BIOFUELS

Biofuel is solid, liquid, or gas fuel made from relatively recently dead biological material. Biofuel is different from fossil fuels, such as coal or oil, which are derived from long dead biological material. The most common sources of biofuels are photosynthetic plants. Biofuels are most commonly used to power vehicles, heat homes, and cook. Biofuel industries are growing in Europe, Asia, and the Americas.

There are two common ways to make biofuels. One is to grow crops high in sugar, such as sugar cane, or high in starch, such as corn, and then use yeast fermentation to produce ethyl alcohol (ethanol). The second is to grow plants containing high amounts of vegetable oil, such as oil palm. These oils can be burned directly in a diesel engine, or they can be chemically processed to make fuels such as biodiesel. Wood and wood byproducts can be converted into biofuels such as wood gas, methanol, or ethanol.

The benefits of using biofuels include reduced dependence on oil and more energy security. Unlike fossil fuels, which add carbon to the atmosphere, biofuels can produce energy without causing a net increase of atmospheric carbon. This is because as new plants are grown to produce fuel, they remove the same amount of CO_2 from the atmosphere as they will release as fuel.

Humans have used solid biofuels for heating and cooking since the discovery of fire. Biofuels have also been used to generate electrical power. The rising use of fossil fuels dramatically reduced the amount of biomass fuel used for transport, heat, and power. Recently, first in the 1970s and again since the year 2000, there has been renewed interest in biofuels, due to rising oil prices, oil supply worries, greenhouse gas emissions and climate change, rural development interests, and instability in the Middle East.

First-generation biofuels are made from sugar, starch, vegetable oil, or animal fats. Grains such as wheat yield starch that is fermented into bioethanol. Sunflower seeds (and other seeds and grains) can be pressed to yield vegetable oil that can be used in biodiesel. Because these crops are edible, their use in biofuels has been criticized for causing food shortages and price rises by taking food away from the human food chain.

The most common first-generation biofuels are vegetable oil, biodiesel, bioalcohol, biogas, syngas, and solid biofuels. Edible vegetable oil is not generally used as fuel, but lower quality oil can be. Used vegetable oil is increasingly being processed into *biodiesel*, the most common biofuel in Europe. Common sources of biodiesel include animal fats, vegetable oils, soy, other seeds high in oil, palm oil, hemp, and algae.

Bioalcohols, especially ethanol fuel, are the most common biofuels worldwide. Alcohol fuels are produced by fermenting sugars derived from grains, sugar beets, sugar cane, molasses, or other plant products containing sugar. Ethanol can be used as a replacement for gasoline; it can be mixed with gasoline. Most automobile engines can run on blends of up to 15% bioethanol with gasoline. Gasoline with ethanol added has higher octane, which means that engines can burn hotter and more efficiently.

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One drawback of ethanol is that it takes nearly as much energy to produce as it yields. In current production methods using corn, the energy from the ethanol is not much greater than the energy used to make it, when you count the energy used by farm equipment, petroleum fertilizers, and other chemicals, and energy consumed in the production and transport of the fuel. So ethanol does little to reduce un-sustainable imported oil and fossil fuels.

The anaerobic digestion of organic material produces *biogas*. Biogas can be produced either from biodegradable waste materials or by the use of energy crops fed into anaerobic digesters to supplement gas yields. *Landfill gas* is a less clean form of biogas that is produced in landfills through naturally occurring anaerobic digestion. If it escapes into the atmosphere, it is a potent greenhouse gas, so it is good if it can be harvested and turned into fuel instead.

Syngas is a gas made from biofuel. Using syngas is more efficient than using the original biofuel; more of the energy contained in the fuel is extracted. Syngas can be burned directly in internal combustion engines. Syngas can be used to produce methanol and hydrogen, or converted to produce a synthetic gasoline substitute.

Solid biofuels include wood, sawdust, grass cuttings, charcoal, agricultural waste, non-food energy crops, and dried manure. When raw biomass is in a suitable form, it can burn directly in a stove or furnace to provide heat or steam. When it is in an less convenient form (such as sawdust), it can be shaped into pellets and burned in a pellet stove.

Some experts say that a better long-term solution is to develop *second-generation biofuels* that use non-food crops, including cellulosic biofuels. Second-generation biofuels can be produced from waste biomass, the stalks of wheat, corn, wood, and special energy crops. Many second-generation biofuels are under development.

The advantage of producing fuel such as ethanol from cellulose is that it uses non-food crops or inedible waste products and does not divert food away from the food chain. *Lignocellulose* is the "woody" structural material of plants. It is abundant and diverse, and in some cases it is a disposal problem, so using it for fuel would solve two problems at once.

Unfortunately, producing fuel from cellulose presents a difficult technical problem. A fungus has recently been discovered that can convert cellulose into medium length hydrocarbons typically found in diesel fuel. Scientists are also working on genetically engineering organisms that could increase biofuel potential.

Algae fuel, a *third generation biofuel*, is a biofuel from algae. It produces 30 times more energy per acre than land crops such as soybeans. As the prices of fossil fuels rise, so does the interest in farming algae.

There is currently much debate over biofuel production and use. Biofuels are involved in a variety of international issues, including: the mitigation of carbon emissions levels and oil prices, the "food vs. fuel" debate, deforestation and soil erosion, impact on water resources, and energy balance and efficiency. Time will tell whether third generation biofuels will be able to solve some of these problems.

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