuel system configuration. Fuel system configuration refers to the number of fuel tanks and method of fuel delivery. Except for electric vehicles, AFV's fall into the following four configurations: dedicated, bifuel, dual-fuel, and flexible-fuel. Electric vehicles are classified as hybrid or nonhybrid vehicles.

Dedicated vehicles are built to run exclusively on one alternative fuel and, as a result, require fewer components. This design strategy also permits the engine/fuel/emission systems to be optimized for the alternative fuel.

Bifuel vehicles are capable of operating on either an alternative fuel or a conventional fuel (gasoline or diesel), but not on a mixture of the fuels. Each fuel is stored in a separate tank. Vehicles of this type generally have an automatic or manual switch that permits operation on either fuel. Most bifuel vehicles operate on a combination of either natural gas or LPG and gasoline. Dual-fuel vehicles also have two fuel systems but, unlike bifuel vehicles, can burn both fuels simultaneously in the engine combustion chamber. The majority of dual-fuel vehicles operate on CNG and diesel.

Flexible-fuel, or variable-fuel, vehicles have only one fuel tank which contains mixtures of the alternative fuel and conventional fuel. A sensor determines the percentage of the alternative fuel relative to gasoline and adjusts engine operating characteristics automatically. Until methanol and ethanol become more widely distributed, flexible-fuel vehicles are preferred by consumers for alcohol fuel use because these vehicles can operate on gasoline exclusively if alcohol fuels are unavailable.

Electric hybrid vehicles are electric vehicles that either 1) operate solely on electricity, but contain an internal combustion motor that generates additional electricity or 2) contain an electric system and an internal combustion system and are capable of operating on either system. Nonhybrid vehicles are designed to operate exclusively on electricity. Within the hybrid and nonhybrid categories, electric vehicles can be further classified by the type of power source used (battery, fuel cell, solar, etc.).

The majority of nonelectric AFV's made available are dual-, bi-, or flexible-fuel vehicles (Tables 10 and 11). The demand for vehicles that can operate on more than one fuel reflects the need for vehicles that can operate without a completely developed fueling infrastructure. Thirty-two percent of the AFV's made available in 1994, and 38 percent of those planned for 1995, were designed exclusively for one fuel; that is, they were dedicated or nonhybrid vehicles.

The majority of autos and pickup trucks are nondedicated vehicles, while a large percentage of buses are dedicated AFV's. This situation reflects the fact that alternative-fueled buses are largely made for centrally fueled fleets, while light duty vehicles are often used in fleets that are not centrally fueled. Nearly all of the electric vehicles made available in 1994 and 1995 are nonhybrid vehicles.

[31]"Targeting Fleet Operations is Key to Selling Propane-Powered Vehicles in the 1990's," *Butane-Propane News* (Arcadia, CA: Butane Propane News, Inc., September 1994), p. 27.

Table 10. Number of Onroad Alternative-Fueled Vehicles Made Available, by Fuel Type and Vehicle Configuration, 1994

Fuel Type	Automobiles	Passenger Vans	Cargo Vans/ Pickups	Other Trucks	Buses	Other Onroad Vehicles	Total
Liquefied Petroleum Gases (LPG)	577	W	2,062	3,741	316	W	7,041
Dedicated	187	W	431	3,332	W	W	4,322
Nondedicated	390	200	1,631	409	W	W	2,719
Compressed Natural Gas (CNG)	1,091	W	3,648	446	413	W	7,048
Dedicated	W	W	W	18	313	W	2,055
Nondedicated	W	380	W	428	100	W	4,993
Liquefied Natural Gas (LNG)	W	W	W	W	W	0	96
Dedicated	0	0	0	W	W	0	84
Nondedicated	W	W	W	W	0	0	12
Methanol, 85 percent[a] (M85)	W	0	0	0	W	0	W
Dedicated	0	0	0	0	0	0	0
Nondedicated	W	0	0	0	W	0	W
Methanol, Neat (M100)	0	0	0	0	0	0	0
Ethanol, 85 percent[a] (E85)	0	0	0	0	0	0	0
Ethanol, 95 percent[a] (E95)	0	0	0	0	0	0	0
Electricity	255	W	W	0	64	W	636
Hybrid	W	0	W	0	W	0	R5
Nonhybrid	W	W	W	0	R63	W	R631
Other[b]	0	0	0	W	0	0	W
Dedicated	0	0	0	0	0	0	0
Nondedicated	0	0	0	W	0	0	W
Total	**9,563**	**1,546**	**5,998**	**4,265**	**808**	**283**	**22,463**
Dedicated and Nonhybrid	R598	W	R1,334	W	R638	R136	R7,092
Nondedicated and Hybrid	R8,965	W	R4,664	W	R170	R147	R15,371

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
[b]Includes hydrogen, biodiesel, and other alternative fuels.
W = Withheld to avoid disclosure of individual company data.
R = Revised from data made available in October 1995 on EIA's home page on the Internet.
Notes: •Vehicles made available are vehicles that are completed and made available for delivery to dealers or users in a given year. •Dedicated vehicles and nonhybrid electric vehicles are designed to operate exclusively on one alternative fuel. Nondedicated vehicles and hybrid electric vehicles are configured to operate on more than one fuel, usually an alternative fuel and gasoline or diesel fuel. •Data are based on survey responses as of August 31, 1995, and are considered preliminary.
Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

Table 11. Number of Onroad Alternative-Fueled Vehicles Planned to be Made Available, by Fuel Type and Vehicle Configuration, 1995

Fuel Type	Automobiles	Passenger Vans	Cargo Vans/ Pickups	Other Trucks	Buses	Other Onroad Vehicles	Total
Liquefied Petroleum Gas (LPG)	279	139	1,000	W	135	W	4,111
Dedicated	147	W	325	W	W	W	2,992
Nondedicated	132	W	675	W	W	0	1,119
Compressed Natural Gas (CNG)	2,354	1,646	5,514	919	W	W	11,835
Dedicated	W	W	W	353	375	W	3,214
Nondedicated	W	W	W	566	W	W	8,621
Liquefied Natural Gas (LNG)	W	W	W	W	W	0	167
Dedicated	W	0	W	W	W	0	144
Nondedicated	0	W	W	0	0	0	23
Methanol, 85 percent (M85)[a]	W	0	0	0	0	0	W
Dedicated	0	0	0	0	0	0	0
Nondedicated	W	0	0	0	0	0	W
Methanol, Neat (M100)	0	0	0	0	0	0	0
Ethanol, 85 percent (E85)[a]	0	0	0	0	0	0	0
Ethanol, 95 percent (E95)[a]	0	0	0	0	0	0	0
Electricity	347	W	W	0	W	W	856
Hybrid	W	0	W	0	0	0	R29
Nonhybrid	W	W	R240	0	W	W	R827
Other[b]	0	0	0	0	W	0	W
Dedicated	0	0	0	0	0	0	0
Nondedicated	0	0	0	0	W	0	W
Total	**4,758**	**1,805**	**6,787**	**3,497**	**767**	**1,132**	**18,746**
Dedicated and Nonhybrid	R1,295	R916	R1,371	W	R580	W	R7,177
Nondedicated and Hybrid	R3,463	R889	R5,416	W	R187	W	R11,569

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.
[b]Includes hydrogen, biodiesel, and other alternative fuels.
W = Withheld to avoid disclosure of individual company data.
R = Revised from data made available in October 1995 on EIA's home page on the Internet.
Notes: • Vehicles made available are vehicles that are completed and made available for delivery to dealers or users in a given year. • Dedicated vehicles and nonhybrid electric vehicles are designed to operate exclusively on one alternative fuel. Nondedicated vehicles and hybrid electric vehicles are configured to operate on more than one fuel, usually an alternative fuel and gasoline or diesel fuel. •Data are based on survey responses as of August 31, 1995, and are considered preliminary.
Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

Nonroad AFV's

The AFV Suppliers' Survey was designed to cover nonroad vehicles as well as onroad vehicles because the EPACT has identified the use of alternative fuels in nonroad vehicles as a way of possibly reducing reliance on imported energy. Nonroad AFV's are AFV's designed for offroad operation and used for surface/air transportation or for industrial or commercial purposes. They include forklifts and other industrial vehicles, construction and agricultural vehicles, rail locomotives, self-propelled electric rail cars, aircraft, airport service vehicles, and marine vessels. Recreational AFV's such as golf carts, snowmobiles, and pleasure watercraft were not included in the survey.

Preliminary data indicate that there are a large number of nonroad AFV's and that the number may be growing even faster than onroad AFV's (Table 12). Many nonroad AFV's are designed to operate on either LPG or electricity.

Table 12. Number of Nonroad Alternative-Fueled Vehicles Made Available, by Fuel Type, 1994 and 1995

Fuel Type	1994	1995
Liquefied Petroleum Gases (LPG)	W	W
Compressed Natural Gas (CNG)	89	224
Liquefied Natural Gas (LNG)	W	W
Methanol, 85 percent[a] (M85)	0	0
Methanol, Neat (M100)	0	0
Ethanol, 85 percent[a] (E85)	0	0
Ethanol, 95 percent[a] (E95)	0	0
Electricity	W	W
Other[b]	0	0
Total	**34,119**	**37,953**

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline.

[b]Includes hydrogen, biodiesel, and other alternative fuels.

W = Withheld to avoid disclosure of individual company data.

Notes: • Nonroad vehicles are vehicles designed for offroad operation and used for industrial or commercial purposes. They include forklifts, agricultural and construction vehicles, and others. • Vehicles made available are vehicles that are completed and made available for delivery to dealers or users in a given year. • Data are based on survey responses as of August 31, 1995, and are considered preliminary. • Components may not sum to totals due to withheld data.

Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

4. Alternative and Replacement Fuel Consumption

Alternative and replacement fuels continue to gain ground on traditional fuels for vehicular use. In this report, the term "alternative and replacement fuels" refers to all alternative fuels, as defined in Section 301 of the Energy Policy Act of 1992 (EPACT), plus alcohols, ethers, or other qualified fuels (as defined by EPACT) that are blended with traditional fuels in smaller amounts than is required to meet the criteria for an alternative fuel.[32] To reflect the definitions in the EPACT as closely as possible, alternative and replacement fuels include the gasoline portion of alcohol/gasoline mixtures that contain at least 85-percent alcohol, but do not include the gasoline portion of blends that are not defined as alternative fuels (e.g., gasohol, which is a mixture of gasoline and 10-percent or less ethanol). For the latter, the gasoline portion is considered to be traditional fuel.

The major reasons for the growing use of alternative and replacement fuels are new specifications for gasoline required by the Clean Air Act Amendments of 1990 (CAAA90). To reduce carbon monoxide emissions in nonattainment areas, the CAAA90 required the addition of oxygenates to gasoline during the winter months in specified metropolitan areas, beginning in 1992. Requirements for use of reformulated gasoline in designated areas took effect in January 1995. These programs greatly increased the use of ethers and alcohols for transportation fuel blending.

Growth in alternative fuel consumption is being driven by government-mandated alternative-fueled vehicle (AFV) acquisition requirements, tax subsidies, and air pollution emission standards. The greatest impediment to more rapid market penetration of alternative fuels has been the lack of a refueling infrastructure sufficient to support wide-ranging vehicle usage. Concerns and uncertainty regarding fuel quality and economy, safety, and cost relative to conventional fuels have affected marketability as well. In response to these impediments, fuel companies and energy utilities (with financial support from government agencies) have made major investments in alternative fuel projects. Engineering firms have also supported the effort by developing innovative fuel storage and dispensing systems.

Legislative, Regulatory, and Other Government Activity

The Federal Reformulated Gasoline Program

Probably the most important regulatory event for motor fuels in 1995 was the start of the Federal reformulated gasoline (RFG) program in January. Title II of the CAAA90 requires RFG to be sold year-round in the nine most severe ozone nonattainment areas of the United States. Other nonattainment areas may participate in the program by petitioning the Environmental Protection Agency (EPA). A number of these additional areas had opted into the RFG program by the time it began in 1995. Among other specifications, RFG must contain a minimum of 2-percent oxygen, by weight. If RFG areas are also carbon monoxide nonattainment areas, RFG must contain a minimum of 2.7-percent oxygen during four winter months. The RFG program expands market opportunities for oxygenates, such as methyl tertiary butyl ether (MTBE) and ethanol, which are defined as replacement fuels by the EPACT.

Although the transition to RFG has gone smoothly by most accounts, the program has met with controversy as well as political resistance in some States. The States of Maine, Pennsylvania, New York, and Kentucky have

[32]Section 301 of the EPACT defines alternative fuels as: methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more (or such other percentage, but not less than 70 percent, as determined by the Secretary of Energy, by rule, to provide for requirements relating to cold start, safety, or vehicle functions) by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; electricity (including electricity from solar energy); and any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits. The EPACT defines replacement fuels as the portion of any motor fuel that is methanol, ethanol, or other alcohols, natural gas, liquefied 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 the Secretary of Energy determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits.

petitioned the EPA to remove from the RFG program counties that had previously opted to join, arguing that air quality in these counties had improved. Wisconsin is at the center of a debate about claims that RFG increases gasoline prices, causes adverse health effects, and reduces engine performance. (Similar complaints have also occurred in Alaska, Maine and Massachusetts.) Wisconsin petitioned the EPA to remove Milwaukee from the RFG program, citing consumer complaints over the additive MTBE.[33] The EPA refused to grant the exemption, but agreed to study the RFG complaints through a joint study with the Wisconsin Department of Natural Resources. (The study found that RFG use resulted in a 2.8-percent reduction in fuel economy relative to conventional gasoline, but no adverse health effects linked to RFG were found.) Both Wisconsin and Maine are considering legislation that would ban MTBE use. However, with the controversy over alleged MTBE health hazards diminishing, support for MTBE bans in these States appears to have waned.

Alternative Fuel Classifications

Recently, there has been some debate concerning the classification of several fuels as alternative fuels. Comments made by AFV industry representatives on the Department of Energy's (DOE's) proposed rule for AFV acquisitions by alternative fuel providers and State government fleets indicated that the definition of alternative fuels should include biodiesel and alcohol blends of at least 70-percent alcohol.[34,35] The draft of the final rule defines neat biodiesel as an alternative fuel, but does not address the 70-percent alcohol issue.[36] The status of propane as a qualifying alternative fuel under the EPACT has also been raised in testimony submitted to Congress.[37]

In line with Federal promotion of RFG, at least two States are interested in changing the statutory definition of alternative fuels to include RFG and low-sulfur diesel. Texas has already passed into law the definitional change, allowing RFG and clean diesel to be used to meet the State's Low-Emission-Vehicle pollution standards. The Colorado legislature is considering a bill to amend the definition.

The Federal Renewable Oxygenate Standard

A regulatory event important to the ethanol industry was the EPA's failed attempt to institute the Renewable Oxygenate Standard (ROS). On June 30, 1994, the EPA issued a rule that mandated a phase-in of renewable oxygenates into reformulated gasoline supplies. The ROS called for 15 percent of the oxygenate content of RFG in 1995 to be derived from renewable resources. In 1996 and thereafter, the renewable requirement was to be 30 percent. A petition to review the ROS and place a stay on the regulation was filed by the American Petroleum Institute and the National Petroleum Refiners Association. On September 13, 1994, the stay was granted by the U.S. Court of Appeals, District of Columbia Circuit. The case was decided on April 28, 1995. The Court found that the EPA was not statutorily authorized to adopt the ROS, and granted the petition for review.[38] Having failed to obtain a rehearing from the Court of Appeals, the EPA currently does not anticipate further action on the ROS.

Tax and Economic Incentives

State legislatures have continued to make tax structure changes favorable to the production and consumption of alternative fuels. For example, almost 20 States now have tax incentives for ethanol production or blending; some States also have reduced "special fuel" excise taxes, while others have ordered State fleets to use alcohol-blend fuels when practical. State regulatory agencies have implemented economic incentive programs to attract alternative-fuel industry investment. Virginia recently established a job-creation tax credit of $700 for each new job created in the State by AFV manufacturers, parts suppliers, and converters. Federal agencies, through the authority granted by the EPACT and other laws, have proposed or promulgated tax incentives and other rules for alternative fuels. For example, the Internal Revenue Service proposed in January 1995 to lower the Federal excise tax for liquefied natural gas (LNG) to that of compressed natural gas (CNG). That proposal, however, was defeated.

[33]Milwaukee is one of the nine ozone nonattainment areas required by the CAAA90 to use reformulated gasoline.

[34]The current DOE definition of alternative fuels includes alcohol blends of no less than 85-percent alcohol by volume, although the EPACT provides DOE with the authority to lower the percentage to a minimum of 70 percent to meet cold start, safety, or other vehicle function requirements.

[35]Biodiesel is made from vegetables oils, animal fats, and microalgal oils.

[36]As of December 26, 1995, the final rulemaking is pending.

[37]For example, the Propane Consumers Coalition submitted testimony stating that the EPACT AFV programs would result in rapid increases in propane prices and imports, and therefore called for the removal of propane from the list of EPACT alternative fuels. Propane Consumers Coalition, "Statement Submitted to the Energy & Power Subcommittee, Committee on Commerce, U.S. House of Representatives," (June 6, 1995).

[38]American Petroleum Institute v. U.S. E.P.A., 52 F.3rd 1113 (D.C. Cir. 1995).

Research, Development, and Marketing Activities

A major area of research for transportation fuels is the conversion of biomass to ethanol, methanol, RFG components, and biodiesel. Through the DOE's Biofuels Systems Program, government and industry are engaged in collaborative efforts to commercialize a variety of biomass-derived fuels. Several cooperative research and development agreements and other joint venture arrangements have been established with fuel producers, agricultural/forest products companies, educational institutions, and research foundations. Biomass feedstocks being studied for fuel conversion applications include corn waste, rice straw, sugar cane, wood waste, soybean oil, processed municipal waste, and energy crops. The National Renewable Energy Laboratory (NREL) has been at the forefront of biofuels research, and has recently built a pilot plant to study hydrolysis and fermentation processes needed to economically convert a range of biomass resources into ethanol.[39]

Another area of research is the development and testing of new fuel additives, particularly new oxygenates. Examples include di-isopropyl ether (DIPE), tertiary butyl alcohol (TBA), tertiary amyl methyl ether (TAME), and dimethyl ether, which is being investigated as a diesel fuel replacement or extender. The oil refining industry has focused on new process technologies to reduce production costs and increase refinery yields for these alternative fuel components. A number of experimental additives made from methanol are also being investigated. An example is dimethylcarbonate (DMC), a high-oxygen, low-vapor-pressure methanol derivative.

Fuel cell research has accelerated, particularly with the recent formation of the National Fuel Cell Alliance, a partnership between the NREL, Ford, General Motors, and Chrysler. Fuel cells, which convert hydrogen and oxygen to electricity, are viewed as a long-term prospect for electric vehicles.[40] The goal of the National Fuel Cell Alliance is to develop a proton-exchange-membrane (PEM) fuel cell propulsion system capable of providing passenger cars with triple the fuel efficiency of conventional vehicles. Ford and Chrysler will evaluate the feasibility of onboard hydrogen storage, while General Motors will evaluate the formation of hydrogen from onboard methanol supplies. Other automotive engineering companies are also developing fuel cell technologies. For example, a company from British Columbia, Canada, recently unveiled the first commercial PEM fuel cell bus at Los Angeles International Airport.

Electric vehicle battery research continues at a fast pace, with many efforts targeted at improving lead-acid battery technology. (Lead-acid batteries are the likely candidate for powering the first mass-produced electric vehicles.) Other battery technologies being investigated include sodium-sulfur, nickel-cadmium, and zinc-air.

Although alternative fuels are currently limited to specialized uses, AFV technology and fuel-use experience point to a number of potential market growth areas. CNG is increasingly being considered for medium and heavy duty fleet vehicles with a limited operating range and for light duty vehicles that make frequent short-duration trips. Vehicles in the first category include transit buses, utility/government maintenance vehicles, and dump trucks. Vehicles in the second category include taxis, utility vans, and pickup trucks. Gas utilities are aggressively marketing natural gas for transportation use. They have established refueling station projects and promotional programs with various financial incentives. However, controversy has developed in some States over ratepayer subsidization of such utility promotional efforts. For example, the California Public Utilities Commission ruled that only about half of the $338 million proposed for AFV programs by California utilities would be allowed into the ratebase. In the State of Washington, the public utility commission reduced natural gas rates for a gas utility because of opposition to consumer subsidization of natural gas vehicle marketing efforts.

Ethanol fuels, such as blends of 85-percent ethanol with gasoline (E85), have been targeted for the light duty vehicle market, particularly in the midwestern States. Major E85 vehicle production programs have been planned by General Motors and Ford, while States such as Wisconsin and Illinois have made commitments to develop a regional E85 refueling station infrastructure. The demand for ethanol as an oxygenate in RFG continues to be strong in spite of the Federal Court ruling on the EPA Renewable Oxygenate Standard and the consideration by some States (such as New Jersey and

[39]The pilot plant, called a process development unit, is designed to test new ethanol conversion processes for application to commercial-scale facilities. The plant, which recently completed startup and operations testing, has a biomass feedstock capacity of one ton per day. Q. Nguyen, and others, "Design, Installation, and Operation of A Lignocellulosic Biomass-to-Ethanol Pilot Plant," paper presented at the Sixth National Bioenergy Conference (Reno, Nevada, October 2-6, 1994).

[40]Pure hydrogen can be stored in the vehicle for use in fuel cells, or hydrogen can be produced by reforming a simple hydrocarbon fuel stored in the vehicle.

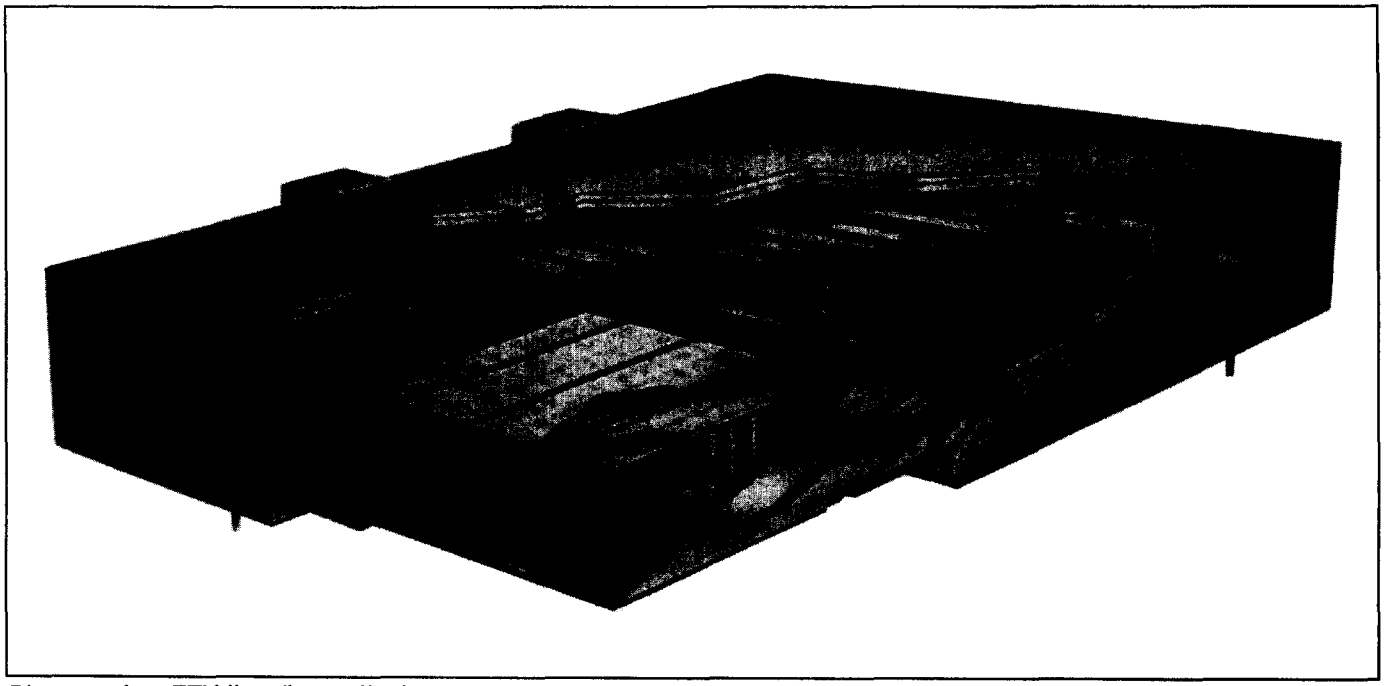


Diagram of an ETX-II sodium-sulfur battery.

Connecticut) to remove counties from the Federal oxygenated fuel program. To meet the increase in demand for ethanol, the ethanol industry has targeted States such as Minnesota, Nebraska, and Iowa for new ethanol production plants. Planned new ethanol capacity for these States alone totals about 500 million gallons per year.[41]

In contrast, MTBE markets have been hurt by high prices for the methanol feedstocks used to produce MTBE as well as the lingering controversies over methanol and MTBE safety. A number of MTBE production facilities have been shut down in the United States and abroad due to market weakness.

Propane is becoming more attractive as an alternative to diesel fuel for transit buses, while LNG is finding a niche as a fuel for long-haul tractor-trailers and buses. Recent tests for demonstration and prototype vehicles have shown generally lower particulate and nitrous oxide emissions from propane and LNG than from diesel. However, propane and LNG vehicle acquisitions have been sensitive to conventional fuel prices. For example, a number of LNG vehicle acquisition plans have been reconsidered recently due to falling diesel prices.

The initial market focus for electricity as a transportation fuel will be on meeting the zero-emission-vehicle mandates in California, New York, and Massachusetts. There is considerable disagreement as to when the automotive industry can introduce a performance- and cost-competitive electric vehicle that is widely accepted by consumers. Indications are that the immediate niche for electricity is to power slow-speed shuttle systems, such as those found in airports and downtown shopping districts. Although consumer reactions have been favorable for some demonstration vehicles, the major automakers are skeptical that electric vehicle demand will support the production levels required under current regulatory mandates. Automakers are also concerned over issues such as recharging station accessibility and vehicle service requirements.

Refueling Infrastructure Development

The past year has seen rapid growth in the infrastructure for alternative transportation fuels (ATF's). Growth is being driven by AFV acquisition mandates and associated government grant programs for refueling station construction and service technician training programs. California has the largest number of public ATF refueling sites, followed by Texas and Florida (Table 13). About 74 percent of the alternative fuel refueling stations dispensed LPG, while CNG was available at 24 percent of the stations.

[41]"New Ethanol Plants Considered In Iowa," *Oxy-Fuel News*, (Potomac, MD: Hart Publications, Inc., February 6, 1995), p. 3.

Table 13. Number of Refueling Stations, by Fuel and State, 1995

State	Fuel Type				Total
	M85	E85	CNG	LPG	
Alabama	—	—	16	85	101
Alaska	—	—	—	8	8
Arizona	1	—	20	45	66
Arkansas	—	—	6	104	110
California	60	1	118	214	393
Colorado	2	—	42	48	92
Connecticut	—	—	11	19	30
Delaware	—	—	2	6	8
District of Columbia	1	1	8	—	10
Florida	3	—	38	222	263
Georgia	1	—	47	80	128
Idaho	—	—	6	20	26
Illinois	2	10	23	165	200
Indiana	—	1	39	124	164
Iowa	—	6	4	108	118
Kansas	—	2	19	38	59
Kentucky	—	—	9	35	44
Louisiana	—	—	14	44	58
Maine	—	—	—	12	12
Maryland	2	—	25	21	48
Massachusetts	—	—	11	41	52
Michigan	2	1	29	182	214
Minnesota	—	1	16	125	142
Mississippi	—	—	—	75	75
Missouri	—	—	10	83	93
Montana	—	—	11	48	59
Nebraska	—	5	10	47	62
Nevada	—	—	8	20	28
New Hampshire	—	—	1	31	32
New Jersey	—	—	18	36	54
New Mexico	—	—	15	46	61
New York	7	—	42	100	149
North Carolina	—	—	8	72	80
North Dakota	—	—	5	17	22
Ohio	2	—	53	98	153
Oklahoma	—	—	48	56	104
Oregon	—	—	4	21	25
Pennsylvania	1	—	51	133	185
Rhode Island	—	—	2	5	7
South Carolina	—	—	3	43	46
South Dakota	—	6	5	24	35
Tennessee	2	—	6	80	88
Texas	—	—	77	202	279
Utah	—	—	48	20	68
Vermont	—	—	1	33	34
Virginia	—	—	25	39	64
Washington	1	—	30	37	68
West Virginia	1	—	37	16	54
Wisconsin	—	2	22	139	163
Wyoming	—	—	19	33	52
U.S. Total	**88**	**36**	**1,078**	**3,385**	**4,587**

Notes: • Data represent private and public refueling stations as of February 3, 1995. • M85 is a blend of 85-percent methanol and 15-percent gasoline. • E85 is a blend of 85-percent ethanol and 15-percent gasoline. • CNG = compressed natural gas. • LPG = liquefied petroleum gases.

Source: National Renewable Energy Laboratory, Alternative Fuels Data Center Database.

A recent trend has been the construction of increasingly large refueling stations for the centralized fuel-distribution requirements of large CNG- and LNG-fueled vehicle fleet programs. These programs require refueling facilities with high fuel-dispensing rates and multiple dispensers that can handle as many as several hundred vehicles. A number of mass transit agencies and airport authorities around the country have planned or constructed such high-capacity fuel stations. For example, the Greater Cleveland Regional Transit Authority recently opened a bus garage with a CNG station capable of refueling 200 buses in an 8-hour period. Other notably large facilities include the retail CNG station at the Phoenix Sky Harbor International Airport (with a 1,200 cubic-foot-per-minute dispensing rate) and a planned CNG/LNG facility in El Paso, Texas, with two CNG dispensers (4 gallons per minute) and three LNG dispensers (50 gallons per minute).

In addition to the appearance of increasingly large refueling facilities, companies have introduced new fuel delivery system designs that can be tailored to fit user requirements. For example, a company based in Toronto, Canada, markets a small appliance for refueling light duty CNG vehicles at home or at commercial locations. Known as a Vehicle Refueling Appliance, the unit attaches to the gas line, and can be configured for slow-fill or fast-fill operation. At the other extreme, one company is building a "clean fuels superstation" in Oakland, California, with fast-fill facilities for CNG, LNG, and methanol. The station uses a central station compressor that distributes the bulk fuel to satellite stations within an 80-mile radius. The first self-serve LNG station was recently installed in Bloomfield, New Mexico. These three technologies demonstrate the progress being made in improving the accessibility of alternative fuels to increasing numbers of consumers.

The past year also saw the start of a number of regional infrastructure and vehicle-use-pattern planning initiatives. One of the most prominent examples is a consortium formed from the Coalition of Northeastern Governors, the Ozone Transport Commission, the Southern States Energy Board, and other regional organizations to develop a north-south clean fuels corridor along Interstate Highway 95. The Pennsylvania Alternative Fuels Highway Task Force, composed of government agencies and private companies, has planned the development of refueling infrastructure along the Pennsylvania Turnpike. In Florida, corridor infrastructure is planned for the "Gold Coast," consisting of Dade, Broward, and Palm Beach counties. In the western United States, Colorado Springs, Colorado, is planning to build a refueling corridor uniting six counties and the city of Denver.[42]

Trends in Alternative and Replacement Fuel Consumption, 1992-1996

Consumption by onroad vehicles of alternative and replacement fuels is increasing much faster than consumption of traditional transportation fuels. Consumption of traditional highway fuels increased 4 percent from 1992 to 1994. Meanwhile, alternative and replacement fuel consumption increased 49 percent (Table 14). From 1994 to 1996, traditional fuel consumption is expected to increase another 4 percent, while alternative and replacement fuel consumption is expected to increase 45 percent. As a result, the share of total highway fuel provided by alternative and replacement fuels is increasing.

The EPACT established a goal of displacing 30 percent of projected U.S. motor fuels with replacement fuels by 2010.[43] In 1992, alternative and replacement fuels accounted for 1.6 percent, on a gasoline-equivalent gallon basis, of onroad transportation fuel use. By 1994, that share increased to 2.2 percent, and is expected to increase to 3.1 percent in 1996. The primary growth factor has been increased blending of oxygenates with gasoline. Alternative fuels alone accounted for 0.17 percent of onroad fuel consumption in 1992. That share is expected to increase to 0.22 percent by 1996.

Alternative Fuels

The consumption of liquefied petroleum gases (LPG), or propane, exceeds consumption of all other ATF's combined due to the large number of LPG vehicles in use compared to other AFV's.[44] However, since 1992, the percentage change in consumption of most of the other ATF's has been larger than the percentage change in consumption of LPG. As discussed in Chapter 2, the proportion of LPG vehicles in the AFV market is expected to decline from 88 percent to 66 percent between

[42]National Renewable Energy Laboratory, U.S. Department of Energy, *Clean Cities Drive*, Vol. 2, Issue 1 (Winter 1995), p. 4.

[43]Displacement of motor fuels does not equal displacement of petroleum. Additional factors must be considered to determine the amount of petroleum displaced. For one, some alternative and replacement fuels contain a petroleum component. Secondly, the entire fuel cycle must be considered.

[44]Because the current U.S. standards restrict automotive LPG to being mostly propane, LPG automotive fuel is frequently referred to as propane.

Table 14. Estimated Consumption of Vehicle Fuels in the United States and Percent Change, 1992-1996
(Thousand Gasoline-Equivalent Gallons)

Fuel	1992	1993	1994	1995	1996	Percent Change 1992-1996
Alternative and Replacement Fuels						
Alternative Fuels						
Liquefied Petroleum Gases (LPG)	208,142	264,655	248,550	259,940	*263,130*	26
Compressed Natural Gas (CNG)	16,823	21,603	24,160	43,631	*48,230*	187
Liquefied Natural Gas (LNG)	585	1,900	2,320	3,110	*3,150*	438
Methanol, 85 Percent[a] (M85)	1,069	1,593	2,340	2,372	*3,540*	231
Methanol, Neat (M100)	2,547	3,166	3,190	3,050	*3,160*	24
Ethanol, 85 Percent[a] (E85)	21	48	80	105	*1,030*	4,805
Ethanol, 95 Percent[a] (E95)	85	80	140	140	*140*	65
Electricity	374	309	430	571	*590*	58
Subtotal	**229,646**	**293,355**	**281,210**	**312,919**	***322,970***	**41**
Oxygenates						
Methyl Tertiary Butyl Ether (MTBE)	1,175,000	2,069,200	2,018,800	2,973,300	*3,330,200*	183
Ethanol in Gasohol	701,000	760,000	845,900	919,300	*914,000*	30
Other Alcohols and Ethers[b]	NA	NA	NA	201,200	*NA*	NA
Total	**2,105,646**	**3,122,555**	**3,145,910**	**4,406,719**	***4,567,170***	**117**
Traditional Fuels						
Gasoline[c]	110,135,000	111,323,000	113,144,000	115,809,000	*117,917,000*	7
Diesel	23,866,000	24,296,630	26,422,490	26,739,580	*27,315,700*	14
Total Fuel Consumption[d]	**134,230,646**	**135,912,985**	**139,847,700**	**142,861,499**	***145,555,670***	**8**

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline. Consumption data include the gasoline portion of the fuel.

[b]Primarily Tertiary Amyl Methyl Ether (TAME) and Ethyl Tertiary Butyl Ether (ETBE).

[c]Gasoline consumption includes ethanol in gasohol and MTBE.

[d]Total fuel consumption is the sum of alternative fuel, gasoline, and diesel consumption. Oxygenate consumption is included in gasoline consumption.

NA = Not available.

Notes: • Fuel quantities are expressed in a common base unit of gasoline-equivalent gallons to allow comparisons of different fuel types. Gasoline-equivalent gallons do not represent gasoline displacement. Gasoline equivalent is computed by dividing the lower heating value of the alternative fuel by the lower heating value of gasoline and multiplying this result by the alternative fuel consumption value. Lower heating value refers to the Btu content per unit of fuel excluding the heat produced by condensation of water vapor in the fuel. • Totals may not equal sum of components due to independent rounding. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.

Sources: **1992-1994 Oxygenate Consumption:** Energy Information Administration, *Petroleum Supply Monthly*. **1992-1994 Traditional Fuel Consumption:** Energy Information Administration, *Petroleum Supply Annual*, Volume 1 (June 1995). Highway use of gasoline was estimated as 97.1 percent of consumption, based on data in the *Transportation Energy Data Book: Edition 15*, prepared by Oak Ridge National Laboratory for the U.S. Department of Energy (July 1995). Diesel consumption was adjusted for highway use by multiplying by .467, derived from Energy Information Administration, *Fuel Oil and Kerosene Sales* 1993, Table HL1. **1995-1996 Oxygenate and Traditional Fuel Consumption:** Energy Information Administration, *Short Term Energy Outlook*, Third Quarter 1995. **Alternative Fuel Consumption:** Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

1992 and 1996. Natural gas vehicles are expected to capture much of the lost share, growing from 9 to 20 percent of total AFV's. The situation is similar for fuel consumption. LPG consumption accounted for 91 percent of total alternative fuel consumption in 1992, but its share is expected to drop to 81 percent in 1996. Meanwhile, consumption of natural gas is expected to increase from 8 percent to 16 percent of total alternative fuel consumption over the period. One reason that the LPG consumption share declines less than the LPG vehicle share is that the proportion of heavy duty vehicles is greater for LPG vehicles than for CNG vehicles.

As a result of General Motors' (GM's) plan to introduce a line of flexible-fuel ethanol pickup trucks, consumption of E85 is expected to increase substantially between 1995 and 1996. It should be noted, however, that E85 consumption still accounts for only about 0.1 percent of transportation ethanol consumption. Only a small portion of the GM trucks are expected to consume E85, at least until a larger fueling infrastructure is in place. The Energy Information Administration (EIA) estimate of E85 consumption is based on assumptions about the regional distribution of the GM trucks and ethanol production capacities.

Alternative fuel consumption estimates are derived from the number and types of vehicles in use. Alternative fuel consumption is a function of the miles traveled and the fuel efficiency (miles per unit of fuel consumed) of AFV's while using alternative transportation fuels. (See Appendix A for a detailed explanation of the estimation methodology.) Within each fuel category, there are different mixes of vehicle types and kinds of usage, for example, rental and service vehicles, private passenger vehicles, and government pool vehicles. Vehicle type and usage are the bases for estimates of fuel efficiency and vehicle miles traveled. In general, AFV's are used less intensively than conventional vehicles. Therefore, average vehicle miles traveled for AFV's are lower than for similar conventional vehicles. ATF consumption estimates also take into consideration the proportions of dedicated and nondedicated vehicles in each class and the proportion of time that nondedicated vehicles are operated on alternative fuels. In terms of fuel efficiency, the Btu-equivalent amounts of alternative fuels and traditional fuels do not always produce the same vehicle miles traveled, partly because some AFV engines are not optimized for ATF's.

Consumption estimates calculated for CNG were further adjusted to reflect baseline consumption information that was obtained from a CNG vehicle survey (see Appendix A). Therefore, estimates of natural gas consumption are considered somewhat more reliable than consumption estimates for other fuels.

While the most important factor in overall ATF consumption growth is number of vehicles in use, other factors also affect the rate of growth. For example, the mix of vehicles by weight and usage classification, and the proportion of alternative fuels used in bifuel, dual-fuel, or flexible-fuel vehicles can cause growth rates of vehicles and fuel consumption to differ. Heavy duty vehicles, especially transit and intercity buses, consume much more fuel per vehicle than light duty vehicles. From 1992 to 1996, the number of light duty AFV's is expected to grow faster than the number of heavy duty AFV's. As a result, total ATF consumption will increase at a slower rate (41 percent from 1992 to 1996) than the number of AFV's, which is expected to increase 68 percent over the same time period.

The mixture of fuel types is also an important factor in determining overall ATF growth. LPG vehicles, for instance, consume more ATF on average than CNG vehicles. This is partly due to the higher proportion of heavy duty LPG vehicles and partly to the higher proportion of dedicated LPG vehicles. Average consumption for alcohol fuels tends to be lower than other fuels because most of these vehicles are flexible-fuel vehicles that do not operate exclusively on alternative fuels. As CNG and alcohol vehicles increase their shares of AFV's, ATF consumption will show slightly smaller gains than the number of AFV's.

The regional distribution of ATF consumption is very similar to the distribution of AFV's. Regional ATF consumption is subject to the same influences as vehicles, namely, State laws and incentives, fuel availability, and regional fuel costs. Regional consumption patterns do reflect different mixes of vehicles in different regions. In general, the Northeast region is the smallest ATF-consuming region (Table 15). LPG is distributed fairly evenly across the remaining regions. Methanol consumption is predominant in the West, and ethanol consumption occurs primarily in the Midwest. There has been no significant regional shift in consumption since 1992, and none is expected for 1996. However, initiatives by the Ozone Transport Commission may cause a shift toward more ATF consumption in the Northeast in the future.

As is the case for regional distribution, the distribution of ATF consumption by type of owner is similar to the distribution of AFV's (Figure 5). In 1994, the Federal government accounted for 1 percent of ATF consumption, State and local governments 8 percent and private entities 91 percent (Table 16). As the public sector

Table 15. Estimated Share of Alternative Fuel Consumption by U.S. Non-Federal Entities, by Region, 1994 and 1996
(Percent)

Fuel	1994				1996			
	Northeast	South	Midwest	West	Northeast	South	Midwest	West
Liquefied Petroleum Gases (LPG)	10	39	27	24	*10*	*39*	*27*	*24*
Compressed Natural Gas (CNG)	13	30	21	35	*11*	*26*	*24*	*39*
Liquefied Natural Gas (LNG)	1	95	2	3	*	*93*	*2*	*5*
Methanol, 85 Percent[a] (M85)	1	1	*	98	*	*	*	*99*
Methanol, Neat (M100)	4	2	0	93	*5*	*1*	*0*	*94*
Ethanol, 85 Percent[a] (E85)	*	*	99	*	*4*	*9*	*80*	*7*
Ethanol, 95 Percent[a] (E95)	0	*	99	*	*0*	*	*99*	*
Electricity	7	19	7	67	*9*	*17*	*10*	*64*
Total	10	38	26	26	*10*	*37*	*26*	*27*

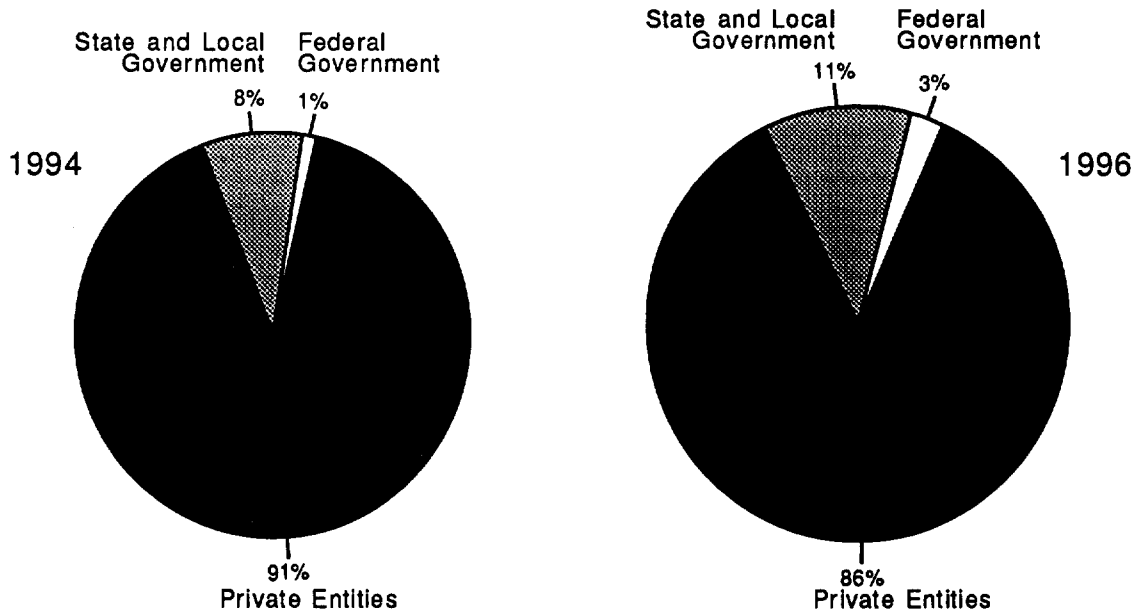
[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline. Consumption data include the gasoline portion of the fuel.

* Less than 0.5 percent rounded to 0.

Notes: • Totals may not equal sum of components due to independent rounding. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.

Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

Figure 5. Estimated Share of Alternative Fuel Consumption, by Ownership, 1994 and 1996



Source: Table 16.

Table 16. Estimated Consumption of Alternative Fuels in the United States, by Vehicle Ownership, 1992, 1994, and 1996
(Thousand Gasoline-Equivalent Gallons)

Fuel	1992				1994				1996			
	Federal	State and Local	Private	Total	Federal	State and Local	Private	Total	Federal	State and Local	Private	Total
Liquefied Petroleum Gases (LPG)	8	6,189	201,944	**208,142**	100	9,160	239,290	**248,550**	*100*	*9,160*	*253,870*	***263,130***
Compressed Natural Gas (CNG)	211	5,298	11,314	**16,823**	1,990	8,060	14,110	**24,160**	*6,729*	*20,250*	*21,250*	***48,230***
Liquefied Natural Gas (LNG)	0	490	93	**585**	0	2,280	40	**2,320**	*0*	*3,080*	*70*	***3,150***
Methanol, 85 Percent[a] (M85)	302	757	9	**1,069**	1,090	330	920	**2,340**	*1,280*	*570*	*1,690*	***3,540***
Methanol, Neat (M100)	0	2,534	12	**2,547**	0	3,190	*	**3,190**	*0*	*3,160*	*	***3,160***
Ethanol, 85 Percent[a] (E85)	1	13	7	**21**	20	50	10	**80**	*180*	*80*	*770*	***1,030***
Ethanol, 95 Percent[a] (E95)	0	80	5	**85**	0	130	10	**140**	*0*	*130*	*10*	***140***
Electricity	4	152	218	**374**	10	140	280	**430**	*11*	*250*	*330*	***590***
Total	**526**	**15,513**	**213,602**	**229,646**	**3,210**	**23,340**	**254,660**	**281,210**	***8,299***	***36,680***	***277,990***	***322,970***

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline. Consumption data include the gasoline portion of the fuel.
* Less than 0.5 thousand gasoline-equivalent gallons.
Notes: • Fuel quantities are expressed in a common base unit of gasoline-equivalent gallons to allow comparison of different fuel types. Gasoline-equivalent gallons do not represent gasoline displacement. Gasoline equivalent is computed by dividing the lower heating value of the alternative fuel by the lower heating value of gasoline and multiplying this result by the alternative fuel consumption value. Lower heating value refers to the Btu content per unit of fuel excluding the heat produced by condensation of water vapor in the fuel. • Totals may not equal sum of components due to independent rounding. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.
Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995).

increases its share of the vehicle pool, its share of ATF consumption will increase. In 1996, the Federal Government, State and local governments, and the private sector are expected to consume 3, 11, and 86 percent of alternative fuels, respectively.

The role of heavy duty AFV's is much more significant in terms of fuel consumption and traditional fuel displacement than their numbers suggest. In 1996, heavy duty vehicles are expected to comprise 16 percent of total AFV's, yet ATF consumption by heavy duty vehicles is expected to account for 35 percent of total ATF consumption. ATF consumption by heavy duty vehicles increased 24 percent from 1992 to 1994 and is expected to increase 17 percent between 1994 and 1996 (Table 17). ATF consumption by light duty vehicles increased 22 percent from 1992 to 1994 and is expected to increase 14 percent from 1994 to 1996.

Oxygenates

The term "oxygenates" refers to alcohols and ethers that are blended with gasoline. Alcohols and ethers are hydrocarbons that contain oxygen and thus act to raise the oxygen content of gasoline. With a higher oxygen content, gasoline produces fewer carbon monoxide emissions when combusted. Oxygenates are also relatively high-octane fuel components. The main oxygenates in use today are ethanol, or grain alcohol, and the ether, MTBE. There is small, but growing, usage of two other ethers, TAME and ethyl tertiary butyl ether (ETBE).

Oxygenates have been used in gasoline for a number of years. Ethanol has been used at various times and places to increase the volume of gasoline available. Its importance rose, for example, during gasoline shortages caused by the 1973 oil embargo. MTBE came into use in the late 1970's to increase gasoline octane levels as lead was phased out. But the CAAA90, with requirements for oxygenated and reformulated gasoline, provided the strongest force to increase the use of these additives. The EPACT also added some impetus to oxygenate use by establishing goals for petroleum fuel displacement.

Since the introduction of oxygenate mandates, the share of oxygenates in the gasoline supply has increased greatly. In 1992, oxygenates comprised 1.9 percent, on a gasoline-equivalent gallon basis, of the gasoline consumed. By 1994, oxygenates accounted for 2.8 percent of gasoline supplied, and by 1996, oxygenates are

Table 17. Estimated Consumption of Alternative Fuels in the United States, by Fuel and Vehicle Weight, 1992, 1994, and 1996
(Thousand Gasoline-Equivalent Gallons)

Fuel	1992			1994			1996		
	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total	Light Duty	Heavy Duty	Total
Liquefied Petroleum Gases (LPG)	141,042	67,100	**208,142**	167,300	81,250	**248,550**	*177,200*	*85,930*	***263,130***
Compressed Natural Gas (CNG)	10,477	6,345	**16,823**	15,490	8,670	**24,160**	*28,949*	*19,280*	***48,230***
Liquefied Natural Gas (LNG)	*	583	**585**	*	2,320	**2,320**	*	*3,150*	***3,150***
Methanol, 85 Percent[a] (M85)	607	461	**1,069**	2,290	50	**2,340**	*3,490*	*50*	***3,540***
Methanol, Neat (M100)	13	2,534	**2,547**	0	3,190	**3,190**	*0*	*3,160*	***3,160***
Ethanol, 85 Percent[a] (E85)	20	1	**21**	80	0	**80**	*1,030*	*0*	***1,030***
Ethanol, 95 Percent[a] (E95)	3	82	**85**	*	140	**140**	*	*140*	***140***
Electricity	226	148	**374**	280	150	**430**	*311*	*280*	***590***
Total	**152,388**	**77,254**	**229,646**	**185,440**	**95,770**	**281,210**	***210,979***	***111,990***	***322,970***

[a]The remaining portion of 85-percent methanol and both ethanol fuels is gasoline. Consumption data include the gasoline portion of the fuel.

* Less than 0.5 thousand gasoline-equivalent gallons.

Notes: • Fuel quantities are expressed in a common base unit of gasoline-equivalent gallons to allow comparisons of different fuel types. Gasoline-equivalent gallons do not represent gasoline displacement. Gasoline equivalent is computed by dividing the lower heating value of the alternative fuel by the lower heating value of gasoline and multiplying this result by the alternative fuel consumption value. Lower heating value refers to the Btu content per unit of fuel excluding the heat produced by condensation of water vapor in the fuel. • Weight classes are based on Environmental Protection Agency definitions: light duty is less than or equal to 8,500 pounds gross vehicle weight; heavy duty is greater than 8,500 pounds gross vehicle weight. • Totals may not equal sum of components due to independent rounding. • Estimates for historical years are in roman type; estimates for 1996, based on plans or projections, are in italic.

Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1995) and spreadsheet prepared for the Energy Information Administration.

expected to make up 3.9 percent of the gasoline supply (Table 14).

MTBE is the predominant oxygenate and is responsible for most of the total oxygenate growth. In 1992, 1.2 billion gasoline-equivalent gallons of MTBE were consumed. In 1995, after RFG requirements took effect, 3.0 billion gasoline-equivalent gallons were consumed, and consumption was expected to grow again to 3.3 billion gasoline-equivalent gallons by 1996. In the meantime, ethanol consumption grew just 31 percent between 1992 and 1995 and was expected to decrease between 1995 and 1996. MTBE's share of total oxygenate demand, on a gasoline-equivalent gallon basis, is expected to grow from 56 percent in 1992 to 73 percent in 1996.

MTBE is produced by chemically combining methanol and isobutylene (produced in refineries or natural gas plants). It is usually blended with gasoline at or near the refinery and can be shipped through the gasoline distribution system. Ethanol, made from corn at corn processing plants, however, is not compatible with the gasoline distribution system. It is usually shipped by trucks or barge and "splash blended" at terminals just before gasoline is delivered to retailers. Transport difficulties and uncertain tax status have restrained growth in production capacity for ethanol. From 1991 to 1994, production capacity for MTBE in the United States increased by 85 percent, while production capacity for ethanol increased only 10 percent.[45] In 1994, the Federal tax exemption for ethanol was extended to ETBE, which is made from ethanol and isobutylene in a process similar to MTBE. In response, ETBE capacity is likely to grow, and some MTBE production plants may be converted to ETBE production.

[45]Energy Information Administration, *Energy Information Administration Assessment of Reformulated Gasoline, Volume I*, SR/OOG/94-02/1 (Washington, DC, October 1994), p. 16.

Appendices

Appendix A
Estimation Methods and Data Quality

Estimation methods and data quality issues for alternative-fueled vehicle (AFV) inventories (Chapter 2) and alternative and replacement fuel consumption (Chapter 4) are presented in this appendix. Data for 1992, 1993, and, in some cases, 1995 are from *Alternatives to Traditional Transportation Fuels 1993*. No substantial changes in methodology have been introduced in *Alternatives to Traditional Transportation Fuels 1994*, which focuses on historical data for 1994 and projected or planned data for 1996. Minor methodological changes are explained below. In cases where 1994 and 1996 values differ substantially from 1995 projections published in the 1993 report, the 1995 estimates have been revised based on updated information.

Alternative-Fueled-Vehicle Inventory

The methods employed to estimate the number of alternative-fueled vehicles in use (AFV inventories) vary by vehicle ownership category (Federal Government, State and local government, and private) and by fuel type.

Federal

The number of Federal AFV's in use was obtained from vehicle acquisition data compiled by the U.S. Department of Energy's (DOE's) Office of Alternative Fuels and the General Services Administration's (GSA's) Automotive Commodity Center. Acquisition data are based on Federal agency counts of AFV's planned to be purchased, leased, or converted. No retirements of Federal AFV's are assumed.

For 1992 and 1993, GSA data on leased AFV's and new purchases through the Automotive Commodity Center were added to data on agency-owned vehicles and agency conversions reported to DOE's Office of Alternative Fuels. For calendar year 1994, AFV inventories, by fuel type, were estimated from acquisitions reported to DOE. Conversion acquisitions reported by fuel type are approximate because the fuel choice for some vehicles was not determined at the time data were collected. (Most often, the choice is between compressed natural gas and liquefied petroleum gases.)

Federal AFV inventory estimates for 1995 represent planned acquisitions required to meet Executive Order 12844. For 1996, the inventory estimates are based on the planned acquisitions needed to meet the EPACT Federal AFV requirement (25 percent of Federal vehicle acquisitions in fiscal year 1996 must be AFV's). The 1995 and 1996 planned AFV acquisitions were obtained from the GSA.

The vehicle acquisition plans announced by Federal agencies assume full DOE funding of the incremental cost of acquiring the AFV's. However, both the amount of funds available and the date of their release by DOE were highly uncertain at the time that Federal AFV data were gathered. If Congress reduces DOE's AFV acquisition budget for fiscal year 1996, AFV acquisitions by Federal agencies will probably be reduced or delayed. Consequently, the 1996 Federal AFV inventory estimates in this report may be high.

State and Local Government and Privately Owned AFV's

Liquefied Petroleum Gases (LPG). There are no accurate government or private sector sources of data for the number of onroad LPG vehicles. A lower bound for the number of LPG vehicles by State was estimated from State records and reported LPG consumption data. The national LPG vehicle inventory is therefore the aggregation of State estimates. For the 1994 and 1996 vehicle count estimates performed in 1995, the motor vehicle departments of all 50 states were contacted for data on LPG vehicles or on all AFV's. Fourteen States reported significant numbers of AFV's or LPG vehicles. In those States that reported total AFV's only, LPG vehicles were estimated by subtracting estimated vehicle counts for CNG vehicles, alcohol-fueled vehicles, and electric vehicles from the total AFV counts. The adjusted LPG vehicle counts were then compared to reported State estimates of LPG usage in onroad transportation engines, as reported in *State Energy Data Report 1993*, DOE/EIA-0214(93), July 1995. Two States were found to have questionable vehicle counts based on the implied LPG usage per vehicle, and were subsequently removed from the enumerable group of States.

For the 38 States for which LPG vehicles could not be enumerated, the counts were imputed. An estimate of average fuel consumption (gallons of LPG per vehicle)

was calculated for the 12 enumerable States using State-level LPG consumption data, as reported in the *State Energy Data Report*. The number of vehicles was then computed by dividing each State's total LPG consumption by the average number of gallons consumed per vehicle. The imputed values were then adjusted to account for heavy duty vehicles, which were not recognized in most of the State motor vehicle department statistics. The adjustment was based on discussions with industry sources and is consistent with independent estimates from the National Propane Gas Association and the EIA. The allocations between State and local government vehicles and private vehicles and among light duty vehicles as a group and heavy duty vehicles as a group are based on discussions with members of the LPG industry.

The number of LPG-fueled vehicles is estimated to increase at 3 percent per year, slightly faster than the general automobile population, between 1994 and 1996.

Estimates of the number of LPG vehicles in use are highly uncertain. The implied usage of LPG per vehicle varies greatly among the 12 states used in the enumeration (from less than 500 gallons per vehicle per year to more than 2,500 gallons per vehicle per year). Inconsistent and inaccurate reporting of vehicles and fuel consumption is the primary cause of this variation. The extent of such misreporting is difficult to estimate. The vehicle counts in this report are believed to represent a lower bound estimate of the actual vehicle count. The LPG consumption data from which vehicle counts were imputed indicate declining onroad-vehicle LPG consumption, but these data are inconsistent with sales data for tanks, regulators, and other equipment primarily designed for onroad vehicles. This inconsistency indicates a likelihood that underreporting for regulatory and taxation purposes is widespread.

Compressed Natural Gas (CNG). Estimates of the number of CNG vehicles in use in 1994 and expected to be in use in 1996 were derived from a private, independent survey of natural gas suppliers and owners of CNG refueling stations conducted in 1995. This survey is an update to similar surveys conducted in 1993 and 1994, which collected data for 1992 and 1993 and projections for 1995. Respondents reported the number of vehicles served (by vehicle type and ownership) as of the end of the calendar year. Data were collected by ownership class, including utility, private, and government (State-owned, local government-owned, and federally owned).

The 1995 survey covered a minimum of 98 percent of all U.S. suppliers of natural gas for CNG-fueled vehicles. The survey response rate was nearly 100 percent, although a few suppliers did not provide breakdowns by vehicle type and ownership. Two major fuel suppliers reported the data in a manner that required imputation for some values. As a result, for 5 percent of the reported vehicles, the vehicle counts by type and ownership are estimated. The survey conducted in 1995 was used to adjust projections for 1995 that were reported in 1994.

The 1996 projections are somewhat less certain than the historical estimates. Some respondents included firm program plans in their projections, whereas others provided more speculative estimates.

Liquefied Natural Gas (LNG). Inventories of LNG vehicles are based on reported or planned purchases of LNG transit buses and other vehicles. Data were obtained through the independent survey of natural gas suppliers. The survey data were supplemented by information provided by LNG suppliers and verified by industry literature.

The LNG-fueled vehicle data are reasonably accurate; ownership is concentrated at transit bus companies and a few truck operations, so data collection consists primarily of identifying all LNG users. The local natural gas companies are not a sufficient source for LNG information because they do not necessarily supply the LNG. The numbers reported are believed accurate with a margin of error between 3 and 5 percent.

Alcohol Fuels. Vehicle counts for each State were obtained from State energy offices and, to a lesser extent, transportation departments, corn growers associations (ethanol only), fuel supply companies, vehicle demonstration programs, and manufacturers and converters of vehicles and engines.

Counts of methanol-fueled vehicles for 1992 through 1994 are considered to be reliable. Almost all methanol vehicles are operated in California, so an accurate enumeration in that State would virtually ensure an accurate National count. California methanol vehicle counts were obtained principally from the California Energy Commission (CEC). Since 1994, CEC data have been based on vehicle sales by model year. The numbers of methanol vehicles in use in States other than California are based on State-by-State enumerations of relatively small vehicle fleets and, thus, are considered fairly accurate. Estimates of methanol vehicles in use for 1995 and 1996 are somewhat less reliable.

Ethanol-fueled vehicle data are as reliable as methanol-fueled vehicle data. The number and size of ethanol-fueled vehicle fleets are small. Therefore, vehicles can

be easily tracked by State offices and private associations.

Electricity. Data from States with appreciable numbers of electric vehicles were collected from telephone contacts with State energy, transportation, or conservation offices, national electric vehicle associations (the Electric Automobile Association's State and local chapters), and electric utilities. Original equipment manufacturers and converters were also contacted. A survey conducted by the Electric Vehicle Association of the Americas was the principal source used to disaggregate total vehicle counts by vehicle type.

There is considerable uncertainty associated with the electric vehicle data. Uncertainty is caused by differences in the definitions of an onroad electric vehicle, by the relatively large percentage of electric vehicles that do not operate in the same way as conventional vehicles, and by possible incentives for vehicle associations to inflate estimates. To improve the accuracy of electric vehicle count information, a restrictive definition of electric vehicles was applied when requesting data for *Alternatives to Traditional Transportation Fuels 1994*. For example, prototypes, school-based kit vehicles, unconfirmed hobbyist vehicles, and nonhighway vehicles were excluded from the electric vehicle definition. Therefore, electric vehicle data for 1994 through 1996 are considered somewhat more accurate than 1992 and 1993 data.

Alternative Fuel Consumption

Alternative fuel consumption was calculated using the following four basic inputs:

1. *Alternative-Fueled Vehicle Inventories*: By vehicle fuel (e.g., M85, M100, E85), ownership (i.e., private, State and local government, Federal Government), and classification (e.g., autos, light duty trucks, heavy duty trucks, school buses, and transit buses.)
2. *Conventional Vehicle Miles Traveled (VMT)*: In miles per year, by vehicle ownership and classification.
3. *Miles-per-Gallon (MPG) on Conventional Fuel*: For gasoline or diesel, by vehicle classification.
4. *Thousand Btu (kBtu) per Native Unit of Fuel*: By neat (i.e., pure) replacement fuel. The native units used are: gallons (M85, M100, E85, E95, LPG, and LNG), therms (CNG), and kWh (electricity).

The following is a description of the eight-step approach used in estimating total annual fuel consumption.

1. Alternative-Fueled Vehicles Categorization

Alternative-fueled vehicles in a given year were categorized according to vehicle classification (auto, light duty truck, heavy duty truck, school bus, and transit bus), fuel (M85, M100, E85, E95, LPG, CNG, LNG, and electricity), and ownership (privately owned and government).

2. Vehicle Miles Traveled (VMT) by Alternative-Fueled Vehicle Classification and Fleet Type

The annual VMT values known from conventional fleets were assigned to each vehicle classification. Light duty vehicles were segmented further into three broad fleet types: rental and service vehicles, private passenger and car pool vehicles, and government pool vehicles. Heavy duty trucks as defined by the EPACT were segmented into medium and heavy duty categories. The conventional fleet characteristics used in the estimation process are listed in Table A1.

Table A1. Typical Conventional Vehicle Characteristics

Vehicle Classification/Fleet Type	Vehicle Weight (pounds)	Annual Vehicle Miles Traveled	Miles per Gallon
Automobile/Private Rental and Service	0-8,500	24,600	24
Automobile/Passenger Vehicles and Car Pools	0-8,500	12,000	24
Automobile/Government Pool	0-8,500	8,000	24
Light Duty Truck	0-8,500	16,400	16
Medium Duty Truck	8,501-14,000	16,400	8
Heavy Duty Truck	14,001-26,000	16,400	6
School Bus	All	8,000	8
Transit Bus	All	33,200	4

Source: Science Applications International Corporation, "Alternative Transportation Fuels and Vehicles Data Development," unpublished final report prepared for the Energy Information Administration (McLean, VA, August 1994).

3. Adjustments to Alternative-Fueled Vehicle Annual Vehicle Miles Traveled

The annual VMT values of conventional vehicles shown in Table A1 were revised downward to reflect the less intensive use of AFV's compared to conventional vehicles. Average VMT is lower for AFV's than for conventional vehicles due to differences in vehicle classification and issues of choice. Conventional light duty fleet vehicles are typically rental cars and high-usage service vehicles, whereas AFV light duty fleet vehicles are typically government pool vehicles and relatively low-usage service vehicles. Factors that reduce AFV utilization relative to conventional vehicles include:

- More frequent refueling because of lower heat content of alternative fuels
- Range restrictions because of limited fuel availability
- Higher maintenance needs and increased incidence of mechanical failures
- Operator perceptions (when choice is available, fleet and vehicle operators may drive conventional vehicles more often than AFV's because of their perceptions of safety, vehicle performance, and refueling ease, regardless of whether these perceptions are correct).

4. Alternative Fuel Consumption Adjustments

As defined in the EPACT, alternative transportation fuels (ATF's) may be in either a neat form (e.g., pure CNG, LNG, LPG, M100, or electricity), or in a blend (e.g., M85, E85, E95). In the latter case, consumption of ATF's includes both the replacement (i.e., alcohol) and conventional fuel components.

For several AFV types, the effective total fuel cycle of ATF consumption per mile of travel is higher than commonly thought. Consumption of ATF's is almost always estimated by assuming that Btu-equivalent amounts of ATF and traditional fuel produce the same VMT.[46] This assumption is not strictly accurate because of venting of fuel vapor during refueling and maintenance, leakage of gaseous fuels from fuel lines and storage cylinders, engine efficiency differences, and vehicle weight differences. Although natural gas utilities, transit bus facilities, fleet owners, and related industry members are not generally able to isolate and quantify these factors, the net effect is lower miles per Btu for most AFV's than for conventional vehicles.

The efficiencies in miles per gallon of gasoline were determined for all vehicle categories. These values were adjusted to account for higher effective fuel consumption for LNG-, CNG-, and electricity-fueled vehicles. For these AFV's, the miles per Btu ratio was lowered by decreasing the nominal heating values per native unit of fuel (Table A2).

5. Vehicle Miles Traveled and Fuel Consumption Adjustments for Bi-, Dual-, and Flexible-Fuel Vehicles

Dedicated vehicles were assumed to be fueled exclusively by replacement fuels; therefore, no adjustment

Table A2. Original and Adjusted Lower Heating Values of Conventional and Replacement Fuels
(Thousand Btu per Native Unit of Fuel)

Fuel Type	Original Heating Value per Native Unit of Fuel[a] (thousand Btu)	Added Fuel Loss (percent)	Adjusted Heating Value per Native Unit of Fuel (thousand Btu)
Methanol	57.00/Gallon	0.01	57.00/Gallon
Ethanol	76.00/Gallon	0.01	76.00/Gallon
Liquefied Petroleum Gases (LPG)	84.00/Gallon	0.00	84.00/Gallon
Compressed Natural Gas (CNG)	93.00/Therm	0.50	92.54/Therm
Electricity	3.41/kWh	2.00	3.34/kWh
Liquefied Natural Gas (LNG)	68.00/Gallon	2.00	66.64/Gallon
Diesel	128.00/Gallon	0.00	128.00/Gallon
Gasoline	115.00/Gallon	0.00	115.00/Gallon

[a]Lower heating value.

Source: Science Applications International Corporation, emissions model prepared for the Energy Information Administration, (McLean, VA, updated 1994).

[46]A notable exception is in Argonne National Laboratory, Center for Transportation Research, *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity*, ANL/ESD/TM-22, prepared by Dr. Mark Delucchi, Vol. 1 (Argonne, IL, November 1991) and Vol. 2 (Argonne IL, November 1993), which provides miles-per-Btu adjustment factors for AFV's.

was necessary. However, bi-, dual-, and flexible-fuel AFV's consume proportions of replacement and traditional fuels that may be significantly different from the nominal proportions in blended fuels. Flexible-fuel vehicles using M85, for example, do not necessarily consume 85-percent methanol and 15-percent gasoline. To obtain the net amount of alternative fuel used by bi-, dual-, and flexible-fuel vehicles, their VMT values were divided by their adjusted consumption proportions of alternative versus traditional fuels. These proportions are a function of the following:

- *Replacement Fuel Availability*: The percentage of traditional fuel used because no replacement fuel is available at the time of refueling
- *Operator's Fuel Choice*: The percentage use of replacement fuel that results from the vehicle operator's fuel choice when available. Choice is affected by perceptions of safety, vehicle performance, and refueling ease, and by familiarity with the fuel.

These adjustments can be expressed as follows:

VMT on 100% alternative fuel =
(fuel availability) × (fuel choice) .

6. Conversion to Replacement and Alternative Fuel Consumption in Native Units

The net adjusted annual VMT for 100-percent alternative fuel use were then divided by miles per unit of alternative fuel. The result was alternative fuel consumption by AFV's.

7. Conversion to Gasoline-Equivalent Gallons

Fuel consumption in terms of gasoline-equivalent gallons was computed by dividing the lower heating value of the alternative fuel by the lower heating value of gasoline and multiplying this result by the alternative fuel consumption value (from step 6).

8. Final Adjustments to the Compressed Natural Gas Consumption Estimates

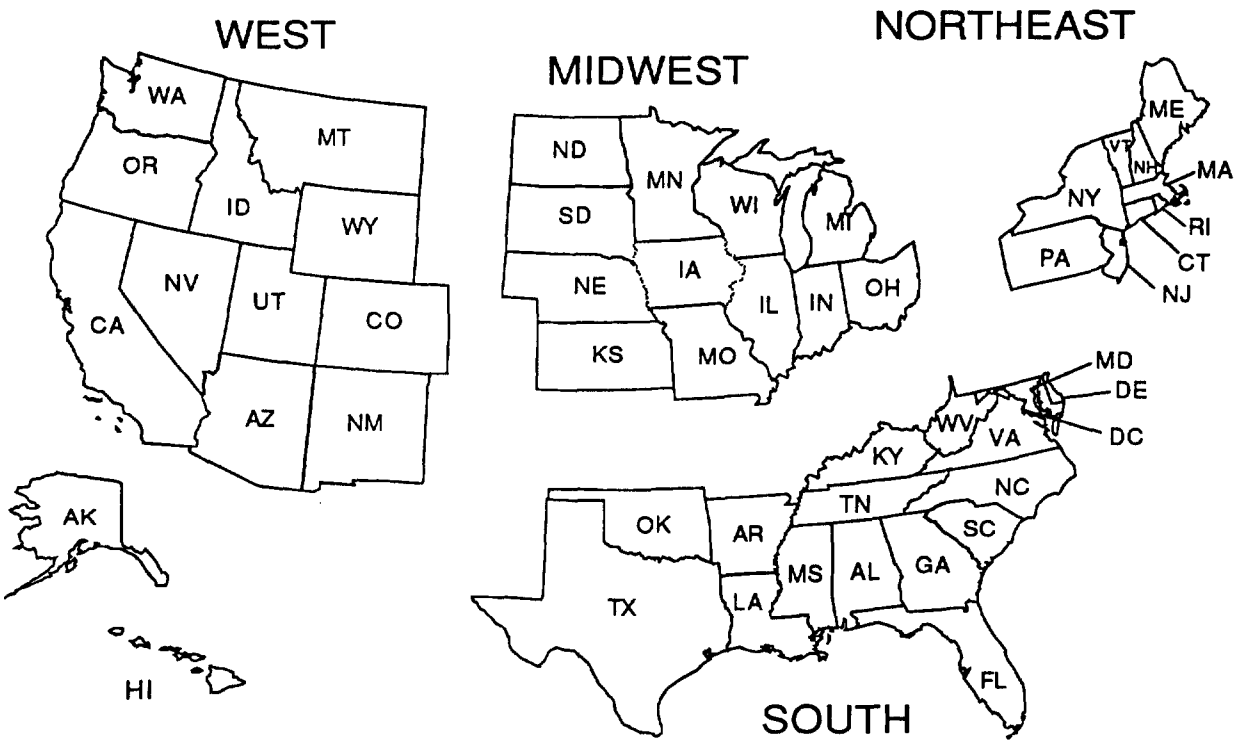
Two final adjustments were made to the CNG fuel consumption estimates, based on information obtained from the natural gas survey described above. First, it was assumed that vehicles added during the year operated, on average, for one-half year. The number of vehicles added in a year was estimated from the natural gas vehicle survey. This adjustment improves the estimate of fuel use in a market where the number of vehicles is rapidly changing. Second, the assumed dedicated/nondedicated distribution and the fuel consumption adjustment for nondedicated vehicles were adjusted to be consistent with the results of the natural gas vehicle survey, and thus match more closely the current market. In the natural gas vehicle survey, respondents were asked to report the number of dedicated vehicles in each weight class and the percentage of natural gas usage in nondedicated vehicles by weight class for 1994. A weighted average of reported percentages was used as an adjustment factor.

Oxygenate Consumption

The consumption of ethanol and methyl tertiary butyl ether (MTBE), for 1992 through the first quarter of 1995, was estimated from production, net imports, and stock change data obtained from the *Petroleum Supply Monthly* (DOE/EIA-0109). The *Petroleum Supply Monthly* compiles data from the Monthly Petroleum Supply Reporting System, a series of surveys that collect data from refiners, importers, and transporters of crude oil and petroleum products. Oxygenate data are also collected on the Form EIA-819M, "Monthly Oxygenate Telephone Report." Oxygenate consumption is calculated as production plus net imports less stock change. For the remainder of 1995 and for 1996, consumption is derived from unpublished data prepared in support of the *Short Term Energy Outlook, Third Quarter 1995*, DOE/EIA-0202(95/3Q).

Appendix B
U.S. Census Region Map

Figure B1. U.S. Census Region Map



Source: U.S. Department of Commerce, Bureau of the Census

Appendix C
Contact List of Alternative-Fueled Vehicle Converters and Original Equipment Manufacturers

Table C1. Alternative-Fueled Vehicle Suppliers

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
AC Propulsion Inc.	462 Borrego Ct. San Dimas CA 91773	Alan Cocconi	(909) 592-5399	CONVERTER	LD
Electric Alternative Fuels Conversions	9214 Converse Bus Line #6 Converse TX	Darrell Godfredson	(210) 658-8945	CONVERTER	LD/CNG
Amerigas	Over 500 Locations	Paula Wilson	(610) 337-7000	CONVERTER	LD
Arkansas Western Gas Co.	1118 Borick Dr. Fayettville AR 72701	Charles W. Holt	(501) 521-5400	OTHER	NG
Automotive Research Tech.	1460 Earl L. Core Rd. Morgantown WV 26505	Randy Stirewal	(304) 291-2925	CONVERTER	LD
AZ Technologies, Inc.	Rt. 2, Box 77 Hardy AR 72542	Les Adam	(501) 856-3237	OEM	LD/ ELECTRIC
Ace Gas Co.	1111 Rt. 37 W. Toms River NJ 08755-4999	Brian Clayton	(908) 349-1586	CONVERTER	LD/LPG
Advanced Vehicle Systems (AVS)	3101 Parker Ln. Chattanooga TN 37419	Joe Ferguson	(615) 821-3146	OEM	BUSES/ ELECTRIC
Al's Car Care, Inc.	1645 Grove Boise ID 83702	Richard Foerester	(208) 344-3800	CONVERTER	LD/CNG
Allied Propane Service, Inc.	5000 Seaport Ave Richmond CA 94804	Bob Long	(510) 237-7077	CONVERTER	LD/LPG
Alternate Energy Corporation	3 Brook Street Providence RI 02903	Tom Aubee	(401) 351-1232	CONVERTER	LD/CNG
Alternate Fuel Systems	29931 Beverly Rd. Romulus MI 48174	Harry Sayre	(313) 728-0300	CONVERTER/ OTHER	CNG
Alternative Dual Fuels, Inc.	6532 L.B.J Suite 201 Dallas TX 75244	Robert A. Lynch	(214) 247-1949	CONVERTER	LD/CNG
American Dual Fuels Inc.	7182 Hwy 14 Suite 701 Middleton WI 53562	Dan Mackin	(608) 836-6300	CONVERTER	LD/CNG
Atlantic Propane	3248 Lantana Rd. Lantana FL 33462	Sulllivan Palermo Sr.	(407) 965-0111	CONVERTER	LD/LPG
Automatic L.P. Gas Co.	813 S Frazier St. Conroe TX 77301	Mike Stubblefield	(409) 756-3389	CONVERTER	LD/LPG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Automotive Diagnostic Service	5730-A Roseville Road Sacramento CA 95842	Ahmed Mohamed	(916) 332-5333	CONVERTER	LD/CNG
Automotive Inc.	1730 East 18th Owensboro KY 42303	Steve Roberts	(502) 926-9731	DEALER	LD/CNG
Automotive Natural Gas, Inc.	265 North Janesville Street P.O. Box 39 Milton WI 53563	Philip Brooks	(608) 868-4626	CONVERTER	LD/CNG
B.H.P./The Gas Company	P.O. Box 3379 Honolulu HI 96842	Brad Saito	(808) 594-5584	CONVERTER	LD/LPG
Beatty Gas, Inc.	140 RT 1195 Home PA 15747	Glenn Beatty	(412) 349-2550	CONVERTER	LD/LPG
Big Valley Ford	3282 Auto Center Circle Stockton CA 95212	Nate Stoller	(209) 956-5244	CONVERTER	LD/CNG
Birdsong's Freeway American	860 IH-10S Beaumont TX 77707	Carl Birdsong	(409) 842-2822	DEALER	
BKM, Inc.	5141 Santa Fe Street San Diego CA 92109	John F. Kelly	(619) 270-6760	OTHER	CNG
Bullok Propane Gas Co. Inc.	Rt. 1 Box 95A Union Springs AL 36089	Tony Gibson	(334) 738-2337	CONVERTER	MD/LPG
Bus Industries of America, Inc.	Base Road, P.O. Box 449 Oriskany NY 13424	John Riet	(315) 768-8101	OEM	BUSES/ CNG
Baker Equipment	P.O. Box 25609 Richmond VA 23260	Bill Chappell	(804) 358-0481	CONVERTER	LD/ ELECTRIC
Barnes Energy Service, Inc.	113 North Ave Moberly MO 65270	Don Barnes	(816) 263-1130	CONVERTER	LD/LPG
Bay Gas Inc.	2694 Calder League City TX 77573	Hobie Sibley	(713) 332-2630	CONVERTER	LD/LPG
Bay State Gas	300 Friberg Parkway Westborough MA 01581-5039	Gary W. Robinson	(508) 836-7188	CONVERTER	LD/CNG
Baytech Corporation	P.O. Box 1148 Los Altos CA 94023	Rebecca J. Royer	(415) 949-1976	OEM	LD/CNG
Big H Inc.	240 Denny Way El Cajon CA 92020	Howard Hawkins	(619) 449-6263	CONVERTER	LD/CNG
Bison Oil	2249 South Coffeen Ave. Sheridan WY 82801	Toby Frey	(307) 674-4522	CONVERTER	LD/LPG
Blue Skies NGV Conversion Co	2077 S Vineyard Ave PO Box 3310 Ontario CA 91761-3310	Brian G Brown	(909) 923-8780	CONVERTER	MD/CNG
Blue Sky Design	1929 W. 25th Place Eugene OR 97405	Mark Murphy	(503) 345-8376	OTHER	

See notes at the end of the table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Boston Gas Company	201 Rivermoor Street West Roxbury MA 02132	Jim White	(617) 723-5512	OTHER	CNG
Brick Propane, Inc.	721 S. State Aberdeen SD 57401	Jerry Brick	(605) 225-6383	DEALER	LD/LPG
Bus Manufacturing USA	325-C Rutherford Ave. Goleta CA 93117	Yolanda Davis	(805) 964-0970	OEM	ELECTRIC
C & M	2230 E Main St. Visalia CA 93292	Doug Martin	(209) 625-3619	CONVERTER	HD/CNG
C. Clark Propane	916 W. Wilks Pampa TX 79065	Mark Clark	(806) 665-4018	CONVERTER	LD/LPG
Callaway LP Gas	601 N. IH-27 Lubbock TX 79403	Kenneth Callaway	(806) 765-9573	CONVERTER	LD/LPG
Champion Motor Coach	331 Graham Rd. Imlay City MI 48444	Tim Farney	(810) 724-6474	OEM	BUSES/ LPG
Clean Energy Enterprises	Discovery Drive Raleigh NC 27603	David Zeigler	(919) 836-2352	CONVERTER	LD/CNG
CNG Services of Pittsburgh, Inc.	Wellington Square Suite 453 Pittsburgh PA 15235	Robert E. Petsinger	(412) 372-5568	CONVERTER	LD/CNG
Commercial Truck & Tractor Rep	300 North Ohio Ave. Clarksburg WV 26301	Michael Davis	(304) 623-0981	CONVERTER	LD/CNG
Compressed Natural Gas Corp.	2809 C Broadbent NE Albuquerque NM 87107	Adrienne Stone	(505) 343-8808	CONVERTER	LD/CNG
Cady Oil Co.	5023 N. Galena Road Peoria Heights IL 61614	Craig Dupuy	(309) 688-2111	CONVERTER	LD/CNG
Cajun Propane of Lafayette, Inc.	111 Patin Rd. Scott LA 70583	Mike Kibodeaux	(318) 261-1294	CONVERTER	OTHER/ LPG
Car Doctor Inc.	3705 Industrial Rd. Las Vegas NV 89109	Walt Monaghan	(702) 732-0112	OEM	LD/CNG
Carburation Labs of Midwest	1819 Ridge Ave. Evanston IL 60204	Peter Suttle	(708) 328-3161	CONVERTER	BUSES/ CNG
Carburetion & Turbo Systems	I1897 Eagle Creek Blvd. Shakopee MN 55379	David E. Leivestad	(612) 445-3910	CONVERTER	LD/CNG
Cardinal Automotive Inc.	7200 Fifteen Mile Road Sterling Heights MI 48312-4524	Joe Theisen	(810) 268-6375	OEM	LD/CNG
Carpenter Manufacturing	1500 Main Street Mitchell IN 47446	Dan Pearcy	(812) 849-3131	OEM	BUSES/ CNG
Central Valley Truck Center	2707 S.E. Ave. Fresno CA 93715	Penny Nilmeier	(209) 266-9531	OEM	MD/CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Chadwell & Son Gas Co.	608 Hwy 199 E Springtown TX 76082	Kenneth Chadwell	(817) 523-4443	DEALER	LD/LPG
Champagne Alternate Fuel Systems	200 W. 5th Street Lansdale PA 19446	Doug Marino	(215) 361-1304	CONVERTER	LD/CNG
Chance Coach, Inc.	4219 W. Irving Wichita KS 67209	Dick Carlon	(316) 942-7411	OEM	BUSES/ CNG
Chesapeake Automotive Enterprises	47 Main St. Reisterstown MD 21136	Bill Brill	(410) 833-7700	CONVERTER	LD/CNG
Chico Butane Gas Company	Hwy 101 So. Chico TX 76431	G.A. Buckner	(817) 644-2624	CONVERTER	LD/LPG
Chrysler Corporation	27777 Franklin Rd. Southfield MI 48034	Mike Clement	(810) 948-3644	OEM	LD/CNG
Cincinnati Gas & Electric Co.	2111 Dana Ave. Room M65M Cincinnati OH 45207	Robert Hallas	(513) 287-3957	CONVERTER	LD/CNG
Clark's	520 West Pontatock Roff OK 74865	Joe Richburg	(405) 456-7794	CONVERTER	LD/LPG
Clean Vehicle Systems	1160 Castleton Avenue Staten Island NY 10310	Robert Meeker	(718) 447-3038	CONVERTER	LD/CNG
Coal County Propane	P.O. Box 71 Colgate OK 74538	David Cometti	(405) 927-2302	CONVERTER	LD/LPG
Concho Butane Co.	8750 N US Hwy 87 San Angelo TX 76901	Cary Tomerlin	(915) 653-8924	CONVERTER	LD/LPG
Connecticut Natural Gas Corp.	100 Columbus Blvd. Hartford CT 06144	Peter Casarella	(203) 727-3264	CONVERTER	LD/CNG
Consumer Gas-NGV Fuel Systems	950 Burnhamthope Rd., W. Mississauga ON L5C 3B4 Canada	Stan Kokotka	(416) 276-3425	CONVERTER	LD/CNG
Conversions of Connecticut	226 Pratt Street Southington CT 06489	Roger Hackbarth	(203) 567-4382	CONVERTER	
Coots Carburetion & Service	505 Center St. Lathrop MO 64465	Harold Coots	(816) 528-4505	CONVERTER	LD/LPG
Covington Gas Company	300 S. College St. Covington TN 38019	Billy Fleming	(901) 476-9531	CONVERTER	LD/CNG
Crawford Motors	351 Richmond Street Chatham ON N7M 1P5 Canada	Dan Crawford	(519) 352-4937	CONVERTER	LD/LPG
Cropmate Company	805 St. Patrick St. Thibodaux LA 70301	Bill Cain	(504) 447-4081	CONVERTER	LD/LPG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Cryogas, USA, Inc.	5111 85th Avenue, East Building C #6 Puyallup WA 98371	M.D. Herron	(206) 926-7278	CONVERTER	LD/LNG
Cummins Engine Co.	500 Jackson St. Columbus IN 47201	Gary R. Farrell	(812) 377-3747	OEM	OTHER
Cummins Power Systems, Inc.	2727 Ford Road Bristol PA 19007-6895	Gary L. Jones	(215) 785-6005	OTHER	
Cushman, Inc.	900 N 21st St. Lincoln NE 68501	Ralph Miller	(402) 474-8562	OEM/OTHER	ELECTRIC
DAI Controls	5100 Academy Drive Lisle IL 60532	Dennis Graham	(708) 971-2442	CONVERTER	CNG
Delta Liquid Energy	1960 Ramada Paso Robles CA 93446	Bob Jacobs	(805) 239-0616	DEALER	LD/LPG
Darrel's Amoco	11955 Pacific St Omaha NE 68154	Darrel Smith	(402) 333-1777	CONVERTER	LD/CNG
Dee's Auto & Truck Service	1428 N. Summit Arkansas City KS 67005	Don Rottmayer	(316) 442-2781	CONVERTER	LD/LPG
Diversified Technical Services	5045 S. 33rd Street Phoenix AZ 85040	Tom Convey	(602) 243-1641	CONVERTER	LD/ ELECTRIC
Doyle's Garage & LP Conversion	7112 N CR 16 Drawer 40 Shallowater TX 79363	Doyle Greenway	(806) 832-5597	CONVERTER	LD/LPG
Dudley Automotive Services	9 Dudley Street Arlington MA 02174	Eddie Farrell	(617) 646-8473	CONVERTER	LD/CNG
E-Motion	P.O. Box 556 McMinnville OR 97128	Lon Gillas	(503) 434-4332	OEM	LD/ ELECTRIC
Ecoelectric Corp.	3244 E. Pennsylvania P.O. Box 85247 Tucson AZ 85754	Mary Ann Chapman	(602) 889-1056	CONVERTER	LD/ ELECTRIC
Eddins-Walcher Co.	1400 West Broadway Hobbs NM 88240	Wade Cavitt	(505) 393-2197	CONVERTER	LD/LPG
Electric Launch Co. (ELCO)	261 Upper North Rd. Highland NY 12528	Joe Flemming	(914) 691-3777	OEM/OTHER	ELECTRIC
Electric Vehicles of America	48 Acton St. Maynard MA 01754	Bob Batson	(508) 897-9393	CONVERTER	LD/ ELECTRIC
Energy Partners, Inc.	1501 Northpoind Parkway Suite 102 West Palm Beach FL 33407	Rhett Ross	(407) 688-0500	CONVERTER	OTHER
Earnest Automotive & Delco Tec	4401 Crawford Dr. Suite B Abilene TX 79602	Earnest Johnson	(915) 691-0151	CONVERTER	LD/CNG
Eco-Motion	6021 32nd Ave., N.E. Seattle WA 98115	Steven Lough	(206) 524-1351	CONVERTER	LD/ ELECTRIC

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
EcoGas, Inc.	6300 Bridgepoint Parkway Suite 300 Austin TX 78730	Sher Neely	(512) 338-9874	CONVERTER	LD/CNG
Eddie's Garage	8231 Main Needville TX 77461	David Luedeke	(409) 793-6420	CONVERTER	LD/LPG
ElectriCar Seattle	4649 Sunnyside Ave. W. Suite 342, Seattle WA 98103	Olof Sundin	(206) 634-0263	CONVERTER	LD/ ELECTRIC
Electric Auto Crafters	2-S-643 Nelson Lake Road Batavia IL 60510-9762	John Stockberger	(708) 879-0207	CONVERTER	LD/ ELECTRIC
Electric Corporation of America	720 Laramie Dr. Lewisville TX 75067	Mike Bain	(214) 221-4840	CONVERTER	LD/ ELECTRIC
Electric Motor Cars	4301 Kingfisher Dr. Houston TX 77035	Ken Bancroft	(713) 729-8668	CONVERTER	LD/ ELECTRIC
Electrickar	8191 Hunnicut Road Dallas TX 75228	Robert Bucy	(214) 327-7197	CONVERTER	LD/ ELECTRIC
Energy Conversions, Inc.	6411 Pacific Hwy. East Tacoma WA 98424	Paul D. Jensen	(206) 922-6670	CONVERTER	OTHER
Enginuity	1424 N Great Neck Rd. Virginia Beach VA 23454	Bill Dozier	(804) 481-7374	CONVERTER	LD/CNG
Entemanns Bakery	3325 NW 62nd St. Miami FL 33146	Luis Rubio	(800) 432-8266	CONVERTER	HD/CNG
Environmental Conversions, Inc.	944 W 20th Street Ogden UT 84404	Jerry Williamson	(801) 629-0999	CONVERTER	LD/CNG
Environmental Fuel Systems, Inc.	3801 E. Ft. Lowell Road Tucson AZ 85176	Richard Tofel	(602) 327-5374	CONVERTER	LD/CNG
Envirotech	202 Country Club Road Sherwood AR 72116	Nelson Brumley	(501) 835-1209	CONVERTER	LD/CNG
Envirotech Equipment Company	7277 Havenhurst Ave. B-3 Van Nuys CA 91406	Toni Lennon	(818) 373-0285	CONVERTER	HD/CNG
Eric's Auto/RV Performance	275 South 7th Ave Sequim WA 98382	Eric Davis	(206) 683-3696	CONVERTER	LD/LPG
ExproFuels	500 N. Loop 1604 East Suite 250 San Antonio TX 78232	Frank Alderman	(800) 831-9532	CONVERTER	LD/CNG
Eyeball Engineering	5420 Via Ricardo Riverside CA 92509	Ed Rannberg	(909) 682-4535	CONVERTER	LD/ ELECTRIC
Farstad Oil, Inc.	County Rd 19 Minot ND 58701	Ted Medler	852-1194 X156	CONVERTER	LD/LPG
Fosseen Manu. & Dev., Ltd.	206 May St (P.O. Box 10) Radcliffe IA 50230	Dave Stone	(515) 899-2115	CONVERTER	BUSES/ OTHER

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Farr Automotive Specialists	136 West Main Bozeman MT 59715	Francis Farr	(406) 587-8781	CONVERTER	LD/CNG
Finger Lakes Ambulance	20 Crane St. Clifton Springs NY 14432	Robert Boerjean	(315) 462-6642	CONVERTER	LD/LPG
Fletcher Service Co.	Hwy 1021 Eagle Pass TX 78852	Douglas Fletcher III	(210) 773-2816	CONVERTER	LD/LPG
Flxible Corp., The	970 Pittsburgh Drive Delaware OH 43015	David Kossler	(614) 362-2607	OEM	BUSES/ CNG
Forklift Svc. Co. of Houston	3312 Toliver Houston TX 77093	Johnny Wells	(713) 695-5225	CONVERTER/ OTHER	LPG
Fountain Hills L P Gas, Inc.	P.O. Box 17208 Fountain Hills AZ 85269	Martin Dawson, Jr.	(602) 837-9760	CONVERTER	LD/LPG
Franklin & Son	600 Lamesa Hwy Stanton TX 79782	Barbara McKenzie	(915) 756-2808	CONVERTER	LD/CNG
Fricks Butane Gas	2307 E 9th St. Texarkana AR 75502	Clay Fricks	(501) 774-5892	CONVERTER	LD/LPG
GASCO Propane	P.O. Box 203 Hwy M & 87 Eldon MO 65026	Ed Simmons	(314) 392-4275	CONVERTER	LD/LPG
Glaser Gas, Inc.	215 Auburn Dr. Colorado Springs CO 80909	David Glaser	(719) 596-4765	CONVERTER	LD/LPG
Greater Cincinnati Conversion	2111 Dana Ave. Cincinnati OH 45207	Bob Hallas	(513) 287-7367	CONVERTER	LD/CNG
Green's Blue Flame Gas Co. Inc.	13823 Packard Houston TX 77040	Joe Green	(713) 462-5414	CONVERTER	LD/CNG
Gabriel Marine	P.O. Box 65372 Port Ludlow WA 98365	Burton Gabriel	(206) 437-2136	CONVERTER	LD/ ELECTRIC
Gaines Propane Co.	P.O. Box 1365 Okmulgee OK 74447	Randy Gaines	(918) 756-3785	CONVERTER	LD/LPG
Gales Gas Service	P.O. Box 996 Pierre SD 57501	Jack Nafus	(605) 224-5518	CONVERTER	LD/LPG
Gasco Clean Air	PRI Tower 733 Bishop Street Honolulu HI 96842	Milton Emada	(808) 527-6191	DEALER	
George E. Kuhn & Co.	28 W. Center Street Germantown OH 45327-0181	George W. Kuhn	(513) 855-2454	CONVERTER	LD/LPG
Gilbert Gas Co.	810 W. Church Street Livingston TX 77351	Richard Gilbert	(409) 327-8222	CONVERTER	LD/LPG
Gillig Corporation	25800 Clawiter Rd Hayward CA 94545	Chuck Koske	(510) 785-1500	OEM	CNG
Godfrey Butane Co.	2947 W Division Arlington TX 76012	Eddie Godfrey	(817) 277-6328	CONVERTER	LD/LPG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Grasmere Sunoco	500 Grasmere Ave. Fairfield CT 06430	Jerry Kozera	(203) 255-0328	CONVERTER	LD/CNG
Gray's Petroleum/Southern LPG	512 East Stillwell De Queen AR 71832	Ray Still	(501) 642-2234	CONVERTER	LD/LPG
Green Motorworks	5228 Vineland Ave. N. Hollywood CA 91601	William Meurer	(818) 766-3800	CONVERTER	LD/ ELECTRIC
Green World Technologies	2600 Telegraph Ave. Berkeley CA 94704	Allan Reese	(510) 204-9500	CONVERTER	LD/CNG
Greene's Auto and Truck Serv.	51 W. Raymond Street Indianapolis IN 46225	Kenny Pearson	(317) 786-6253	CONVERTER	LD/CNG
Greengas America	685 Ramsey Avenue Hill Side NJ 07205	Urban Ellis	(908)-686-4443	CONVERTER	LD/CNG
Greg's Garage	1261 E. 7th Street Reno NV 89512	Greg Doyle	(702) 324-0911	CONVERTER	LD/CNG
Hocon Gas	33 Rockland Rd. Norwalk CT 06854	Ralph Tirella, Sr.	(203) 853-1500	CONVERTER	LD/LPG
Haigood & Campbell	305 North Scott Witchita Falls TX 76301 Archer City TX 76351	Ward A. Campbell	(800) 766-0016	CONVERTER	LD/LPG
Hall Propane Co., Inc.	Hwy 35 South, PO Box 602 Port Lavaca TX 77979	Sharon Hall	(512) 552-5587	CONVERTER	LD/LPG
Hank's Southeastern Propane	I795 American Legion Hwy Westport MA 02790	Hank Demers	(508) 636-2632	OTHER	LPG
Hansford Implement Company, Inc.	P.O. Box 518 Spearman TX 79081	Frank Edwards	(806) 659-2568	OTHER	LNG
Hereford Butane Inc.	E Hwy 60 & Veteran Park Rd. Box 510 Hereford TX 79045	Calvin Goodin	(806) 364-3367		LPG
Hutchins Carb and Automotive	375 Court St. Binghamtom NY 13904	David Hutchins	(607) 723-6486	CONVERTER	LD/CNG
Hyundai American Technical Center	5075 Benture Drive Ann Arbor MI 48108	Mr. JK Jeong	(313) 747-6600	OEM	LD/CNG
ITE Auto and Fleet Services	7190 Oakland Mills Road Columbia MD 21046	Dave Liebl	(410) 290-6740	CONVERTER	LD/CNG
Illinois Industrial Equipment	P.O. Box 69 Orland Park IL 60462	Robert Johnson	(708) 460-7070	CONVERTER	LD/CNG
Independent Oil Co.	305 N Waco St. Hillsboro TX 76645	Lynn B. Gray	(817) 582-5359	CONVERTER	LD/LPG
Intermountain Gas Company	555 S Cole Road Boise ID 83707	Mike Huntington	(208) 377-6059	CONVERTER	CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
International Electric Vehicle	N.A.W.C. Warminster PA 18974	James H. Smith; Robert Moore	(215) 646-8686	CONVERTER	ELECTRIC
J&L Propane, Inc.	Miller Rd Krum TX 76249	Raymond Johnson	(817) 482-3225	CONVERTER	LD/LPG
J-W Operating Company	36629 US Hwy 385 Wray CO 80758	Kendall Read	(303) 332-3151	CONVERTER	LD/CNG
Jettgas	302 Boomtown Rd. Laredo TX 78043	Douglas M. Brice	(210) 723-5551	CONVERTER	LD/LPG
JL Associates, Inc. (JLA)	22 Enterprise Pkwy Olympia Place Suite 310 Hampton VA 23666-0460	Gary Sweitzer	(301) 863-9659	CONVERTER	LD/CNG
JTR Sales & Service	2006 N Timberland Dr. Lufkin TX 75901	Matt Krawczynsky	(409) 639-1404	CONVERTER	CNG
Jefferson Transit Authority	1615 West Sims Way Port Townsend WA 98368	Steve Iden	(206) 385-4777	CONVERTER	LD/LPG
Jerry's Auto Shop	410 South 2nd St. Ponca City OK 74601	Jerry Gass	(405) 765-6236	CONVERTER	
John Roth Chevrolet	1405 W Main St. Merced CA 95340	Joe Baker	(209) 723-0451	DEALER	LD/CNG
Kamps Propane	9823 East Moffat Blvd. Manteca CA 95336	Rick Regelman	(209) 823-7641	CONVERTER	MD/LPG
Kaylor Energy Products	20000 Big Basin Way Boulder Creek CA 95006	Roy Kaylor	(408) 338-2200	CONVERTER	LD/ ELECTRIC
Kirksey Propane Service, Inc.	1126 S Colorado St. Lockhart TX 78644	Warren Kirksey	(512) 398-2112	CONVERTER	
Leahys Propane Gas Service	130 White St. Danbury CT 06810	Steve Rosentel	(203) 748-3535	CONVERTER	LD/LPG
Lemens LP Gas	I-20 & Kent Merkel TX 79536	Warren Lawler	(915) 677-6209	CONVERTER	LD/LPG
LP Propane	20638 Krick Cleveland OH 44146	Les Ashby	(216) 232-4111	DEALER	LD/CNG
Lektro, Inc.	1190 SE Flightline Drive Warrington OR 97146	Mike Brace	(503) 861-2288	OEM/OTHER	ELECTRIC
Live Oak Gas Co., Inc.	US 90 West Live Oak FL 32060	David Chandler	(904) 362-2424	DEALER	
Lockheed/Schless ElectroMotive	3165 E Main Ashland OR 97520	Ely Schless	(503) 488-8226	CONVERTER	LD/ ELECTRIC
Loren's Auto Repair	817 West Center Street Kalispell MT 59901	Loren Sallie	(406) 755-7757	CONVERTER	CNG
Mathes Electric Motorcar, Corp.	P.O. Box 44 Ocala FL 34478-0044	Charles West	(904) 351-3700	OEM	LD/ ELECTRIC

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Mesa Environmental Ventures Co	3125 West Bolt St. Ft. Worth TX 76110-5813	Technical Services	(817) 924-2353	CONVERTER	LD/CNG
Montana Power Company	40 East Broadway Butte MT 59701	Wally Norley	(406) 723-5421	CONVERTER	LD/CNG
Moulden Supply Co. Inc.	3600 Hwy 80 West Jackson MS 39209	John Titcomb	(601) 922-4611	CONVERTER	LD/CNG
Mack Trucks, Inc.	P.O. Box 1907 Allentown PA 18105-1907	Ed Merkel	(610) 709-8125	OEM	HD/LNG
Marcus Whitman School District	Main Street Gorham NY 14461	David Adam	(716) 526-5700	CONVERTER	BUSES/ CNG
Matthews Engineering Technologies	2900 Rt. 9 Ballston Spa NY 12020	Michael J. Marlin	(800) 288-6287	OEM	LD/CNG
McCormick, Inc.	2401 Ave Q Snyder TX 79549	Bill McCormick	(915) 573-6313	CONVERTER	LD/LPG
Metro-Dade Transit Agency	3311 NW 31st St. Miami FL 33142	Fred Shields	(305) 638-7232	OTHER	BUSES/ CNG
MetroPane, Inc.	2772 Sawbury 1632 Richmond Terrace Columbus OH 43235	Robert Turan	(718) 720-5198	CONVERTER	LD/CNG
Michigan Gas Company	16587 Enterprise Drive Three Rivers MI 49093	Bob Fegan	(616) 279-2222	CONVERTER	LD/CNG
Mid-Continent LP Service	3711 N. Main Great Bend KS 67530	Dick Dougherty	(316) 793-3573	CONVERTER	LD/LPG
Midland 66 Oil Co., Inc.	1612 Garden City Hwy Midland TX 79701	Kenneth Peeler	(915) 682-9404	CONVERTER	LD/LPG
Midtex LP Gas	P.O. Box 140 Midlothian TX 76065	Rodney Jenkins	(214) 723-3900	CONVERTER	LD/LPG
Mike Anderson Pontiac-Olds-GMC	P.O. Box 179 Logansport IN 46947	Bob Pear	(219) 753-6288	OEM	LD/CNG
Mission Gas Company	10625 Hwy 181 South San Antonio TX 78223	Ted Terry	(210) 633-0721	CONVERTER/ OTHER	LPG
Missouri Propane	712 S Main Carrollton MO 64633	Mitch Hilbrenner	(816) 542-1862	CONVERTER	LD/LPG
Modern Butane, Inc.	4803 Lockhart Hwy Austin TX 78744	J.R. Anderson	(512) 385-2130	CONVERTER	LD/LPG
Modern Engineering Inc.	2727 Beech Daly Dearborn Hts. MI 48125	Robert Childs	(313) 336-4570	CONVERTER	LD/CNG
Monterey County Fleet Management	855 E. Laurel Dr. Bldg. A Salinas CA 93905	Fred Skripka	(408) 755-4984	CONVERTER	LD/CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Mountain Fuel	1175 West 130 South Salt Lake City UT 84139	Terry Keddington	(801) 539-3673	CONVERTER	LD/CNG
Murray & Massie Butane Co	206 Main, P.O. Box 193 Byers TX 76357	Vincent Pharries	(817) 529-6237	CONVERTER	BUSES/ LPG
Natural Gas 2000, Inc.	808 North Pike Rd Cabot PA 16023	Chuck Martin	(412) 352-9100	CONVERTER	LD/CNG
Nelson Putman Propane Gas Inc.	2500 N Hwy 75 Corsicana TX 75110	Wayne Nelson	(903) 874-5641	DEALER	LD/LPG
NEVCOR	P.O. Box 8683 Stanford CA 94309-8683	Dr. John Reuyl	(415) 856-2706	CONVERTER	LD/ ELECTRIC
NGV Southeast Technologies Cen	616 Highway 138 Riverdale GA 30274	William Champ	(404) 907-0999	CONVERTER	LD/CNG
National Fuel Gas Distribution Co	365 Mineral Spring Rd. Buffalo NY 14210	Carmen E. Rossi	(716) 827-5520	CONVERTER	LD/CNG
Nebraska Alternate Fuels, Inc.	924 S. Claude Rd. Grand Island NE 68801	Dale Roberts	(308) 384-5003	CONVERTER	LD/CNG
New Flyer Industries Limited	600 Pandora Avenue West Winnipeg MBR2C 3T4 Canada	Rick Zebinski	(204) 244-6378	OEM	CNG
Nissan North America	750 17th St. NW Suite 900 Washington DC 20006	Michinori Hachiya	(202) 466-5284	OEM	LD
Norman's Automotive Services	7649A Fullerton Rd. Springfield VA 22153	Norman Canfield	(703) 451-9222	CONVERTER	LD/CNG
North Valley Propane	526 South Butte St. Willows CA 95988	Vance Pattison	(916) 934-7005	CONVERTER	LD/LPG
O'Gwynn Inc.	303 Midred Street Montgomery AL 36104	Benny McDaniel	(334) 244-2243	CONVERTER	LD/CNG
Orange County Transportation	A550 South Main St. Orange CA 92613-1584	Frank Lonyai	(714) 560-5910	CONVERTER	BUSES/ LPG
Oshkosh Truck Corporation	552 Hyatt Street Gaffney SC 29341	Dean Schaper	(803) 487-1700	OEM	MD/CNG
PACA/TEECO Products	7471 Reese Road Sacramento CA 95828	Gary Lane	(800) 225-6621	CONVERTER	LD/CNG
Piedmont Natural Gas Company	1915 Rexford Road Charlotte NC 28211	Greg A. Johnson	(704) 364-3120	CONVERTER	LD/CNG
Propane Center	1156 Bridge St. Clay Center KS 67432	Roxie Baer	(913) 632-3644	CONVERTER	LD/LPG
Panhandle Forklift & Equipment	10814 Canyon Dr. Amarillo TX 79119	David Wing	(806) 622-1183	OEM/OTHER	LPG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Perryman Propane	12634 Beaumont Hwy Houston TX 77049	Nathan Perryman	(713) 458-3110	CONVERTER	LD/LPG
Petty Butane Company	10224 Hwy 287 West Vernon TX 76384	Scott/R.B. Inglisy	(817) 552-7072	CONVERTER	LD/LPG
Precision Sales & Service, Inc	3732 Airport Hwy Birmingham AL 35236	Buddy Gamel	(205) 591-2266	CONVERTER	LD/CNG
Pro Energy Corporation	11 Apple Street Tinton Falls NJ 07724	Ron Cassell	(908) 747-3795	CONVERTER	LD/CNG
Propane Service Inc.	5625 N Harrison Shawnee OK 74801	Tom Atwood	(405) 275-3740	CONVERTER	LD/LPG
Quality Automotive	303 S. Wyoming Butte MT 59701	Carl M. Popovich	(406) 723-9213	CONVERTER	LD/CNG
Quapaw Texaco	716 East Ninth St. Little Rock AR 72202	Marc Yelenich	(501) 375-0804	CONVERTER	LD/CNG
Razzari Ford	1300 Auto Center Dr. Merced CA 95340	Ernie Campora	(209) 383-3673	CONVERTER	LD/CNG
Renaissance Cars Inc.	2730 Kirby Ave. NE Palm Bay FL 32905	Theodore F. Glaser	(407) 676-2228	OEM	LD/ ELECTRIC
RODAGAS Energy Systems Inc.	10355 Capital Avenue Oak Park MI 48237	Gerald G. Flood	(810) 398-3660	CONVERTER	LD/CNG
Reliable Gas Co.	13776 Hwy 69 N Tyler TX 75712	David Guthrie	(903) 882-6106	CONVERTER	LD/LPG
Richter Enterprises	5120 Cane Run Rd. Louisville KY 40216-1157	Troy R. Royalty	(502) 447-7304	CONVERTER	LD/CNG
Rocking Bayto & Fuel Supply	2 mi. West of Bushland off I-40 Bushland TX 79012	Sandra Ball	(806) 355-4942	CONVERTER	LD/LPG
Schagrin Gas Co.	1000 N. Broad St. Middletown DE 19709	Christopher Cafarella	(302) 378-2000	CONVERTER	LD/LPG
Scherer Truck Equipment Co.	2670 Auburn Rd. Auburn Hills MI 48326	Donald Anderson	(810) 853-7277	CONVERTER	LD/CNG
Smith's Propane Service	Loop 143E Perryton TX 79070	Rusty Mounsey	(806) 435-5844	CONVERTER	LD/LPG
Sterling Oil & Gas Co.	213 E Chestnut St. Sterling CO 80751	Larry Edwards	(970) 522-3496	CONVERTER	LD/LPG
Suburban Propane	240 Route 10 West Whippany NJ 07981	Douglas N. Nagoshi	(201) 887-5300	DEALER	LD/LPG
Suntera, Solar Elec. Chariot Co.	5-487 Lehua St. Honokaa HI 96727	Steven Parente	(808) 775-7771	OEM	LD
Sabre Equipment	106 River Road McKees Rocks PA 15136	Frank Bellay	(412) 771-9320	CONVERTER	LD/CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
San Diego Electric Automobile	9011 Los Coches Road Lakeside CA 92040	Ron Larrea	(619) 443-3017	CONVERTER	LD/ ELECTRIC
Sarasota County Sheriff's Department	P.O. Box 4115 Sarasota FL 34239	Steve Meadows	(813) 966-2160	CONVERTER	LD/LPG
Sewalt Butane Company	1107 Commerce St Brownwood TX 76801	Donnie Varner	(915) 646-7571	DEALER	LD/LPG
Sierra Gas Products, Inc.	Highway 118 North Alpine TX 79831	Robert Mahle	(915) 837-3348	CONVERTER	LD/LPG
Sierra Pacific Power Company	P.O. Box 10100 Reno NV 89520-0400	Peter Konesky	(702) 689-4702	CONVERTER	LD/CNG
Solar Trikes	14 Creekside Drive Enola PA 17025	Wendy Tomlinson	(717) 732-6703	OEM	ELECTRIC
Solarmax Corporation	1040 Commerce Blvd., North Sarasota FL 34243	David Vigoda/ Valerie Morawa	(813) 351-6443	OEM	LD/ ELECTRIC
Solectria Corporation	68 Industrial Way Wilmington MA 01887	Deborah Goldsmith	(508) 658-2231	OEM	LD/ ELECTRIC
Southeastern Michigan Gas Company	2915 Lapeer Road Port Huron MI 48060	Walter E. Fitzgerald	(810) 987-7900	CONVERTER	LD/CNG
Southwest Gas Equipment Co.	P.O. Box 335 Liberal KS 67901	Joe Atkins	(316) 624-3877	CONVERTER	LD/LPG
Specialty Vehicle Manufacturing	9250 Washburn Rd. Downey CA 90242	Rich Krantz	(310) 904-3434	OEM	BUSES/ CNG
State Avenue Goodyear	6717 West 119th Street Overland Park KS 66209	Buck Bales/ Bill Oades	(913) 788-7272	CONVERTER	LD/CNG
Stephen Miracle, Mechanician	RD2 Box 4892 Dog River Rd Montpelier VT 05602	Stephen Miracle	(802) 223-3524	CONVERTER	LD/ ELECTRIC
Steve's Gas Supply, Inc.	P.O. Box 5087 Essex Junction VT 05453	Larry Stevens	(802) 878-5845	CONVERTER	LD/LPG
Stewart & Stevenson Services	8631 East Freeway Houston TX 77029	Jim Tobola	(713) 671-6269	CONVERTER	BUSES/ CNG
Sunset Auto Repair	22 Sunset Drive Kalispell MT 59901	Joe Drewniak	(406) 752-7479	CONVERTER	LD/CNG
TDM World Conversions	1020 Doris Road Auburn Hills MI 48321	Ted Hansen	(810) 377-2288	CONVERTER	LD/CNG
Ted Johnson Propane Co.	5140 N. Elton St. Baldwin Park CA 91706	David A. Turner	(800)576-4LPG	CONVERTER	LD/LPG
Texas Propane	Highway 77 North Rockdale TX 76567	Gordon Todd	(512) 446-4949	CONVERTER	LD/LPG
The Clean Air Fuels Corp.	1945 Las Plumas Ave. San Jose CA 95133	Charles Vacek	(408) 259-5710	CONVERTER	LD/CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Tonowanda Truck Repair	1453 Military Road Tonowanda NY 14217	Melvin Raab	(716) 873-1044	CONVERTER	LD/CNG
Teledyne Brown Engineering	300 Sparkman Dr. Huntsville AL 35807-7007	Dennis Lampiasi	(205) 726-1000	CONVERTER	LD/CNG
Thompson's Gas, Inc.	1431 N. Illinois St., Rt. 159 Belleville IL 62220	Phil Thompson	(618) 233-6541	CONVERTER	LD/LPG
Tom Gorman Company, Inc.	Tulsa OK 74112	J. Smart	(918) 835-8408	CONVERTER	LD/CNG
Toyota Technical Center	1588 Woodridge, RR 7 Ann Arbor MI 48105	John Shipinski	(313) 995-3754	OEM	LD/CNG
Toyotalift of Houston	9159 Wallisville Rd. Houston TX 77029	Steve Dorr	(713) 675-7000	DEALER/ OTHER	ELECTRIC
Transtar Technologies, L.C.	2415 Beatrice St. Dallas TX 75208	Terry Anglin	(214) 761-0143	CONVERTER	LD/CNG
Truck Suppliers, Inc.	2401 West Towne Glendive MT 59330	Jim Stanfill	(406) 365-5284	CONVERTER	LD/CNG
Valley Gas Company	Cumberland RI 02864	Warren Johnson	(401) 334-1188	CONVERTER	LD/CNG
Van's Garage	4341 Starlite Ln Corpus Christi TX 78410	Ted VanBlarcum	(512) 241-4331	CONVERTER	LD/CNG
Vermont Electric Car Company	RD 3, Box 3272 Middlesex VT 05602	Hilton Dier, III	(802) 223-6652	CONVERTER	LD/ ELECTRIC
Walters Gas Service, Inc.	M6326 Hwy. 151 Beaver Dam WI 53916	J.L. Walters	(414) 885-4030	CONVERTER	LD/LPG
Washington Natural Gas Company	P.O. Box 1869 Seattle WA 98111	Chuck Dougherty	(206) 224-2347	CONVERTER	LD/CNG
Welch Gas	613 E Main St. Atlanta GA 75551	George Welch	(903) 756-5271	CONVERTER	LD/LPG
Welsh Technologies, Inc.	P.O. Box 4214 River Edge NJ 07661	Jonathan Welsh	(201) 489-3465	CONVERTER	LD/CNG
Western Natural Gas Co.	290 Strickland St. Jacksonville FL 32254	George Pompilius	(904) 387-3511	CONVERTER	LD/LPG
Western Radiator and Automotive	1150 Custer Ave. Helena MT 59601	Jim Prothero	(406) 443-5817	CONVERTER	LD/CNG
Westex Propane	5524 El Paso Dr. El Paso TX 79905	E. Kettle	(915) 772-1404	CONVERTER	LD/LPG
Whitey's Truck Center	No. 1 Voorhees Dr. POB 190452-72219-0452 Little Rock AR 72209	Lloyd White	(501) 568-7812	CONVERTER	LD/CNG
Willard's Garage	1305 Broadwater Ave. Billings MT 59102	Willard Myers	(406) 259-1472	CONVERTER	LD/CNG

See notes at end of table.

Table C1. Alternative-Fueled Vehicle Suppliers (Continued)

Name of Organization	Address	Contact	Phone	Type of Operation	Vehicle/ Fuel Type
Williams Automotive Service	200 E. 5th St. Ft. Stockton TX 79735	Mike Williams	(915) 336-2341	CONVERTER	LD
Willmut Gas	315 S Main St. Hattiesburg MS 39402	Greg Ryland	(601) 544-6001	CONVERTER	LD/CNG
Wisconsin Fuel & Light Co.	P.O. Box 1627 Wausau WI 54402-1627	Rick Braenne	(715) 847-6217	CONVERTER	LD/CNG
Wisconsin Public Service Corp.	700 N Adams Street P.O. Box 19001 Green Bay WI 54301	Jay G. Froming	(414) 433-1027	CONVERTER	LD/CNG
Young Co. Butane	Hwy 67 S. Graham TX 76450	John Rich	(817) 549-3535	CONVERTER	LD/LPG

CNG = Compressed natural gas.
HD = Heavy duty.
LD = Light duty.
LNG = Liquefied natural gas.
LPG = Liquefied petroleum gases.
MD = Medium duty.
NG = Natural gas.
OEM = Original Equipment Manufacturer.
Source: Energy Information Administration, Form EIA-886, "Alternative Fuel Vehicle Suppliers' Annual Report."

Glossary

Aftermarket Conversion: A standard, conventionally fueled, factory-produced vehicle to which equipment has been added that enables the vehicle to operate on an alternative fuel.

Alcohols (CH_3-$(CH_2)_n$-OH): The family name of a group of organic chemical compounds composed of carbon, hydrogen, and oxygen. The series of molecules vary in chain length and are composed of a hydrocarbon, plus a hydroxyl group (for example, methanol, ethanol, and tertiary butyl alcohol).

Aldehydes: One of several families of compounds formed as products of incomplete combustion in engines using gasoline, methanol, ethanol, propane, or natural gas as fuels. As a general rule of thumb, the presence of methanol or methyl ethers in the fuel will lead to formaldehyde as the primary aldehyde in the exhaust, while ethanol or ethyl ethers will lead to acetaldehyde as the primary aldehyde in the exhaust. In both cases, other aldehydes are present, but in much smaller quantities. Formaldehyde and acetaldehyde are toxic and possibly carcinogenic.

Alternative Fuel: As defined pursuant to the EPACT, methanol, denatured ethanol, and other alcohols, separately or in mixtures of 85 percent by volume or more (or other percentage not less than 70 as determined by DOE rule) with gasoline or other fuels, CNG, LNG, LPG, hydrogen, coal-derived liquid fuels, fuels other than alcohols derived from biological materials, electricity, or any other fuel determined to be substantially not petroleum and yielding substantial energy security benefits and substantial environmental benefits.

Alternative-Fueled Vehicle (AFV): A vehicle either designed and manufactured by an original equipment manufacturer or a converted vehicle designed to operate in either dual-fuel, flexible-fuel, or dedicated modes on fuels other than gasoline or diesel. This does not include a conventional vehicle that is limited to operation on blended or reformulated gasoline fuels.

Alternative-Fueled Vehicle Converter: An organization (including companies, government agencies, and utilities), or an individual who performs conversions involving alternative fueled vehicles. An AFV converter can convert (1) conventionally fueled vehicles to AFV's, (2) AFV's to conventionally fueled vehicles, or (3) AFV's to another alternative fuel.

Barrel: A volumetric unit of measure for crude oil and petroleum products equivalent to 42 U.S. gallons.

Bi-Fuel Vehicle: A vehicle with two separate fuel systems designed to run on either an alternative fuel or conventional fuel using only one fuel at a time.

Biodiesel: Any liquid biofuel suitable as a diesel fuel substitute or diesel fuel additive or extender. A diesel substitute made from transesterification of oils of vegetables such as soybeans, rapeseed, or sunflowers (end product known as methyl ester) or from animal tallow (end product known as methyl tallowate). Biodiesel can also be made by transesterification of hydrocarbons produced by the Fisher-Tropsch process from agricultural byproducts such as rice hulls.

British Thermal Unit (Btu): A standard unit for measuring the quantity of heat energy equal to the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

California Air Resources Board (CARB): A State regulatory agency charged with regulating the air quality in California. Air quality regulations established by the Board and often stricter than those set by the Federal Government.

Carbon Cycle: All reservoirs and fluxes of carbon; usually thought of as a series of the four main reservoirs of carbon interconnected by pathways of exchange. The four reservoirs, regions of the Earth in which carbon behaves in a systematic manner, are the atmosphere, terrestrial biosphere (usually includes freshwater systems), oceans, and sediments (includes fossil fuels). Each of these global reservoirs may be subdivided into smaller pools ranging in size from individual communities or ecosystems to the total of all living organisms (biota). Carbon exchanges from reservoir to reservoir by various chemical, physical, geological, and biological processes.

Carbon Dioxide (CO_2): A colorless, odorless, nonpoisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion.

Although CO_2 does not directly impair human health, it is a greenhouse gas that traps the earth's heat and contributes to the potential for global warming.

Carbon Monoxide (CO): A colorless, odorless gas slightly lighter than air. It is poisonous if inhaled, in that it combines with blood hemoglobin to prevent oxygen transfer. It is produced by the incomplete combustion of fossil fuels with a limited oxygen supply (as in automobiles). It is a major component of urban air pollution, which can be reduced by the blending of an oxygen-bearing compound such as alcohols and ethers into hydrocarbon fuels.

Chlorofluorocarbons (CFC's): A family of inert, non-toxic, and easily liquified chemicals used in refrigeration, air conditioning, packaging, and insulation, or as solvents or aerosol propellants. Because they are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

Clean Alternative Fuel: Any fuel (including methanol, ethanol, or other alcohols (including any mixture thereof containing 85 percent or more by volume of such alcohol with gasoline or other fuels), reformulated gasoline, diesel, natural gas, liquefied petroleum gases, and hydrogen) or power source (including electricity) used in a clean fuel vehicle that complies with the standards and requirements of the Clean Air Act Amendments of 1990.

Compressed Natural Gas (CNG): Natural gas compressed to a volume and density that is practical as a portable fuel supply (even when compressed, natural gas is not a liquid).

Carbon Monoxide Nonattainment Area: Areas with carbon monoxide design values of 9.5 parts per million or more (generally based on data for 1988 and 1989).

Converted Vehicle: A vehicle originally designed to operate on gasoline that has been modified or altered to operate on an alternative fuel.

Criteria Pollutant: A pollutant determined to be hazardous to human health and regulated under the Environmental Protection Agency's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require the Environmental Protection Agency to describe the health and welfare impacts of a pollutant as the criteria for inclusion in the regulatory regime.

Dedicated Vehicle: A vehicle designed to operate solely on one alternative fuel.

Diesel Fuel: A complex mixture of hydrocarbons with a boiling range between approximately 350 and 650 degrees Fahrenheit. Diesel fuel (simply referred to as "diesel") is composed primarily of paraffins and naphthenic compounds that auto-ignite from the heat of compression in a diesel engine. Diesel is used mainly by heavy-duty road vehicles, construction equipment, locomotives, and by marine and stationary engines.

Dual-Fuel Vehicle: A vehicle designed to operate on a combination of alternative fuel, such as CNG or LPG, and conventional fuel, such as gasoline or diesel. These vehicles have two separate fuel systems which inject both fuels simultaneously into the engine combustion chamber.

E85: A fuel containing a mixture of 85 percent ethanol and 15 percent gasoline.

E95: A fuel containing a mixture of 95 percent ethanol and 5 percent gasoline.

Energy Efficiency: The inverse of energy intensiveness: the ratio of energy outputs from a process to the energy inputs (for example, miles traveled per gallon of fuel).

Environmental Protection Agency (EPA): A government agency, established in 1970. Its responsibilities include the regulation of fuels and fuel additives.

Ethyl Tertiary Butyl Ether (ETBE), $(CH_3)_3COC_2H_5$: A colorless, flammable, oxygenated hydrocarbon blend stock formed by the catalytic etherification of isobutylene with ethanol.

Ethanol (C_2H_5OH): Otherwise known as ethyl alcohol, alcohol, or grain-spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. However, it forms a binary azeotrope with water, with a boiling point of 78.15 degrees Celsius at a composition of 95.57 percent by weight ethanol. It is used in the United States as a gasoline octane enhancer and oxygenate (10 percent concentration). Ethanol can also be used in high concentrations in vehicles optimized for its use.

Ether: The family name applied to a group of organic chemical compounds composed of carbon, hydrogen, and oxygen, and which are characterized by an oxygen atom attached to two carbon atoms (for example, methyl tertiary butyl ether).

Flexible-Fuel Vehicle: A vehicle with the ability to operate on alternative fuels (such as M85 or E85), 100 percent traditional fuels, or a mixture of alternative fuel and traditional fuels.

Global Warming: The theoretical escalation of global temperatures caused by the greenhouse effect.

Greenhouse Effect: A popular term used to describe the roles of water vapor, carbon dioxide, and other trace gases in keeping the Earth's surface warmer than it would be otherwise. These radiatively active gases are relatively transparent to incoming shortwave radiation, but are relatively opaque to outgoing long wave radiation. The latter radiation, which would otherwise escape to space, is trapped by these gases within the lower levels of the atmosphere. The subsequent reradiation of some of the energy back to the Earth maintains the surface at temperatures higher than they would be if the gases were absent.

Greenhouse Gases: Those gases, such as water vapor, carbon dioxide, tropospheric ozone, nitrous oxide, and methane, that are transparent to solar radiation but opaque to long wave radiation. Their action is similar to that of increased humidity in a greenhouse.

Gross Vehicle Weight Rating: The weight of the empty vehicle plus the maximum anticipated load weight.

Heavy Duty Vehicles: Pursuant to the EPACT, trucks and buses having a gross vehicle weight rating of 8,500 pounds or more.

Hydrogen (H_2): The lightest of all gases, the element (hydrogen) occurs chiefly in combination with oxygen in water. It also exists in acids, bases, alcohols, petroleum, and other hydrocarbons.

Light Duty Vehicles: Automobiles and trucks having a gross vehicle weight rating of less than 8,500 pounds.

Liquefied Natural Gas (LNG): Natural gas that has been refrigerated to temperatures at which it exists in a liquid state.

Liquefied Petroleum Gases (LPG): Propane, propylene, normal butane, butylene, isobutane, and isobutylene produced at refineries or natural gas processing plants (includes plants that fractionate raw natural gas plant liquids).

Lower Heating Value (LHV): The Btu content per unit of fuel excluding the heat from the condensation of water vapor in the fuel.

M85: A fuel containing a mixture of 85 percent methanol and 15 percent gasoline.

M100: 100 percent (neat) methanol.

Methane (CH_4): The simplest of the hydrocarbons and the chief constituent of natural gas. Methane, a gas at normal temperatures and pressures, boils at -263 degrees Fahrenheit.

Methanol (CH_3OH): A colorless liquid with essentially no odor and very little taste. The simplest alcohol, it boils at 64.7 degrees Celsius. It is miscible with water and most organic liquids (including gasoline) and is extremely flammable, burning with a nearly invisible blue flame. Methanol is produced commercially by the catalyzed reaction of hydrogen and carbon monoxide. It was formerly derived from the destructive distillation of wood, which caused it to be known as wood alcohol.

Methyl Tertiary Butyl Ether (MTBE), ($(CH_3)_3COCH_3$): A colorless, flammable, liquid oxygenated hydrocarbon that contains 18.15 percent oxygen and has a boiling point of 55.2 degrees Celsius. It is a fuel oxygenate produced by reacting methanol with isobutylene.

Midwest Census Region: This region includes the following States: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

Mcf: Million cubic feet.

Motor Gasoline Blending of Oxygenates: Blending of gasoline and oxygenates under the Environmental Protection Agency's "Substantially Similar" Interpretive Rule (56 FR [February 11, 1991]).

Natural Gas: A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in the gaseous phase or in solution with crude oil in natural underground reservoirs at reservoir conditions. The primary constituent compound is CH_4. Gas coming from wells also can contain significant amounts of ethane, propane, butanes, and pentanes, and widely varying amounts of carbon dioxide and nitrogen. Pipeline-quality natural gas has had most, but not all natural gas liquids and other contaminants removed. On board a vehicle, it is stored under high pressure at 2,500 to 3,600 pounds per square inch (psi). A gallon of natural gas at 2,000 psi contains about 20,000 Btu; at 3,600 psi, a gallon contains about 30,000 Btu.

Neat Alcohol Fuels: Straight alcohol (not blended with gasoline) that may be either in the form of ethanol or methanol. Ethanol, as a neat alcohol fuel, does not need to be at 200 proof; therefore, it is often used at 180 to 190 proof (90 to 95 percent). Most methanol fuels are not strictly "neat," since 5 to 10 percent gasoline is usually blended in to improve its operational efficiency.

Nitrogen Oxides (NO_x): Air-polluting gases contained in automobile emissions, which are regulated by the

Environmental Protection Agency. They comprise colorless nitrous oxide (N_2O) (otherwise known as dinitrogen monoxide, or as the anaesthetic "laughing gas"), colorless nitric oxide (NO), and the reddish-brown-colored nitrogen dioxide (NO_2). Nitric oxide is very unstable, and on exposure to air it is readily converted to nitrogen dioxide, which has an irritating odor and is very poisonous. Nitrogen dioxide contributes to the brownish layer in the atmospheric pollution over some metropolitan areas. Other nitrogen oxides of less significance are nitrogen tetroxide (N_2O_4) and nitrogen pentoxide (N_2O_5). Nitrogen oxides are sometimes collectively referred to as "NO_x" where "x" represents any proportion of oxygen to nitrogen.

Nonattainment Area: A region that exceeds minimum acceptable National Ambient Air Quality Standards (NAAQS) for one or more criteria pollutants, in high population density areas, in accordance with the U.S. Census Bureau population statistics. Such regions (areas) are required to seek modifications to their State Implementation Plans, setting forth a reasonable timetable using means (approved by the Environmental Protection Agency) to achieve attainment of NAAQS by a certain date. Under the Clean Air Act, if a nonattainment area fails to attain NAAQS, the Environmental Protection Agency may superimpose a Federal Implementation Plan with stricter requirements or impose fines, construction bans, or cutoffs in Federal grant revenues until the area achieves applicable NAAQS.

Northeast Census Region: This region includes the following States: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Original Equipment Manufacturers (OEM's): Vehicle manufacturers that provide the original design and materials for assembly and manufacture of their product. They are directly responsible for manufacturing and modifying vehicles, making the vehicles commercially available, and providing a warranty for the finished product.

Oxygenated Fuel: Any fuel substance containing oxygen (includes oxygen-bearing compounds such as ethanol and methanol). Oxygenated fuel tends to give a more complete combustion of its carbon into carbon dioxide (rather than monoxide), thereby reducing air pollution from exhaust emissions.

Oxygenated Gasoline: Gasoline with an oxygen content of 1.8 percent or higher, by weight, that has been formulated for use in motor vehicles.

Ozone (O_3): An oxygen molecule with 3 oxygen atoms that occurs as a blue, harmful, pungent-smelling gas at room temperature. The stratospheric ozone layer, which is a concentration of ozone molecules located at 6 to 30 miles above sea level, is in a state of dynamic equilibrium. Ultraviolet radiation forms the ozone from oxygen, but can also reduce the ozone back to oxygen. The process absorbs most of the ultraviolet radiation from the sun, shielding life from the harmful effects of radiation. Tropospheric ozone is normally present at the ground level in low concentrations. In cities where high levels of air pollutants are present, the action of the sun's ultraviolet light can, through a complex series of reactions, produce a harmful concentration of ozone in the air. The resulting air pollution is known as photochemical smog. Certain air pollutants (e.g., chlorofluorocarbons) can drift up into the atmosphere and damage the balance between ozone production and destruction, resulting in a reduced concentration of ozone in the layer.

Ozone Precursor: A chemical compound (such as nitrogen oxides, methane, nonmethane hydrocarbons and hydroxyl radicals) that, in the presence of solar radiation, reacts with other chemical compounds to form ozone.

Petroleum: A generic term applied to oil and oil products in all forms (such as crude oil, lease condensate, unfinished oil, refined petroleum products, natural gas plant liquids, and finished petroleum products).

Propane (C_3H_8): A normally gaseous straight-chain hydrocarbon, it is a colorless paraffinic gas that boils at a temperature of -43.67 degrees Fahrenheit. It is extracted from natural gas or refinery gas streams.

Reformulated Gasoline (RFG): Gasoline whose composition has been changed (from that of gasolines sold in 1990) to 1) include oxygenates, 2) reduce the content of olefins and aromatics and volatile components, and 3) reduce the content of heavy hydrocarbons to meet performance specifications for ozone-forming tendency and for release of toxic substances (benzene, formaldehyde, acetaldehyde, 1,3-butadiene, and polycyclic organic matter) into the air from both evaporation and tailpipe emissions.

Replacement Fuel: The portion of any motor fuel that is methanol, ethanol, or other alcohols, natural gas, liquefied petroleum gases, hydrogen, coal derived liquid fuels, electricity (including electricity from solar energy), ethers, or any other fuel the Secretary of

Energy determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits.

South Census Region: This U.S. Census Bureau region consists of the following States: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Tax Incentives: In general, a means of employing the tax code to stimulate investment in or development of a socially desirable economic objective without the direct expenditure from the budget of a given unit of government. Such incentives can take the form of tax exemptions or credits.

Tertiary Amyl Methyl Ether (TAME) $(CH_3)_2(C_2H_5)$-$COCH_3$: An oxygenate blend stock formed by the catalytic etherification of isoamylene with methanol.

West Census Region: This U.S. Census Bureau region consists of the following States: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

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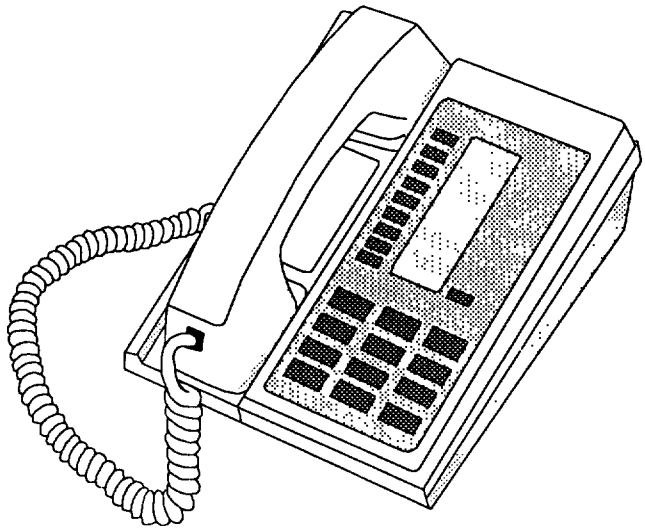

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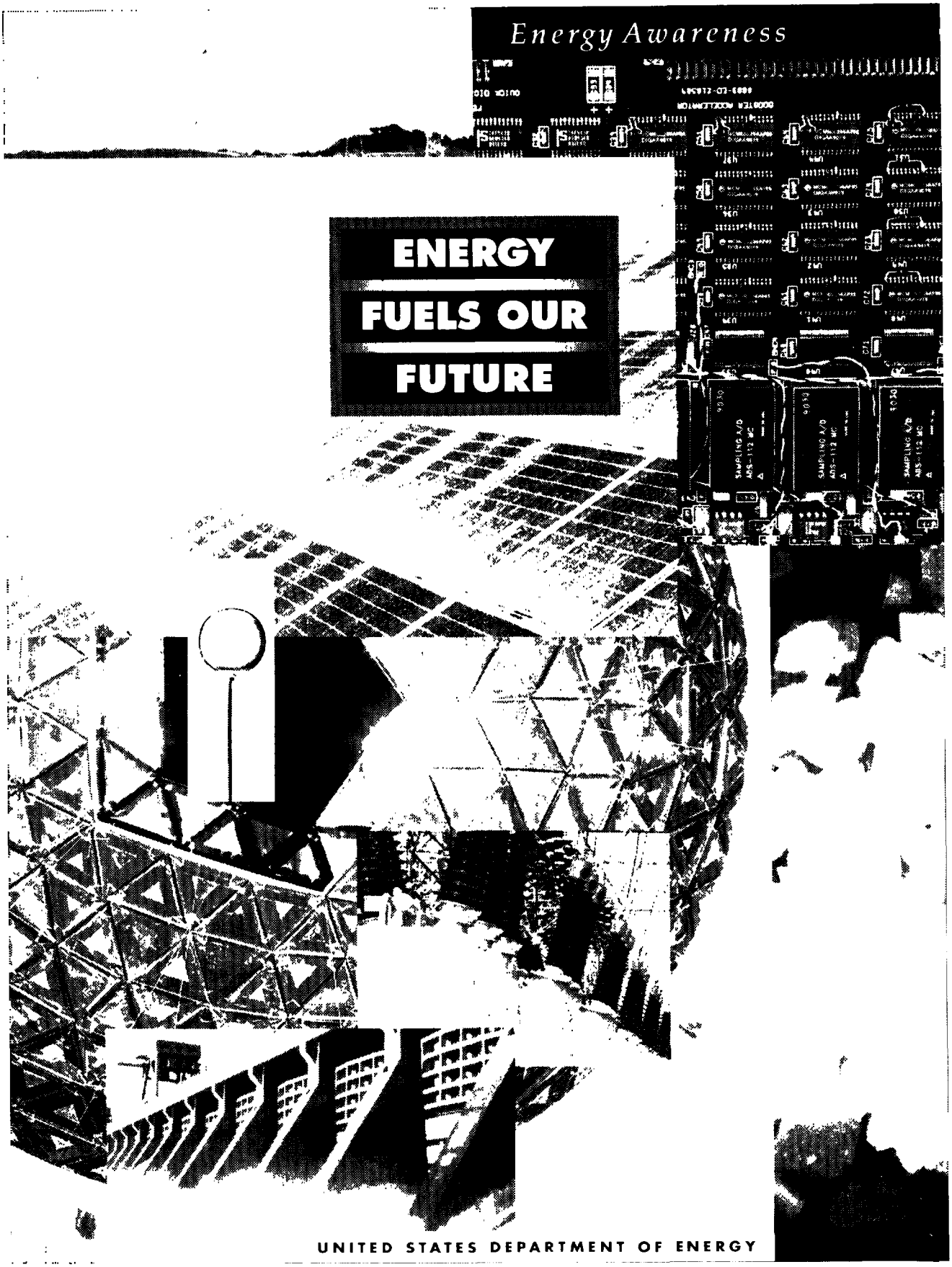

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