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Report to the Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives

July 1990

AIR POLLUTION

Air Quality Implications of Alternative Fuels

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Resources, Community, and
Economic Development Division

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July 9, 1990

The Honorable Philip R. Sharp
Chairman, Subcommittee on Energy
and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

As requested in your March 2, 1988, letter and as agreed to in subsequent meetings with your office, this letter provides information about the impact of alternative motor vehicle fuels on improving air quality. These fuels include methanol, ethanol, liquified petroleum gas, compressed natural gas, oxygenated fuels, and reformulated gasoline.

Results in Brief

It is generally recognized that most alternative fuels will reduce such air pollutants as ozone, carbon monoxide, and air toxics, but there is disagreement over the extent of the reductions, as well as concerns that some alternative fuels may increase the levels of other pollutants. Although research has been done on the air quality implications of alternative fuels, the results reported by the Environmental Protection Agency (EPA) and the petroleum and automobile industries vary. For example, EPA estimates that alternative fuels are capable of reducing ozone-forming hydrocarbons by approximately 80 percent or more compared to conventional gasoline burned in vehicles meeting the more stringent emission standards proposed by the agency. While industry groups also believe that hydrocarbons can be reduced by using alternative fuels, they are less optimistic about the extent of these reductions.

Background

In spite of significant improvements in air quality, over 120 million people continue to live in areas that exceed one or more national air quality standards. The more than 178 million vehicles that travel the nation's highways are major contributors of hydrocarbons, carbon monoxide, and other air pollutants. Approximately two-thirds of all carbon monoxide and at least one-third of all hydrocarbons and nitrogen oxides that are emitted into the air each year in the United States are estimated to come from motor vehicles. Hydrocarbons and nitrogen oxides react in the atmosphere to form ozone, a primary ingredient of urban smog.[1] In addition to these pollutants, motor vehicles also emit approximately one-half of the nation's toxic air pollutants.

According to EPA, today's automobiles may emit 60 to 80 percent less of some air pollutants than automobiles built in the 1960s; however, much of the emission reductions are offset by increases in the number of vehicles and the number of miles traveled. One solution being considered by the Congress and the Administration is the use of alternative fuels that burn cleaner than gasoline or diesel fuel.

Alternative fuels reduce air pollution because hydrocarbon emissions contained in the exhaust of alternative-fueled vehicles are less reactive in the atmosphere and thus less likely to form ozone than hydrocarbons emitted from gasoline vehicles, and alternative fuels have lower evaporative emissions. For example, methanol and ethanol will not evaporate from conventional fuel tanks as readily as gasoline, and liquified petroleum gas and compressed natural gas, although more volatile, are contained in sealed vehicle fuel tanks.

Uncertainties About the Influence of Alternative Fuels on Air Quality

Although alternative fuels offer many advantages to improving air quality when compared to conventional gasoline, uncertainties remain regarding their specific pollution-reduction potential and the extent that they will be attractive to and thus widely used by consumers. For example, while EPA estimates that methanol can reduce ozone-forming hydrocarbon emissions from vehicles by up to 90 percent, representatives of the oil industry estimate the reductions to be much less. One of the negative aspects of methanol is also the subject of disagreement. EPA estimates that while methanol-fueled vehicles will triple toxic formaldehyde emissions from tailpipe exhausts, these increases will be offset by reductions in formaldehyde formed by reactive hydrocarbons in the atmosphere. The Congressional Research Service (CRS) and a private research firm report that formaldehyde emissions from methanol-fueled vehicles could be higher than those produced by gasoline-fueled vehicles.

Consumers' willingness to purchase alternative-fueled vehicles and to operate them using cleaner fuels will be a major determinant of the extent to which these fuels will be used and of the ultimate reduction in

[1] Ozone is also a critical component of the earth's stratosphere that absorbs much of the sun's destructive ultraviolet radiation.

air pollution. Alternative fuels that are the most attractive from a cost and convenience standpoint may be more widely accepted by consumers.

Although some alternative fuels such as liquified petroleum gas and compressed natural gas are estimated to be cost- competitive with conventional gasoline, other factors such as the lack of a network of refueling stations and reduced driving ranges may impede their widespread use for other than commercial fleets. Also, while the cost of liquified petroleum gas and compressed natural gas may be competitive with gasoline, additional costs will be required to either modify existing automobiles or to equip new cars to use these fuels.

Unlike most other alternative fuels, reformulated gasoline—a fuel produced by changing the concentration of one or more components of conventional gasoline to reduce emission levels—can be delivered to consumers through existing gasoline distribution systems with little or no inconvenience to distributors, retailers, or consumers. Limited quantities of reformulated gasoline are currently being sold at approximately the same price as conventional gasoline, but larger quantities of more extensive reformulations that are required to significantly reduce air pollution are likely to cost more. Petroleum industry officials estimate that reformulating large quantities of gasoline may require purchasing $20 to $30 billion of new refinery equipment and may require several years for constructing new refineries.[2] Similarly, widespread use of methanol will require costly changes in existing production facilities.

Appendixes I through VII provide a more detailed discussion of the air quality implications for each alternative fuel as well as information on related health, safety, and cost implications.

Objective, Scope, and Methodology

Our work, which was conducted from November 1989 through June 1990, was directed at identifying, reviewing, and summarizing the results of studies, research projects, and reports done by EPA, CRS, the Office of Technology Assessment (OTA), and industry and environmental groups. We did not independently verify the results of these studies, research projects, and reports. We discussed the facts contained in this report with EPA officials and made changes as appropriate; however, we did not obtain official agency comments.

[2] A related report (GAO/RCED-90-153) provides additional information on reformulated gasoline.

Unless you publicly announce its contents earlier, we plan no further distribution of this report for 30 days. At that time we will make copies available to others upon request. If you have any questions about the report, please call me at (202) 275-6111. Other major contributors are listed in appendix VIII.

Sincerely yours,

Richard L. Hembra
Director, Environmental
Protection Issues

Contents

Abbreviations

API	American Petroleum Institute
ARCO	Atlantic Richfield Company
CO_2	Carbon Dioxide
CO	Carbon Monoxide
CNG	Compressed Natural Gas
CRS	Congressional Research Service
EPA	Environmental Protection Agency
ETBE	Ethyl Tertiary Butyl Ether
LPG	Liquified Petroleum Gas
MTBE	Methyl Tertiary Butyl Ether
OTA	Office Of Technology Assessment
NO_x	Nitrogen Oxides
VOC	Volatile Organic Compound

Some Advantages and Disadvantages of Alternative Fuels Compared to Gasoline

Methanol

Advantages

- May reduce ozone-forming hydrocarbon emissions by up to 40 percent when used as a mixture of 85 percent methanol and 15 percent gasoline
- May reduce ozone-forming hydrocarbon emissions by up to 90 percent when 100 percent methanol is used
- Eliminates benzene and other toxic emissions

Ethanol

- Reduces ozone-forming hydrocarbon and toxic emissions similar to methanol
- Reduces carbon dioxide emissions

Liquified Petroleum Gas

- Produces an estimated 50 percent fewer hydrocarbons, which have less ozone-forming potential
- May reduce carbon monoxide emissions by an estimated 25 to 80 percent

Compressed Natural Gas

- Reduces hydrocarbon emissions by an estimated 40 to 90 percent
- Reduces carbon monoxide emissions by an estimated 50 to 90 percent
- Reduces emissions of benzene and other toxic pollutants

Oxygenated Fuels

- Reduces carbon monoxide emissions by an estimated 12 to 22 percent
- Increases gasoline octane levels, thus decreasing the need for harmful additives such as benzene

Reformulated Gasoline

- Deliverable to consumers through existing distribution system
- Estimated to reduce ozone and air toxics produced by automobile emissions
- Requires few, if any, vehicle modifications

[1]These statements represent opinions held by EPA or organizations, such as the petroleum and automobile industries, whose viewpoints often differ greatly. This is not a comprehensive listing but is intended to illustrate that the use of alternative fuels presents difficult choices because the environmental benefits are sometimes uncertain and may be offset by other problems.

Methanol

Disadvantages

- May increase formaldehyde emissions
- Requires significant costs for new production and distribution systems
- Reduces vehicle driving range and is corrosive to engine parts
- Difficult to start vehicle in cold temperatures

Ethanol

- Emits more acetaldehyde
- Would cost consumers substantially more without federal tax exemption
- Requires vehicle modifications estimated at $300 per vehicle

Liquified Petroleum Gas

- Reduces vehicle driving range and causes refueling inconveniences
- Required pressurized fuel tanks restrict vehicle cargo space
- Increases new car cost by up to $1000

Compressed Natural Gas

- Emits more nitrogen oxides
- Requires new distribution system
- Reduces vehicle driving range and causes refueling inconveniences
- Requires large, heavy, pressurized fuel tanks
- May increase vehicle costs by up to $2,000

Oxygenated Fuels

- Increases evaporative emissions of volatile organic compounds
- Oxidizes to form toxic chemicals, such as formaldehyde
- May increase nitrogen oxide emissions
- May contribute to auto fuel system problems and reduced fuel economy
- Increases the cost of gasoline

Reformulated Gasoline

- May require purchasing significant amounts of new refinery equipment and constructing new refinery units
- Will not provide emission benefits comparable to fuels such as pure methanol and compressed natural gas
- Extensive reformulation could result in substantial price increases to consumers

Methanol

Methanol is a clear, colorless liquid, most of which is made from natural gas. It can also be made from coal, wood or methane (a gas produced from municipal waste). Today methanol is produced at about 75 plants in over 30 countries. Although methanol is probably best known as a fuel for Indianapolis-type racing cars, it is primarily used to produce other chemicals and as a gasoline additive. Of the approximately 1,300 methanol-burning vehicles in use in the world today, most are in the United States.

Air Quality Implications

EPA reports that methanol has the potential to significantly reduce ozone levels in the most seriously polluted areas of the country. There is disagreement, however, about how much methanol can reduce vehicle emissions and improve air quality.

Two forms of methanol for motor vehicle use have been evaluated by EPA. One form—a mixture of 85 percent methanol and 15 percent gasoline (M85)—is estimated by EPA to reduce ozone-forming emissions by 20 to 40 percent as compared to vehicles operating on pure gasoline. The other form—100 percent methanol (M100)— is estimated to produce ozone-forming emissions that are 75 to 90 percent lower than those from gasoline vehicles. The reductions are due, in part, to methanol's low volatility, which significantly reduces evaporative emissions and the lower photochemical reactivity of methanol emissions.

Studies by Ford Motor Company, the American Petroleum Institute (API), and Chevron Corporation, and others have also addressed methanol's potential for reducing ozone. Their findings differ somewhat from those reported by EPA. For example, Chevron reports that methanol use would probably reduce peak ozone levels by less than five percent and could potentially increase ozone levels. Ford reports that tests on both M85 and M100 vehicles showed hydrocarbon emissions to be about the same as those from conventional gasoline vehicles. Furthermore, API states that EPA's claims regarding ozone reductions are overestimated because EPA calculates the reductions based on gasoline vehicles which emit more VOCs than some vehicles already on the road.

An official in EPA's Office of Mobile Sources told us that EPA's findings on methanol's impact on ozone formation may not be as different from those of the oil and auto industries as they appear. He stated that industry studies have focused on the use of M85 (instead of M100) and have primarily addressed tailpipe emissions, ignoring methanol's lower evaporative emissions and reduced photochemical reactivity.

There is less disagreement among EPA and industry officials over the impact of methanol-fueled vehicles on nitrogen oxides (NO_x), another component of ozone. Most research results show that vehicles burning methanol will produce NO_x emissions that are generally equivalent to those from gasoline-fueled cars. The Congressional Research Service reports that, in general, NO_x emissions tend to be lower from engines running on methanol, but that emissions from individual cars vary considerably.

Methanol use could have a significant impact on reducing toxic air pollutants. EPA reports that M100 virtually eliminates emissions of benzene and other air toxics that cuase up to 1,500 cancer cases a year in the United States. Its impact on formaldehyde emissions, however, is less certain. For example, EPA estimates that M100 fueled vehicles will emit three times the amount of formaldehyde from the tailpipe as gasoline-fueled vehicles, yet ambient formaldehyde levels formed by reactive hydrocarbons in the atmosphere will be less. In contrast, a private research firm and CRS report that formaldehyde emissions from methanol vehicles could be as much as 10 times higher than those from gasoline vehicles. API states that EPA is considering formaldehyde controls, which have not yet been effectively demonstrated. A study prepared by Chevron indicates that almost all tests for formaldehyde emissions have been done on vehicles with less than 30,000 miles, and normal deterioration of an automobile's emission control equipment may have a significant impact on formaldehyde emissions in older vehicles.

Other Implications

There is also considerable disagreement among EPA, industry, and others concerning the cost competitiveness of methanol compared to gasoline. Reports by EPA, the Department of Energy, and OTA have shown methanol to be economically competitive with gasoline based on current oil prices. EPA, for example, estimates that on an energy-equivalent basis, methanol could sell for between $.85 and $1.09 compared to the cost of a gallon of gasoline. API estimates, however, range from $1.30 to $2.07 a gallon.

EPA, CRS, and the Petroleum Marketers Association of America report that significant increases in methanol use will entail additional costs. These include a major investment in new methanol production facilities estimated at up to $1 billion for a large plant; a retrofit of existing service stations, estimated at $30,000 to $45,000 per station; and increased distribution costs. They also estimate that it will cost up to $300 more to build a car that can use either methanol or gasoline.

Other factors that may affect consumer acceptance of methanol as a motor vehicle fuel are difficulty starting vehicles at temperatures below about 50 degrees, the corrosive effect of methanol on engine and other parts, and reduced driving ranges compared to gasoline. Also, methanol has some advantages and disadvantages regarding health and safety risks as compared to gasoline. For example, methanol is more readily absorbed through the skin and ingestion of significantly smaller amounts can be fatal. Also, according to EPA, methanol's lower volatility makes it less flammable, resulting in fewer and less severe vehicle fires. Once ignited, however, methanol burns with an almost invisible flame, which makes fire detection more difficult.

Ethanol

Ethanol is a liquid alcohol fuel produced from corn and other agricultural products such as sugar cane. In 1988, United States production of ethanol was about 840 million gallons. Ethanol is primarily used as a component of gasohol, a blend of ethanol and gasoline. In Brazil, government-subsidized ethanol has been used in modified motor vehicles since the early 1980s and is currently widely used as a vehicle fuel. This appendix discusses the use of 100 percent ethanol used in vehicles specifically designed to operate on alcohol fuels. The use of ethanol as a gasoline blend is discussed in appendix VI.

Air Quality Implications

EPA reports that ethanol offers several air quality advantages over gasoline. First, EPA estimates that ethanol-fueled vehicles can reduce ozone-forming hydrocarbon emissions at approximately the same levels as methanol. EPA also reports that ethanol use eliminates benzene emissions and could reduce carbon dioxide (CO_2) emissions. One disadvantage of ethanol is that it yields higher acetaldehyde emissions, a toxic pollutant that may cause cancer.

Other Implications

Ethanol prices ranged from $1.00 to $1.20 per gallon in 1989, reflecting a federal tax exemption of 60 cents per gallon which is scheduled to expire in September 1993. A California Energy Commission study estimates that the retail price of ethanol could increase to $2.33 (in 1988 dollars) per gallon by the year 2000, without the tax exemption.

Currently, vehicle modifications needed to burn ethanol in automobiles produced in the United States include a cold starting system and corrosion resistant fuel tanks and fuel pumps. According to Ford Motor Company, the production cost of an ethanol vehicle is about $300 more than a gasoline vehicle. Ethanol vehicles are currently being sold in Brazil by Ford, Volkswagen, and General Motors.

Although ethanol may not present as great a health risk as some other fuels, EPA reports that ethanol use presents some potential health concerns. Ingestion of several ounces of ethanol, while not harmful to adults, could be harmful to children. Also, some additives used to distinguish ethanol from alcohol used for beverage purposes may be toxic.

Liquified Petroleum Gas

Liquified Petroleum Gas (LPG) is a mixture of petroleum and natural gases that become liquid under pressure or at reduced temperatures. The principle liquified petroleum gases are propane and butane, which are converted into a liquid state for ease of storage and handling. LPG comes from two main sources: natural gas processing and crude oil refining. Domestic production of LPG in 1987 was about 15.7 billion gallons.

There are currently an estimated 330,000 highway vehicles using LPG in the United States. Most of these vehicles were converted from gasoline to LPG by modifying their carburetors and fuel tanks. There are approximately 10,000 stations in the United States capable of providing vehicle refueling. Currently only about 2.8 percent of the total U.S. LPG supply is used in transportation.

Air Quality Implications

Limited data are available to assess the air quality implications of LPG as a motor vehicle fuel. At the time of this report EPA was assessing the economic and environmental implications of LPG along with other alternative fuels. Information contained in this appendix was obtained primarily from the LPG industry.

The National Propane Gas Association states that hydrocarbon emissions from LPG vehicles are 50 percent lower than those from gasoline vehicles. The reduction is due in part to the negligible evaporative emissions associated with LPG because it is always contained in sealed tanks. Not only are there fewer hydrocarbons, but the Western Liquid Gas Association and the California Air Resources Board both report that hydrocarbons emitted from LPG-fueled vehicles are 47 to 60 percent less reactive than those from gasoline-powered vehicles and thus have a lower ozone-formation potential.

Research sponsored by the LPG industry indicates that CO emissions can be significantly decreased by using LPG. Estimated reductions range from 25 to more than 80 percent compared to gasoline. Research conducted by a private organization for Arizona's Maricopa County Association of Governments found that the extent of CO reductions attributable to LPG depends on the quality of vehicle conversions and that CO emissions can increase as the conversion systems age.

Other Implications

According to the National Propane Gas Association, LPG and gasoline prices are generally comparable and LPG may result in some savings.

Estimates of the cost to convert a vehicle to run on LPG, however, range from $700 to $2,000 per vehicle. The additional cost for an LPG option in a production passenger car is expected to be between $300 and $1,000.

Several factors concern consumers about the use of LPG as a motor vehicle fuel. These include reduced driving range, refueling inconvenience, restrictions on cargo space, and safety concerns. The main safety concern is the risk of rupturing LPG fuel tanks on impact and fuel contact with ignition sources. Studies show, however, that LPG presents no more of an explosion risk than gasoline. Because LPG is non-toxic and is not water soluble, it does not present as great a threat to underground wells or aquifers as some other fuels.

Compressed Natural Gas

Compressed Natural Gas (CNG), a gaseous fuel composed primarily of methane and smaller amounts of other gases, is predominately used for heating and power generation. Small amounts of natural gas have been used as an automotive fuel since the last century. The technology never flourished, however, because gas storage and compression facilities have not been readily available. Currently, there are about 500,000 natural gas-fueled vehicles worldwide. Approximately 30,000 are in the United States, mostly in commercial fleets.

Air Quality Implications

EPA reports that CNG-fueled vehicles can contribute to significant decreases in ozone levels because of CNG's lower levels of photochemically reactive emissions. CNG vehicles are estimated to emit 50 to 80 percent fewer reactive hydrocarbons than gasoline vehicles. However, they can emit significantly higher levels of NO_x, another component of ozone. The net effect appears to be a reduction in ozone formation compared to gasoline vehicles. However, CRS has reported that additional research is required to substantiate estimates of ozone reductions attributable to CNG.

EPA estimates that CNG-fueled vehicles will emit 50 to 90 percent fewer CO emissions compared to gasoline vehicles and will virtually eliminate particulate emissions when CNG is substituted for diesel fuel. According to OTA, CNG also has the potential to reduce emissions of benzene and other toxic compounds as compared to gasoline. Also, formaldehyde emissions from CNG vehicles are estimated to be no higher than those from gasoline-fueled vehicles.

Other Implications

Cost estimates prepared by the California Energy Commission show CNG fuel to be cost-competitive with gasoline. However, like LPG, vehicles must be equipped at the factory or later converted to use CNG at costs estimated by EPA at $1,000 to $2,000 per vehicle. Other obstacles impede its widespread use for other than commercial fleets. For example, there is no network of CNG refueling stations, and there is little incentive to establish one because of the large capital costs required (estimated by EPA to be $200,000 to $400,000 per station). Other consumer concerns include CNG vehicles' limited driving range (75 to 150 miles per fill-up) and required pressurized tanks, which restrict cargo space and vehicle performance. Although the California Air Resources Board reports that some consumers perceive CNG as a safety hazard, fleet-use experience indicates that CNG offers no greater safety risk than gasoline or methanol.

Oxygenated Fuels

Oxygenated fuels are blends of gasoline with additives such as alcohol and ether that increase the fuels' oxygen content and cause more complete combustion. The more widely discussed oxygenated fuels are the gasoline/ethanol blend (gasohol), the gasoline/methanol blend, the gasoline/Methyl Tertiary Butyl Ether blend (MTBE), and the gasoline/Ethyl Tertiary Butyl Ether blend (ETBE).

Gasohol, a blend of 10 percent ethanol and 90 percent gasoline, is the most widely used oxygenated fuel, comprising about 7 percent of the vehicle fuel market. A gasoline/methanol blend, containing no more than 5 percent methanol, is used in a limited number of cities. According to API, MTBE has captured about 1 percent of the national gasoline market, while ETBE is not available commercially.

Air Quality Implications

Studies by EPA and others have shown that oxygenated fuels will reduce CO emissions. API estimates that, in general, oxygenated fuels can reduce CO emissions from 10 to more than 20 percent. It's estimated that gasohol can reduce CO emissions by up to 22 percent when compared to the gasoline burned in today's automobiles. Improvements in pollution control equipment on newer vehicles, however, may limit the reduction to around 17 percent by the year 2000.

Adding oxygenates such as methanol and ethanol to gasoline increases both the octane and volatility of the fuel. Higher octane levels reduce the need to add toxic aromatics such as benzene, toluene, and xylene, which increase hydrocarbon emissions. The increased volatility of some oxygenated fuels, however, can result in more evaporative emissions of VOCs, partly offsetting the reductions in exhaust emissions. Additionally, EPA estimates that oxygenated fuels' higher volatility will increase NO_x emissions from 2 to 8 percent. Furthermore, gasohol and gasoline/methanol blends can oxidize to form toxic chemicals, such as formaldehyde and acetaldehyde.

Other Implications

Oxygenated fuels are estimated to cost somewhat more than conventional gasoline. A feasibility study prepared for Arizona's Maricopa County Association of Governments estimates the increased cost of using oxygenated fuels to be between 2.0 and 8.0 cents per gallon. API estimates that if a gasoline/methanol blend represented half of the nation's automotive fuel consumption, the increased cost would be between 1.0 and 1.8 cents per gallon. The increased cost is estimated to be between 2.1 and 2.8 cents per gallon if gasohol accounted for half the automotive fuel used in the United States.

Several factors may affect the viability of oxygenated fuels as alternatives to gasoline. For example, gasohol can contribute to fuel system problems such as vapor locks and may reduce fuel economy. Furthermore, as many as 10 percent of the nation's underground fuel tanks may need to be replaced to insure that their linings are suitable for gasohol storage.

Reformulated Gasoline

Reformulated gasoline is produced by changing the concentration of one or more components of conventional gasoline to reduce emission levels. The removal of lead from gasoline and the recent development of ARCO's EC-1 and Shell's SU-2000E gasolines are examples of gasoline reformulations. However, the term is most commonly used to refer to more extensive changes that are expected to result from ongoing research by the petroleum and auto industries to develop cleaner gasolines. Until this research is completed, the exact content of reformulated gasoline will not be known.

Refineries generally lack the capacity to produce significant quantities of reformulated gasoline, but limited amounts of reformulated gasoline can be produced almost immediately by changing existing refinery blending processes. Several petroleum companies are already marketing reformulated gasolines in selected areas. For example, the Atlantic Richfield Company (ARCO) is selling EC-1 in southern California, replacing its former leaded regular gasoline. Conoco and Diamond-Shamrock are also selling limited amounts of reformulated gasoline in some areas of Colorado. Shell's SU-2000E will replace the company's premium unleaded gasoline in the 10 U.S. cities experiencing the most severe air pollution problems.

Air Quality Implications

The air quality implications of reformulated gasoline are difficult to quantify at this time. Petroleum industry officials informed us that they cannot predict the benefits until the results of current research efforts are available. In general, however, they expect reformulated gasoline to help improve air quality. More specifically, industry officials believe that reformulated gasoline will reduce the levels of ozone and air toxics produced by automobile emissions.

Unlike other alternative fuels, reformulated gasoline offers some immediate emission benefits, especially for older vehicles, which are often the most serious polluters. For example, it is estimated that pre-1975 vehicles without catalytic converters make up about 15 percent of all highway vehicles in southern California. ARCO estimates that using EC-1, its reformulated gasoline, in these older vehicles could reduce emission levels equivalent to removing 20 percent of the vehicles from the road.

EPA officials view reformulated gasoline as a positive step, but one that should not be considered a long-term solution to the nation's air quality problems. In their opinion, it is unlikely that reformulated gasoline can provide emission benefits comparable to some cleaner alternative fuels, including 100 percent methanol and CNG. Therefore, EPA views reformulated gasoline as a short-term solution until cleaner fuels can be made available in sufficient quantities.

Other Implications

Although reformulated gasoline can be distributed through existing gasoline delivery systems, reformulating large quantities of gasoline would require purchasing significant amounts of new refinery equipment and constructing new refinery units that could take several years, at a minimum. Some petroleum industry officials estimate that needed refinery reconfigurations may cost the industry $20 to $30 billion. One company estimates that it would need to spend about $2 billion over the next five years to modify its facilities to reformulate all of its gasoline. Another company estimates that three to four years would be required to prepare for and to construct new refinery units to produce reformulated gasoline in significantly larger quantities.

It is almost certain that reformulated gasoline will cost consumers more than conventional gasoline, but the amount of increase will not be known until the extent of reformulation is determined. According to ARCO officials, EC-1 is selling for approximately the same price as leaded regular gasoline, although it costs about 2 cents a gallon more to produce. Petroleum industry officials acknowledge, however, that more extensive reformulations are likely to increase fuel costs. A preliminary study by EPA suggests that reducing aromatic levels from the current industry average of 35 percent of gasoline volume to 15 percent could raise the price of gasoline by approximately 10 cents a gallon.

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