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City of Las Cruces - National Clean Cities Program

Alternative Fuels Summary

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Contact Mr. Frank Burcham,
Coordinator of the Land of
Enchantment Clean Cities
Coalition at
loecleancities@comcast.net

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- [Beyond A Billion: Clean Cities Celebrates Petroleum Milestone](#)
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Alternative fuels are being used worldwide in a variety of vehicle applications. Using these alternative fuels in vehicles can generally reduce harmful pollutants and exhaust emissions. In addition, most of these fuels can be domestically produced and derived from renewable sources.



Biodiesel

Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant greases. Biodiesel is safe, biodegradable, and reduces serious air pollutants such as particulates, carbon monoxide, hydrocarbons, and air toxics. Blends of 20% biodiesel with 80% petroleum diesel (B20) can generally be used in unmodified diesel engines; however, users should consult their OEM and engine warranty statement. Biodiesel can also be used in its pure form (B100), but it may require certain engine modifications to avoid maintenance and performance problems and may not be suitable for wintertime use. Users should consult their engine warranty statement.

Pure biodiesel (B100) is considered an alternative fuel under EPA Act. Lower-level biodiesel blends are not considered alternative fuels, but covered fleets can earn one EPA Act credit for every 450 gallons of B100 purchased for use in blends of 20% or higher. Biodiesel (fatty acid alkyl esters) is a cleaner burning diesel replacement fuel made from natural, renewable sources such as new and used vegetable oils and animal fats. Just like petroleum diesel, biodiesel operates in compression-ignition engines. Blends of up to 20% biodiesel (mixed with petroleum diesel fuels) can be used in nearly all diesel equipment and are compatible with most storage and distribution equipment. These low-level blends (20% and less) generally do not require any engine modifications, however, users should consult their OEM and engine warranty statement. Biodiesel can provide the same payload capacity and as diesel.

Higher blends, even pure biodiesel (100% biodiesel, or B100), may be able to be used in some engines (built since 1994) with little or no modification. However, engine manufacturers are concerned about the impact of B100 on engine durability. Additionally, B100 is generally not suitable for use in low temperature conditions. Transportation and storage of B100, however, require special management.

Using biodiesel in a conventional diesel engine substantially reduces emissions of unburned hydrocarbons, carbon monoxide, sulfates, polycyclic aromatic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and particulate matter. These reductions increase as the amount of biodiesel blended into diesel fuel

increases. The best emission reductions are seen with B100.

The use of biodiesel decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO₂) and reduces the sulfate fraction (biodiesel contains less than 15 ppm sulfur), while the soluble, or hydrocarbon, fraction stays the same or increases. Therefore, biodiesel works well with emission control technologies such as diesel oxidation catalysts (which reduce the soluble fraction of diesel particulate but not the solid carbon fraction).

Emissions of nitrogen oxides increase with the concentration of biodiesel in the fuel and the increase is roughly 2% for B20. Some biodiesel produces more nitrogen oxides than others, and some additives have shown promise in reducing the increases. More R&D is needed to resolve this issue.

Biodiesel has physical properties very similar to conventional diesel.

Electricity

Electricity can be used as a transportation fuel to power battery electric and fuel cell vehicles. When used to power [electric vehicles](#) or EVs, electricity is stored in an energy storage device such as a battery. EV batteries have a limited storage capacity and their electricity must be replenished by plugging the vehicle into an electrical source. The electricity for recharging the batteries can come from the existing power grid, or from distributed renewable sources such as solar or wind energy.

Fuel cell vehicles use electricity produced from an electrochemical reaction that takes place when hydrogen and oxygen are combined in the fuel cell "stack." The production of electricity using fuel cells takes place without combustion or pollution and leaves only two byproducts, heat and water.

Electricity is unique among the alternative fuels in that mechanical power is derived directly from it, whereas the other alternative fuels release stored chemical energy through combustion to provide mechanical power. Motive power is produced from electricity by an electric motor.

Electricity used to power vehicles is commonly provided by batteries, but fuel cells are also being explored. Batteries are energy storage devices, but unlike batteries, fuel cells convert chemical energy to electricity.

Ethanol

Ethanol is an alcohol-based alternative fuel produced by fermenting and distilling starch crops that have been converted into simple sugars. Feed stocks for this fuel include corn, barley, and wheat. Ethanol can also be produced from "cellulosic biomass" such as trees and grasses and is called bioethanol. Ethanol is most commonly used to increase octane and improve the emissions quality of gasoline.

Ethanol can be blended with gasoline to create E85, a blend of 85% ethanol and 15% gasoline. E85 and blends with even higher concentrations of ethanol, E95, for example, qualify as alternative fuels under the [Energy Policy Act of 1992](#) (EPAct). Vehicles that run on E85 are called flexible fuel vehicles (FFVs) and are offered by several vehicle manufacturers.

In some areas of the United States, lower concentrations of ethanol are blended with gasoline. The most common low concentration blend is E10 (10% ethanol and 90% gasoline). While it reduces emissions, E10 is not considered an alternative fuel under EPAct regulations.

Ethanol (ethyl alcohol, grain alcohol, EtOH) is a clear, colorless liquid. In dilute

aqueous solution, it has a somewhat sweet flavor, but in more concentrated solutions it has a burning taste. Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is made up of a group of chemical compounds whose molecules contain a hydroxyl group, $-\text{OH}$, bonded to a carbon atom. Ethanol made from cellulosic biomass materials instead of traditional feed stocks (starch crops) is called *bioethanol*.

The Clean Air Act Amendments of 1990 mandated the sale of oxygenated fuels in areas with unhealthy levels of carbon monoxide. Since that time, there has been strong demand for ethanol as an oxygenate blended with gasoline. In the United States each year, approximately 2 billion gallons are added to gasoline to increase octane and improve the emissions quality of gasoline.

Blends of at least 85% ethanol are considered alternative fuels under the [Energy Policy Act of 1992](#) (EPAct). E85, a blend of 85% ethanol and 15% gasoline, is used in flexible fuel vehicles (FFVs) that are currently offered by most major auto manufacturers. FFVs can run on gasoline, E85, or any combination of the two and qualify as alternative fuel vehicles under EPAct regulations.

In some areas, ethanol is blended with gasoline to form an E10 blend (10% ethanol and 90% gasoline). Chemical properties: Ethanol is ethane with a hydrogen molecule replaced by a hydroxyl radical.

Hydrogen

Hydrogen (H_2) will play an important role in developing sustainable transportation in the United States, because in the future it may be produced in virtually unlimited quantities using renewable resources. Hydrogen has been used effectively in a number of internal combustion engine vehicles as pure hydrogen mixed with natural gas.

In addition, hydrogen is used in a growing number of demonstration fuel cell vehicles. Hydrogen and oxygen from air fed into a proton exchange membrane (PEM) fuel cell "stack" produce enough electricity to power an electric automobile, without producing harmful emissions.

The simplest and lightest fuel is hydrogen gas (H_2). Hydrogen is in a gaseous state at atmospheric pressure and ambient temperatures. Hydrogen may contain low levels of carbon monoxide and carbon dioxide, depending on the source.

Hydrogen is being explored for use in combustion engines and fuel cell electric vehicles. On a volumetric basis, the energy density of hydrogen is very low under ambient conditions. This presents greater transportation and storage hurdles than for liquid fuels. Storage systems being developed include compressed hydrogen, liquid hydrogen, and physical or chemical bonding between hydrogen and a storage material (for example, metal hydrides).

The ability to create hydrogen from a variety of resources and its clean-burning properties make it a desirable alternative fuel. Although there is no significant transportation distribution system currently for hydrogen transportation use, we can transport and deliver hydrogen for early market penetration using the established hydrogen infrastructure; for significant market penetration, the infrastructure will need further development.

Methanol

Methanol, also known as wood alcohol, can be used as an alternative fuel in flexible fuel vehicles that run on M85 (a blend of 85% methanol and 15% gasoline). However, it is not commonly used because automakers are no longer supplying methanol-powered vehicles.

Methanol can be used to make methyl tertiary-butyl ether (MTBE), an oxygenate which is blended with gasoline to enhance octane and create cleaner burning fuel. MTBE production and use has declined because it has been found to contaminate ground water.

Methanol (CH₃OH) is an alcohol fuel. Today most of the world's methanol is produced by a process using natural gas as a feedstock. However, the ability to produce methanol from non-petroleum feedstocks such as coal or biomass is of interest for reducing petroleum imports.

Chemical Properties: As engine fuels, ethanol and methanol have similar chemical and physical characteristics. Methanol is methane with one hydrogen molecule replaced by a hydroxyl radical (OH).

Natural Gas

Natural gas is domestically produced and readily available to end-users through the utility infrastructure. It is also clean burning and produces significantly fewer harmful emissions than reformulated gasoline or diesel when used in [natural gas vehicles](#). In addition, commercially available medium- and heavy-duty natural gas engines have demonstrated over 90% reductions of carbon monoxide (CO) and particulate matter and more than 50% reduction in nitrogen oxides (NO_x) relative to commercial diesel engines. Natural gas can either be stored onboard a vehicle as compressed natural gas (CNG) at 3,000 or 3,600 psi or as liquefied natural gas (LNG) at typically 20-150 psi. Natural gas can also be blended with hydrogen.

Natural gas is a mixture of hydrocarbons—mainly methane (CH₄)—and is produced either from gas wells or in conjunction with crude oil production. Natural gas is consumed in the residential, commercial, industrial, and utility markets.

The interest in natural gas as an alternative fuel stems mainly from its clean burning qualities, its domestic resource base, and its commercial availability to end users. Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous state (CNG) or in a liquefied state (LNG).

Chemical Properties: The main constituent of natural gas is methane, which is a relatively unreactive hydrocarbon. Natural gas as delivered through the pipeline system also contains hydrocarbons such as ethane and propane; and other gases such as nitrogen, helium, carbon dioxide, hydrogen sulfide, and water vapor.

Propane

Propane or liquefied petroleum gas (LPG) is a popular alternative fuel choice for vehicles because there is already an infrastructure of pipelines, processing facilities, and storage for its efficient distribution.

Besides being readily available to the general public, LPG produces fewer vehicle emissions than gasoline. Propane is produced as a by-product of natural gas processing and crude oil refining.

According to the [Gas Processors Association](#) HD5 specification for LPG as a transportation fuel, LPG must consist of 90% propane, no more than 5% propylene, and 5% other which is primarily butane and butylene. It is produced as a by-product of natural gas processing and petroleum refining. The components of LPG are gases at normal temperatures and pressures.

P-Series

P-series fuel is a unique blend of natural gas liquids (pentanes plus), ethanol, and the biomass-derived co-solvent methyltetrahydrofuran (MeTHF). P-Series fuels are clear, colorless, 89-93 octane, liquid blends that are formulated to be used in flexible fuel vehicles (FFV's). P-Series are designed to be used alone or freely mixed with gasoline in any proportion inside the FFV's gas tank. These fuels are not currently being produced in large quantities and are not widely used.

Since 1992, when the [Energy Policy Act \(EPAct\)](#) was passed, only one new fuel has been recognized as an alternative fuel under the EPAct petitions provision. P-Series fuels were added to the list of alternative fuels in 1999.

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