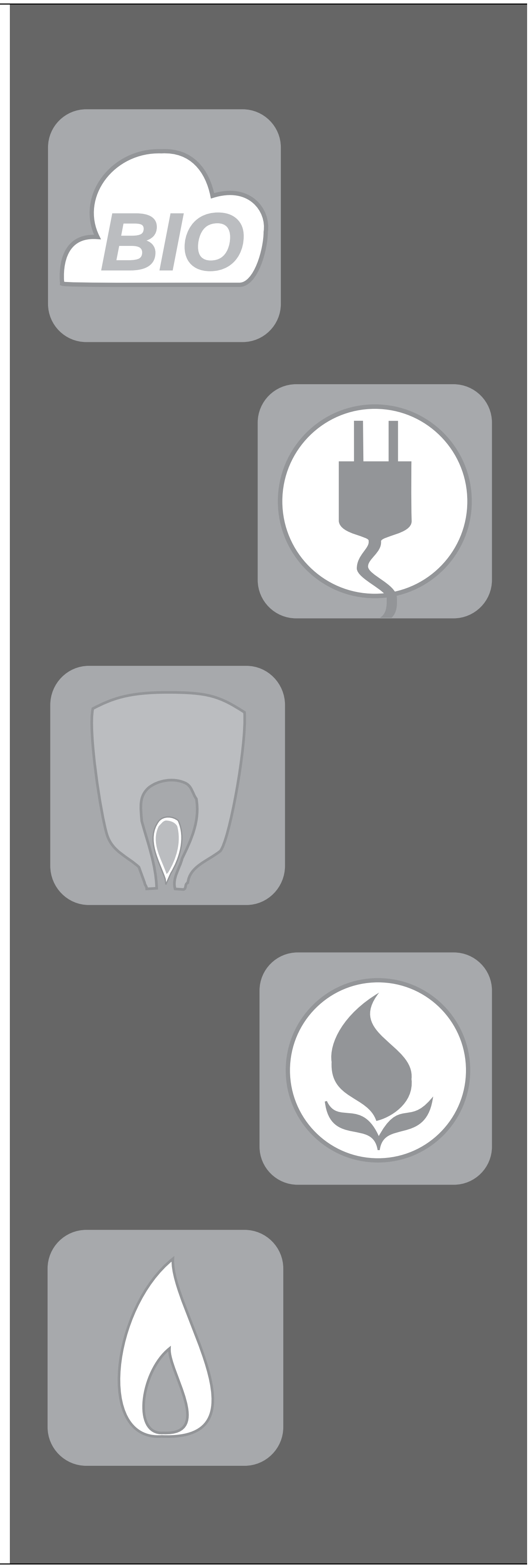
Nebraska Alternative Transportation Fuels Handbook



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Introduction

Alternative transportation fuels such as ethanol, methanol, propane, natural gas, biodiesel and electricity are being introduced in public and private sector fleets across the nation at an unprecedented rate. The motivation for expanding the use of alternative fuels varies, but three key goals appear to be providing the impetus — improving air quality; reducing dependence on imported oil, which is a primary source of energy in the transportation sector; and expanding the use of domestically available, cost competitive energy resources.

These goals are reflected in several major pieces of federal legislation and programs which promote, and in some cases require, the use of alternative fuel vehicles in certain fleets. In addition, many states have implemented aggressive alternative fuel vehicle programs, independent of federal action. Private sector companies are also encouraging the use of alternative fuels by incorporating alternative fuel vehicles into fleet operations and promoting expansion of the necessary refueling infrastructure. Cooperation among the various public and private sector stakeholders (e.g., regulators, auto manufacturers, fuel retailers and fleet administrators) must be achieved and their efforts coordinated if alternative fuel vehicles are to gain acceptance.

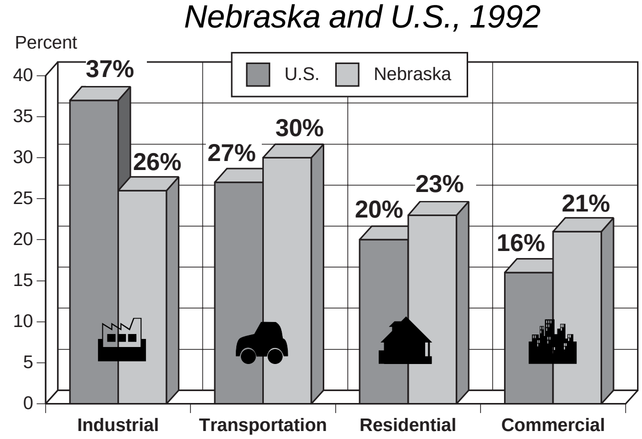
The purpose of this *Handbook* is to provide public and private fleet managers in Nebraska with basic yet comprehensive information concerning alternative fuels and vehicle technologies. Topics covered in this *Handbook* include an evaluation of the various alternative fuels, an overview of the legislative and regulatory framework supporting increased use of alternative fuels, sources of financial assistance for alternative fuel vehicle acquisitions, conversions and infrastructure development and barriers which may constrain efforts to promote widespread adoption of alternative fuel vehicles. To better assess the potential role and viability of alternative fuels in

Nebraska, it is necessary to examine transportation energy use trends in the state and their resulting impact on the economy and environment.

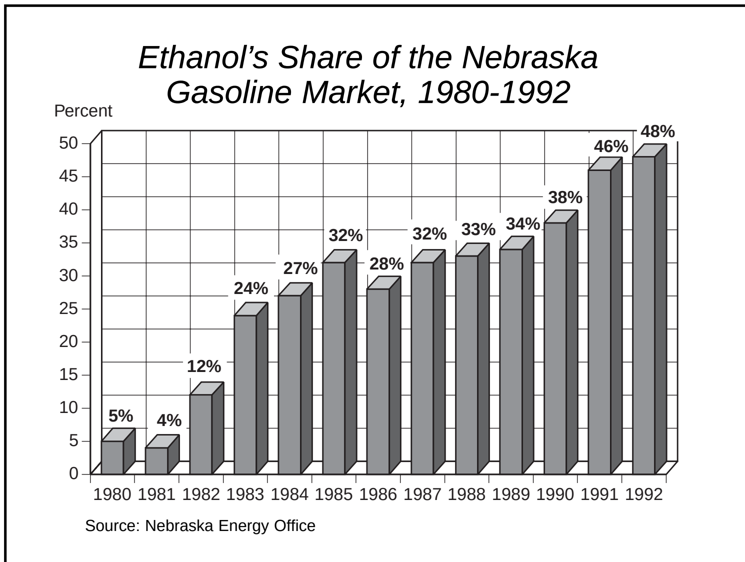
Despite a number of concerted efforts, the United States has not been able to effectively sever its traditional reliance on conventional fuels (gasoline and diesel) in the transportation sector. Transportation accounts for approximately two-thirds of total domestic oil consumption and currently uses more oil than the United States produces domestically. The United States Department of Energy projects continued growth in transportation energy demand between 1990 and 2010 at a rate of 1.3 percent per year. The Department also forecasts petroleum use in the transportation sector to continue to increase as well. Relative to gasoline and diesel fuel, the alternative transportation fuels market is small. According to Department of Energy estimates, alternative fuels accounted for only 0.14 percent of total transportation fuels consumed in 1992.

Since 1981, more energy has been consumed in the transportation sector in Nebraska than any other energy end use sector. In 1992, about a third of all energy consumption in the state was attributed to transportation, more than the national average of 27.3 percent. Consistent with national trends, nearly all the transportation energy consumed in Nebraska is derived from conventional fuels. In 1992, gasoline and diesel fuel combined for 91 percent of total transportation fuels consumption. Noteworthy, however, is ethanol's increasing use in the transportation sector. Almost one of every two gallons of gasoline sold

Energy Consumption by Sector, Nebraska and U.S., 1992

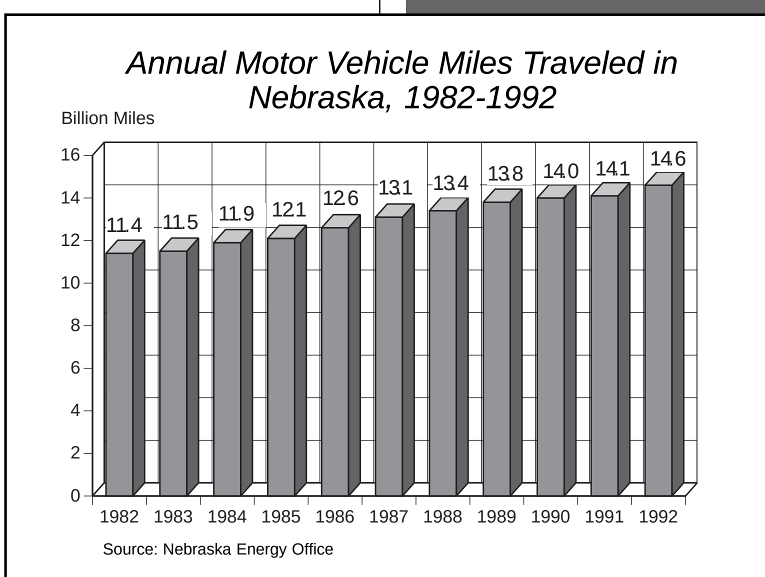


Source: Nebraska Energy Office



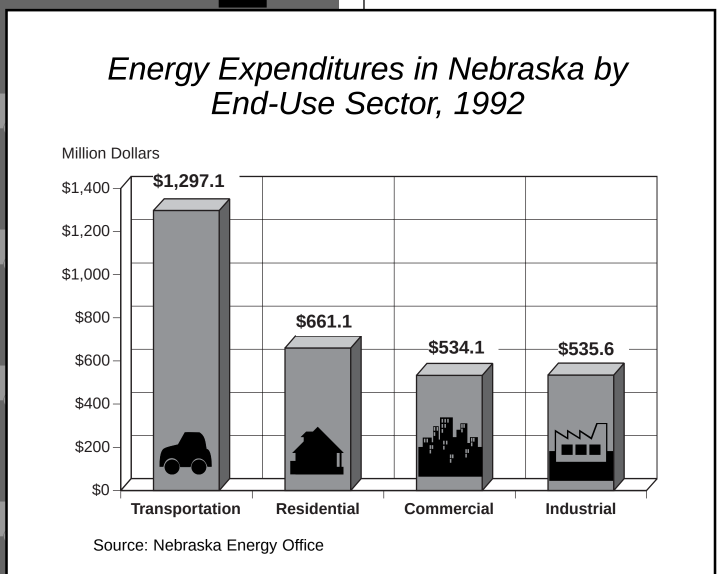
in Nebraska in 1992 contained 10 percent ethanol.[1] Increased use of nonpetroleum based, domestically available alternative transportation fuels can potentially reduce Nebraska's dependency on imported oil. Additionally, by diversifying its mix of transportation energy resources, the state economy will become more resilient to price fluctuations associated with international oil markets.

Nebraska's near total reliance on conventional fuels is exacerbated by growing vehicle use. Between 1982 and 1992, vehicle miles traveled in the state increased approximately 21 percent while the state population grew by only one percent[2]. The increase in vehicle miles traveled in Nebraska also outpaced the national average of 14.5 percent. One factor contributing to the rapid increase in vehicle miles traveled is the substantial growth in the vehicle population — approximately 215,000 new vehicles were registered in Nebraska between 1982 and 1992. This represents a 13.3 percent increase in motor vehicle registrations.



Nebraskans pay more than one billion dollars for energy used in transportation, almost twice the cost incurred by any other energy use sector. Transportation energy costs represent approximately 42 percent of total energy costs. Substantial fuel cost savings can be achieved with some types of alternative fuel vehicles. Additionally, local economies can benefit from expanding markets for domestically produced alternative fuels.

While Nebraska consumes significant quantities of transportation fuels, its production of fuels from indigenous resources is limited. With respect to alternative fuels production, Nebraska produces natural gas, ethanol and electricity. The state does not produce propane or biodiesel. However, Nebraska is a major producer of soybeans, the primary feedstock of soydiesel. Methanol is neither used nor produced in Nebraska.



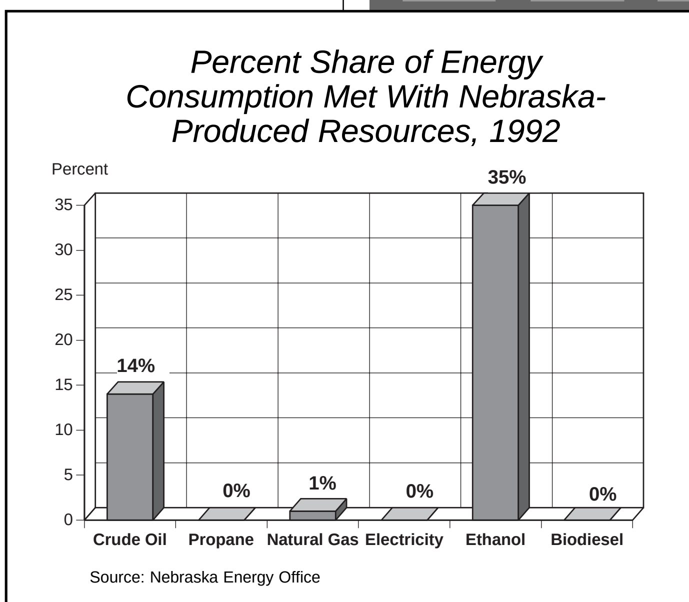
Energy Expenditures in Nebraska by End-Use Sector, 1992

Source: Nebraska Energy Office

Since 1960, natural gas production in the state has declined significantly, although an increase of 393 million cubic feet was reported in 1992. Of the total amount of natural gas consumed in 1992, only 1.1 percent was met with in-state supplies. The balance of the demand was supplied via pipeline from other states. Ethanol production in 1992 reached approximately 13 million gallons, or 35 percent of total in-state demand. While 65 percent of the ethanol consumed in Nebraska was imported from other states in 1992, in-state ethanol production increased in 1993 to the point where Nebraska became a net exporter. By 1996, Nebraska's ethanol productive capacity will have more than doubled, bringing total capacity to 280 million gallons of ethanol annually. Nebraska corn is expected to comprise 80 percent of the feedstock mix. In 1992, 22,390 gigawatt-hours (one billion watt-hours) of electricity were produced, a slight decrease from record 1991 levels. Coal accounted for

55.5 percent of generation, nuclear power - 29.1 percent, hydroelectric - 4.8 percent and natural gas and petroleum - 0.7 percent. It is important to note that while Nebraska is a net exporter of electricity, the coal and raw nuclear material used in Nebraska power plants are imported.

In 1992, crude oil production in Nebraska fell to 5,474,188 barrels — its lowest level since 1960. This represented only 13.9 percent of the total petroleum consumed in the state. Crude oil is not refined in Nebraska.



Emissions produced from gasoline and diesel fueled vehicles pose a threat to human health and the environment. In an effort to combat the nation's persistent air pollution problems, the U.S. Environmental Protection Agency established national ambient health standards for a number of pollutants, many of which are produced by vehicles. The six pollutants with National Ambient Air Quality Standards are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (smaller than ten microns) and sulfur dioxide. Regions of the country failing to meet these standards are required to implement clean air programs designed to bring the affected regions into compliance with the standards. The cost to individuals and businesses in nonattainment areas for implementation of clean air programs can be significant.[3] Alternative fuels can reduce emissions which contribute to air pollution. By introducing alternative fuel vehicles with low emissions into communities with pollution problems, the harmful effects of air pollution can be mitigated.

Likewise, by introducing such vehicles into "clean" cities, future air pollution problems can be preempted.

The remainder of this *Handbook* is divided into four parts. A Survey of Alternative Transportation Fuels evaluates the various alternative fuels based on an analytic framework which includes such factors as life cycle costs, fuel cycle emissions and consumer acceptance. The chapter on Alternative Fueled Vehicle Policy Initiatives summarizes key federal and state policy initiatives and legislation promoting increased use of alternative fuels. This chapter also updates the status of the regulatory framework implementing the alternative fuel provisions contained in the *Energy Policy Act* of 1992 and the *Clean Air Act Amendments* of 1990. The chapter on Financial Incentives for Vehicle Conversions and Infrastructure Development identifies sources of financial assistance available to prospective owners of alternative fuel vehicles and fueling station developers. Lastly, the chapter on Barriers to the Use of Alternative Fuels in Nebraska identifies barriers which may impede efforts to accelerate the introduction of alternative fuel vehicles in fleets in Nebraska.

END NOTES

1 The remaining share of total transportation fuels consumed in Nebraska (nine percent) was met with other petroleum derived fuels (e.g., aviation fuel and residual fuel) and alternative fuels such as propane, natural gas and near neat ethanol blends. Insufficient data exists to permit an accurate reporting of the percent contribution of each of the alternative fuels in the state's transportation sector. However, as the Department of Energy's Energy Information Administration broadens its data collection responsibilities to include alternative fuels under the *Energy Policy Act* of 1992, the reporting of alternative fuel consumption is expected to become more detailed and reliable.

2 Annual vehicle miles travelled in Nebraska is calculated by the Department of Roads based on traffic-count data rather than fuel tax receipts.

3 Nebraska is fortunate in that it has only one nonattainment area in the state — Omaha is in nonattainment for lead. The lead pollution in Omaha is not attributed to mobile sources (e.g., vehicle emissions); rather, it is produced by a lead smelting facility.

A Survey of Alternative Transportation Fuels

Various alternative transportation fuels, vehicles and refueling technologies are in use today. Other alternative fuels and technologies are currently in the developmental stage. Each fuel possesses its own unique set of chemical characteristics and economic attributes which may or may not yield net benefits to a fleet operator. For example, while one fleet operator may find a particular alternative fuel well suited for a specific fleet task, such as short distance delivery routes, another fleet operator may find that fuel ill suited for a different type of fleet task (e.g., mass transit) and elect to use a different fuel. It is therefore difficult to conclusively state that one particular fuel is superior or inferior to another. Likewise, it is difficult to rank fuels based on their overall strengths and weaknesses. Additionally, as alternative fuels and vehicle research and development progress, the relative performance and consumer appeal of the various transportation fuels may change.

Given the current state of alternative fuel vehicle development, this section surveys the major alternative fuels in use today and the alternative vehicle technologies expected to be commercially available in the near term.[4] The fuels and vehicle technologies addressed in this section are ethanol, methanol, biodiesel, propane, natural gas, electric vehicles and hybrid vehicles. This chapter is divided into two parts. The first part defines each of the criteria constituting the analytic framework for evaluating the alternative fuels. The second part profiles each of the alternative fuels based on the criteria.

Criteria Description

Each of the alternative fuels is evaluated according to its economics, emissions characteristics, fuel availability, fuel accessibility and consumer acceptance.

Economics

To adequately assess the economic benefits and costs which may accrue through the use of a particular alternative fuel, it is necessary to examine the life cycle costs of the vehicle powered by that fuel. Life cycle costs of alternative fueled vehicles include quantifiable costs incurred beginning with the initial purchase and lasting through the operating life of the vehicle. These costs include fuel costs, purchase or conversion costs, operating costs and resale value. In this assessment of the economics of the fuels, a broad spectrum of life cycle costs will be employed. In particular, the following economic factors will be addressed:

Fuel costs

- Current fuel prices (using Nebraska specific data where possible)
- Future fuel prices (using national forecasts)
- Reliability of supplies (e.g., dependence on domestic or foreign sources)
- Price volatility
- Overview of federal and state tax treatment

Vehicle purchase/conversion costs:

- Conversion costs
- Original equipment manufacturer costs

Vehicle operating costs:

- Vehicle maintenance
- Engine durability

Vehicle resale value.

In some cases, uncertainties with respect to the evolution of vehicle and fuel production technologies limit analysis of the economics of the various alternative fuels. It is also important to note that this analysis does not take into account other types of costs, such as greenhouse gas emissions and emissions of criteria pollutants below regulatory standards, which are excluded from the market price calculation of alternative fuels. These environmental externalities are addressed in the following section.

Emissions Characteristics

One of the claimed benefits of alternative fuels use is their potential to reduce emissions of harmful air pollutants. The type, source and extent of vehicle emissions attributed to the use of alternative fuels, however, is not uniform. Each alternative fuel possesses its own unique set of emission characteristics derived in large part from the fuel's chemical characteristics and the propulsion technology used. For example, not all alternative fuel vehicles produce tailpipe emissions. Vehicles powered by internal combustion engines directly emit air pollutants. Electric vehicles, on the other hand, do not directly produce emissions. Emissions associated with them can be traced to a stationary source — the power plants generating the electricity required by electric vehicles. Note, however, that the production of other alternative fuels also involves emissions.

When examining emissions it is important to note that while today's new gasoline vehicles are about ten times less polluting than models produced 25 years ago, further emission reductions are expected to be achieved with conventionally fueled vehicles. For example, the California Air Resources Board expects its stringent Low-Emission Vehicle regulations to lead to reduction of ozone precursors by 50 to 75 percent compared to current model year vehicles.[5] Already, a number of conventionally fueled vehicles have been certified to the Low-Emission Vehicle standards. As a result of improvements in vehicle emissions control technologies and the required use of reformulated gasoline in ozone and carbon monoxide nonattainment areas, conventionally fueled vehicles will be able to compete from an emissions standpoint with alternative fuels in the clean fuels market.[6]

In an attempt to distinguish the various alternative fuels and conventional fuels in terms of their emissions characteristics, this section assesses each fuel's capacity to reduce emissions of the following air pollutants:

Carbon Monoxide

Carbon monoxide is a colorless, odorless gas. The pollutant is 200 times more attractive to blood hemoglobin than is oxygen and impairs the ability of blood to carry oxygen throughout the body. Carbon monoxide can cause reduced mental and physical performance, induce headaches and cause dizziness at concentrations of nine to 35 parts per million. The concentration of carbon monoxide in ambient air is regulated under National Ambient Air Quality Standards established by the U.S. Environmental Protection Agency.

Nonmethane Organic Gases

Nonmethane organic gases include such gases as aldehydes, formaldehyde and reactive hydrocarbons which play a prominent role in ground level ozone (smog) formation. (See discussion of nitrogen oxides below.)

Nitrogen Oxides

Nitrogen oxides form when oxygen and nitrogen react as engine temperatures increase during fuel combustion. Nitrogen oxides, particularly nitrogen dioxide, are critical to ground level ozone formation. With energy from the sun (ultraviolet radiation) serving as a catalyst, an oxygen atom may detach from a molecule of nitrogen dioxide and unite with a molecule of oxygen. When this occurs, ozone is formed. Nonmethane organic gases enhance the conversion of nitric oxide to nitrogen dioxide, the principal source of the oxygen atom required in the formation of ozone. Heat accelerates ozone formation; therefore, peak ozone levels typically occur during summer months. Ozone irritates the nose, throat and lungs and can also be damaging to plants and crops. In addition to these effects, ozone obscures visibility and contributes to brown cloud formation. National Ambient Air Quality Standards have been established for both nitrogen dioxide and ozone.

PM-10

PM-10 is the term used for small particulates of ten microns or less in diameter which are suspended in air. In sufficient quantities, PM-10 can form unsightly "brown clouds" which dramatically reduce visibility levels. PM-10 can reach the lower pathways of the lungs and aggravate preexisting respiratory ailments such as asthma, bronchitis and emphysema. PM-10 is a regulated pollutant for which National Ambient Air Quality Standards have been established.

Greenhouse Gases

Carbon dioxide and methane are the primary gases contributing to global climate change. These gases are produced at each stage of fuel production, distribution and use.

Carbon Dioxide — Although carbon dioxide's chemical impact on the global climate system is only partially understood, it is classified as a major greenhouse gas due to its capacity to absorb infrared radiation. At this time, there are no emissions standards for carbon dioxide. The federal government, however, is taking steps to reduce carbon dioxide emissions and will study the contribution of transportation to carbon dioxide emissions.

Methane — After carbon dioxide, methane is considered by some experts to be the next largest contributor to global warming. On a molecule per molecule basis, methane is 20 to 25 times more effective than carbon dioxide in trapping heat, although its duration in the atmosphere is much shorter than carbon dioxide's. When methane is removed from the atmosphere via chemical reaction with hydroxyl radicals, it forms two other gases, carbon dioxide and water vapor. Methane is not a regulated pollutant for which National Ambient Air Quality Standards have been established.

Fuel Availability

This fuel evaluation criterion will note whether the fuel is available in Nebraska or, if not, how difficult it would be to make the fuel available.

Fuel Accessibility

Given that a fuel is available in Nebraska, this criterion then determines the extent to which it is accessible at public and/or private fueling stations. The potential for an alternative fuel to capture a greater share of the transportation fuels market is partially dependent on the accessibility of that fuel. If the fueling infrastructure for a particular fuel is inadequate to meet the needs of public and private fleet operators, there is likely to be less incentive to incorporate vehicles powered by that fuel into fleet operations.

Consumer Acceptance

This last criterion focuses on basic noncost operational factors linked to consumer acceptance of an alternative fuel vehicle. Such factors include driving comfort and refueling convenience. The more an alternative fuel vehicle resembles a conventionally fueled vehicle in terms of its operational requirements (e.g., refueling) and performance capabilities, the broader its consumer acceptance will be. This section assesses each alternative fuel's potential to gain broad consumer acceptance by addressing the following:

- Vehicle range between refuelings
- Refueling time
- Refueling procedures
- Fuel tank size and weight/impact on fuel efficiency
- Number of fuel tanks needed on-board vehicle/cargo space
- Safety concerns

Ethanol

Ethanol is a clear liquid alcohol fuel suitable for use in light-duty and heavy-duty vehicles in various concentrations. Ethanol's primary application is in gasohol (E10 — a blend containing 10 percent ethanol and 90 percent unleaded gasoline by volume) and in blends lower than E10 to meet oxygenated gasoline requirements. Gasoline containing up to 10 percent ethanol can be used in any spark ignited, gasoline powered vehicle without modification to fuel system or fuel storage components. E85, a blend containing 85 percent ethanol and 15 percent gasoline by volume, can be used in flexible fuel vehicles (passenger cars designed to run on any ratio of E85 and unleaded gasoline). Ethanol can also be used in a fuel mixture made up of 95 percent ethanol and 5 percent denaturant (E95). E95 fuel is used principally in dedicated heavy-duty vehicles and buses. Dedicated vehicles are designed to operate solely on one alternative fuel. All ethanol fuels must contain 2 to 5 percent denaturant to avoid taxation as an alcohol beverage. In light of the denaturant requirement, E100 (straight ethanol) is not considered an alternative transportation fuel.

Economics

Fuel Costs

Because E85 and E95 are not available at commercial fueling stations in Nebraska, it is not possible to report the retail pump price for these blends. The State of Nebraska does, however, operate several E85 fueling facilities to support the E85 vehicles operating in the state fleet. It costs the state approximately $1.37 per gallon of E85 to fill its fuel storage tanks.[7] This price reflects the cost of ethanol, the cost of blending ethanol with gasoline, distribution costs, blender markup and state tax. It is important to note that the amount paid by the state for E85 excludes the federal motor vehicle fuel tax as public fleets are exempt from federal taxation. For privately owned vehicles, the federal excise tax on E85 is 13 cents per gallon — ethanol blends receive a 5.4 cents exemption from taxation. The price the state pays for E85 also does not include the benefit of a 54 cents per gallon ethanol tax credit available to ethanol blenders as state agencies are not permitted to simultaneously receive the benefit of federal fuel excise tax exemptions and fuel tax credits.[8] The value of the ethanol tax credit is intended to be passed on to end users. Private fleets in Nebraska are eligible to receive the benefit of the ethanol tax credit; therefore, it can be assumed that the retail price for E85 in Nebraska would not exceed that which the state currently pays. The state taxes all blends of ethanol fuel at 23.9 cents per gallon.[9]

E85 fuel has about 71 percent of the energy content of gasoline on a volumetric basis.[10] On a gas equivalent basis, the price for E85 in Nebraska (including federal taxes) would be approximately $2.12 per gallon.[11] Ethanol's reduced energy content compared to gasoline is partially offset by other factors (see section on consumer acceptance for additional information on fuel economy).

A 10 percent ethanol blend in Nebraska currently retails for approximately $1.185 per gallon. The tax on E10 includes the 23.9 cents per gallon state excise tax and the 13 cents per gallon federal excise tax. Regular unleaded gasoline costs about $1.176 at the pump.[12]

During the past 15 years, supply and demand for ethanol has been in relative equilibrium.[13] Ethanol production in the U.S. is projected to nearly double within the next two to three years from its present level of 1.3 billion gallons a year to 2.5 billion gallons a year as a result of its use in the Reformulated Gasoline Program.[14] The National Renewable Energy Laboratory forecasts that in 2000 it will cost $1.00 (in 1990 dollars) to produce a gallon of ethanol, assuming a national productive capacity of two billion gallons. The laboratory further projects that by 2005, ethanol production will reach three billion gallons — 1.5 billion produced from corn and 1.5 billion made from lignocellulosic waste (e.g., municipal solid waste, waste paper and wood waste) — and the cost of producing a gallon of ethanol will drop to $0.80 (in 1990 dollars).[15] The U.S. Department of Agriculture estimates that as the ethanol industry adopts innovative corn-to-ethanol production technologies and as biomass derived ethanol innovations come on line, production costs will decline and the industry will be able to compete more effectively with other transportation fuels.[16]

Fueling station development costs for a 10,000 to 12,000 gallon capacity, key-card operated E85 facility range between $65,000 and $85,000.[17] However, the National Ethanol Vehicle Coalition has been able to install E85 fueling pumps at existing filling stations for $40,000. This cost estimate covers both equipment (underground storage tank, pump and key card system) and installation costs. It costs only about $5,000 to install a 1,000 gallon above ground storage tank and pump and less than $5,000 to convert an existing gasoline storage tank and pump to ethanol use.[18]

Vehicle Costs

After market conversion kits are not commercially available to modify a conventionally fueled vehicle to ethanol use; ethanol vehicles are available only from original equipment manufacturers. In model year 1995, Ford will produce a limited number of flexible fueled E85 Tauruses for testing and demonstration by selected fleets. Ford expects to produce commercially available flexible fueled Tauruses in model year 1996. The incremental cost of these vehicles is projected to be approximately several hundred dollars. Chrysler and General Motors are reviewing their respective ethanol vehicle programs and will not be selling ethanol powered vehicles to the public in model year 1995.

An ethanol powered transit bus costs between $20,000 and $40,000 more than the cost of an equivalent diesel bus. The incremental cost for ethanol buses will vary within this cost range depending on the number and type of fuel tanks installed in the buses.

Vehicle Operating Costs

Flexible fuel vehicles are designed to maintain the same types of operations and maintenance procedures characteristic of gasoline vehicles. The actual cost of operating ethanol powered vehicles (excluding fuel costs) is not well documented and hence difficult to determine, due in large part to the limited numbers of these vehicles in fleets nationwide. According to the State of Illinois, which operates one of the largest fleets of ethanol vehicles in the U.S. — 67 E85 light-duty vehicles and 14 E95 transit buses — the only significant difference in operating and maintenance costs between ethanol and gasoline powered vehicles is the cost of motor oil. The special motor oil required by alcohol fueled vehicles costs about three times more than that for conventionally fueled vehicles. The State of Illinois reports that its ethanol vehicle fleet has not required any additional service compared to equivalent conventionally fueled vehicles.[19]

Vehicle Resale

Insufficient data exist to permit a reliable assessment of the resale value of ethanol vehicles. Nevertheless, anecdotal evidence from the State of Illinois may prove instructive. Illinois expects their ethanol fleet vehicles to have the same resale value as equivalent conventionally fueled vehicles as both vehicle types share similar operation and maintenance procedures and have exhibited consistent engine wear patterns.

Emissions

Emissions data on near neat blends of ethanol are limited due to the small number of E85 and E95 vehicles in use today compared to other alternative fuel vehicles. The following review of the emissions performance of ethanol vehicles should therefore not be considered definitive.

Criteria Pollutants

Emissions of carbon monoxide and nitrogen oxides from flexible fueled E85 vehicles are about equal to those produced from equivalent gasoline powered vehicles. However, according to the EPA, formation of nitrogen oxides during combustion may be reduced due to ethanol's lower combustion temperature.[20] Emissions of PM-10 from E85 and E95 vehicles are slightly reduced as are emissions of highly reactive ozone forming hydrocarbons.[21] Aldehyde emissions may pose a concern.

A recent study which modeled the emissions characteristics of E95 and reformulated gasoline on a fuel cycle basis (from production to consumption) in 2010, concluded that E95 will outperform reformulated gasoline with respect to carbon dioxide, sulfur dioxide and volatile organic compounds.[22]

Greenhouse Gas Emissions

In 1993, disagreement pervaded the debate concerning ethanol's contribution to greenhouse gas emissions. While some studies pointed to increased net releases from ethanol, others said emissions are reduced compared to gasoline. There did seem to be general agreement that ethanol use will not result in increased tailpipe emissions of methane and carbon dioxide relative to gasoline. The controversy was focused principally on the issue of emissions resulting from the production of ethanol. Some researchers estimated that the use of ethanol made from corn will result in net increases of greenhouse gases during two phases of the corn-to-ethanol production cycle: the use of fertilizers to grow corn and the burning of coal at the ethanol production facility.[23] According to DOE, increased carbon dioxide emissions stemming from ethanol production will not accumulate in the atmosphere. Instead, it will be recycled and utilized as a nutrient by ethanol producing crops. This closed carbon dioxide cycle is expected to result in a neutral carbon dioxide balance.[24] Although there appears to be consensus that carbon dioxide emissions will be recaptured by biomass crops, uncertainty exists as to whether nitrous oxide releases associated with fertilizer use will result in a net increase in greenhouse gas emissions relative to gasoline use. The Congressional Research Service reports that "as this issue gets more attention, it appears that the consensus is toward equivalency with gasoline within a range of 10 percent or so either way...."[25]

By 1995, more conclusive studies indicated that ethanol use resulted in decreased levels of greenhouse gas emissions.

The Availability and Accessibility of Ethanol for Vehicles

Nebraska produces enough ethanol from its three existing plants to satisfy in-state demand. Approximately 80 percent of the ethanol produced in Nebraska is made by fermenting sugars derived from starch in corn. The remainder is produced mostly from grain sorghum. By 1996, six ethanol production facilities with a total production capacity estimated at 280 million gallons per year will be operating. About 80 percent of the new ethanol production is expected to come from Nebraska corn.

E10 is available at over 700 commercial fueling stations across Nebraska. E85 is available at three fueling facilities operated by the state — two in Lincoln and one in Grand Island. Two state operated fueling stations serve E95 vehicles — one in Lincoln and one in Grand Island. The E85 and E95 fueling stations are limited to use by state fleet vehicles only; the public cannot access these pumps. At this time, there are no public access E85 or E95 fueling stations in Nebraska.

Consumer Acceptance

E85 has about 71 percent of the energy content of gasoline on both a mass and volume basis. The resulting loss in fuel economy (as measured in miles per gallon) is partially offset by ethanol's higher octane rating which allows it to achieve greater power density and fuel efficiency than gasoline.[26] To compensate for ethanol's reduced fuel economy, ethanol vehicles require larger fuel tanks than conventionally fueled vehicles. For example, Ford's model year 1995 flexible fueled E85 Taurus (test vehicle) has a 20.4 gallon fuel tank instead of the standard 16 gallon gasoline fuel tank. With this larger fuel tank, Ford claims that its E85 fueled Taurus can travel the same distance as its gasoline equivalent. Thus, to travel the same distance, the E85 Taurus will require approximately 27 percent more fuel than the gasoline fueled Taurus. Even if prices for E85 and gasoline were equal in Nebraska, operators of the E85 Taurus should expect to incur greater fuel costs compared to gasoline as a result of ethanol's lower Btu content.

Flexible fuel vehicles are designed to be refueled in the same manner as conventionally fueled vehicles. Ethanol dispensing equipment is essentially the same as gasoline pumps and refueling time is essentially the same as well. Operators of E85 and E95 vehicles will, therefore, not have to learn how to operate any special refueling equipment or spend additional time refueling their vehicle.

With respect to safety, the primary concern is whether ethanol is more likely than gasoline to ignite under accident conditions. Compared to gasoline, ethanol fuel has a higher flammability limit, a higher autoignition temperature and lower volatility. As a consequence of these chemical characteristics, ethanol is less likely than gasoline to ignite in an open air environment following a fuel spill.[27] If ethanol does ignite, its low heat of combustion and high heat of vaporization will cause it to burn cooler and slower than gasoline fires. A second safety issue concerning ethanol fires is its low luminosity. E95 burns with a faint blue flame which may be difficult to see in open sunlight. E85 burns with a much more luminous flame due to its increased gasoline component compared to E95.

Methanol

Methanol is a colorless liquid alcohol fuel made mostly from natural gas. Methanol can also be produced from coal and biomass feedstocks, but these production processes currently cannot compete economically with natural gas derived methanol. In the transportation sector, methanol is used primarily as a component of methyl tertiary butyl ether (MTBE), an oxygenate in reformulated gasoline. It is also used on a more limited basis in the form of M85 (a fuel mixture of 85 percent methanol and 15 percent gasoline by volume) and M100 (100 percent methanol).[28] M85 fuel is used mostly in light-duty, flexible fueled vehicles, whereas M100 is used principally in heavy-duty vehicles (e.g., transit buses).[29] The Department of Energy estimates that roughly 3,200 vehicles running on M85 and M100 were in service in 1992, mostly in the State of California. The Department estimates that by 1995, approximately 10,000 methanol fueled vehicles will be in operation in the United States, with M85 constituting a dominant share of the methanol vehicle population.[30]

Economics

Fuel Costs

M85 and M100 are not sold in Nebraska, nor do any methanol fueled vehicles operate in the state. Although it is not possible to report pump prices of M85 or M100 in the state, examining the cost of methanol in California (the state with the largest fleet of methanol vehicles and subsequently the largest market for methanol fuel) illustrates the economics of the fuel relative to gasoline.

M85 in California currently retails for approximately 92 cents per gallon.[31] The price for M85 includes a market development price,[32] a state tax of nine cents per gallon,[33] a federal tax of 11.4 cents per gallon, distribution costs and dealer margins. M100 is not available at retail outlets in California. However, it is purchased by state and municipal transit agencies. The Los Angeles County Metropolitan Transit Authority, which operates 333 M100 transit buses pays 55 cents per gallon for neat methanol. Unleaded gasoline in California retails for approximately $1.19 per gallon.[34]

M85 fuel has about 57 percent of the energy content of gasoline on a volumetric basis.[35] On a gasoline equivalent basis, the price for M85 in California would be approximately $1.61 per gallon.[36] M100 on a gasoline equivalent basis would cost slightly more. (See section on consumer acceptance for additional information on methanol fuel economy).

The methanol fuel market has been characterized by its historic price volatility. However, since mid-1992, the market has experienced a consistent upward swing in prices due to increasing demand for MTBE. The spot price for barge delivered Gulf Coast methanol in July 1992, was 30 cents per gallon. During the same period in 1994, the reported spot price was about $1.21 per gallon.[37] The California Energy Commission forecasts instability in the near term price and supply of methanol fuel. According to the Commission, the current "demand for methanol as an MTBE feedstock is exacerbating an already tight supply situation and is threatening to raise methanol prices...."[38] The Commission projects that the growing demand for MTBE in reformulated gasoline will exceed methanol supply by the mid-1990s. The Commission also reports that capital investments needed to expand production capacity are not keeping pace with growing demand and that a worldwide methanol shortage may occur in the near future. Based on its observation of past industry behavior, the Commission expects the methanol industry to respond to shortages by increasing production in response to the higher prices induced by the shortages. Currently, most methanol used in vehicles in the United States is produced in Canada and Texas. However, the nation may need to look to foreign sources of methanol to augment limited North American supplies. One report projecting the future cost of methanol indicates that the price for a gallon of M85 will be lower than a gallon of gasoline by the year 2010. This price forecast is contingent on the methanol industry making necessary investments to expand production.[39]

Capital costs of methanol fueling system equipment to be installed at an existing gasoline station range from $35,000 to $45,000. Installation of the equipment costs an additional $35,000 to $45,000.[40] Installation and equipment costs for a large fleet (60 to 100 vehicles) or retail station methanol fueling system containing a 10,000 gallon underground storage tank and a blending dispenser are reported to be between $60,000 and $150,000. The cost for an above ground 1,000 gallon tank and methanol tolerant dispensing pump is estimated at $40,000.[41]

Vehicle Costs

After market conversion kits are not available to modify conventionally fueled vehicles to methanol use; methanol vehicles are available only from original equipment manufacturers. Ford and Chrysler will both be offering light-duty methanol fueled vehicles in model year 1995. See the table below for a listing of the methanol fueled vehicles to be available in model year 1995 and their incremental costs as reported by the auto manufacturers.

Domestically Produced
Model Year 1995
Methanol Fueled Vehicles (Light-Duty)

Manufacturer	Model	Fuel System	Incremental Cost
Ford	Taurus	Flexible fuel — M85	Several hundred dollars
Chrysler	Dodge Intrepid	Flexible fuel — M85	None
Chrysler	Eagle Vision	Flexible fuel — M85	None
Chrysler	Concord	Flexible fuel — M85	None

Heavy-duty methanol fueled transit buses cost approximately $20,000 to $40,000 more than equivalent diesel fueled buses.[42] The wide incremental cost range is attributed to the type of methanol engine used and the number and type of fuel storage tanks installed. The cost of a heavy duty, compression ignition methanol engine alone is estimated to be between two and two and a half times the cost of an equivalent diesel engine. As production volumes increase, however, the incremental cost for methanol engines may drop to $2,000 to $3,000 above current diesel engine costs.[43]

Vehicle Operating Costs

Flexible fuel vehicle operation and maintenance procedures are essentially the same as for gasoline vehicles. California's extensive fleet experience with methanol vehicles indicates, however, that light-duty methanol vehicles require more frequent oil changes than conventional vehicles. In addition, methanol fueled vehicles require a special lubricant which costs more than conventional engine oil. The reduced oil change interval coupled with the higher cost of the special motor oil for methanol vehicles constitutes the one area where operation and maintenance costs are higher compared to equivalent gasoline vehicles.[44]

Vehicle Resale

The used vehicle market in California reveals that in general, gasoline vehicles have no resale value advantage over methanol vehicles. In fact, some methanol vehicles, which were originally purchased with no incremental cost, were later resold at higher prices compared to their gasoline equivalents.[45]

Emissions

Criteria Pollutants

The greatest emissions benefit achieved with methanol is a significant reduction in ozone forming hydrocarbons relative to gasoline. It is important to note that while tailpipe emissions of nonmethane organic gases have been reported to increase slightly in flexible fuel vehicles, emissions of photochemically reactive (ozone forming) hydrocarbons are reduced compared to gasoline. Reduced reactive hydrocarbon emissions from M85 flexible fuel vehicles result in lower tailpipe emissions of ozone per mile compared to equivalent gasoline vehicles.[46] This was determined by examining the reactivity of chemical species found in the mix of nonmethane organic compounds from both gasoline and methanol tailpipe emissions. Additionally, due to methanol's low volatility, evaporative emissions of ozone forming pollutants are reduced.

Tests performed on flexible fuel methanol vehicles indicate that emissions of carbon monoxide and nitrogen oxides are about the same as equivalent gasoline vehicles, although slight reductions have been achieved on some vehicles.[47] Theoretically, methanol's low flame temperature should result in reduced production of nitrogen oxides during combustion. Methanol engines produce somewhat higher levels of formaldehyde, but these emissions can be controlled with a catalytic converter. Ford's model year 1995 flexible fuel M85 Taurus has been certified to California's Transitional Low Emission Vehicle standard with documented emissions of 0.091 grams of nonmethane organic gases per mile, 1.4 grams of carbon dioxide per mile and 0.1 grams of nitrogen oxides per mile.

The emissions benefits attributed to methanol in light-duty vehicles are expected to be greater with dedicated methanol vehicles as their engines are optimally calibrated to burn only one fuel. In dedicated methanol fueled transit buses using the Detroit Diesel 6V-92TA (the most widely used methanol engine in transit buses), emissions of reactive hydrocarbons, carbon monoxide, nitrogen oxides and particulate matter are reduced compared to equivalent diesel buses.[48]

Greenhouse Gas Emissions

Two major reports assessing greenhouse gas production from various transportation fuels on a fuel cycle basis — one by Argonne National Laboratory, the other by the California Energy Commission — indicate that neat methanol derived from natural gas[49] yields slight net reductions compared to gasoline and increased emissions compared to diesel.[50] According to the Argonne report, M100 used in both light and heavy-duty vehicles results in reduced vehicular emissions[51] of greenhouse gases compared to gasoline and diesel fuel, but the benefit is not the same for both vehicle classes. Vehicular emissions of greenhouse gases from methanol fueled light-duty vehicles are reduced significantly compared to gasoline equivalent vehicles. In heavy-duty vehicles, the reduction is minor due to diesel's lower carbon/Btu content compared to gasoline and because methanol does not enjoy a thermal efficiency advantage over diesel.[52] Carbon dioxide accounts for a dominant share of the greenhouse gas emissions released during combustion of M100.

Greenhouse gas emissions released during the fuel and vehicle production and distribution (upstream) process are estimated to be greater for methanol than conventional fuels. Argonne attributes this to the energy intensive nature of methanol from natural gas production. As with methanol fuel combustion, carbon dioxide is the principal greenhouse gas produced during the upstream process. Methane releases are greater during the upstream process than during fuel combustion, but its contribution remains relatively minor.

The Availability and Accessibility of Methanol for Vehicles

Methanol is neither produced nor sold as a vehicle fuel in Nebraska.

Consumer Acceptance

Methanol possesses about half of the energy content of gasoline per unit volume. It takes approximately 1.6 gallons of M85 to match the energy density of a gallon of gasoline. According to information from Chrysler Corporation, its flexible fuel Dodge Intrepid can travel approximately 220 highway miles on 20 gallons of M85, whereas its dedicated gasoline powered Intrepid can travel approximately 350 highway miles on the same amount of fuel. Transit buses operating on neat methanol require about 2.3 to 2.6 times as much fuel as equivalent diesel buses to travel the same distance. M100 transit buses are therefore outfitted with larger fuel tanks than is customary on diesel buses in order to offset their reduced fuel economy. With expanded fuel storage, the operating range of methanol buses is typically 250 to 350 miles, 150 miles below that for diesel buses. Despite operating range limitations, methanol buses are capable of serving most transit routes.[53] Operators of methanol vehicles can expect to incur increased fuel costs due to methanol fuel's lower energy density, current higher cost compared to gasoline and diesel and expected near term price increases.

Methanol refueling equipment and procedures are essentially identical to those encountered at conventional fueling facilities. Methanol vehicle operators will not have to learn how to operate unfamiliar fuel dispensers or spend additional time refueling their vehicles.

Low level exposure to methanol vapors or fuel will not produce any overt health effects.[54] As a precautionary measure, however, it is suggested that well ventilated areas be used for refueling and maintenance work. Additionally, although the rate of evaporation of M100 is much greater than its rate of adsorption through skin, M100 fueling attendants are advised to wear protective gloves during refueling to minimize dermal exposure. Drinking methanol poses the most severe threat to human health. Ingestion of between two and four ounces of methanol can be fatal. Consumption of three to four teaspoonfuls has produced minor adverse health effects.

M100 is less likely than gasoline to ignite in an open air environment following an accident as a result of its higher flammability limit, lower autoignition temperature and lower volatility. Methanol spills, however, are more likely to ignite than diesel spills. If a neat methanol fire does occur, it will burn less intensely than gasoline due to its low flame temperature and high heat of vaporization. M85, on the other hand, is expected to behave more like gasoline in response to similar combustion conditions because of its gasoline content. Luminosity is a safety concern for neat methanol as it burns with an invisible flame in daylight. M85 does not present a similar fire hazard; its flame is as visible as gasoline's flame.[55]

Biodiesel (Soydiesel)

Biodiesel is a liquid fuel which can be made from a variety of oils — oilseed crops (e.g., soybean, rapeseed), animal tallow, yellow grease (waste vegetable oils) and lipids. Biodiesel is produced via a chemical process called transesterification in which organically derived oils are combined with alcohol (ethanol or methanol) in the presence of a catalyst to form fatty esters. Following transesterification, the resultant fatty esters can be blended with conventional diesel fuel or used in neat form. All biodiesel in use today is derived from soybean crops and is referred to as soydiesel. In concentrations between 40 and 50 percent by volume, biodiesel can be used in conventional diesel engines without modification to engine and fuel system components. In neat form, slight modification to fuel system components is required. Biodiesel's principal application is in heavy-duty vehicles (e.g., transit vehicles) in concentrations of 20 to 30 percent by volume with diesel fuel. As biodiesel use in heavy-duty engines progresses, its use in light-duty vehicles is expected to increase.

The remainder of this biodiesel fuel profile focuses on blends containing between 20 and 30 percent soydiesel by volume. These blends are considered by the biodiesel industry to be current optimum blends with respect to emissions, fuel economy and cost. Unless stated otherwise, the term "biodiesel" used hereafter refers to biodiesel blends composed of 20 to 30 percent soydiesel.

Economics

Fuel Costs

The current retail price for a gallon of biodiesel in Nebraska (25 percent soydiesel/75 percent diesel fuel by volume) is approximately $2.03.[56] The cost of biodiesel includes a wholesale price, distribution costs, supplier markup, a federal excise tax of 24.4 cents per gallon[57] and a state tax of 23.9 cents per gallon.[58] Diesel fuel in Nebraska currently retails for about $1.177 a gallon.[59]

Biodiesel's energy content is two percent lower than that of diesel fuel on a volumetric basis.[60] Therefore, on a diesel equivalent basis, the price for biodiesel would be only slightly higher (two percent higher) than its current reported price. (See section on consumer acceptance for additional information on biodiesel fuel economy).

The demand for biodiesel fuel in the U.S. is being met entirely with domestically grown soybean crops.[61] In the near term, only a small fraction of total biodiesel production is expected to be derived from nonsoybean feedstocks. By 2000, domestic biodiesel production capacity is projected to reach between 350 and 400 million gallons a year. The National Renewable Energy Laboratory estimates that by 2000 to 2005, the biodiesel production feedstock mix will become more diverse as advanced technologies to convert nonsoybean feedstocks to biodiesel are commercialized.[62] As the market for biodiesel fuels expands and as new production technologies utilizing diverse feedstocks are brought online, production costs are projected to decline to levels competitive with conventional diesel fuel by 2005.[63] Additionally, it should be noted that future U.S. demand for biodiesel is expected to continue to be met with domestic supplies.

Biodiesel fueling station development costs are the same as those incurred for conventional fueling facilities. No special equipment (e.g., soydiesel tolerant materials) is required for biodiesel fueling systems.[64]

Vehicle Costs

In concentrations up to 40 to 50 percent by volume with diesel fuel, biodiesel can be used in any diesel engine with no associated incremental cost (excluding fuel costs). Use of neat biodiesel fuel, however, necessitates slight modification to fuel system components as certain rubber and plastic materials used in conventional diesel engines are sensitive to the neat fuel. The incremental cost associated with use of neat biodiesel is therefore limited to installation of biodiesel tolerant materials to replace sensitive rubber and plastic components (e.g., hoses and O-rings).

Vehicle Operating Costs

Operation and maintenance procedures for biodiesel fueled vehicles are the same as those characteristic of vehicles running on 100 percent diesel. In addition, biodiesel vehicle operating costs (excluding fuel costs) are similar to diesel fueled vehicles. No engine durability problems have yet been reported in the more than 150 biodiesel demonstration projects currently in progress in the United States that are sponsored by the National SoyDiesel Development Board. With respect to neat biodiesel fuel, a number of engine manufacturers in Europe recommend that engine oil be changed more frequently than is customary in conventional diesel (and low soydiesel blends) fueled vehicles.[65]

Vehicle Resale

The resale value of vehicles operating on biodiesel is estimated to be equivalent to vehicles running on 100 percent diesel fuel.

Emissions

Criteria Pollutants

Unlike 100 percent diesel fuel, neat biodiesel contains no sulfur and thus will not contribute to acidic deposition (acid rain).[66] In tests performed on unmodified heavy-duty engines running on 20 percent soydiesel blends, emissions of carbon monoxide, hydrocarbons and PM-10 were reduced compared to diesel fuel. Emissions of nitrogen oxides, however, increased slightly.[67] The most favorable emissions results achieved to date with a 20 percent soydiesel blend were with a Detroit Diesel 6V-92TA DDECII engine modified with a catalytic converter and retardation in injector pump timing. During tests performed on this engine, emissions of all the major pollutants (including nitrogen oxides) were reduced compared to emissions achieved with an unmodified engine operating on 100 percent diesel fuel. In addition to adjustments of injector pump timing and use of catalytic converters, other methods (e.g., use of special fuel additives and dedicated biofueled diesel engine development) are being investigated which may reduce nitrogen oxide emissions without detracting from biodiesel's ability to reduce PM-10.[68]

Greenhouse Gas Emissions

According to a study conducted by the American Biofuels Association, biodiesel use significantly reduces emissions of carbon dioxide compared to diesel fuel on a fuel-cycle basis. Findings from the study indicate that when "current average industry technology" is used to produce a quantity of biodiesel equivalent to the energy content of one gallon of diesel, 3.8 fewer pounds of carbon are released than producing and burning a gallon of diesel. If the "best available technology" is used, 4.7 fewer pounds less carbon are released. The study also notes that the potential exists to reduce as much as 5.2 pounds of carbon per diesel equivalent gallon during the biodiesel fuel cycle compared to diesel.[69]

The Availability and Accessibility of Biodiesel for Vehicles

Biodiesel is not produced in Nebraska, nor is it available at commercial fueling stations in the state. Entities interested in obtaining bulk quantities of biodiesel for personal vehicle or fleet consumption, however, can arrange to have an in-state supplier deliver the fuel to their storage tanks. Nebraska obtains its supply of biodiesel from a manufacturer in Kansas City.[70] Although biodiesel is not produced in the state, it is important to note that Nebraska grows a substantial portion of the soybean crops used to make the fuel.

Consumer Acceptance

Neat biodiesel contains less energy per unit volume than 100 percent diesel fuel — 119,000 Btu/gallon versus 127,000 Btu/gallon, respectively. Studies assessing the fuel economy of biodiesel blends compared to diesel fuel are inconclusive. Some studies reveal improved fuel economy with biodiesel as measured in miles per gallon, other tests indicate reduced fuel economy. Still other tests show no difference in miles per gallon achieved with either fuel.

Biodiesel refueling procedures are the same as with diesel fuel. Operators of biodiesel vehicles do not need to learn how to operate special fuel dispensing equipment or spend additional time fueling their vehicles.

Neat biodiesel is not toxic and presents no known exposure risks if ingested or inhaled. Neat biodiesel also has a high flash point and high lower-flammability limit and is therefore not likely to combust in an open environment. Lastly, neat biodiesel is biodegradable — if spilled, it poses less threat than fossil fuels.[71]

Propane

Propane is derived from natural gas processing and petroleum refining. To date, it is the most widely used alternative transportation fuel in the United States. At atmospheric pressure and temperature, propane exists as a gaseous fuel; however, it is stored on board vehicles in liquid form under pressure prior to combustion as a vapor. Unlike ethanol, methanol and biodiesel fuels, propane is not blended with conventional fuels for use in vehicles. Instead it is used in neat form. Propane's principal application is in light- and medium-duty vehicles — its use in heavy-duty engines is limited mostly to demonstration projects. The Department of Energy estimates that in 1992 there were between 220,520 to 330,770 propane fueled vehicles operating in the nation. The Department projects that an additional 11,000 propane vehicles will be placed in service in fleets across the country before 1995.[72]

Economics

Fuel Costs

In the summer of 1994, propane retailed for about 68 cents per gallon in Nebraska.[73] The retail price for propane reflects the wholesale cost of the fuel, distribution costs, dealer margins and a federal excise tax of 18.3 cents per gallon. In addition, the State of Nebraska requires propane vehicle owners to purchase an alternative fuel user permit on an annual basis to cover their estimated fuel use tax liability. For passenger cars the state tax is estimated to be approximately 23.66 cents per gallon.[74]

Propane has about 73 percent of the energy content of gasoline on a volumetric basis.[75] On a gasoline-equivalent basis, the price of propane in Nebraska would be approximately $0.92 per gallon (excluding the estimated state fuel tax).[76] Propane's reduced energy content relative to gasoline is partially offset by other factors. (See the section on consumer acceptance for additional information on propane fuel economy).

Approximately 88 percent of national demand for propane is met with domestic supplies from natural gas plants and crude oil refineries. The balance of demand (11 to 12 percent) is met with imports supplied mostly from Canada.[77] The Energy Information Administration forecasts propane consumption in the transportation sector to increase 13.8 percent annually through 2010. This increase in consumption is attributed primarily to expected growth in the propane vehicle population during the forecast period. The oil and gas industries expect domestic supplies of propane to gradually increase through 2000 with production from refineries accounting for an increasing share of total domestic production. Propane production from natural gas processing is projected to slowly decline through 2000.[78] Propane from natural gas processing is expected to decline through the 1990s as dry gas production increases and crude oil and associated gas production rates decline. The Energy Information Administration estimates that propane prices will increase by about 2.7 percent annually through 2010.[79]

Propane fueling station development costs vary depending on the capacity and type of the fueling system installed. A common practice in the propane industry is for local distributors to underwrite or lease fueling equipment to small fleet operators at a favorable rate in exchange for fuel supply contracts. Large fleet operators, however, may find it more desirable to purchase their own equipment. Installation and equipment costs for a 1,000 gallon above ground storage tank and a simple dispenser are approximately $8,800. Installation of a 2,000 gallon tank and dispenser costs about $12,800. A computer controlled fueling system employing a credit card operated dispenser and a 1,000 gallon above ground tank can cost between $40,000 and $50,000. Installation costs for underground storage tanks are an additional $3,000 (excluding capital costs).[80]

Vehicle Costs

Propane can be used in conventionally fueled vehicles converted to operate on propane and in original equipment manufactured vehicles. In model year 1995, Ford and Chrysler will each offer a dedicated propane vehicle. General Motors has not yet announced its propane vehicle production plans (an announcement is expected by the end of 1994), but the company will continue a program whereby about 500 to 600 medium-duty vehicles will be converted to propane by a contractor using GM "prepped" engines. See the table below for a listing of factory built propane vehicles to be available in model year 1995 and their incremental costs as reported by the auto manufacturers.

Domestically Produced Model Year 1995 Propane Fueled Vehicles

Manufacturer	Model	Fuel System	Incremental Cost
Ford	Medium-Duty Heavy Truck F700 (21,000 to 37,600 GVRW)	Dedicated	$1,100, but likely to be higher if owner opts to replace temporary seven gallon tank with larger storage tank
Chrysler Canada	Dakota Mid-Size Pickup	Dedicated	N/A

According to the National Propane Gas Association, vehicle conversions cost from $1,000 to $2,000. Cost estimates from several conversion companies based in the West, however, reveal a higher price range — $1,500 to $4,000.[81] This conversion cost range reflects differences in vehicle type and age, type of fuel control equipment used, capacity and configuration of fuel storage tanks and the amount of labor required to perform the conversion. Excluding the propane pressurized storage tank, conversion kits consist of four pieces of equipment — a converter-pressure regulator, an air-fuel mixer, a dual control/fuel delivery processor and a fuel lock-off filter/valve.[82] Some conversion companies may offer discounts on conversions to fleet operators.

Vehicle Operating Costs

According to the National Propane Gas Association, propane's high octane value (104) and low carbon and oil contamination characteristics can result in extended engine life compared to gasoline. This claim was substantiated by a private sector fleet administrator in Nebraska who reported savings in fleet maintenance costs, extended oil change intervals and reduced engine wear with a sizeable fleet of propane medium-duty vehicles.

Vehicle Resale

Propane vehicle resale cost information is limited. Anecdotal evidence from British Columbia, however, may prove instructive. The province reports that in general, dual fuel propane vehicles are resold at values equivalent to gasoline equivalent vehicles, but dedicated vehicles are more difficult to sell. The LP-Gas Clean Fuel Coalition reports that most used propane vehicles in the United States are sold into secondary markets (businesses that purchase vehicles which previously were owned and operated by other companies) such as the agriculture sector and commercial delivery fleets. In general, many of the used propane vehicles in secondary markets are converted to gasoline use if they were not originally built as dedicated propane vehicles. As in British Columbia, prices for used dual fuel propane vehicles in the United States are comparable to gasoline equivalent vehicles.

Emissions

Criteria Pollutants

Original equipment manufactured, dedicated propane fueled vehicles have the potential to reduce emissions of reactive hydrocarbons and carbon monoxide relative to gasoline and diesel.[83] In addition, dedicated propane vehicles can virtually eliminate PM-10 and evaporative emissions.[84] Emissions of nitrogen oxides, however, are equal to and sometimes higher in propane vehicles compared to similar gasoline-powered vehicles.[85]

In contrast to factory built dedicated propane vehicles, emissions of major air pollutants from converted propane vehicles are often higher than those produced from equivalent gasoline powered vehicles.[86] British Columbia reported that during a six month period (December 1993 to May 1994), dedicated propane vehicles (converted) failed an emissions inspection test at a rate of 35.8 to 42 percent on a monthly basis, whereas the failure rate of gasoline powered vehicles during the same period never exceeded 14.5.[87] The province attributed the disappointing emissions performance results of converted propane vehicles to improper conversion kit installation, faulty adjustments and system tampering. U.S. Environmental Protection Agency regulations, however, make it unlawful for any person to tamper with vehicle components in a manner which adversely affects emission performance. Additionally, aftermarket conversion equipment certification standards are in place to ensure that installed conversion equipment meets applicable vehicle emission standards.

Optimum emissions performance of propane vehicles is best achieved with original equipment manufactured vehicles. According to Ford Motor Company, emissions of carbon monoxide, hydrocarbons and nitrogen oxides from its model year 1995 F700 dedicated truck will be below levels permitted under the 1998 federal clean fuel vehicle standards.

Greenhouse Gas Emissions

Unlike conventional fuels which are composed of complex mixtures of hydrocarbons, propane fuel is a mixture of simple hydrocarbons containing relatively few carbon atoms. As a result of propane's inherently low carbon content, vehicular emissions[88] of carbon dioxide are reduced compared to gasoline (light-duty vehicles). According to a comprehensive study of greenhouse gas emissions from vehicle fuels on a fuel cycle basis, propane use in both light- and heavy-duty vehicles produces fewer net greenhouse gas releases compared to other fossil fuels (reformulated gasoline, diesel, methanol from natural gas and natural gas). The reduction in greenhouse gas emissions from propane compared to other fossil fuels is particularly significant during the upstream (fuel production and distribution) process.

Vehicular emissions of carbon dioxide from heavy-duty propane vehicles are reported to be slightly higher than those from diesel powered heavy-duty vehicles, but an overall reduction in greenhouse gas emissions is achieved when upstream releases are taken into account. Vehicular emissions of methane from propane vehicles are about equal to conventionally fueled vehicles, however a slight reduction is gained during the upstream process.[89]

The Availability and Accessibility of Propane for Vehicles

Propane is not produced in Nebraska — it is imported from producing states via pipeline and tanker trucks. Propane fuel is available to Nebraskans at more than 90 retail outlets.

Consumer Acceptance

Propane fuel has about 73 percent of the energy content of gasoline on a mass and volume basis. Propane's reduced energy content relative to gasoline is partially offset by its higher octane rating which allows for a higher engine compression ratio and subsequent improvements in power and fuel efficiency.[90] Propane fuel economy (as measured in miles per gallon) ranges between 80 and 90 percent that of gasoline, depending on the type of propane vehicle used.[91] Maximum fuel economy is achieved with factory built dedicated propane vehicles. Vehicles converted to bifuel use, on the other hand, are not optimized to take advantage of propane's higher octane value and are burdened with the extra weight of two fuel systems. As a consequence, bifuel vehicles are not able to travel as many miles per gallon while running on propane compared to dedicated vehicles. Due to propane's reduced fuel economy, propane fueled vehicles require more fuel to achieve the same driving range as conventionally fueled vehicles. Depending on the size of a propane vehicle, larger fuel storage tanks can be installed beneath the vehicle and/or in the cargo space to expand driving range. The tanks are cylindrical in shape and cargo space may be reduced to accommodate the larger fuel tanks.[92] Research and development work is underway to alter the shape of pressurized propane fuel storage tanks to minimize cargo space reductions.

Although about ten to 20 percent more fuel is needed for a propane vehicle to travel the same distance as an equivalent gasoline vehicle, fueling costs may be equal to or lower than gasoline. For example, if the percentage of additional fuel needed (10 to 20 percent) is less than the difference in fuel prices for propane and gasoline on a gallon basis (expressed as a percentage), fuel costs will be lower with propane. If the percentage of additional propane needed were equal to the difference in price (expressed as a percentage), fueling costs would be about the same.

Propane vehicles are fueled using dispensing nozzles equipped with standard one and three-quarter inch ACME-thread fittings to accommodate propane vehicle fuel inlets. Once the fittings are connected, the tank is filled to 80 percent capacity; this allows room for fuel expansion as storage tank temperatures increase.[93] Fueling time is about the same as for conventionally fueled vehicles.[94]

One of the major safety issues concerning propane use in vehicles is the risk of a fire in the event of a fuel leak. Compared to gasoline, propane has a higher flammability limit and an autoignition temperature (855 ºF) at the higher end of the ignition temperature range than gasoline (442 to 880 ºF). At ambient conditions, propane exists in gaseous form and will descend from the location of a leak because it is heavier than air. In light of these chemical characteristics, the Department of Energy has concluded that the risk of fire with propane fuel is lower than that with gasoline.[95] A second safety concern with propane is whether the pressurized fuel storage tanks on board will rupture under accident conditions. Propane fuel tanks are constructed to withstand internal pressures of 1000 pounds per square inch. “In the event of a collision this translates to a resistance more than 20 times greater than that for gasoline or diesel tanks.”[96] In addition, the fuel storage tanks are equipped with pressure relief valves that will release fuel vapors when internal pressure reaches predetermined levels (250 pounds per square inch). In Nebraska, the typical operating pressure of propane fuel tanks ranges from 50 to 150 pounds per square inch, depending on seasonal fluctuations in ambient air temperature.

Natural Gas

Natural gas is formed from buried organic material and consists mostly of the hydrocarbon methane. Water, inert molecules and a few other hydrocarbons such as butane and propane are also present in natural gas. Natural gas in the transportation sector is most often used in compressed form in light-, medium- and heavy-duty vehicles. It is also used on a limited basis in liquefied form in fuel intensive transportation activities such as transit buses, railway locomotives, line haul and inter/intracity pickup and delivery trucks. According to the Department of Energy, natural gas vehicles comprised the second largest population of alternative fuel vehicles (behind propane) in 1992 with nearly 24,500 vehicles in operation across the United States.

The Department projects that more than 30,000 additional compressed natural gas vehicles will be placed in service in the United States by 1995.[97] The remainder of this fuel profile focuses only on compressed natural gas vehicle applications as compressed natural gas accounts for nearly all natural gas use in the transportation sector.

Economics

Fuel Costs

In the summer of 1994, natural gas retailed for approximately 50.2 cents per gasoline-equivalent gallon (excluding state fuel tax).[98] The pump price is based on the cost of natural gas, the cost of distribution (of which the cost of raising the pressure of the delivered natural gas for fast-fill refueling stations is a major component), dealer margins and the tax treatment of the fuel.

These factors may change over time. For example, in 1992, the average wellhead price of domestically produced natural gas was $1.75 per thousand cubic feet.[99] Most forecasts of natural gas prices show an increase in wellhead prices between now and 2000. The Energy Information Administration estimates that wellhead prices will increase to $2.42 per thousand cubic feet by 2000 (in 1992 dollars).[100]

The reliability of fuel supplies and the volatility of fuel prices are also important factors to consider. In the case of natural gas, approximately 99.6 percent of the natural gas used in the United States in 1993 was produced domestically and in Canada. Overseas imports of natural gas amounted to only about 0.4 percent of supplies, although these imports are forecast to increase to slightly over one percent in 2000.[101] Domestic natural gas production is expected to increase through 2010 due in large part to the application of new technologies for producing natural gas. Imports are expected to increase through 2010 as well, with Canada supplying most of the imported natural gas.[102]

Natural gas, when used as a transportation fuel, is taxed by the federal government at 5.89 cents per gasoline equivalent gallon.[103] The current federal government tax on gasoline is 18.4 cents per gallon. Instead of paying a state motor fuel tax at the pump, operators of natural gas vehicles in Nebraska are required to purchase an alternative fuel user permit on an annual basis to cover their estimated annual fuel use tax liability. For passengers cars, this tax is estimated to be approximately 23.66 cents per gasoline equivalent gallon.[104] The state tax on gasoline is 23.9 cents per gallon.

The cost of natural gas refueling stations is substantial, ranging from $10,000 to $400,000 for a slow-fill facility and $250,000 to more than $500,000 for a fast-fill station.[105] Installation and equipment costs for these types of facilities vary depending on the discharge rate of the compressors, storage capacity and the number of fueling units installed. Small scale home refueling compression stations cost under $5,000.[106]

Vehicle Costs

Historically, most natural gas vehicles were after market conversions of gasoline vehicles. More recently, auto manufacturers have been offering natural gas vehicles. According to a comprehensive report addressing natural gas vehicles, conversion costs range from $2,100 to more than $4,000.[107] Findings from a recent limited survey of conversion companies based in the West, however, reveal higher costs — $3,400 to $4,800 for light-duty conversions.[108] Conversion costs run higher for larger vehicles depending on the number of fuel tanks installed. Conversion costs for vehicles in the same category (e.g., light-duty vehicles) vary due to differences in vehicle type and age, type of conversion kit selected, capacity and configuration of fuel storage system, number of vehicles being converted and labor costs. Fuel cylinder costs alone account for a substantial share of total conversion costs.

In model year 1995, Chrysler and Ford will both be offering natural gas vehicles. The Chrysler vehicles will be factory produced. The following table shows the types of natural gas vehicles Chrysler will be offering along with incremental cost information.

Domestically Produced Model Year 1995
Compressed Natural Gas Vehicles (Factory Built)

Manufacturer	Model	Fuel System	Incremental Cost
Chrysler	B Van/Dodge Ram Van	Dedicated	$4,800 - $5,200
Chrysler	Minivan	Dedicated	$4,800
Chrysler	Dakota Mid-Size Pickup	Dedicated	$4,800 - $5,200
Chrysler	Dodge Full-Size Ram Pickup	Dedicated	$4,800 - $5,200

Ford will not be producing natural gas vehicles in their production plants, rather it will develop a “prepped” engine for use in vehicles built to operate on a 4.9 liter in-line 6 cylinder engine and in F-Series pickup trucks. Certified conversion shops will be authorized to convert these Ford vehicles using the “prepped” engine. The incremental cost of the Ford vehicles is expected to be about $3,000 to $5,000. General Motors has not yet announced its natural gas vehicle production plans for model year 1995, however an announcement is expected by the end of 1994.

It is more difficult to summarize the incremental cost of heavy-duty natural gas vehicles because of the wide variety of such vehicles. However, an example of one type of heavy-duty vehicle may provide useful information on the incremental cost of heavy-duty natural gas vehicles. Recent purchases of compressed natural gas transit buses have cost approximately $50,000 more than the equivalent diesel transit bus.[109]

Vehicle Operating Costs

Natural gas vehicles generally have lower maintenance costs than gasoline vehicles because of the cleaner burning characteristics of the fuel.

Vehicle Resale

There are very limited data on the resale value of natural gas vehicles. Anecdotal evidence from British Columbia, which has had a major natural gas vehicle population for more than ten years, indicates that the vehicles can generally be resold at a cost comparable to equivalent gasoline vehicles.

Emissions

Criteria Pollutants

Natural gas is among the simplest hydrocarbons, in contrast to gasoline and diesel which are mixtures of — often more than 100 — complex hydrocarbons. The major tailpipe emission from natural gas vehicles is unburned methane which, compared to other hydrocarbons, does not react rapidly in the atmosphere to create ozone. Natural gas can significantly reduce carbon monoxide emissions when used in lean-burn, high compression engines. Natural gas is also very effective in reducing particulate emissions, especially when replacing diesel fuel. However, natural gas may provide limited benefit in reducing ozone because it burns at a higher temperature than gasoline and thus tends to form more nitrogen oxide.[110]

The actual emissions from natural gas vehicles, however, can vary significantly depending on how engine performance is optimized and what emission controls are used. One clear advantage for natural gas over gasoline and diesel fuel is the lack of evaporative emissions due to the closed nature of the fueling system.

Data on emissions from natural gas vehicles in use are limited. Most available data are from postfactory conversions which may not be optimized for low emissions or suffer from tampering. Information from vehicle testing in British Columbia and Colorado show high emissions levels from natural gas vehicles.[111 and 112] However, data from certification tests for recent original equipment manufactured vehicles show that natural gas vehicles can achieve very low emissions levels. For example, Chrysler's model year 1994 Dodge Caravan/Plymouth Voyager compressed natural gas powered minivan was certified to the stringent Ultra-Low Emission Vehicle standard by the California Air Resources Board.[113] The best emissions performance from compressed natural gas vehicles will be derived from dedicated vehicles which have been optimized for operation on natural gas and not from bifuel vehicles.

Greenhouse Gas Emissions

Natural gas vehicles emit two major greenhouse gases — carbon dioxide and methane. Methane accounts for more than 90 percent of total hydrocarbon emissions from natural gas vehicles.[114] While natural gas use results in higher vehicular emissions[115] and upstream (fuel production and distribution) releases of methane compared to other transportation fuels, net greenhouse gas releases on a fuel cycle basis are estimated to be lower than conventional fuels. In contrast to the high production of methane stemming from natural gas vehicle use, carbon dioxide releases are reduced relative to conventional fuels. In heavy-duty natural gas vehicles, net greenhouse gas emissions are 5 to 10 percent higher than diesel fueled vehicles, whereas in light-duty vehicles, net greenhouse gas releases are reduced 10 to 15 percent compared to reformulated gasoline. In a fleet consisting of both light and heavy-duty compressed natural gas vehicles, fuel cycle emissions of greenhouse gases are estimated to be 5 to 10 percent lower than those from an equivalent fleet of conventionally fueled vehicles.[116]

The Availability and Accessibility of Natural Gas for Vehicles

In 1992, natural gas production in Nebraska reached its highest level since 1987 at 1.18 billion cubic feet. Despite this production achievement, Nebraska natural gas supplies represented only 1.1 percent of the natural gas consumed in the state. The balance of the natural gas used in Nebraska comes from other states via pipeline. Slightly more than half the towns in Nebraska are served with natural gas.[117] However, there are few fueling stations operating to supply compressed natural gas to vehicles.

Consumer Acceptance

In addition to cost and fuel availability, there are other factors which contribute to consumer acceptance of natural gas vehicles. The major drawback to consumer acceptance of light-duty natural gas vehicles is the limited range of vehicles and the space occupied for fuel storage on board the vehicles. Bifuel light-duty vehicles can generally be driven 150 to 200 miles on natural gas before having to refuel or switch to gasoline. Factory built dedicated compressed natural gas fueled vehicles can travel 200 miles before having to refuel. To expand the driving range of light-duty natural gas vehicles, additional fuel storage cylinders can be installed in the trunk space of the vehicle. This, however, results in reduced cargo space and a slight reduction in fuel efficiency due to the added weight of the cylinders.[118] The problem of range and adequate vehicle fuel storage is much less in larger light-duty vehicles, such as vans and heavy-duty vehicles where tanks can be mounted under the chassis. Research is underway to develop natural gas storage technologies that will conform to the space available in the vehicles, much as gasoline tanks now conform to available space under vehicles.

Other issues affecting customer satisfaction with natural gas vehicles include the initial unfamiliarity with refueling procedures, reduced power in dual fuel vehicles and concerns about performance of the storage cylinders in an accident. The initial unfamiliarity with refueling operations is generally overcome with experience. For example, consumers may refuel using fast-fill facilities, which cut refueling time to approximately that of gasoline, or by using slow-fill refueling, usually overnight, which will allow the tanks to be completely filled. Concerns about reduced power can be addressed in engines optimized for natural gas. Concerns about fire hazards are largely unwarranted as the storage cylinders are required to meet more stringent standards than conventional gasoline tanks in vehicles. Furthermore, natural gas' high autoignition temperature (1,200 ºF) and narrow flammability range (five to 15 percent) make accidental ignition or combustion unlikely.[119]

Electric Vehicles

Prompted by California's zero-emission vehicle requirement and federal government research goals, the "Big Three" automakers, the national laboratories and a host of other business are working to develop commercially viable electric vehicles for sale in 1998. Electric vehicles can be powered by a variety of technologies, including electrochemical batteries, fuel cells, electromechanical flywheels and ultracapacitors. While all these technologies are currently undergoing research and development work, electrochemical batteries have demonstrated the most potential to succeed in commercial applications. As a result, auto manufacturers are focusing their electric vehicle research and development efforts on developing electrochemical batteries. A limited number of battery powered vehicles are in use in fleets today, primarily for demonstration purposes. Most of these electric vehicles are powered by lead-acid batteries and, to a lesser extent, nickel-cadmium batteries. Other promising battery technologies currently being developed, but not expected to be available until 1998 to 2000, include nickel-metal-hydride, sodium-nickel-chloride, sodium-sulfur and lithium-metal-disulfide.

Economics

Batteries are the major factor determining the economics of electric vehicles. They are a major component of the initial purchase price of the vehicle and constitute the major vehicle maintenance cost as they must be replaced every few years during the life of the vehicle.

Fuel Costs

Electricity in Nebraska is currently sold at three different rates — residential, commercial and industrial. In 1993, the average residential rate was 6.34 cents per kilowatt-hour, the average commercial rate was 5.73 cents per kilowatt-hour and the average industrial rate was 4.08 cents per kilowatt-hour.[120] Prospective electric vehicle operators may be subject to one of the three rates depending on the use of the vehicle. In lieu of these rates, an alternative rate (perhaps lower than these three rates) may apply to electric vehicle operators in Nebraska if utilities in the state adopt a discounted rate for overnight charging (fueling).

Electricity used in vehicles is currently not subject to a federal excise tax. However, in Nebraska, electric vehicle owners are required to purchase an alternative fuel user permit on an annual basis to cover their estimated state fuel tax liability. See endnote 74 on page 40 for a detailed description of the state tax treatment of electric vehicles in Nebraska.

In anticipation of increased demand for electricity, which a growing population of electric vehicles will engender, a number of electric utilities in the United States are seeking to implement demand side management programs designed to minimize peaks resulting from vehicle charging. A basic approach to managing electrical load focuses on encouraging overnight electric vehicle charging when electricity demand is at a minimum. For example, several investor owned utilities in California have submitted rate filings to establish time-of-use rates that make it less expensive to charge electric vehicles during off peak periods and more expensive to charge during peak times.[121]

Most electric vehicle charging is expected to take place at the user's home base, such as a residential or company garage. According to a study commissioned by several California utilities, wiring a garage to recharge an electric vehicle will cost between $700 and $900. The wiring costs cover installation of a 240 volt circuit, separate meter, controls and circuit breaker in the garage or parking area. The study also found that it will cost $226 more on average to wire a detached garage compared to an attached garage.[122] Public access electric vehicle recharging facilities will also be needed to augment home base charging; however, insufficient information exists to permit reporting on the installation and capital costs of commercial charging stations.

Vehicle Costs

The cost of electric vehicles produced by original equipment manufacturers is extremely high today due to the limited scale of production. However, as with all new products, production costs are expected to drop significantly as production increases. According to the Manufacturers of Emission Controls Association, "costs for system additions in the automotive industry have a history of rapid decrease in successive model years after introduction. Power steering, fuel injection and catalytic converters are cases in point... A recent example of this pattern is the price decrease of air bag technology since its introduction in 1989."[123] Air bag costs have dropped from $1,200 in 1989 to $550 in 1992 and are expected to drop to $250 by 1995 where the price will reflect full volume production.

Of the "Big Three" automakers, Chrysler is the only one which has an electric vehicle currently available for sale to the public. Ford and General Motors are currently field testing their electric vehicles. See the table below for a listing of the leading edge electric vehicles being developed by the Big Three.

Status of Electric Vehicle Development by the "Big Three" Automakers in Model Year 1995

Manufacturer	Model	Battery Type	Vehicle Cost
Chrysler	Dodge Caravan/Plymouth TE Van *Currently available.	Nickel-Iron	$100,000 - $120,000
Ford	Ecostar (light utility van) *Field testing only; available to the public in 1998.	Sodium-Sulphur	$100,000 for 30 months lease. (Expected to cost three to four times more than gasoline powered equivalent when available to the public.)
General Motors	Impact (commuter car)	Lead-Acid	N/A

*Available to the public by late 1990s.

Vehicle Operating Costs

Operating costs for an electric vehicle include the electricity, the cost of replacement batteries (replaced every three years or 30,000 miles) and various miscellaneous costs (e.g., replacement of low-rolling-resistance tires). Assuming electricity costs of 6.4 cents per kilowatt-hour (five cents per kilowatt-hour for the electricity, a road tax of one cent per kilowatt-hour and sales tax of 0.4 cents per kilowatt-hour), the following projected 1998 lifetime vehicle operating costs were estimated. Costs for a conventional gasoline Ford Escort are also shown.

*Projected 1998 Lifetime Vehicle Operating Costs**
(cents/mile)

	Fuel**	Battery	Other***	Total
Advanced Lead-Acid	1.7-1.9	2.7-3.1	1.9	6.3-6.9
Nickel-Metal Hydride	1.7-1.9	3.4-3.9	1.9	7.0-7.9
Sodium-Nickel Chloride	1.7-1.9	4.5-5.3	1.9	8.1-9.1
Conventional Ford Escort	4.8	0.0	2.9	7.7

*Initial purchase costs for an electric vehicle (minus the battery) and a conventionally fueled vehicle are assumed to be equal and are not included in this analysis. Range of values reflects 100,000 to 120,000 mile vehicle lifetime. Conventional vehicle data are based on the American Automobile Association's *Your Driving Costs*, 1993.

**Includes electricity or gasoline and oil costs.

***Includes maintenance and tires. Maintenance costs for an electric vehicle are expected to be less than the maintenance costs for a comparable gasoline vehicle as electric vehicles have fewer moving parts and fewer contacting components. In addition, electric vehicles require no tune-ups or oil changes. The low-rolling-resistance tires used on electric vehicles, however, may require more frequent replacement compared to the tires used on gasoline vehicles. Tire replacement costs are therefore assumed to be higher for electric vehicles than conventionally fueled vehicles.

Source: *Technical Support Document: Zero-Emission Vehicle Update*, California Environmental Protection Agency, Air Resources Board, April 1994.

Vehicle Resale

No data exist on electric vehicle resale values.

Emissions

With the exception of particulate matter raised by the tires of an electric vehicle, there are no emissions directly associated with the vehicle itself. However, there are emissions from the power plant generating the electricity for the vehicle. The type and extent of such emissions depend on the mix of generating resources used in a state. In 1992, 55.4 percent of the electricity generated in

Nebraska was produced from coal, 39.1 percent from nuclear power, 4.8 percent from hydroelectric power and less than one percent from natural gas and oil.[124] Most analyses of electric vehicles assume that a large portion of the charging will occur overnight because of expected lower rates for off peak use of electricity. In Nebraska, the electricity would most likely be generated from coal power plants which are best suited to increase production during off peak periods to meet electric vehicle charging demand. The emissions resulting from electric vehicle use in Nebraska could be expected to be characteristic of those produced from coal fired power plants (e.g., sulfur dioxide and carbon dioxide). However, Nebraska's electric utilities use coal which has a low sulfur content. As a result, the concentration of sulfur dioxide in power plant stack gas produced by combustion of the coal is minimized. Nebraska is in compliance with National Ambient Air Quality Standards and power plant emission regulations for sulfur dioxide.

The Availability and Accessibility of Electricity for Vehicles

Although Nebraska is a net exporter of electricity, there are no commercial electric vehicle recharging facilities in the state.

Consumer Acceptance

Most electric vehicles in use today can travel 50 to 100 miles between chargings. Market surveys indicate, however, that most prospective electric vehicle operators require a driving range of at least 100 miles. The California Air Resources Board expects that improvements in advanced batteries will allow electric vehicles to achieve ranges beyond 100 miles by 1998.[125] In addition to having a limited driving range, electric vehicles typically do not accelerate as quickly as gasoline vehicles. Acceleration from 0 to 50 miles per hour currently can take about 16.4 seconds. However, as with driving range, improvements in battery design are expected to enhance acceleration over the next few years.[126]

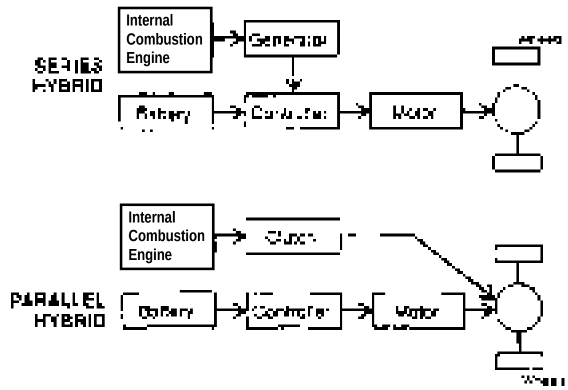
Nearly all electric vehicle charging is expected to involve a 240 volt system and require about four to eight hours depending on the type of battery technology used and level of discharge. Plugging an electric vehicle into a 240 volt charging system is similar in nature to plugging in a mid-sized electrical appliance. Since most charging is expected to occur overnight while the vehicle operator is sleeping, this time demanding approach to charging may not prove to be an inconvenience. Nevertheless, in an effort to significantly reduce the amount of time needed to charge an electric vehicle, the industry is pursuing development of quick charging technologies. One approach involves the use of high power voltages which have the potential to reduce the charging time to between five and 15 minutes. Battery swapping — replacing a discharged battery pack with a fully charged one — is another charging strategy being considered by the electric vehicle industry. Initial findings indicate, however, that labor costs plus the costs associated with owning and maintaining additional battery packs may be prohibitive.

With respect to safety, all batteries present some risk of electrical shock. Additionally, acid leaks from current battery technologies may be dangerous if contact with skin occurs. Not enough information is available to permit an assessment of the risks posed by the various battery technologies during accident conditions.[127]

Hybrid Vehicles

In contrast to the alternative fuel vehicles already examined in this chapter, hybrid vehicles do not utilize just one type of propulsion technology (e.g., internal combustion engines or electrochemical batteries), rather, they employ a propulsion system which integrates two or more energy conversion and storage technologies. Hybrid vehicles are currently in the prototype stages of development and a growing number of advocates believe that near term commercial application of hybrid propulsion systems is technologically more feasible compared to electrochemical batteries. Additionally, advocates report that hybrid vehicles have the potential to meet California's zero-emission vehicle standard while providing extended driving range relative to battery powered electric vehicles. In the U.S., electric powered versions of hybrid vehicles are expected to be used primarily in heavy-duty vehicles, whereas in Europe, hybrid vehicles powered by both electricity and liquid fuels are expected to be used principally in light-duty vehicles.[128]

While a variety of hybrid vehicle propulsion systems are currently undergoing research and development work, the three systems receiving the bulk of attention are series, parallel and battery-battery. In series hybrids, an electric motor provides the sole source of energy to drive the wheels. In parallel hybrids, energy is supplied directly to the wheels via an electric motor or an internal combustion engine. In battery-battery hybrids, two different battery technologies are used, one with high energy density (for driving range) and one with high power density (for acceleration).[129] See the diagram below.



Internal Combustion Engine

A number of different propulsion system configurations are possible with these three systems. For example, a series hybrid vehicle might combine the use of electrochemical batteries and a small, liquid fueled internal combustion engine. Under this scenario, the batteries supply power to an electric motor which drives the wheels and the engine provides energy to a generator on board which can then be used to supply electricity to drive the wheels or charge the battery pack. A second possible configuration for a series hybrid involves the application of a flywheel energy system coupled with electrochemical batteries. Like the first example, the batteries supply energy to an electric motor, but instead of the small engine, a flywheel system is used to charge the batteries or supply electricity directly to the electric motor. No tailpipe emissions are produced under this hybrid vehicle scenario. Flywheel energy storage technology is based on the storage of rotational kinetic energy. Energy added to the flywheel increases its speed of rotation. When no energy is added or removed from the flywheel, it continues to spin at a constant speed (in the absence of frictional losses) and when energy is removed from the flywheel, its speed decreases. Flywheels generate electricity by turning nontouching magnets against each other. In addition to their use in series hybrids in conjunction with batteries, flywheels can be connected to internal combustion engines to recover braking energy, improve vehicle acceleration and increase the energy efficiency of the powertrain. Another application of flywheel systems involves a single large flywheel, or a series of flywheels, providing the sole source of energy storage in an electric vehicle.

Fuel cells represent an energy conversion technology which may also be used in series hybrid vehicles. Fuel cells can achieve approximately twice the energy efficiency of internal combustion engines while producing virtually no emissions. Fuel cells are able to do this by electrochemically transforming hydrogen molecules contained in fuels such as methanol, natural gas and hydrogen into electricity. There are two ways to supply fuel cells with their hydrogen energy source — the vehicle may contain an on board hydrogen fuel tank, or a reformer device can be used to convert one of the above mentioned fuels into a hydrogen-rich gas. The second option is considered the more viable alternative due to the difficulty of storing pure hydrogen on board a vehicle.

The electrochemical process begins with the reformer. Once a fuel has been converted to a hydrogen gas by the reformer, the hydrogen molecules diffuse through the fuel cell. A fuel cell is made up of three parts — an anode (a negative electrode), an electrolyte (a substance which conducts electricity) and a cathode (a positive terminal). These parts are stacked on top of each other. As hydrogen passes through the anode, electrons are stripped away to create an electric current. Hydrogen protons continue to pass through the electrolyte to the cathode, where the protons and electrons combine with oxygen. The electricity generated by this process can be used to charge a battery pack and drive an electric motor. The by-product of this electrochemical reaction is water, in either droplet or vapor form.

Lastly, ultracapacitors are being developed to augment the power supply from electrochemical batteries in battery-battery hybrid vehicles. Ultracapacitors consist of two conducting plates separated by a vacuum. This design allows a large electric charge to be stored in a small volume. During the driving cycle, a large amount of energy from the ultracapacitors can be released to produce short bursts of power for acceleration or hill climbing.

END NOTES

4 Vehicles powered by the liquid and gaseous alternative fuels addressed in this *Handbook* are commercially feasible and many are already available. While limited numbers of battery powered vehicles are in use today primarily for demonstration purposes, the California Air Resources Board expects large-scale production of certain electrochemical battery technologies to commence in 1998. In addition, the Department of Energy estimates that hybrid electric vehicle technology will be commercially available within the next five to ten years.

5 In 1990, the California Air Resources Board established stringent emission standards for four classes of light- and medium-duty vehicles. In order of increasing stringency, the four vehicle classes and their corresponding emissions limits (with mileage at 50,000 or below) are Transitional-Low-Emission Vehicles with Nonmethane Organic Gases — 0.125 grams per mile (gpm), nitrogen oxides — 0.4 gpm, carbon monoxide — 3.4 gpm; Low-Emission Vehicles with nonmethane organic gases — 0.075 gpm, nitrogen oxides — 0.2 gpm, carbon monoxide — 3.4 gpm; Ultra-Low-Emission Vehicles with nonmethane organic gases — 0.040 gpm, nitrogen oxides — 0.2 gpm, carbon monoxide — 1.7 gpm; and Zero-Emission Vehicles with nonmethane organic gases, nitrogen oxides and carbon monoxide at 0.0 gpm (considered to be electric vehicles). These emissions standards become slightly less stringent for vehicles with over 50,000 miles. Beginning in 1994, auto manufacturers are required to meet an increasingly stringent annual fleet-average emission standard by producing any combination of the four vehicle classes. While auto manufacturers are not required to produce a certain number of any one particular vehicle class during the first four years of the program, a small percentage (two percent) of their light-duty fleet must consist of zero-emission vehicles beginning in 1998.

6 *Staff Report: 1994 Low-Emission Vehicle and Zero-Emission Vehicle Program Review*, California Environmental Protection Agency, Air Resources Board, April 1994, pp. 2, 6 and 78.

7 The reported price that the State of Nebraska pays for E85 fuel ($1.37) was derived by averaging the cost quoted by the Department of Administrative Services, Bureau of Transportation Services ($1.35) and the cost quoted by the Department of Roads ($1.39). The prices reported by these state agencies are based on costs for "topping-off" the agencies' 1,000 gallon fuel tanks. At times only 500 gallons of E85 were purchased to fill a tank, while at other times, nearly 1,000 gallons were purchased. Ethanol costs typically decrease on a per gallon basis as the volume of the purchase order increases.

8 For E85, the 54 cents per gallon tax credit is multiplied by .85 (the ethanol content of E85) to yield 45.9 cents per gallon. This amount (45.9 cents per gallon) is then offset by the 5.4 cents per gallon federal excise tax exemption for ethanol blends. The resulting tax credit amount for E85 is 40.5 cents ($.54 x .85 - $.054). The tax credit for ethanol is scheduled to expire on December 31, 2000.

9 The state excise tax for ethanol fuel consists of a fixed rate and a variable rate. The fixed rate is 12.5 cents per gallon. The Nebraska Board of Equalization meets quarterly to establish the variable rate.

10 According to Department of Energy data, a gallon of gasoline contains 115,000 Btus, whereas a gallon of ethanol contains 76,000 Btus. E85 thus contains (115,000 x 0.15) — (76,000 x 0.85) = 81,850 Btus or 71 percent of the energy content of a gallon of gasoline. *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. 50.

11 Calculation: $1.37 (price state pays for gallon of E85 without federal tax) + 13 cents (federal tax per gallon) x 1.41 (energy content factor for gasoline which has 41 percent more Btus than E85 per gallon)= $2.12.

12 The pump prices for gasohol and unleaded gasoline in Nebraska are based on a nine city fuel price survey performed monthly by the Omaha, Nebraska branch of the Automobile Association of America. These fuel prices were taken from the August 1994 survey.

13 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 45.

14 *Economic Benefits of the Renewable Oxygenate Standard*, prepared for the Western Regional Biomass Energy Program and the Great Lakes Regional Biomass Energy Program by ENERGETICS, June 1994, p. 2.

15 Ethanol production capacity and cost data from the National Renewable Energy Laboratory are based on a number of key assumptions, including: (1) lignocellulosic waste will be available to meet 50 percent of demand in 2005; and (2) an efficient means of converting lignocellulosic waste to ethanol will be commercialized.

16 *Emerging Technologies in Ethanol Production*, by Neil Hohmann and C. Matthew Rendleman, U.S. Department of Agriculture, January 1993, p. 14.

17 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 46.

18 Cost data obtained from the National Corn Growers Association Ethanol Work Group and the Illinois Department of Energy and Natural Resources.

19 Anecdotal operating cost information for ethanol vehicles was obtained from the Illinois Department of Energy and Natural Resources.

20 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 52.

21 *Biofuels Update*, National Renewable Energy Laboratory, Winter 1994, p. 3.

22 *Total Fuel Cycle Emissions Analysis of Biomass-Ethanol Transportation Fuel*, National Renewable Energy Laboratory, NREL/TP-463-4950, November 1993.

23 *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991, p.72.

24 *Biofuels Update*, National Renewable Energy Laboratory, Winter 1994, p.2.

25 *Alternative Fuels for Automobiles: Are They Cleaner Than Gasoline?*, CRS Report for Congress by David E. Gushee, February 27, 1992, p. 28.

26 *Introduction to Alternative Fuel Vehicles*, prepared for U.S. Department of Energy by Science Applications International Corporation, January 1993, p. 11.

27 *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, pp. 56-59.

28 In 1991, M85 and M100 accounted for an estimated 0.2 percent of total methanol consumption in North America. This share was expected to increase to 0.3 percent in 1992. During the same period, MTBE's share of total methanol consumption was projected to increase from 29.3 percent to 34.3 percent. (*Alternatives to Traditional Fuels: An Overview*, Energy Information Administration, June 1994, p. 19)

29 M100 has been used in light-duty vehicles on an experimental basis.

30 *Alternatives to Traditional Fuels: An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/0 June 1994, p. xi.

31 The reported retail price for M85 in California was provided by the California Energy Commission. The price represents an average retail price for the month of June 1994. The lowest retail price was 89 cents a gallon; the highest reported price was $1.139 per gallon.

32 Under the California Fuel Methanol Reserve program, the California Energy Commission issues a biannual Notice of Program Opportunity to selected methanol suppliers for commitments of methanol fuel. The notice seeks supply commitments from willing methanol producers at a threshold (market development) price determined by the state. The market development price is based on a formula designed to ensure both a stable price and reliable supply of methanol and is adjusted quarterly. The 1994 third quarter (July 1 - September 30) threshold price for neat methanol was 55 cents per gallon and 54.4 cents per gallon for M85. The fuel methanol reserve program is scheduled to sunset on December 31, 1995.

33 If methanol fuel were sold in Nebraska, it would be subject to state fuel tax of 23.9 cents per gallon.

34 This price represents the average retail price for mid-grade gasoline sold in San Francisco and Los Angeles in June 1994.

35 According to Department of Energy data, a gallon of gasoline contains 115,000 Btus, whereas a gallon of methanol contains 56,800 Btus. M85 thus contains (115,000 x 0.15) — (56,800 x 0.85) = 65,530 Btus or 57 percent of the energy content of a gallon of gasoline. *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. 50.

36 Calculation: 92 cents per gallon (retail price of M85 in California) x 1.75 (energy content factor for gasoline which has 75 percent more Btus than M85 per gallon) = $1.61.

37 Source: TECNON (UK) Ltd.

38 *Calfuels Plan: Developing an Infrastructure Plan for Alternative Fuel Vehicles*, California Energy Commission Staff Report, June 1994, p. III - 3.

39 Ibid., pp. III - 4 and 5.

40 Ibid., p. III - 8. Note: the report does not specify the size of the storage tank or the number of dispensing pumps installed.

41 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, pp. 38 and 41.

42 *Synthesis of Transit Practice 1: Safe Operating Procedures for Alternative Fuel Buses*, Acurex Environmental Corporation for the Federal Transit Administration, U. S. Department of Transportation, 1993, p. 13.

43 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 26.

44 Information on methanol vehicle oil change requirements was provided by the California Energy Commission.

45 Methanol vehicle resale information was furnished by the California Energy Commission.

46 *Alternative Fuels For Automobiles: Are They Cleaner Than Gasoline?*, CRS Report to Congress by David E. Gushee, February 27, 1992, p. 17.

47 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, pp.12 -15.

48 *Alternative Fuels in Washington State*, presentation before the Western Interstate Energy Board, June 1-3, 1994.

49 While methanol can also be produced from coal and biomass, this discussion specifically addresses methanol made from natural gas because it is the principal feedstock used in the methanol industry today and the one most likely to account for a predominant share of the feedstock mix in the near future. Argonne National Laboratory estimates that methanol from coal would result in an increase in per mile emissions of greenhouse gases of approximately 70 percent for light-duty vehicles and 100 percent for heavy-duty vehicles. The Lab estimates that methanol from wood would result in a 55 percent reduction in greenhouse gas emissions compared to conventional fuels. (*Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991, pp. 71, 72)

50 The two comprehensive studies of greenhouse gas emissions from transportation fuels are: (1)*Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991; and (2) *Comparing the Impacts of Different Transportation Fuels on the Greenhouse Effect*, Acurex Corporation for the California Energy Commission, March 1989.

51 Vehicular emissions consist of tailpipe and evaporative emissions.

52 *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991, pp. 67-70.

53 *Synthesis of Transit Practice 1: Safe Operating Procedures for Alternative Fuel Buses*, Acurex Environmental Corporation for Federal Transit Administration, U. S. Department of Transportation, 1993, p. 12.

54 *Alcohol-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 7.

55 Ibid., p. 8.

56 Soydiesel cost information was provided by the Nebraska Soybean Development and Utilization Board.

57 The federal excise tax for biodiesel and diesel fuel is the same (24.4 cents per gallon).

58 Biodiesel and diesel fuel are taxed equally by the State of Nebraska at 23.9 cents per gallon.

59 *Comparative Fuels Report*, American Movers Conference, August 1, 1994.

60 A gallon of diesel fuel contains about 127,000 Btus, whereas a gallon of neat biodiesel contains 119,000 Btus. A biodiesel blend containing 25 percent soydiesel and 75 percent diesel by volume thus contains (119,000 x 0.25) — (127,000 x 0.75) = 125,000 Btus or 98 percent of the energy content of a gallon of diesel. *Biodiesel Alert*, March 1994, p. 4.

61 According to the National Renewable Energy Laboratory, the U.S. is the largest producer of soybean crops.

62 National Renewable Energy Laboratory researchers are making progress on research and development work to demonstrate an efficient means of converting waste carbon dioxide (e.g., carbon dioxide emissions from smoke stacks) to biodiesel using microalgae lipids. During the conversion process, waste carbon dioxide is pumped into water containing fast growing microalgae. The microalgae absorb the carbon nutrient and convert it to natural oil through photosynthesis. The transesterification chemical process is then utilized to convert the stored oil into biodiesel.

63 Based on information provided by the National Renewable Energy Laboratory.

64 Source: National SoyDiesel Development Board.

65 *Biodiesel Alert*, March 1994, p. 3.

66 *Biofuels Update*, National Renewable Energy Laboratory, Winter 1994, p. 3.

67 According to researchers at the National Institute for Petroleum and Energy Research, emissions of hydrocarbons, carbon monoxide and particulate matter were reduced by approximately 5 percent with each 10 percent increment of soydiesel added to low-sulfur diesel fuel in an unmodified Cummins Celect L10 - 280 E heavy-duty engine. Emissions of nitrogen oxides, on the other hand, increased approximately 1.4 percent with each 10 percent increase of soydiesel.

68 An inverse relationship exists between production of nitrogen oxides and PM-10 during fuel combustion. Techniques designed to reduce emissions of one of the pollutants typically results in increased emissions of the other. (*Biodiesel Alert*, March 1994, p. 1)

69 *Biodiesel Alert*, May 1994, pp.1- 2.

70 Information on biodiesel fuel availability and accessibility in Nebraska was provided by the Nebraska Soybean Development and Utilization Board.

71 Fuel safety information was provided by the National Alternative Fuels Hotline at 800-423-1DOE.

72 *Alternatives to Traditional Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. xi.

73 The reported retail price of propane in Nebraska was provided by the Nebraska Propane Gas Association.

74 Operators of vehicles fueled by propane, natural gas and electricity in Nebraska do not pay the state motor fuel tax at the pump. Instead, pursuant to the *Alternative Fuel Tax Act*, these vehicle operators are required to purchase an alternative fuel user permit on an annual basis to cover their estimated annual fuel use tax liability. The *Act* specifies a formula which determines the amount of the annual fuel use tax liability for three vehicle classes: (1) passenger cars; (2) pickup trucks; and (3) buses and trucks other than pickups. The user permit is calculated as follows: a standard annual mileage of 15,000 miles is divided by a fuel economy rating for each vehicle class (25 mpg for passenger cars; 18 mpg for pickups; and 10 mpg for trucks and buses). The result is then multiplied by the average state motor fuel tax rate. Based on this formula, passenger cars require a $142.00 user permit, pickups require a $197.00 user permit and larger trucks and buses require a $356.00 user permit. On a per gallon basis, the annual tax liability is approximately 23.66 cents for passengers cars, 23.64 cents for pickups and 23.7 cents for larger trucks and buses (the cost of the user permit divided by the number of gallons estimated to be consumed in a year — 15,000 miles divided by the applicable fuel economy rating). Note: The *Alternative Fuel Tax Act* is likely to be amended in 1995 to correct for certain inequities arising from the prescriptive calculations for the user permit fee.

75 According to Department of Energy data, a gallon of gasoline contains 115,000 Btus, whereas a gallon of propane contains 84,500 Btus. Propane's reduced energy content represents about 73 percent of the energy content of a gallon of gasoline (84,500 Btus/ 115,000 Btus x 100 = 73.48). *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. 50.

76 Calculation: $0.68 cents per gallon (retail price of propane in the summer of 1994) x 1.36 (energy content factor for gasoline which has approximately 36 percent more Btus than propane per gallon) = $0.92.

77 *Calfuels Plan: Developing an Infrastructure Plan for Alternative Fuel Vehicles*, California Energy Commission Staff Report, June 1994, pp. IV- 15 and 16.

78 *Oil & Gas Journal*, June 13, 1994, p. 60.

79 *Annual Energy Outlook 1994 With Projections to 2010*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0383(94), January 1994, pp. 2, 56 and 59; and *Supplement to the Annual Energy Outlook 1994*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0554 (94), March 1994, p. 128.

80 Propane fueling station development cost information was provided by Phillips 66 Propane Company, Commerce City, Colorado.

81 Based on a telephone survey of five conversion companies located in Colorado, Nebraska and Oklahoma.

82 Source: *Propane, Fact Sheet* supplied by Phillips 66 Propane Company, Commerce City, Colorado.

83 *Gaseous-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 61.

84 *Synthesis of Transit Practice 1: Safe Operating Procedures for Alternative Fuel Buses*, Acurex Environmental Corporation for Federal Transit Administration, U.S. Department of Transportation, 1993, p. 19.

85 *Gaseous-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 61.

86 Ibid, p. 62.

87 *Workshop on Emissions Performance of Alternative Transportation Fuel Vehicle Conversions: Results of AirCare Testing of Propane and Natural Gas Vehicle Conversions*, June 23, 1994, Remarks by David Gourley, Manager, Emissions Testing and Standards, Motor Vehicle Branch, Ministry of Transportation and Highways, British Columbia.

88 Vehicular emissions consist of tailpipe and evaporative emissions.

89 *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991, pp. 67 - 69, 71 and 77.

90 *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. 86.

91 *Introduction to Alternative Fuel Vehicles*, prepared for U.S. Department of Energy by Science Applications International Corporation, January 1993, p. 29.

92 Filled propane storage tanks weigh about as much as filled gasoline tanks; fuel economy is therefore not affected by the weight of the larger propane tanks. (*Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. 86.)

93 *New Mexico Alternative Fuels Handbook*, prepared for the New Mexico Energy, Minerals and Natural Resources Department by the Western Interstate Energy Board, June 1994, p. 33.

94 Fueling time information was provided by the National Propane Gas Association.

95 Propane fire risk assessment provided by the National Alternative Fuels Hotline.

96 *Gaseous-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 66.

97 *Alternatives to Traditional Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/O, June 1994, p. xi.

98 The gas equivalent price for compressed natural gas is based on a survey of nine retail outlets in Nebraska. The lowest reported pump price was 47.3 cents per gasoline gallon, the highest reported price was 62.3 cents per gasoline gallon. Note: the state fuel tax is not reflected in the retail price for compressed natural gas due to the fact that the alternative fuel user permit replaced the tax paid at the pump effective July 1, 1994 (see endnote 74 on this page for a description of the alternative fuel user permit).

99 *Annual Energy Outlook 1994 With Projections to 2010*,Energy Information Administration, U.S. Department of Energy, DOE/EIA-0383(94), January 1994, p. 70.

100 Ibid.

101 Ibid, p. 196; and *Annual Energy Review 1993*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0384(93), p. 193.

102 *1994 Policy Implications of the GRI Baseline Projection of U.S. Energy Supply and Demand to 2010*, Gas Research Institute, 1994.

103 The federal excise tax for a gasoline equivalent gallon of natural gas was provided by the National Alternative Fuels Hotline at 800-423-1DOE.

104 See endnote 74 on this page for description of state tax treatment of natural gas as a vehicle fuel.

105 *Synthesis of Transit Practice 1: Safe Operating Procedures for Alternative Fuel Buses*, Acurex Environmental Corporation for Federal Transit Administration, U.S. Department of Transportation, 1993, p. 19.

106 *Gaseous-Fueled Vehicles, An Alternative Fuels Vehicle, Emissions and Refueling Infrastructure Technology Assessment*, Washington State Energy Office, June 1993, p. 43.

107 Ibid. p. 21.

108 Based on a telephone survey of four conversion companies located in Colorado, Nebraska and Oklahoma.

109 Based on a telephone survey of three major bus manufacturers.

110 Cannon, James S., *Drive for Clean Air: Natural Gas and Methanol Vehicles* , INFORM, 1989, pp. 58-75.

111 During a six month emissions testing period (December 1993 to May 1994) in British Columbia, between 13 and 25 percent of dedicated compressed natural gas vehicles (converted) failed each month compared with a monthly failure rate of 13.6 to 14.5 percent for gasoline vehicles. Noteworthy is the fact that no model year 1993 dedicated compressed natural gas converted vehicles failed the emissions test; however, 33.3 percent of the model year 1989 versions of these vehicles failed. Model year 1993 gasoline vehicles failed at a rate of 1.12 percent, just 0.88 percent lower than the failure rate of model year 1993 converted dual fuel compressed natural gas vehicles (two percent). Approximately one out of every three model year 1988 dual-fueled compressed natural gas vehicles failed the test, whereas about 11 percent of model year 1988 gasoline vehicles failed. (*Workshop on Emissions Performance of Alternative Transportation Fuel Vehicle Conversions: Results of AirCare Testing of Propane and Natural Gas Vehicle Conversions*, June 23, 1994, Remarks by David Gourley, Manager, Emissions Testing and Standards, Motor Vehicle Branch, Ministry of Transportation and Highways, British Columbia.)

112 In tests conducted by the Colorado Department of Health on converted compressed natural gas dual fuel light-duty vehicles, average emissions of nitrogen oxides were higher when the vehicles were operating on compressed natural gas compared to gasoline, but in both instances the emission remained below federal health standards. With respect to carbon monoxide, average emissions from both fuels exceeded federal health standards, but were highest when the vehicles were running on compressed natural gas. Emissions of nonmethane hydrocarbons from both fuels were below federal health standards, however, compressed natural gas produced fewer emissions compared to gasoline. (*Alternative Fuel Vehicle Conversions: In-Use vs. Certification Data* , Colorado Department of Health, 1993)

113 Emissions certification data on model year 1994 factory built alternative fuel vehicles was provided by the California Energy Commission.

114 From remarks of Roberta Nichols on Alternative Fuel Technologies: Research Needs, before the Western Interstate Energy Board, December 1-3, 1993, Santa Fe, New Mexico.

115 Vehicular emissions consist of tailpipe and evaporative emissions.

116 *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity, Volume 1*, Center for Transportation Research, Argonne National Laboratory, November 1991, pp. 67-70 and 77.

117 Natural gas fuel distribution information was provided by the Nebraska Blue Flame Gas Association.

118 *New Mexico Alternative Fuels Handbook*, prepared for the New Mexico Energy, Minerals and Natural Resources Department by the Western Interstate Energy Board, June 1994, p. 32.

119 Ibid.

120 1993 average electricity rate information was provided by the Nebraska Energy Office. 1993 price data is cited because it is the most recent year for which electricity sales and revenue information is available.

121 *Calfuels Plan: Developing an Infrastructure Plan for Alternative Fuel Vehicles*, California Energy Commission Staff Report, June 1994, pp. II - 4 and 5.

122 *The Energy Report*, January 31, 1994.

123 *Technical Support Document: Zero-Emission Vehicle Update*, California Environmental Protection Agency, Air Resources Board, April 1994, p. 28.

124 *Nebraska Energy Statistics 1960-1992*, Nebraska Energy Office, p. 63.

125 *Technical Support Document: Zero-Emission Vehicle Update*, California Environmental Protection Agency, Air Resources Board, April 1994, p. 35.

126 *Alternatives to Traditional Transportation Fuels — An Overview*, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0585/0, June 1994, p. 89.

127 Electric vehicle safety information was provided by the National Alternative Fuels Hotline at 800-423- 1DOE.

128 Remarks of Dr. Lawrence R. Hudson, Senior Project Manager, Transportation Technology Group, New York State Energy Research and Development Authority, before the August 1994 Conference of the National Association of State Energy Officials.

129 *Technical Support Document: Zero-Emission Vehicle Update*, California Environmental Protection Agency, Air Resources Board, April 1994, P. 10.

Alternative Fuel Vehicle Policy Initiatives and Legislation

The network of energy policy initiatives supporting increased use of alternative transportation fuels in Nebraska is expansive. While many of these measures were developed at the federal level, a number of important alternative fuels initiatives have been conceived and implemented by the State of Nebraska, independent of federal action. This chapter provides an overview of the major federal and state policy initiatives and legislation addressing alternative transportation fuels and alternative fuel vehicles. Additionally, this section updates the status of the emerging regulatory framework implementing these initiatives[130] and reviews the status of existing alternative fuel vehicle programs administered by the federal government and the State of Nebraska.

Federal Alternative Fuel Vehicle Initiatives

The federal government's multifaceted alternative fuel and vehicle program is based principally on two major pieces of legislation — the *Energy Policy Act* of 1992 and the *Clean Air Act Amendments* of 1990. The *Energy Policy Act* was enacted on October 24, 1992 and consists of 30 titles affecting a broad spectrum of energy policy issues. Six of the 30 titles contain substantive provisions relating to the development and use of alternative fuels: Title III — Alternative Fuels, General; Title IV — Alternative Fuels, Non Federal Programs; Title V — Availability and Use of Replacement Fuels, Alternative Fuels and Alternative Fueled Private Vehicles; Title VI — Electric Motor Vehicles; Title XIX — Revenue Provisions; and Title XX — General Provisions; Reduction of Oil Vulnerability. The *Clean Air Act Amendments*, signed into law on November 15, 1990, is more focused than the *Energy Policy Act* as it was designed to achieve air quality improvements in polluted communities across the nation. Of the 11 titles contained in the *Clean Air Act Amendments*, only two directly address alternative fuels: Title II — Provisions Relating to Mobile Sources; and Title IX — Clean Air Research. Following enactment of these two legislative measures, additional policy was developed to complete the nexus of federal support for increased use of alternative fuel vehicles. These federal actions include Executive Order 12844, the Federal Fleet Conversion Task Force and the Clean Cities Program. Following is a description of the key policy initiatives comprising the framework of the federal alternative fuel vehicle program.

The *Energy Policy Act* of 1992

Replacement Fuel Supply and Demand Program

Section 502 requires the U.S. Department of Energy to establish a program which promotes the replacement of petroleum fuels with domestically available alternative fuels in order to achieve three key long-term goals — reduce oil imports, improve the performance of the national economy and reduce greenhouse gas emissions.[131] Section 502 also identifies two fuel replacement program milestones and requires the federal agency to determine the feasibility of reaching them. The fuel replacement program objectives are

- ⚜ By 2000, replace 10 percent of projected petroleum motor fuels consumption with alternative fuels, on an energy equivalent basis, with at least half of replacement fuels coming from domestic resources; and
- ⚜ By 2010, replace 30 percent of projected petroleum motor fuels consumption with alternative fuels, on an energy equivalent basis, with at least half of replacement fuels coming from domestic resources.

While section 502 does not specify a date by which the fuel replacement program is to be established, preliminary work has been initiated by the agency's Office of Energy Efficiency and Renewable Energy to develop this program.

Other provisions of section 502 require the agency to assess any potential greenhouse gas implications associated with increased use of alternative fuel vehicles; determine the most suitable means and methods of encouraging alternative fuels use; identify ways to promote the development of alternative fuels and related industries in the United States, including identification of barriers to such development; and estimate existing production capacity to meet the fuel replacement goals. The agency was directed to complete this analysis before October 1, 1993. The Department has completed preliminary study work on these issues and plans to present their findings to Congress in 1995. A lack of funding has constrained progress in this program area.

The fuel replacement goals specified in section 502 should not be misconstrued as mandates. In fact, Section 504 expressly prohibits the Department from mandating the production or delivery of alternative fuels and vehicles under the *Act*. It is also important to note that section 504 provides for periodic modifications to these goals. Before November 1995 and periodically thereafter, the agency must evaluate the goals and adjust them through rulemaking if they are deemed to be unachievable. The Department plans to review the replacement fuel goals once the program is underway.

To achieve the fuel replacement goals specified in section 502, the agency will attempt to obtain voluntary commitments from fuel suppliers, vehicle suppliers and fleet owners in different geographic regions of the United States pursuant to section 505. Section 505 requires the Department to seek voluntary commitments beginning in 1994, to report to Congress on the results of such efforts and to inform the public of any established voluntary commitments. The agency's efforts to secure voluntary commitments from fuel suppliers and local communities are proceeding under its Clean Cities Program (see description of Clean Cities on page 52).

Section 503 requires the Department to estimate on an annual basis for each following calendar year, beginning in 1993, the numbers and geographic distribution of each type of alternative fuel vehicles in use in the United States, the amount and distribution of each type of replacement fuel and the greenhouse gas emissions produced from replacement fuel use. In addition, beginning in 1994 and each year thereafter, fuel suppliers and alternative fuel vehicle manufacturers must provide the agency with information concerning alternative fuel supplies and vehicle production. The agency's Energy Information Administration satisfied section 503 requirements when it issued its first report, *Alternatives to Traditional Transportation Fuels: An Overview,* in June 1994.

Lastly, with respect to the fuel replacement program, Section 506 requires the Department to submit a report to the President and Congress which provides an update on progress made towards achievement of the fuel replacement goals, evaluates the role of alternative fuels and vehicles in reducing consumption of imported oil and assesses the availability of alternative fuels, dedicated vehicles and dual fueled vehicles. Information is being collected by the agency's Office of Energy Efficiency and Renewable Energy for this report and study work is being coordinated with the analysis required under section 502. The report is expected to be issued by March 1995.

Alternative Fuel Vehicle Purchase Mandates

The *Energy Policy Act* will dramatically increase alternative fuel vehicle use by requiring certain "covered fleets" to purchase increasing numbers of vehicles capable of running on alternative fuels. A "covered fleet" is a group of 50 or more vehicles, of which at least 20 are light-duty and capable of being centrally refueled. Additionally, the fleet must be controlled by a single entity or set of affiliated owners and operated in an area of 250,000 people or more. (Omaha is the only city in Nebraska which meets this population requirement.) Vehicles excluded from the "covered fleet" definition include those held for public rental or lease, dealer vehicles held for resale, law enforcement and emergency response vehicles, military vehicles, nonroad vehicles such as farm and construction vehicles and cars normally garaged at personal residences overnight. Under the *Act*, three categories of "covered fleets" are initially mandated to purchase light-duty (8,500 pounds or less) alternative fuel vehicles. They are federal government fleets, pursuant to Section 303, state government fleets, pursuant to Section 507 and fleets operated by providers of alternative fuels, pursuant to Section 501. Covered fleets are required to meet the alternative fuel vehicle acquisition provisions of the *Act* by purchasing either dedicated or dual fueled alternative fuel vehicles in accordance with the schedules appearing in the table below.

Schedule of Alternative Fuel Vehicle Purchase Mandates for Covered Fleets under the Energy Policy Act

	Federal Gov't (Fiscal Year) (Number of vehicles/percent of purchases)	State Gov't (Model Year) (Percent of purchases)	Private Sector Alternative Fuel Providers (Model Year)[132] (Percent of) purchases)
1993	5,000	N/A	N/A
1994	7,500	N/A	N/A
1995	10,000	N/A	N/A
1996	25%	10%	30%
1997	33% of new vehicles	15%	50%
1998	50%	25%	70%
1999	75%	50%	90%
2000+	75%	75%	90%

Federal fleet alternative fuel vehicles purchased under Section 303 are required to refuel at commercial fueling facilities to the maximum extent practicable in accordance with Section 304. Section 304 also authorizes federal agencies to enter into commercial arrangements for purposes of fueling in the event that publicly available fueling sites are not convenient or accessible. While the *Act* does not contain similar refueling provisions applicable to alternative fuel provider and state alternative fuel vehicle fleets, the federal fleet refueling requirement alone may effectively accelerate alternative fuel vehicle fueling infrastructure development in areas where federal fleets operate.

In lieu of states having to purchase new alternative fuel vehicles to meet the annual purchase mandates described in the table above, Section 507 allows each state to prepare a light-duty vehicle plan providing for voluntary vehicle conversions in accordance with a rule to be promulgated by the Department of Energy. According to Section 507, a proposed state plan would have to be approved by the federal agency and, at a minimum, provide for voluntary conversions and/or acquisitions of alternative fuel vehicles by state, local or private fleets in numbers greater than or equal to those specified by the state fleet purchase mandate. Section 507 directs the federal agency to promulgate regulations governing the state fleet program before May 1994. The Department recently decided to include the rulemaking requirement for the state fleet program with the rule for Section 409, State and Local Incentives Programs (see Chapter IV for discussion of financial incentives) and expects to issue a Notice of Proposed Rulemaking by the end of 1994.

In addition to federal, state and fuel provider fleets, other private sector and municipal "covered fleets" may be required to purchase alternative fuel vehicles. Pursuant to Section 507, the federal agency shall make a determination on whether other fleets previously not mandated to acquire alternative fuel vehicles should be required to do so in order to realize the fuel replacement goals stated in Section 502 (10 percent by 2000 and 30 percent by 2010). The Department is required to evaluate the need for expanding the alternative fuel vehicle purchase mandates in time to promulgate a final rule on the matter by

December 15, 1996.[133] The Department may have an advanced notice of proposed rulemaking prepared by June 1995. The expanded alternative fuel vehicle fleet requirement would begin in 1998, or at a later date determined by the agency, in accordance with the *Act*.

Private Sector and Municipal Alternative Fuel Vehicle Fleet Purchase Schedule (Optional)

- 20 percent in model years 1999, 2000 and 2001
- 30 percent in model year 2002
- 40 percent in model year 2003
- 50 percent in model year 2004
- 60 percent in model year 2005
- 70 percent in model year 2006 and all years thereafter

If, by December 15, 1996, the Department determines that an expanded alternative fuel vehicle fleet requirement is not necessary to accomplish the goals of fuel replacement, the Department shall reevaluate the need for such a requirement by the year 2000. If the agency determines at such time that an expanded fleet requirement is needed, the alternative fuel vehicle purchase percentages and dates will be adjusted as follows:

- 20 percent in model year 2002
- 40 percent in model year 2003
- 60 percent in model year 2004
- 70 percent in model year 2005 and all years thereafter

In accordance with Section 508, "covered fleets" may earn a credit for each alternative fuel vehicle acquired in excess of the annual percentage requirement and/or for each alternative fuel vehicle acquired before the start of the program. Credits may be transferred to other "covered fleets" and/or deferred for future purchase requirements. A Notice of Proposed Rulemaking clarifying the role of credits is expected to be issued by the agency by the end of 1994. This rulemaking action is proceeding in conjunction with a proposed rule required under Section 501 governing the alternative fuel provider vehicle fleet program. Section 501 requires the agency to issue regulations by 1994. However, due to lack of funds and insufficient staff, issuance of regulations under sections 501 and 508 is not expected until March 1995.

Public Information Requirements

Section 407 requires the Department to establish a data collection program by November 1993 in at least five geographically and climatically diverse regions of the nation. The purpose of the program is to collect data "which would be useful to persons seeking to manufacture, convert, sell, own or operate alternative fueled vehicles or alternative fueling facilities." Such data shall include information on cost, performance and environmental impacts attributed to alternative fuels; the number and types of vehicle trips made daily; projected combinations of alternative fuel vehicle use and other forms of transit; and other information deemed relevant by the agency. The Department's Energy Information Administration was granted a one-year extension to develop this program. The cornerstone of the planned data collection program will be to establish alternative fuel vehicle data collection centers in several urban areas participating in the Department's Clean Cities program (see p. 52 for description of the Clean Cities program). To date, a pilot program has been set up in Atlanta and a program implementation plan is expected to be issued by 1995.

Section 405 augments Section 407 as it requires the agency to establish a public information program before May 1994 for the purpose of promoting the use of alternative fuel vehicles. This provision specifically directs the Department to produce and make available to the public an "information package for consumers to assist them in choosing among alternative fuels and alternative fueled vehicles." Section 405 details the content of the information package, which shall include, among other things, information on alternative fuel vehicles and alternative fuel characteristics compared to gasoline on a life cycle basis and information on vehicle conversions. The Department is required to update the information package annually. To meet this requirement, Argonne National Laboratory recently released *Taking an Alternative Route* and a series of brochures called "Fast Fuel Facts."

Section 406 requires the Federal Trade Commission to issue a Notice of Proposed Rulemaking for a rule establishing uniform labeling standards for alternative fuels and vehicles. The labeling standards are intended to convey sufficient information to prospective consumers so that they may weigh the costs and benefits of using a particular fuel and vehicle. On May 9, 1994, the Commission published the required Notice of Proposed Rulemaking in the *Federal Register*. For alternative fuels, the Commission proposes that retailers of nonliquid alternative fuels post standard labels identifying the common names of those fuels (compressed natural gas, hydrogen and electricity) on fuel dispensers and electric vehicle recharging stations. The Commission also proposes requiring disclosure of each fuel's principal component and permitting disclosure of other components, expressed as minimum percentages. With respect to the alternative fuel vehicle labeling requirement, the Commission proposes the use of a standard label consisting of three parts. The first component would disclose fuel tank capacity for purposes of assisting consumers in estimating vehicle range. The second part of the label would list factors consumers should consider before purchasing an alternative fuel vehicle, including fuel type, operating costs, environmental impact, health and safety, on road performance and fuel availability. Each factor appearing on the label would be supplemented with a brief statement explaining how it is relevant to an alternative fuel vehicle purchase. The third component of the label would direct consumers to additional sources of objective information concerning alternative fuel vehicles. A final rule on this matter is due by April 25, 1995.

Section 305 directs the Department of Energy and the General Services Administration to jointly disseminate information on alternative fuel vehicles to federal agencies as part of a campaign to educate federal government employees on the benefits of alternative fuel vehicle use. The two agencies are required to provide other federal agencies with information concerning federal fleet alternative fuel vehicle procurement and placement activities, state and local government programs and private sector initiatives. During calendar year 1994, the Department of Energy and the National Renewable Energy Laboratory will conduct alternative fuel vehicle information workshops at a number of the General Services Administration sponsored Interagency Motor Equipment Advisory Committee annual conferences. In addition, the energy agency and the National Renewable Energy Laboratory are developing a technical guide addressing alternative fuel vehicle safety, performance, driving and refueling issues specific to compressed natural gas, liquefied petroleum gas, methanol and ethanol powered vehicles.

Federal Agency Reports to Congress

U.S. Department of Energy

- Section 412 requires the agency to assess the potential contribution that alternative fuels use in nonroad vehicles and engines could make in reducing the transportation sector's reliance on imported oil.[134] The Department is directed to complete the study and report its findings to Congress before May 1994. The Department expects the report to be completed by the end of 1994.
- Pursuant to Section 413, the Department must report to Congress prior to May 1994 on how the purchasing policies of the federal government inhibit the introduction of alternative fuel vehicles into federal government fleets and how the use of alternative fuel vehicles can be promoted through exemptions or other types of preferential treatment under federal, state and local traffic control measures. The final version of this report is now being edited.
- Section 615 requires the Department to explore various methods for encouraging the use of electric vehicles and then present its findings to Congress before May 1994. Section 615 also directs the Department to report annually to Congress on the progress of electric vehicle commercial demonstration projects funded under Title A. A Department report on the costs associated with the purchase and use of electric vehicles is currently in draft form.

General Services Administration

- The agency is directed by Section 310 to report to Congress by November 1993 and every two years thereafter, on its alternative fuel vehicle program. The agency's report to Congress shall address, among other things, the number and type of alternative fuel vehicles procured, the location of alternative fuel vehicles, the number of alternative fuel vehicles used by each federal agency, the extent of coordination among federal, state and local governments with respect to procurement and placement and arrangements with commercial entities for refueling and maintenance of the vehicles. Copies of the agency's first report to Congress are available to the public at no charge. The second report is due in 1995.

U.S. Postal Service

- The Postal Service must also report to Congress on its alternative fuel vehicle program on the same basis. The content of the Postal Service's report to Congress, as specified in Section 311, is similar to that of the General Service Administration's. The Postal Service is required to address several additional items including the number and type of alternative fuel vehicles procured prior to enactment of the *Act*, incentives to promote the use of alternative fuels in dual fuel vehicles and an assessment of the program's success and policy recommendations which may enhance the effectiveness of the program. Section 311 also directs the Postal Service to coordinate its alternative fuel vehicle "procurement, placement, refueling and maintenance programs with those at the Federal, State and local level." Unlike the Postal Service, the General Service Administration is not explicitly required by the *Act* to coordinate its program with other governmental actions and private sector initiatives. Copies of the Postal Service's program report to Congress are available to the public at no charge.

Certification of Alternative Fuel Vehicle Technicians

Section 411 directs the federal government to develop a national program for the certification of training programs for alternative fuel vehicle conversion technicians. The Department of Energy is currently working with outside stakeholders including automakers, fuel providers and educators to develop this program. The certification programs for compressed natural gas and propane technician training are expected to begin by Spring 1995.

Safety Standards for Vehicle Conversions

Pursuant to Section 507(o)(2)(B), the Department of Transportation must promulgate rules establishing safety standards for vehicle conversions by November 1995. Rulemaking for the safety standards is in progress. (Also see the section under the *Clean Air Act Amendments*.)

Alternative Fuel Vehicle Related Research and Development Provisions

Subtitle B of Title XX (Sections 2021-2028) designates the Department of Energy as the lead agency in charge of the federal government's alternative fuel vehicle research and development programs. Pursuant to Section 2022, the Department is to establish a program to develop technologies which improve the fuel economy and emissions performance of light-duty vehicles powered by a conventional internal combustion engine and hybrid vehicles powered by an internal combustion engine/electric motor system. Research and development activity in this area is being coordinated by the Department and will involve significant private sector participation. Section 2023 authorizes the Department to enter into 50/50 cost shared cooperative agreements with public or private entities to support general research and development (excluding electric vehicles). Research and development work in this area is occurring under the Department's Alternative Fuel Vehicle Program. Section 2024 requires the agency to establish a "bifuels user facility to expedite industry adoption of bifuels technologies, including production of alcohol fuels from biomass." In August 1994, the National Renewable Energy Laboratory opened up a new $14 million bifuels production pilot plant. Amoco Corp., the first industry customer scheduled to use the facility, will test the feasibility of making ethanol from wastepaper. Section 2025 complements Section 2023 as it requires the agency to launch a comprehensive electric vehicle research and development program allowing for substantial private sector participation. Existing research and development activities in this area have been expanded and supplemented to accelerate the development of electric vehicles and associated equipment. Lastly, Section 2026 of Title XX directs the agency to conduct a renewable hydrogen energy systems program to develop hydrogen use in fuel cell powered electric vehicles. The Department is currently in the process of reviewing proposals and will soon issue awards for research and development work in this area.

Section 408 authorizes the Federal Energy Regulatory Commission to allow natural gas companies to recover in their rate filings research and development costs of the Gas Research Institute relating to the use of natural gas as a transportation fuel. Section 408 also permits the Commission to allow electric utilities to recover expenses in advance for research and development work on electric vehicles by the Electric Power Research Institute.

Section 410 permits the Department of Transportation to enter into cooperative agreements and joint ventures with any municipal, county or regional transit authority in an urban area with a population in excess of 100,000 (according to latest census data) to "demonstrate the feasibility of commercial application, including safety of specific vehicle design, of using alternative fuels for urban buses and other motor vehicles used for mass transit." Nonfederal participants in any such demonstration program must provide at least 20 percent of the demonstration costs in order to receive financial assistance from the agency. Funding has not been appropriated for this program.

Subtitle A of Title VI (Sections 611-616) establishes a program under the Department of Energy for the commercial demonstration of electric vehicles and associated recharging devices. The mission of this program is to accelerate the development and introduction of electric vehicles, track the performance of electric vehicles and evaluate the associated recharging infrastructure. Section 611 directs the agency to solicit proposals from nonfederal entities, prior to May 1994, for demonstration projects to be conducted in eligible metropolitan areas. Section 601 defines eligible metropolitan areas as those areas with a 1980 population in excess of 250,000 or as the agency approved areas with a 1990 population of 50,000 or more. As part of any electric vehicle demonstration project under Subtitle A, project sponsors are required to provide information to the Department regarding the "operation, maintenance, performance and use..." of the participating electric vehicles. According to Section 612, each demonstration project must include at least 50 electric vehicles, unless the agency determines that a smaller number of vehicles is sufficient. The agency is authorized by Section 613 to pay the incremental costs of the participating vehicles up to $10,000 per vehicle. Section 614 further states that at least 50 percent of the project costs shall come from nonfederal sources, unless the Department determines that a lower percentage is sufficient.

The electric vehicle demonstration program provided for under Subtitle A is complemented by an electric vehicle infrastructure and support systems development program established under Subtitle B (Sections 621-626). Section 622 directs the Department of Energy to solicit proposals by May 1994 from nonfederal entities, including fleet operators, for cost shared research, development or demonstration projects addressing "the infrastructure and support systems needed to support the development and use of energy storage technologies, including advanced batteries and the demonstration of electric vehicles." The agency is authorized to contribute up to $4 million per project and directed to coordinate activities under Subtitle B with those funded under Subtitle A. Lastly, Section 625 requires the agency to perform a study to "determine the means by which electric utilities may invest in, own, sell, lease, service or recharge batteries used to power electric motor vehicles." Work in the area of electric and hybrid vehicle development is ongoing and involves participation from the national labs and the private sector.

The *Clean Air Act Amendments* of 1990

Clean Fuel Fleet Program

Part C, Title II of the *Clean Air Act Amendments* establishes a clean fuel vehicle program under the direction of the Environmental Protection Agency. The clean fuel vehicle program constitutes the first federally administered program to require the use of clean alternative fuels in nonfederal fleets. It is important to note that the *Act* does not restrict "clean fuels" to alternative fuels; reformulated gasoline and diesel are also defined as clean alternative fuels and are therefore eligible to compete with alternative fuels in the clean fuel vehicle program.[135]

The first component of the program mandates the use of clean fuel vehicles in "covered fleets" operating in certain nonattainment areas. "Covered fleets" consist of ten or more vehicles capable of being centrally refueled that operate in serious, severe or extreme ozone nonattainment areas and in nonattainment areas with a carbon monoxide design value at or above 16 parts per million (excluding those areas where mobile sources do not contribute significantly to carbon monoxide exceedances). Qualifying nonattainment areas must also have a 1980 population of 250,000 or more. Beginning with model-year 1998, "covered fleets" operating in these areas are required to purchase clean fuel vehicles and/or convert existing conventionally fueled vehicles to clean fuel use in accordance with the following schedule:

- 30 percent of new light-duty vehicles and light-duty trucks in model year 1998;
- 50 percent in model year 1999; and
- 70 percent in model year 2000 and all years thereafter.
- For heavy-duty vehicles (between 8,500 lbs. gross vehicle weight rating and 26,000 lbs. gross vehicle weight rating), the clean fuel vehicle purchase mandate stays at a constant 50 percent beginning with model year 1998.

Clean fuel vehicles qualifying for the program must be certified to meet any one of three emission standards — Low-Emission Vehicle, Ultra-Low Emission Vehicle and Zero-Emission Vehicle. These standards are identical to the California emission standards described in endnote 5. All clean fuel vehicles shall be exempt from any transportation control measures that restrict vehicle usage. Additional exemptions from transportation control measures will be available for clean fuel vehicles meeting EPA's Inherently Low-Emission Vehicle criteria. An inherently low-emission vehicle is a vehicle which qualifies as a clean fuel vehicle, meets the ultra low-emission vehicle standard for nitrogen oxides, meets a low evaporative emissions standard without control devices and is not allowed to run on higher emitting fuels. EPA has determined that initially, these vehicles will be allowed to use High Occupancy Vehicle lanes; other exemptions/incentives are under consideration.

Under the clean fuel vehicle program, "covered fleets" will earn credits for acquiring clean fuel vehicles which may then be used to demonstrate compliance with the acquisition schedule, or sold or traded to other "covered fleets" operating in the same nonattainment area.[136] Additionally, by following EPA guidelines, emissions credits obtained for clean fuel vehicles may even be traded to stationary sources, as long as the purchaser and seller both operate within the same nonattainment area. Exempted from the clean fuel fleet program are emergency vehicles, off road vehicles, rental cars, demonstration cars and privately garaged vehicles. To date, 21 ozone nonattainment areas are required to participate in the program; Denver, Colorado is the only carbon monoxide nonattainment area directed to participate. No Nebraska cities are included in the program.

The second component of the clean fuel vehicle program calls for the establishment of a pilot program in California wherein automobile manufacturers are required to produce and distribute for sale at least 150,000 clean fueled light-duty trucks and vehicles in model years 1996-98. For model year 1999 and all years thereafter, auto makers must provide at least 300,000 clean fuel vehicles for sale in the state.[137] The purpose of the California pilot program is to "demonstrate the effectiveness of clean fuel vehicles in controlling air pollution in ozone nonattainment areas." (Section 249) Although not required to do so, other states claiming serious, severe or extreme ozone nonattainment areas may "opt-in" to the California pilot program.

The EPA published a final rule governing the clean fuel fleet credit program in the March 1, 1993 *Federal Register*. Regulations implementing other provisions of the clean fuel vehicle program, including emission standards and testing procedures for converted vehicles, were published in the September 30, 1994 *Federal Register*.

Vehicle Conversion Standards

Section 247(e) authorizes the Department of Transportation to develop regulations regarding the "safety of vehicles converted from existing and new vehicles to clean fuel vehicles." In addition, Section 250(c) directs the Department to issue regulations regarding the "safety and use of fuel storage cylinders and fuel systems, including appropriate testing and retesting, in conversion of motor vehicles." The National Highway Traffic Safety Administration published a final rule establishing safety standards for compressed natural gas vehicle fuel systems in the April 25, 1994 *Federal Register*. The final rule establishing a new federal motor vehicle safety standard for compressed natural gas fuel containers was published in the September 26, 1994 *Federal Register.* Safety standards for other types of alternative fuel vehicles are being developed by the agency.

Fuels Research Program

Section 901(d)(2) directs the EPA to establish a research program to determine the risks and benefits to both human health and the environment resulting from the use of clean alternative fuels compared to gasoline and diesel. While this particular section of the *Clean Air Act Amendments* does not specify a date by which work in this area is to be completed, the agency's Office of Research and Development is currently conducting risk characterization studies for various motor fuels in cooperation with the auto industry. According to the Office of Research and Development, a comprehensive comparative risk assessment addressing both alternative fuels and conventional fuels will be performed when the risk characterization studies for each of the motor fuels are completed.

Executive Order 12844

Executive Order 12844, signed by President Clinton on April 21, 1993, requires the federal government to acquire, subject to the availability of funds and life cycle costs, 50 percent more alternative fuel vehicles than required under the *Energy Policy Act* between 1993 and 1995.[138] In addition, the Order called for the creation of a Federal Fleet Conversion Task Force to advise on the implementation of the Order.

Federal Fleet Conversion Task Force

This 33-member Task Force, established via Executive Order 12844, was granted a one-year charter (terminating on April 22, 1994) to craft a plan for converting the federal government's fleet to alternative fuels. As part of its proposed strategy, the Task Force prioritized 38 geographic areas into three tiers where federal fleet alternative fuel vehicle purchases and placement should be accelerated. The Task Force also strongly recommended the development of "a locally based, grassroots process to stimulate demand for and to integrate alternative fuel vehicles into, public and private fleets in targeted geographic areas." (*The First Interim Report of the Federal Fleet Conversion Task Force*, p. 19). The Department of Energy is in the process of developing a strategy to implement these Task Force recommendations within the framework of the Department's Clean Cities Program.

Clean Cities

The Department of Energy's Clean Cities Program is a voluntary program designed to encourage the development of markets for alternative fuels and vehicles in urban areas of all sizes. The Clean Cities Program involves many stakeholders, including fuel suppliers, fleet managers, automobile manufacturers, utilities and federal, state and local governments, working together to coordinate the acquisition and placement of substantial numbers of alternative fuel vehicles in participating communities. A second key objective of the program is to promote the development of the refueling infrastructure needed to support the alternative fuel vehicles. Under the program, the Department will assist Clean Cities participants by initiating and facilitating meetings and providing technical information and assistance. Any Clean Cities program which exceeds its objectives or goals will be eligible to receive a Citation for Exceptional Merit. The national goal of the Clean Cities Program is the acquisition and operation of at least 250,000 alternative fuel vehicles and the installation of 1,000 new fueling stations throughout the U.S. by 1996. To date, 34 cities have secured the Clean Cities designation.

Alternative Fueled Vehicle Initiatives of the State of Nebraska

Policy in support of alternative fuels use in Nebraska emerged at the state level in 1979 when the Governor issued a proclamation that all state vehicles must be fueled with 10 percent ethanol blends whenever practical. Another important policy directive was issued in 1987 when the Governor requested the Nebraska Energy Office to actively coordinate the development and use of ethanol fuels in the transportation sector. This was followed in 1991 by Governor Nelson's successful effort to initiate the formation of the Governors' Ethanol Coalition, a multi-state group devoted to the promotion of ethanol. Additional state policy support for alternative fuel vehicles evolved later in 1992 with issuance of the Governor's *Energy Action Plan for Nebraska*. The *Energy Action Plan* contained a number of objectives designed to increase the use of alternative fuel vehicles in both public and private sector fleets and to facilitate the development of the necessary refueling infrastructure. Lastly, in 1993, Nebraska became a member of both the Mid-States Natural Gas Vehicle Coalition and the Southwest Natural Gas Vehicle Zone. Following are highlights of the key goals which have been established and the various programs developed to date as part of Nebraska's alternative transportation fuels initiative.

The Governors' Ethanol

The Governors' Ethanol Coalition, formed in September 1991, is comprised of 19 states. The Coalition's mission is succinctly stated in its 1992 policy statement:

> "It is the Coalition's goal to increase the use of ethanol based fuels to decrease the nation's dependence on imported energy resources, improve the environment and stimulate the national economy. This will be accomplished through a coordinated set of activities designed to educate and demonstrate to the public the benefits of ethanol use; to encourage ethanol fuel production and use through research and market development efforts; and to make investments in infrastructure to support expansion of the ethanol market. The Coalition supports the production of ethanol from corn or other domestic, renewable resources using sustainable agricultural methods and encourages its use in environmentally acceptable applications."

The Nebraska Energy Office serves as the Coalition's headquarters and administers the group's funds. In 1993, the Coalition asked Nebraska to perform a comprehensive study documenting the economic benefits of ethanol. The report is being developed by the state Energy Office.

The *Energy Action Plan* for Nebraska

Alternative Fuel Vehicles in State Fleets

The first objective of the *Energy Action Plan* established a goal of substantially increasing the number of light-duty alternative fuel vehicles operating in the state fleet by urging adherence to the following acquisition schedule:

- 10 percent of new light-duty vehicles purchased in model years 1994, 1995 and 1996;
- 15 percent in model year 1997;
- 25 percent in model year 1998;
- 50 percent in model year 1999; and
- 75 percent in model year 2000 and all years thereafter.

The state successfully met its model year 1994 alternative fuel vehicle acquisition goal of 10 percent by purchasing 54 flexible fuel vehicles capable of operating on E85.

Refueling Infrastructure Development

A second objective of the *Energy Action Plan* directed the state to make arrangements for the fueling of alternative fuel vehicles in the state fleet. To meet the refueling needs of state operated alternative fuel vehicles, three E85 refueling stations were installed — one at the Transportation Services Bureau's garage in Lincoln, a second at the Department of Roads' facility in Lincoln and a third at the Department of Roads' Grand Island facility.

Financial Incentives

To accelerate the introduction of alternative fuel vehicles in fleets operating within Nebraska, the *Energy Action Plan* directed the state to provide financial incentives for the purchase or conversion of vehicles to alternative fuel use and for installation of fueling stations. The Nebraska Energy Office established a no interest loan fund under the School Weatherization Program for school bus conversions or purchases of original equipment alternative fuel vehicles. The Dollar and Energy Saving Loan Program was also expanded to accommodate loans supporting alternative fuel projects. For a description of these two sources of financial assistance, see page 60.

The Nebraska Alternative Fuels Committee

An additional goal of the *Energy Action Plan* called for establishment of an alternative fuels advisory committee to develop strategies for decreasing the state's consumption of petroleum products, particularly in the transportation sector. On April 22, 1993, Governor Nelson signed Executive Order 92-2 creating the Nebraska Alternative Fuels Committee. The Committee consists of representatives from a wide range of public and private sector organizations and is chaired by the director of the Nebraska Energy Office.[139] The Order directs the Committee to develop and recommend strategies which promote increased use of alternative transportation fuels in Nebraska. Other important tasks with which the Committee is charged include identifying barriers to increased alternative fuel vehicle use, informing the public about the development of a refueling infrastructure in the state and tracking the supply of fuel and the demand for vehicles in the state. The Order also created a new position called the Nebraska Alternative Fuels Transportation Coordinator. The Administrator of the Department of Administrative

Service's Transportation Service Bureau is specifically designated by the Order to occupy this new position and to disseminate information to state agencies and local government subdivisions regarding alternative fuel vehicle acquisitions and fueling station locations.

Southwest Natural Gas Vehicle Zone

In June 1993, Governor Nelson signed a letter of proclamation authorizing the State of Nebraska to join Arkansas, Arizona, Kansas, Louisiana, New Mexico, Oklahoma and Texas in becoming a member of the Southwest Natural Gas Vehicle Zone. The objective of this multi-state initiative is to establish a fueling infrastructure along the major transportation corridors, particularly the national interstate highways linking member states. The ultimate goal is to extend the Southwest Natural Gas Vehicle Zone nationwide.

The Mid-States Natural Gas Vehicle Coalition

Since 1993, Nebraska has maintained membership in the Mid-States Natural Gas Vehicle Coalition. The Coalition is comprised of ten states (Arkansas, Colorado, Kansas, Louisiana, Montana, Nebraska, New Mexico, Oklahoma, Texas and Wyoming) and functions to promote the use and development of natural gas vehicles among its membership. The group also seeks to influence the development and implementation of state incentives and governmental policies facilitating increased use of natural gas as a vehicle fuel.

END NOTES

130 For further updates on the status of rulemaking activities regarding the alternative fuel related provisions of the *Energy Policy Act* of 1992 and other legislation contact the National Alternative Fuels Hotline at 800-423-1DOE.

131 The *Energy Policy Act* defines alternative fuels as methanol, ethanol and other alcohols in concentration of at least 85 percent by volume with gasoline or diesel (but not less than 70 percent as determined by the Secretary through rulemaking), natural gas, liquefied petroleum gas, hydrogen, coal derived liquid fuels, nonalcohol biofuels, electricity and any other fuels determined by the Department through rulemaking (Sec. 301).

132 For electric utilities planning on satisfying the alternative fuel vehicle acquisition mandates with electric vehicles, the requirements will not take effect until January 1, 1998. A Notice of Proposed Rulemaking for Section 501 provisions is expected to be issued by the end of 1994.

133 In testimony before Congress, Assistant Secretary for Energy Efficiency and Renewable Energy Christine Ervin reported that the private/municipal fleet program is probably necessary, but not sufficient, to meet the fuel replacement goal of 30 percent by 2010.

134 According to Section 412, nonroad vehicles and engines include those used for "surface transportation or principally for industrial or commercial purposes, vehicles used for rail transportation, vehicles used at airports, vehicles or engines used for marine purposes and other vehicles or engines at the discretion of the Secretary."

135 The *Clean Air Act Amendments* define clean alternative fuels as any fuel (including reformulated gasoline, diesel and the alternative fuels defined under the *Energy Policy Act*) or power source (e.g., electricity) used in a clean fuel vehicle that complies with the standards and requirements applicable to such a vehicle.

136 Credits awarded for the various classes of clean fuel vehicles (e.g., low-emission vehicle, ultra low-emission vehicle) are weighted to reflect the level of emission reductions achieved by the vehicle.

137 The EPA anticipates that the clean fuel vehicle requirements of the California pilot program will be met through implementation of the state's Low-Emission Vehicle and Zero-Emission Vehicle Program (see discussion of this program under endnote 5 on page 38).

138 The federal government fleet alternative fuel vehicle purchase mandates contained in the *Energy Policy Act* are adjusted by Executive Order 12844 as follows: in Fiscal Year (FY) 1993 — from 5,000 to 7,500 alternative fuel vehicles; FY-1994 — from 7,500 to 11,250; and FY-1995 — from 10,000 to 15,000.

139 According to the Order, the Committee shall be composed of one representative from each of the following: League of Nebraska Municipalities; Lincoln Transportation System; Metropolitan Area Transit Administration; Nebraska Association of School Administrators; Nebraska Association of Transportation Providers; Nebraska Blue Flame Natural Gas Association; Nebraska County Officials Association; Nebraska Department of Education; Nebraska Ethanol Board; Nebraska Motor Carriers Association; Nebraska New Car Dealers Association; Nebraska Petroleum Marketers; Nebraska Power Association; Nebraska Department of Administrative Services, Transportation Services Bureau; Nebraska Department of Agriculture; Nebraska Department of Environmental Quality; Nebraska State Energy Office; Nebraska Department of Roads; Nebraska Soybean Board; Propane Gas Association of Nebraska; University of Nebraska; one member to represent consumers; one member to represent conservation interests; and two representatives from the state's private fleet operators.

Financial Incentives for Vehicle Conversions and Infrastructure Development

While alternative fuel vehicle use may result in transportation cost savings over the lifetime of the vehicle compared to conventionally fueled vehicles, market surveys reveal that the high initial purchase price of original equipment manufacturer alternative fuel vehicles and the incremental costs of vehicle conversions deter many prospective fleet operators from switching to alternative fuels. In addition, the high capital cost of installing alternative fuel refueling facilities has proven to be an obstacle to accelerated development of the fueling infrastructure needed to support alternative fuel vehicles. To help prospective alternative fuel vehicle owners and fueling station developers overcome these cost barriers, a number of financial incentive programs have been established. This chapter surveys the various sources of financial assistance available from the federal government, the State of Nebraska and nongovernmental sources in the state. Lastly, the chapter concludes with a description of several financial assistance/incentive programs offered by private sector fuel providers in other states.

Federal Sources

The *Energy Policy Act* of 1992

Tax Credits and Deductions

Section 1913 permits tax deductions for qualified clean fuel vehicle property and qualified clean fuel refueling property. Clean fuels are defined as natural gas, liquefied petroleum gas, blends of alcohol and gasoline containing not less than 85 percent alcohol by volume, hydrogen and electricity. Effective June 30, 1993, owners of clean fuel vehicles (factory built and converted) meeting federal and state standards for emissions, testing and warrantee requirements are eligible for tax deductions in the tax year such vehicles are placed in service. Tax deductions for the incremental costs of certain clean fuel vehicles are currently available with the following restrictions:

- ✤ up to $2,000 for light-duty vehicles;
- ✤ up to $5,000 for medium-duty trucks (10,000 to 26,000 lbs gross vehicle weight rating);
- ✤ up to $50,000 for heavy-duty trucks (gross vehicle weight rating more than 26,000 lbs.); and
- ✤ up to $50,000 for buses with a seating capacity of at least 20 passengers.

Businesses constructing clean fuel refueling facilities are also eligible for tax deductions during the taxable year such facilities are placed in service. The maximum tax deduction that an owner of a clean fuel refueling property can claim is currently set at $100,000.

Lastly, Section 1913 provides a tax credit (an offset against taxes owed) equal to 10 percent of the cost of an electric vehicle or $4,000, whichever is lower, during the taxable year the electric vehicle is placed in service. Both the tax deductions and credits will be gradually phased out between 2002 and 2004. For more information see 26 U.S. Code, Sections 30 and 179A and IRS Publication 535, Catalogue No. 15065Z. The following table summarizes the alternative fuel vehicle and refueling station tax incentives contained in the *Energy Policy Act*.

Alternative Transportation Fuel Related Tax Incentives of the Energy Policy Act *of 1992*

Tax incentives:

- ■ Tax deduction per vehicle;
  - ● Up to $2,000 for vehicles weighing up to 10,000 lbs.
  - ● Up to $5,000 for vehicles weighing from 10,001 to 26,000 lbs.
  - ● Up to $50,000 for vehicles weighing over 26,000 lbs.
  - ● Up to $50,000 for buses seating 20 or more people
- ■ Tax credit per vehicle:
  - ● 10 percent up to $4,000 for electric vehicles
- ■ Tax deduction per fueling site:
  - ● Up to $100,000 per fueling site

State Alternative Fuel and Vehicle Incentive Program

Section 409 requires the Department of Energy to issue regulations by May 1993 governing the development and implementation of comprehensive state alternative fuel plans designed to accelerate the use and introduction of alternative fuel vehicles. States are not mandated to submit comprehensive plans to the Department; rather, they may elect to do so on a voluntary basis. At a minimum, a state plan must contain provisions which will result in the introduction of a substantial number of alternative fuel vehicles into the state by the year 2000 and a description of the requirements, including a proposed budget, necessary for program implementation. Technical and financial assistance shall be available to states for purposes of implementing a comprehensive alternative fuel vehicle program (including funds for acquisitions), provided that the state plan includes a description of how the state will coordinate its activities with federal and local governmental bodies. To receive technical and financial assistance, state plans must also address, among other things, tax treatment of alternative fuels; alternative fuel vehicles and fueling stations; use in state fleets; public awareness programs; recovery of expenditures by public utilities; role of municipal, county and regional transit authorities; and possible impacts on programs under the *Intermodal Surface Transportation Efficiency Act* of 1991, as amended. While the *Energy Policy Act* does not specify a maximum dollar limit for federal contributions per state plan, it does require each state to provide at least 20 percent of the program costs if it is to receive any federal assistance. The Department is currently developing regulations for this section and plans to implement the program in fiscal year 1995.

Low interest Loan Program

Section 414 requires the Department to establish a low interest loan program by October 1993 to help businesses with fleets finance purchases and conversions of vehicles to alternative fuels. The agency is mandated to give loan preference to small businesses and priority to fleets "where the use of alternative fuels would have a significant beneficial effect on energy security and the environment." To date, no funds have been appropriated to establish the loan program. In light of the funding constraints, the agency has decided to concentrate its resources to develop the financial assistance program required by Section 409 (State Alternative Fuel and Alternative Fuel Vehicle Incentive Program).

Intermodal Surface Transportation Efficiency Act of 1991

Title I of the *Intermodal Surface Transportation Efficiency Act* established the Congestion Mitigation and Air Quality Improvement Program under the administrative jurisdiction of the U.S. Department of Transportation. The program directs funds to states specifically for transportation efforts and projects designed to help states achieve compliance with the national ambient air quality standards for carbon monoxide, ozone and, in some cases, PM-10. A total of $6 billion is authorized to be appropriated from fiscal years 1992-1997. Since the inception of the program in 1992, approximately $1 billion has been budgeted annually for programs and projects. Every state is guaranteed at least 0.5 percent (approximately $4.8 million) of the annual appropriation. Remaining funds are apportioned to states claiming ozone nonattainment areas.[140] The federal contribution for most projects is 80 percent, however, the federal share may increase to 100 percent under certain circumstances.[141] States with nonattainment areas are required to use their funds in those nonattainment areas to support projects aimed at reducing ozone precursors and carbon monoxide from transportation sources. A state, such as Nebraska which does not qualify for more than 0.5 percent of the annual appropriation, may budget its apportionment for any project eligible under this or the Surface Transportation Program. With respect to alternative fuel vehicles, Nebraska may use program funds to purchase alternative fuel vehicles for use in public fleets, provided that such acquisition is included in the State Implementation Plan. Nebraska may also use program funds to acquire mass transit alternative fuel vehicles in accordance with the Surface Transportation Program.[142]

Heavy-Duty State/Municipal Vehicle Alternative Fuel Demonstration Program

This Department of Energy program, authorized by the *Alternative Motor Fuels Act* of 1988, provides financial assistance to state and municipal fleet managers for purchases of heavy-duty original equipment manufactured alternative fuel vehicles. In accordance with the terms of the program, states may apply for grant money to defer the incremental costs of up to four heavy-duty alternative fuel vehicles. In exchange for the financial assistance, award recipients are required to submit weekly vehicle logs containing data on mileage, maintenance, reliability and exhaust emissions to the National Renewable Energy Laboratory for five years. Information reported in the vehicle logs will be compiled and catalogued in the Alternative Fuels Data Center.

Federal Transit Act

Sections 3, 9, 16 and 18 authorize the U.S. Department of Transportation to provide financial assistance in the form of grants, loans and appropriations to states and local governmental bodies for a variety of transportation projects, including acquisitions of mass transit vehicles. The Department's Federal Transit Administration is responsible for administering these funding programs. With respect to alternative fuel vehicles, the Federal Transit Administration adheres to a fuel neutral policy. This policy coupled with the four sections of the *Federal Transit Act* described below, allows recipients of *Federal Transit Act* funds to purchase alternative fueled mass transit vehicles. Conversions and acquisitions of nonmass transit alternative fuel vehicles in public fleets and alternative fuel vehicles in private sector fleets are not eligible for funding under the *Act*.

- Under section 3, state agencies and metropolitan planning organizations may submit applications to the agency for grants or loans to finance the capital costs of new mass transit vehicles. Section 3 grants and loans are awarded by the agency on a 80/20 (federal/state and local government) cost share basis. The Nebraska State Constitution prohibits state agencies from applying for Section 3 discretionary funds. Rural areas within the state are also denied access to this source of financial assistance as funding for rural mass transit projects is allocated by the state, not metropolitan planning organizations. Metropolitan planning organizations retain access to Section 3 funds.
- Section 9 authorizes funding from the Department to states and metropolitan planning organizations to support the capital and operational costs of mass transit projects in urbanized areas with populations greater than 50,000. Section 9 funds are apportioned to states on an annual basis in accordance with allocation formulas specified in the *Federal Transit Act*. For capital projects, at least 20 percent of the project funds must be provided by nonfederal sources; the Department contributes the remainder (up to 80 percent). For operational costs, the federal share is limited to 50 percent. Metropolitan areas in Nebraska with populations between 50,000 and 200,000 are required to submit project proposals for Section 9 funding to the state. The state then files an application with the

Department on behalf of the metropolitan planning organizations requesting funding. Metropolitan areas with populations over 200,000 may bypass the state and submit project proposals directly to the Department.

- Section 18 complements Section 9 as it authorizes funding to support capital and operational costs of mass transit projects in rural areas (communities with a population under 50,000). Each year, the Department apportions Section 18 funds to states who in turn distribute the funds to rural communities on an 80/20 federal/local cost share basis for capital projects and at a 50/50 matching ratio for operational costs. While the capital costs of new mass transit vehicles are eligible costs under Section 18, the State of Nebraska has made it a policy to prioritize the application of these funds for operational costs. This policy was established in light of the fact that the annual apportionment of Section 18 funds does not adequately meet the capital and operational needs of all the rural transit systems in Nebraska. First priority is given to operational costs as requested by affected transit systems. Alternative fueled mass transit vehicles can therefore not be obtained with section 18 funds in rural Nebraska; however, alternative fuel vehicle inspection, operation and maintenance costs remain eligible for funding.
- Section 16 authorizes an annual apportionment of funds from the Department to states to be used by non-profit organizations in providing transportation services to meet the special needs of elderly persons and persons with disabilities. Section 16 funds are restricted for use by nonprofit groups to support the capital costs of special transportation service projects. Although the statutory cost sharing responsibility of nonprofit transportation service providers is set at 80/20 percent, the state of Nebraska adheres to a policy requiring these providers to contribute at least 30 percent of the capital costs. Section 16 provisions do not explicitly exclude the acquisition of alternative fuel vehicles.

State Government Sources

School Weatherization Fund

Under legislation which became effective in September 1993, the Nebraska Energy Office administers a $5 million no interest loan program covering purchases or conversions of alternative fuel school buses and construction of alternative fuel vehicle fueling stations. Any Nebraska school district may apply to the Energy Office for a no interest loan from the School Weatherization Fund to finance an alternative fuel vehicle project intended to reduce energy use or conserve available energy resources. Loans supporting alternative fuel vehicle projects are required by state statute to be repaid on a semiannual basis beginning six months after the project is completed. The last payment is due within ten years from the date of the loan. Each school district receiving loan funds is also required to submit an annual energy consumption report on its project(s) to the Energy Office. The program is scheduled to end June 30, 1996.

The Dollar and Energy Saving Loan Program

The Dollar and Energy Saving Loan Program, established in 1990 with oil overcharge funds, is a low interest revolving loan program designed to finance energy saving improvements in the and agricultural sectors. Up to $250,000 in low cost loans is available to fleet operators to finance the incremental cost of alternative fuel vehicles, conversions of public and private fleet vehicles to alternative fuels and the purchase and installation of fueling facilities needed to support the vehicles.

Nongovernmental Sources

The Nebraska Soy Bean Development Utilization and Marketing Board is currently the only nonfederal or nonstate organization offering financial assistance for alternative fuel vehicle acquisitions and conversions in the state. The Board will accept and review applications for financial assistance from private and public fleet operators interested in conducting demonstration projects involving vehicles powered by soydiesel. Applications for funding may be submitted to the Board at anytime and will be reviewed on a case-by-case basis. Funds are awarded at the discretion of the Board and not in accordance with any annual or other fixed time cycle.

Examples from Other States

Southern California Gas Company

Since 1990, Southern California Gas has provided financial incentives to its customers for purchases of original equipment manufactured natural gas vehicles and conversions of vehicles to natural gas use. The amount of financial assistance available to prospective owners of natural gas vehicles is based on gross vehicle weight, as follows:

- $1,750 per vehicle up to 10,000 lbs.;
- $2,500 per vehicle between 10,001 and 19,500 lbs.;
- $4,500 per vehicle between 19,501 and 26,000 lbs.; and
- $7,500 per vehicle over 26,000 lbs.

Pacific Gas & Electric Pacific Gas & Electric offers financial incentives for both natural gas vehicles (original equipment manufactured and converted vehicles) and refueling station development. Under the utility's natural gas vehicles incentive program, a base amount of up to $2,000 is available to cover the installation of under-the-hood components and up to seven therms of on-board fuel storage. An additional $100 is provided per therm above the seven therm base amount. Natural gas vehicles certified to the California Air Resources Board emission standards also receive an additional financial incentive as follows:

- Transitional Low Emission Vehicles —$100
- Low Emission Vehicles — $250
- Ultra-low Emission Vehicles — $500

Up to $7,500 is available per vehicle under the program and each customer is eligible to receive no more than $100,000 in financial assistance while funding lasts. Financial incentives are reduced if the customer uses other sources of funding.

Under the incentive program, up to $200,000 is available to interested parties to cover the costs of installing a 24 hour publicly accessible fueling facility. The financial assistance is limited to 50 percent of the installation costs and may be reduced if other funding sources are accessed. The utility expects to provide financial assistance for the development of between three and six natural gas fueling stations situated along the major freeway corridors in its service territory.

Duke Power Company

For the past year, Duke Power has been conducting an experimental time-of-use incentive rate program to encourage electric vehicle recharging during off peak hours of the day. An incentive rate of three cents per kilowatt-hour is available for electric vehicle charging between 9:00 p.m. and 6:00 a.m., Monday through Friday and all day on weekends. At all other times, the rate is approximately nine cents per kilowatt-hour. A separate meter is required and the utility bills participating customers an extra $7.75 per month.

Propane Suppliers

A common practice of large propane suppliers in some western states is to underwrite fueling station development costs or lease fueling equipment under favorable terms to propane fuel retailers. In return, a fuel retailer agrees to purchase propane fuel at a specified price from the fuel supplier sponsoring development of the fueling station. Some propane suppliers may also finance the cost of vehicle conversions of private and public fleets and train fleet mechanics in exchange for supply commitments from fleet administrators.

END NOTES

140 Additional Congestion Mitigation and Air Quality funding is apportioned to states claiming both ozone and carbon monoxide nonattainment areas. States, such as Nebraska that are in attainment for ozone, but in nonattainment for other criteria pollutants (e.g., carbon monoxide, lead, nitrogen dioxide, particulate matter and sulfur dioxide) are not eligible to receive additional funding beyond the 0.5 percent annual apportionment.

141 *Intermodal Surface Transportation Efficiency Act: A Guide to the Congestion Mitigation and Air Quality Improvement Program*, p. 8 (U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA-PD-94-008)

142 Under the Surface Transportation Program, states may obligate funds for capital projects eligible for assistance under the *Federal Transit Act* (including acquisitions of mass transit alternative fuel vehicles). See description of *Federal Transit Act* in this chapter.

Barriers to the Use of Alternative Fuels in Nebraska

This chapter identifies factors which may impede efforts to accelerate the introduction of alternative fuel vehicles in fleets operating in Nebraska. The major impediments identified to date and treated in this section are vehicle cost, fuel cost and tax treatment of the various alternative fuels, fueling infrastructure, consumer acceptance and technological improvements. Noticeably absent from this list of impediments are emissions. Although the emissions performance of alternative fuel vehicles in use today varies widely, it is expected that emissions performance will steadily improve as vehicle emissions control technologies advance in response to the stringent emissions standards scheduled to take effect over the next few years. Emissions from alternative fuel vehicles are therefore not considered to be a significant barrier to their use. Additionally, it should be noted that while reductions in emissions are expected to be achieved, gasoline and diesel fuels are also expected to become cleaner burning. Thus, over time, both conventional and alternative fuels are expected to reach general environmental equivalence.

Vehicle Costs

All currently available alternative fuel vehicles cost at least as much, but typically more than their gasoline and diesel powered counterparts. With respect to model year 1995 original equipment manufactured light-duty vehicles, biodiesel and the alcohol fuels (ethanol and methanol) have the lowest incremental vehicle costs compared to all the other alternative fuels. In concentrations up to 40 to 50 percent by volume with diesel fuel, biodiesel ranks the lowest with no incremental vehicle costs incurred. Light-duty alcohol fueled vehicles rank second, with incremental costs ranging from zero to several hundred dollars. Factory built propane vehicles cost substantially more than conventionally fueled equivalent versions with the additional costs starting at over $1,000. Incremental costs for factory built light-duty natural gas vehicles range between $3,000 to $5,200. Electric vehicles are likely to have the highest incremental cost relative to the other alternative fuel vehicles. The model year 1998 Ford Ecostar is expected to cost three to four times more than its gasoline powered equivalent. Hybrid vehicles are also expected to have high incremental costs; however, not enough information is available to permit an accurate assessment of these vehicle costs.

With the exception of biodiesel transit buses, factory built heavy-duty alternative fuel vehicles cost significantly more than equivalent vehicles powered by diesel fuels. For example, the incremental costs for alcohol-powered transit buses range between $20,000 and $40,000. Compressed natural gas transit buses cost approximately $50,000 more than equivalent diesel buses.

Costs are also incurred when converting conventionally fueled vehicles to alternative fuels use. Conversion kits are available to retrofit vehicles to natural gas and propane; other alternative fuel vehicles are available only through original equipment manufacturers. Installation and equipment costs for conversion kits total several thousand dollars per vehicle. Propane conversion costs are about $1,000 less than natural gas conversions.

The cost premiums associated with factory built alternative fuel vehicles and vehicle conversions may prove to be financial barriers to fleet operators in Nebraska. To the extent that the financial incentives available from federal, state and private sector sources do not adequately offset these additional costs, fleet operators may view alternative fuel vehicle acquisition costs as prohibitive. While cost premiums today are significant, over the long-run these costs are expected to decline as economies of scale are realized in the industry.

Operating costs (excluding fuel costs) represent another area where fleets administrators may perceive alternative fuel vehicles to result in increased expenditures. In general, the operating costs of alternative fuel vehicles are not well documented. It is therefore difficult to rank the various alternative fuel vehicles in terms of operation and maintenance costs. Some fleet operators have reported reduced maintenance costs and reduced engine wear with propane and compressed natural gas vehicles compared to gas equivalent vehicles. Ethanol, methanol and biodiesel fueled vehicles are designed to maintain the same type of operations and maintenance procedures characteristic of gasoline vehicles. No additional operating costs have been reported for biodiesel vehicles operating on 20 to 30 percent biodiesel blends. The only extra operating cost reported for ethanol vehicles stems from the use of a specially formulated motor oil required for ethanol engines. This motor oil costs approximately three times more than conventional motor oil. Methanol vehicles also require the use of a specially formulated motor oil and require more frequent oil changes compared to conventionally fueled vehicles. Periodic battery replacement constitutes the major maintenance expense with electric vehicles.

Not enough information exists to permit comment on hybrid vehicles.

Fuel Costs and Tax Treatment

High pump prices of some of the alternative fuels in Nebraska may deter prospective alternative fuel vehicle operators from incorporating such vehicles into fleet operations. In the summer of 1994, gasoline and diesel fuel both retailed in the state for approximately $1.18 per gallon. The retail price for all but two of the alternative fuels sold in Nebraska exceeds that reported for conventional fuels when calculated on the basis of energy content. The pump price for biodiesel is approximately $2.07 per gasoline gallon. E85 is also more expensive than conventional fuels in Nebraska at $2.12 per gasoline gallon. M85 is not sold in the state, however, if it were sold its cost would be higher than gasoline.

Propane and compressed natural gas are the only alternative fuels sold in Nebraska at prices competitive with gasoline and diesel. The propane equivalent of a gallon of gasoline retails for approximately $1.16 ($0.92 gasoline equivalent price plus an estimated state tax of 23.66 cents per gallon — see the paragraph below on state fuel tax treatment). The compressed natural gas equivalent of a gallon of gasoline retails for approximately $0.74.[143] It is important to note that although the prices reported here are based on the energy content of the various alternative fuels relative to gasoline and diesel, the actual fuel economy achieved with alternative fuels may not be reduced to the same extent reflected in the reduced Btu content of such fuels. This is due to certain chemical characteristics of the alternative fuels, such as the high octane values of compressed natural gas, E85 and propane compared to gasoline, which may partially offset their reduced energy content.

The varying tax treatment of the various alternative transportation fuels in Nebraska may also discourage their use. The state taxes gasoline, diesel, biodiesel (all blends), ethanol (all blends) and methanol (all blends) equally at 23.9 cents per gallon. Vehicle operators purchasing these fuels in Nebraska are required to pay this state motor fuel tax at the pump.

The state employs a different fuel tax instrument for propane, natural gas and electricity used in vehicles. Instead of paying the state motor fuel tax at the pump, owners of vehicles powered by these fuels are required to purchase an alternative fuel user permit on an annual basis pursuant to the *Alternative Fuel Tax Act*. The *Act* specifies a formula which determines the amount of the annual fuel use tax liability for three vehicle classes — passenger cars, pickup trucks and buses and trucks other than pickups. The user permit is calculated by assuming a standard annual mileage of 15,000 miles which is divided by a fuel economy rating for each vehicle class, the result is then multiplied by the average state motor fuel use tax rate. Based on this formula, passenger cars require $142.00 user permits, pickups require $197.00 user permits and larger trucks and buses require $356.00 user permits.

Assuming that affected vehicles travel exactly 15,000 miles a year, the annual tax liability on a per gallon basis is approximately 23.66 cents for passenger cars, 23.64 cents for pickups and 23.7 cents for larger trucks and buses. Because the cost of the user permit is based on a fixed annual vehicle mileage rate, vehicles travelling less than 15,000 miles are likely to incur a fuel use tax liability on a gallon basis which is higher than if the tax were linked to actual fuel purchased at the pump. Operators of propane and natural gas vehicles in the agricultural sector in particular may incur high fuel use taxes on a gallon basis as they typically travel less than 15,000 miles per year.

Lastly, it should be noted that bifuel propane and natural gas vehicles are subject to double fuel taxation — owners of this class of vehicles are required to purchase an alternative fuel user permit and pay the per gallon tax at the pump when refueling with gasoline. The fuel tax structure for bifuel vehicles in Nebraska may deter prospective alternative fuel vehicle operators from acquiring this type of vehicle. *The Alternative Fuel Tax Act* may be revised by the 1995 session of the Nebraska legislature to correct for the inequities described above.

Fueling Infrastructure

One of the often cited barriers to widespread use of alternative fuel vehicles is the proverbial “chicken-and-egg” dilemma. Prospective operators will be reluctant to purchase such vehicles if fueling stations are not available and convenient, but such stations will not be constructed unless demand is created by alternative fuel vehicle use. In Nebraska, propane claims the most extensive vehicle fueling network compared to all the other alternative fuels with more than 90 fueling stations located across the state. Compressed natural gas ranks second with a dozen commercial fueling stations followed by ethanol which has three E85 and two E95 fueling sites in the state. The five ethanol fueling facilities are limited to use by state fleet vehicles only; the public does not have access to these pumps. There are no commercial fueling stations in Nebraska providing methanol, biodiesel or electricity.

With the exception of compressed natural gas, the costs for equipment and installation of alternative fuel vehicle fueling facilities are not exceedingly high. Financial incentives are available from federal, state and private sector sources to partially offset the costs of developing fueling stations.

Nebraska produces only limited quantities of alternative fuels from indigenous resources. While all of the in-state demand for ethanol is derived from domestically grown feedstocks, the state relies on substantial imports of raw materials for electricity generation and imports significant volumes of natural gas and propane. Biodiesel and methanol are not produced in Nebraska; these fuels must also be imported from out-of-state suppliers. The production outlook for ethanol in the state is favorable — new productive capacity is scheduled to come on line in the future. The outlook for production of the other alternative fuels in the state is less promising by comparison.

In addition to demanding convenient access to affordable fuel, operators of alternative fuel vehicles require access to trained technicians for servicing their vehicles. The current population of technicians in Nebraska is small compared to the number of technicians trained to service gasoline and diesel fueled vehicles. However, as the alternative fuel vehicle market in the state matures and as national certification standards for technicians are developed and implemented in accordance with the *Energy Policy Act*, the number of alternative fuel vehicle technicians in the state is expected to increase.

Consumer Acceptance

In general, consumer satisfaction with alternative fuel vehicles is directly related to the extent to which such vehicles represent a departure from the familiar driving comforts and operating procedures characteristic of conventionally fueled vehicles. For alternative fuel vehicles to be accepted by the driving public, such vehicles will at least have to meet driver expectations with respect to driving range, engine power and fueling procedures.

All the alternative fuels, with the possible exception of biodiesel blends, have reduced driving ranges compared to gasoline and diesel on a per gallon basis. Battery powered electric vehicles have the most limited driving range followed by natural gas, M85, ethanol and propane. To travel the same distance as equivalent conventionally fueled vehicles, alternative fuel vehicles powered by these fuels require more fuel which necessitates expanded on board fuel storage capacity. In the case of light-duty natural gas vehicles, installation of additional fuel cylinders can result in significant reductions of cargo space. Compared to gasoline fueled vehicles, the alcohol fueled vehicles are capable of achieving increased engine power. Propane and compressed natural gas vehicles, however, are not able to match the engine power of gasoline vehicles.

Operators of alternative fuel vehicles powered by biodiesel, methanol, ethanol and propane will not have to spend additional time fueling their vehicles or learning new refueling procedures; these fuels are dispensed in a manner similar to conventionally fueled vehicles. Natural gas and electric vehicle fueling procedures differ from those associated with liquid fuels and require additional fueling time.

Technological Improvements

The following table lists various technological barriers identified by the "Big Three" automakers which need to be overcome in order for alternative fuel vehicles to compete more effectively with conventionally fueled vehicles.[144]

Needed Technological Improvements in Alternative Fuel Vehicle Development

Fuel Type	Technological Barriers
Ethanol	Neat-fuel cold starting; evaporative emissions control; special engine oil; on-board fuel concentration sensor; advanced aldehyde catalysts.
Electricity	Battery technology (e.g., increase energy density for driving range, increase power density for performance, reduce cost, extend life); improve climate control systems; lightweight body materials.
Methanol	M100 cold starting; on-board fuel mixture sensor; special engine oil; evaporative emissions control.
Natural Gas	Fuel storage (e.g., tanks to conform to unique shapes, lower pressure, light weight materials); refueling connector standardization; fuel composition standards; methane catalysts; nitrogen oxides control.
Hybrid	Flywheel technology (e.g., magnetic bearings); fuel cells.
Liquefied Petroleum Gas	Lean burn catalyst; liquid fuel injection system.

END NOTES

143 The gas equivalent price for compressed natural gas is 50.2 cents per gallon excluding the state motor fuel tax. The gasoline gallon price for compressed natural gas including a state tax estimated for passenger cars based on the alternative fuel user permit rate is 50.2 cents — 23.66 cents = 74 cents.

144 Based on presentations by representatives of Chrysler Corporation, Ford Motor Company and General Motors before the Western Interstate Energy Board's Winter Meeting, December 1-3, 1993, Santa Fe, New Mexico.

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