U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MOBILE SOURCES

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Clean Fuels: An Overview

What are Clean Fuels?

The most familiar transportation fuels in this country are gasoline and diesel fuel, but any number of energy sources are capable of powering motor vehicles. These include alcohols, electricity, natural gas, and propane.

Some vehicle fuels, because of physical or chemical properties, create less pollution than do today's gasolines. These are called "clean fuels."

Why Switch to Clean Fuels?

Cars operating on today's gasolines emit complex mixtures of compounds that lead to the formation of ground-level ozone; many of these compounds are also toxic. A lot has been done to reduce automobile pollution, from development of innovative emission control technologies to establishment of Inspection and Maintenance programs. But each year sees more cars on the road, traveling more miles, and the pollution control measures taken so far have not been sufficient to solve the ozone problem in many large cities.

Clean fuels have a number of inherent properties that make them cleaner than conventional gasoline. In general, these fuels emit less hydrocarbons, and the hydrocarbons they do emit are less reactive (slower to form ozone) and less toxic. Emissions from electricity, natural gas, or alcohol-powered vehicles can be as much as 90 percent lower in toxics and ozone-forming hydrocarbons than emissions from vehicles fueled with conventional gasoline. New gasoline formulations ("reformulated gasoline") are expected to reduce these emissions up to 25 percent over today's gasoline.

Use of clean fuels could also help slow atmospheric buildup of carbon dioxide, a "greenhouse gas" that contributes to the potential for global warming. Combustion of any carbon-based fuel produces carbon dioxide. But the overall impact of a given fuel on global warming depends on how the fuel is made. In general, fuels produced from biomass (crops, trees, etc.) and from natural gas result in less carbon dioxide accumulation than fuels made from petroleum or coal.

Clean fuels have benefits that reach beyond their air quality advantages. New fuels in the marketplace give consumers new choices and could decrease our dependence on imported oil.

FUEL	ADVANTAGES	DISADVANTAGES
ELECTRICITY	• Potential for zero vehicle emissions • Power plant emissions easier to control • Can recharge at night when power demand is low	• Current technology is limited • Higher vehicle cost; lower vehicle range, performance • Less convenient refueling
ETHANOL	• Excellent automotive fuel • Very low emissions of ozone-forming hydrocarbons and toxics • Made from renewable sources • Can be domestically produced	• High fuel cost • Somewhat lower vehicle range
METHANOL	• Excellent automotive fuel • Very low emissions of ozone-forming hydrocarbons and toxics • Can be made from a variety of feedstocks, including renewables	• Fuel could initially be imported • Somewhat lower vehicle range
NATURAL GAS (METHANE)	• Very low emissions of ozone-forming hydrocarbons, toxics, and carbon monoxide • Can be made from a variety of feedstocks, including renewables • Excellent fuel, especially for fleet vehicles	• Higher vehicle cost • Lower vehicle range • Less convenient refueling
PROPANE	• Cheaper than gasoline today • Most widely available clean fuel today • Somewhat lower emissions of ozone-forming hydrocarbons and toxics • Excellent fuel, especially for fleet vehicles	• Cost will rise with demand • Limited supply • No energy security or trade balance benefits
REFORMULATED GASOLINE	• Can be used in all cars without changing vehicles or fuel distribution system. • Somewhat lower emissions of ozone-forming hydrocarbons, nitrogen oxides, and toxics	• Somewhat higher fuel cost • Few energy security or trade balance benefits

• ELECTRICITY

Battery-powered vehicles give off virtually no pollution and offer one of the best options for reducing motor vehicle emissions in polluted cities. Power plants that produce electricity do pollute. But these plants are often in rural areas where the emissions do not drive pollution levels above health standards. Also, efficient emission controls can be installed and maintained more easily on individual power plants than on millions of vehicles. The driving range of today's electric cars is limited by the amount of power the battery can provide. Current batteries take hours to recharge and the cost of electric vehicles is high. Recent developments in electric vehicle technology show much promise for the future.

• ETHANOL

Ethanol ("grain alcohol") is the primary automotive fuel in Brazil, and ethanol/gasoline blends (known as "gasohol") have been used in the United States for many years. Pure ethanol fuel offers excellent performance, plus low hydrocarbon and toxic emissions. It can be produced domestically from corn or other crops, as well as from cellulosic materials such as wood or paper wastes, potentially minimizing the accumulation of greenhouse gases (since these "renewable" feedstocks draw carbon dioxide out of the atmosphere as they grow). With current technology and price structures, ethanol is more expensive than gasoline. New technologies offer the hope of significantly reduced costs.

- **METHANOL**
  Methanol ("wood alcohol"), like ethanol, is a high-performance liquid fuel that emits low levels of toxic and ozone-forming compounds. It can be produced at prices comparable to gasoline from natural gas and can also be produced from coal and wood. All major auto maufacturers have produced cars that run on "M85," a blend of 85 percent methanol and 15 percent gasoline. Cars that burn pure methanol (M100) offer much greater air quality and efficiency advantages. Many auto manufacturers have developed advanced M100 prototypes. Methanol has long been the fuel of choice for race cars because of its superior performance and fire safety characteristics.

- **NATURAL GAS (METHANE)**
  Natural gas is abundant and is widely used for home heating and industrial processes. It is easily transported through pipelines and costs about the same or slightly less than gasoline. Compressed natural gas (CNG) vehicles emit low levels of toxics and ozone-forming hydrocarbons. But CNG fuel must be stored under pressure in heavy tanks, and the cost of accommodating these tanks must be considered. There are significant tradeoffs for CNG vehicles among emissions, vehicle power, efficiency, and range; however, natural gas is already used in some fleet vehicles and appears to have a bright future as a motor vehicle fuel.

- **PROPANE**
  Propane, or liquefied petroleum gas, is a by-product of petroleum refining and natural gas production. It burns more cleanly than gasoline but is limited in supply. Propane-fueled vehicles are already common in many parts of the world.

- **REFORMULATED AND OXYGENATED GASOLINE**
  The petroleum industry is beginning to market gasoline formulations that emit less hydrocarbons, nitrogen oxides, carbon monoxide, and toxics than conventional gasoline. These new gasolines can be introduced without major modification to existing vehicles or the fuel distribution system. The Clean Air Act requires some gasoline modifications to reduce carbon monoxide emissions beginning in 1992 and use of reformulated gasoline in certain polluted cities beginning in 1995.

Are Clean Fuels Feasible?

Clean-fueled vehicles are here today and widespread use in the near future is feasible. To enable the transition, technologies must be refined so vehicles can achieve optimum performance and emissions characteristics. Consumers must accept the new vehicles and fuels, and government and industry must cooperate to ensure their availability. It will take a concerted effort by all sectors of society, but a switch to clean fuels may be the most viable way for many cities to attain clean and healthy air.

For More Information:

The Office of Mobile Sources is the national center for research and policy on air pollution from highway and off-highway motor vehicles and equipment. You can write to us at the EPA National Vehicle and Fuel Emissions Laboratory, 2565 Plymouth Road, Ann Arbor, MI 48105. Our phone number is (313) 668-4333.