

Facts about Biomass Fuels

Introduction

Throughout history humans have used fuels made from plant and animal matter for heating and cooking. Today, technological advances and society's increasing demand for energy have led to an expanded role for these biomass fuels. Biomass is plant or animal matter. Biomass fuels are created from agricultural wastes, alcohol fuels, animal wastes, and municipal solid waste. Wood is also a type of biomass fuel. (See "Facts about Wood.") Biomass fuels get their energy from the sun. Photosynthesis converts solar energy striking the leaves of plants into chemical energy, which is stored in the plants themselves. Animals that eat plants store some of this energy in their bodies; some of it is also ultimately stored in manure and other wastes. Biomass fuels are renewable because the raw materials can be replaced within a human lifetime simply by growing more crops or collecting more waste. The energy content of biomass fuels is usually measured in Btu (British thermal units). The energy produced by a lit match is roughly equal to one Btu.

Types, Production, and Uses

Agricultural Wastes

Agricultural wastes are plant parts left over after farmers have harvested their crops. These wastes include stalks, husks, prunings, straw, and corn cobs. Agricultural wastes can be collected, dried, and burned to produce energy. Burning agricultural wastes in small power plants can provide a convenient source of energy for rural areas and developing countries. The ash that remains can sometimes be used as a fertilizer. Agricultural wastes are used to produce energy in many parts of the world. In Hawaii and Brazil, bagasse, a residue left over after sugarcane is harvested and processed, is burned in power plants to produce electricity. In Denmark, straw is burned to produce heat for farms. Wisconsin produced about 1.7 trillion Btu of energy from crop residues in 1994, an amount equal to the energy used to heat about 20,000 average-sized Wisconsin homes.

Alcohol Fuels

Certain plants can be used to produce liquid alcohol fuels such as ethanol (grain alcohol) and methanol (wood alcohol). Ethanol can be produced by fermenting crops such as corn, sugar beets, or grasses, or by fermenting by-products of cheese and paper manufacturing. Methanol can be produced by heating wood in an enclosure that has little air and then using chemicals to convert the gases given off by the heated wood into a liquid. Both ethanol and methanol can be used to run cars, trucks, and buses. The United States produced about 2.8 billion gallons of ethanol in 2003. Midwestern states produce most U.S. ethanol, because these states grow large amounts of corn. Very little ethanol produced in the U.S. is made from biomass; it is cheaper to manufacture it from natural gas. Analysts estimate potential ethanol production in Wisconsin to be over 900 million gallons annually—enough to meet a large portion of the state's transportation needs. Wisconsin's first ethanol plant opened in 1996 near Plover. It manufactures ethanol from cheese whey, vegetable waste, and paper waste.

Gasoline mixed with 10 percent ethanol, called gasohol, is currently sold in many service stations in the Midwest. A majority of vehicles on roads today can run on this 10 percent gasohol. Fuels with high concentrations of ethanol and methanol (80 percent or greater) can also be used to run motor vehicles; these are called flexible fuel vehicles. For example, about one-third of Brazil's automobiles are powered by pure ethanol produced from sugarcane. Most high-performance racing cars use methanol. However, motor vehicle engines that burn gasoline would need to be modified to use alcohol fuels.

Animal Wastes

Animal waste products such as manure have long provided biomass fuel for rural societies. People in developing countries often burn dried manure for heating and cooking. Manure can also be placed in tanks called anaerobic digesters, where it is broken down by bacteria and various chemical processes to produce biogas (60 percent methane and 40 percent carbon dioxide). Small-scale production of biogas can provide fuel for space heating and cooking, while larger-scale production of biogas can generate electricity or provide heat for manufacturing processes. A number of small biogas-fueled power plants are in operation throughout the world. Plants in the U.S. use manure from farms and cattle feedlots. For example, one plant in California that burns cattle manure supplies electricity to as many as 20,000 homes. A small number of Wisconsin farms generate biogas from manure, although the state's dairy farms have the potential to produce more.

References:

Cliburn, J. K., and Associates. Great Lakes Regional Biomass Energy Program: Activities and Accomplishments. Chicago: Council of Great Lakes Governors, July 1994.

Deudney, Daniel, and Christopher Flavin. *Renewable Energy: The Power to Choose*. New York:

W. W. Norton, 1983. The Ethanol Industry. www.pioneer.com/media/knowhow/ethanol/ethanol_industry.htm. Accessed December 2, 2004.

Flavin, Christopher, and Nicholas Lenssen. *Power Surge: Guide to the Coming Energy Revolution*. New York: W. W. Norton, 1994.

Miller, G. Tyler, Jr. *Environmental Science: Working with the Earth*. 5th ed. Belmont, Calif.: Wadsworth, 1995.

Reddy, Amulya K. N., and Jose Goldemberg. "Energy for the Developing World." In *Energy for Planet Earth: Readings from Scientific American Magazine*. New York: W. H. Freeman, 1991.

Renewable Energy Fact Sheet – *Turning Wastewater into Energy. Focus on Energy*. Madison, Wisc., 2002.

Municipal Solid Waste (MSW)

Waste disposed of by residents and businesses, called municipal solid waste (MSW), can provide a source of fuel. A large percentage of this waste is made up of organic materials such as wood, paper products, food waste, and yard waste. Therefore, some MSW is a form of biomass fuel. Specially equipped waste-to-energy power plants can use MSW to produce electricity or heat. The waste is separated and non-combustible materials are removed before the remaining waste is taken to the power plant to be burned. 116 waste-to-energy facilities in the United States burned about 100,000 tons of waste per day. Another source of fuel from MSW is landfill gas. This gas is produced by the breakdown of organic material. Landfill gas, which is similar to natural gas, can be added to natural gas pipelines or burned in small power plants. One-third of these facilities are located in California. Some also exist in Wisconsin. Wastewater treatment facilities can also be utilized to generate energy, through anaerobic digestion, in the form of methane gas. The methane gas can then be used to supplement natural gas which would normally be used to heat digester tanks which break down waste and kill pathogens in the waste. The benefits of this technique include odor control, waste reduction, and valuable byproducts (mulch). McCain Foods in Plover, Wisconsin, built a wastewater treatment facility on site that converts waste into energy. In 2002 this technology saved the company \$50,000 in fuel bills. A plant in Madison, Wisconsin, reports \$370,000 in electrical savings and \$75,000 in gas heating.

Effects

Using biomass fuels provides a number of benefits for society and the environment. Biomass is a renewable resource when harvested sustainably. Biomass fuels can be produced from organic materials found throughout the world. Since most biomass is grown in rural areas, biomass fuel production can benefit rural economies by providing jobs. Using ethanol and methanol fuels in motor vehicles helps conserve oil resources.

Sulfur dioxide and nitrogen oxide emissions from burning biomass fuels are generally lower than those from burning coal. Emissions from burning biogas and biomass-produced methane are comparable to emissions from burning natural gas. Burning biomass fuels releases carbon dioxide, a suspected cause of global warming. However, the plants used to produce biomass consume carbon dioxide. Also, unburned biogas and methane gas are greater contributors to global warming than carbon dioxide. Burning these gases as fuel prevents them from being released into the atmosphere. There are also several drawbacks to using biomass fuels.

- Harvesting large areas to produce biomass fuels can harm wildlife habitats and may contribute to soil erosion.
- Repeatedly growing the same kinds of plants may reduce biological diversity. Biomass crops only grow part of the year and may fail, limiting supplies of biomass fuels.
- Burning agricultural wastes may deprive the soil of nutrients; burning municipal solid waste may produce toxic emissions.
- Using crops to produce alcohol fuels competes with their use as food.
- Large amounts of energy are often needed to harvest crops and transport them long distances. This may limit the advantages of using certain types of biomass as energy resources, especially by large power plants.
- Total energy produced is usually less than the energy used in production if the energy to grow, harvest, produce and transport with current farming methods is included. (Net negative energy)

Outlook

Biomass fuels are versatile, which allows nations with different levels of technical development to meet their energy needs without having to import energy resources. The use of biomass fuels is increasing, but these fuels are not likely to replace the use of fossil fuels in the near future unless gasoline prices rise substantially. Environmental impacts, competing land uses, the need for food, and the energy required to harvest biomass material are limiting factors. Harvesting biomass sustainably and burning biomass fuels efficiently will help ensure that they are widely used in the future.



U.S. Department of Energy, Energy Information Administration, Office of Coal, *Nuclear, Electric, and Alternate Fuels*. Renewable Energy Annual 1995. Washington, D.C., December 1995. DOE/EIA-0603 (95).

U.S. Department of Energy, Energy Information Administration, Office of Coal, *Nuclear, Electric, and Alternate Fuels*. Renewable Energy Annual 1996. Washington, D.C., April 1997. DOE/EIA-0603 (96).

Wisconsin Division of Energy, Department of Administration. *Wisconsin Energy Statistics*. Link to most recent version found on the KEEP Web site.