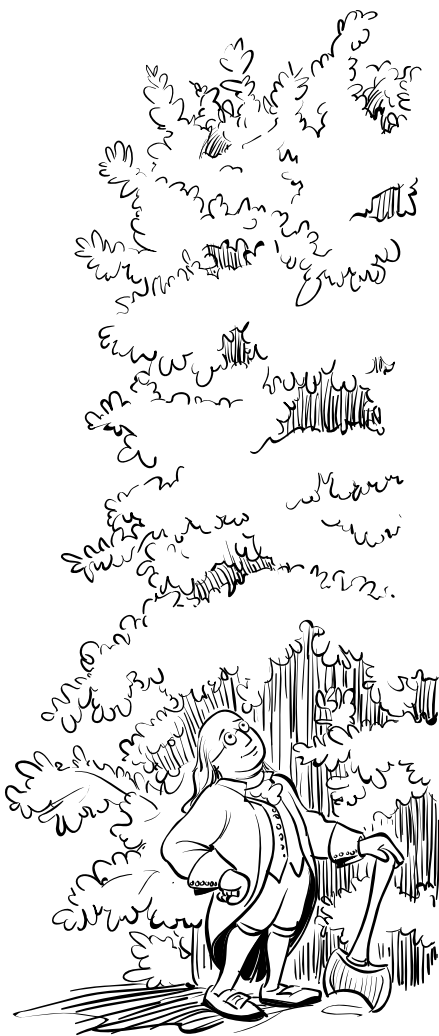




Renewable Energy Source: BIOMASS

TERMS IN GLOSSARY

byproduct
carbon cycle
decompose
energy farm
gasification
green waste
methane gas
microbe
soil erosion



Fast-growing trees are ready to be harvested for use in a biomass power plant.

B IOMASS WAS ONE OF THE FIRST energy resources ever used by humans. It includes anything that is or was once alive. Ever since the discovery of ways to create fire, humans have been burning wood and other organic material to create heat and light.

In the United States, biomass, mostly from trees, was the premier energy source until the 1830s. It was displaced by fossil fuels (mainly coal) when the Industrial Revolution took hold. Recently, however, the use of biomass, in a widening range of forms, has begun to increase. Today it is an important energy source for many processes, including the generation of electricity.*

THE BIOMASS RESOURCE

Most living things receive and store energy from the sun. This energy is released when the organic material is digested, burned, or decomposed. This released energy can be used to produce electricity. Today, many kinds of biomass are used as energy resources.

Solid Biomass

Solid biomass is anything organic that has not yet broken down into a gas or a liquid. There are many kinds of solid biomass. Chipped wood, whole trees, energy crops, and agricultural wastes are examples. Other solid biomass sources are trimmings from forests and orchards; wastes from building construction, food processing, and paper industries; animal manure; and plain old garbage.

At home and at work people produce tons of waste each year, much of which is organic. Many of us produce a lot of this "green" waste just from cutting our lawns and trimming our trees and bushes.

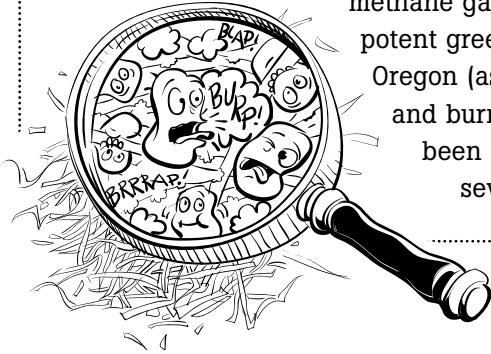
Until recently, all garbage (including organic waste) was dumped into landfills or burned without any pollution controls. Today, many biomass power plants (complete with pollution controls) use solid biomass to produce electricity. Instead of going to landfills much of our green waste is now trucked directly to biomass plants. A plant in Michigan uses 300,000 tons per year of wood waste from local timber industries (and puts wastewater to use in its cooling towers). A plant in Wisconsin uses 250,000 tons of wood wastes, shredded railroad ties, and even scrap tires.



*Biomass can also be used a fuel for space heating and factory processing, and to produce liquid transportation fuel such as ethanol.

POWER SKETCH: Munching Microbes

Picture a landfill teeming with rotting, long-buried waste. Microbes gobble this decaying quagmire of leftover stuff that originally came from living things. As the microbes munch, they burp methane gas. Methane gas is normally released into the atmosphere and is a potent greenhouse gas (see Glossary). However, at a landfill near Eugene, Oregon (as at many others around the United States), the gas is collected and burned for heat to generate electricity. This biomass power plant has been in operation since 1992 and continues to send electrical power to several thousand homes.



Biofuels and Biogas

We can produce both liquid and gas fuels from solid biomass. This is not a new idea. The production of biomass gas, called gasification, is based on a method developed in the early 1800s to produce gas from coal for town streetlights in both England and the United States. And since the 1940s, in over a million homes in India, people have cooked with biomass gas made in their own small gasifiers.

Today, gasifiers use high-tech processes to produce a gas from solid biomass by heating it under very controlled conditions. This gas can then be converted to a liquid. Gasification facilities can be large or small, serving power plants that range from just a few kilowatts to 50 MW or more.

WASTE TO ENERGY

A biomass power plant in Shasta County, California, processes about 90 tons of solid waste from timber mills, forests, and orchards every hour, producing enough electricity to power 50,000 homes. Each day at a biomass power plant in Vermont, about 200 tons of waste wood from local forests are converted to gas, which is burned to produce “homegrown” electricity.



Some biomass gas occurs naturally. Leftover biomass will decompose on its own, producing gases such as methane (a colorless, flammable gas). These gases can be collected for use in a biomass power plant. Some of these plants are located at landfills to burn the gas right as it's formed. Of the estimated 2,500 municipal solid waste landfills throughout the United States, at least 340 are now the sites of landfill gas power plants, with plans for dozens more.

Near Vancouver, British Columbia, a new landfill gas "co-generation" power plant is being constructed at a greenhouse where it will produce electricity and, at the same time, supply heat for growing tomatoes. Denmark has solved its livestock manure problem by turning most of it into a biomass gas fuel for heating and for generation of electricity.

Biomass Energy Farms

Sometimes specific crops and trees are grown just for biomass power. These are often referred to as energy farms. Hybrid willow and poplar trees as well as switchgrass are the crops most widely used today. They grow fast, help keep loose soil from eroding, and thrive in a variety of growing conditions. Hybrid willows and poplars can be cut and used for energy as often as every three years, as they regrow quickly from the cut stumps.

For many years, farmers have been growing switchgrass as a side crop for livestock feed and to control soil erosion. Now, some of these farmers are growing switchgrass as their main crop – an energy crop. For example, in Alabama, farmers are successfully raising switchgrass energy crops in soil once depleted and eroded by the over-harvesting of cotton.

Besides providing a local, abundant, and "green" energy source, growing energy crops can also revitalize the economies of rural areas. It has been estimated that the United States has sufficient available land to grow enough biomass to supply one fourth of its current energy needs.



REMINDER

W = watt

kW = kilowatt = 1,000 watts

MW = megawatt = 1,000 kilowatts

1 megawatt can serve about 1,000 homes in the United States.



Switchgrass, a biomass energy crop, swiftly grows to 10 feet high.

GENERATING ELECTRICITY FROM BIOMASS RESOURCES

Biomass Power Plants

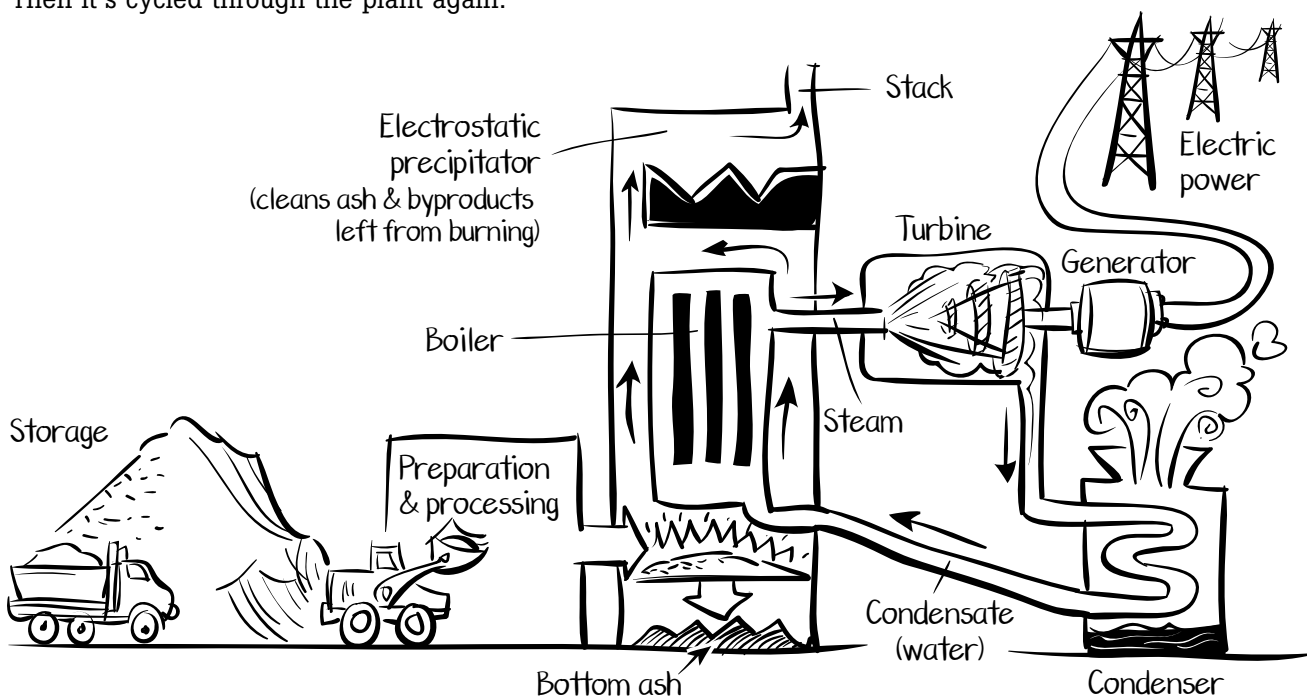
Biomass power plants usually work by burning organic matter or a biofuel to produce heat to boil water for steam to drive a turbine generator. These power plants vary in size.

Large Biomass Power Plants. Large-scale biomass power plants often resemble traditional steam-driven plants, such as those that run on fossil fuels. In a biomass plant, however, the energy production process includes the preparation and processing of the biomass for burning. If it's wood, it might be chipped. If it is garbage, non-burnable materials are removed, and sometimes the remainder is formed into pellets. At other biomass plants, the biomass is converted into a gas or liquid fuel before it is burned.

The processed biomass is then burned in enormous furnaces. The resulting heat boils water for steam that is used to drive turbine generators. Biomass power plants have special technologies that clean most of the ash byproducts and smoke produced from burning before they are released into the atmosphere. Like most other power plants, they have condensers that cool and condense the steam back to water. Then it's cycled through the plant again.

IT'S A GAS!

While biofuels are often burned to heat water for steam-driven electrical generation, they can also produce electricity without creating steam. Biofuel gases themselves are sometimes used to drive gas turbines. Gas turbines are driven by heated and pressurized gas instead of by steam (see page 91).



Large-scale biomass power plant

In Pietarsaari, Finland, one of the world's largest "biofueled" power plants produces up to 260 MW of electricity from forest residues. This plant produces steam for forest industries, as well as electricity for the local grid. Finland is actively promoting the increased use of biomass, as are many other European countries.

Small Biomass Power Plants. Small biomass power plants are often found in rural areas and in the villages of developing countries. These little powerhouses can deliver electricity to a single facility or to a limited number of nearby users. They usually make use of locally generated biomass. In America's midwest, one dairy farmer uses cow manure to produce methane gas. This gas drives a biomass power plant that generates enough electricity for his farm and for fifty of his neighbors.

Cofiring. Biomass can also be burned along with another type of fuel, such as coal, in a process called cofiring. This can be done using existing equipment in a traditional coal power plant. The addition of biomass at these power plants reduces the amount of pollutants produced. Most of the electricity in the United States is produced from coal, so adding biomass can have a positive effect. Some coal power plants even dedicate a portion of their operations to burning only biomass.

FUELING AROUND IN SPAIN

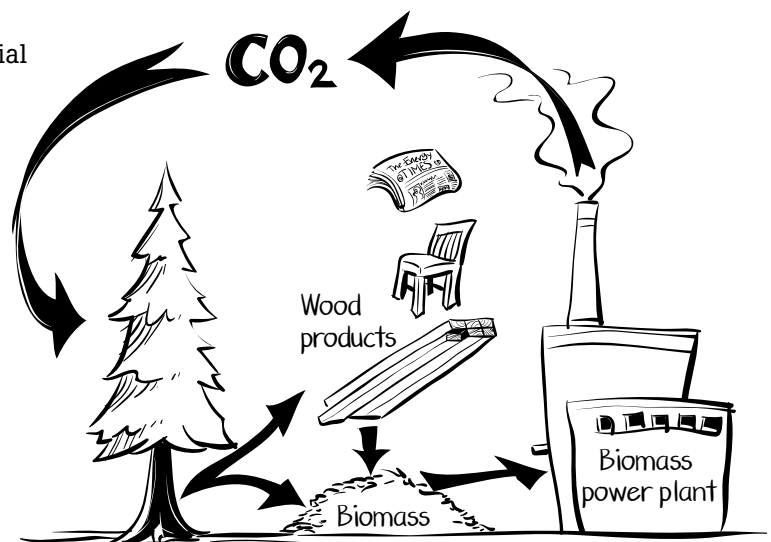
Spain, the world's largest producer of olive oil, is the first country to produce electricity from olives. Since 1995, a power plant located amidst the olive groves of Andalusia has been producing enough electricity for 27,000 households. Growers in the area routinely turn their waste from olive oil production into biomass for power production.

CONSIDERATIONS



- Biomass energy crops are beneficial to the environment because they take in carbon dioxide as they grow. This can offset CO₂ – a greenhouse gas – given off when they are burned.
- Use of orchard and forest trimmings, along with other green waste for biomass fuel, can reduce waste disposal and landfill costs.

(continued)



CO₂ from biomass power plants is offset by growing trees and crops.

CONSIDERATIONS (continued)

- Anything that is burned gives off some byproducts (ash and gases, for example). Power plants that use solid biomass have special equipment to prevent most of these pollutants from going into the atmosphere.
- Gases produced from decomposing organic material in landfills are pollutants and, if highly concentrated, are toxic. Collecting and burning these gases as fuel helps solve this problem.
- When transported or stored for use as a combustible material, solid biomass can take up a lot of space.
- Some people think that thinning overgrown forests and collecting fallen branches and tree trunks from the forest floor for biomass fuel protects forests from catastrophic wildfires and contributes to a healthier forest ecosystem. Others fear that, if not done correctly, this practice can adversely affect animal habitats and/or disrupt fragile ecosystems.
- Biomass is a renewable resource if we don't harvest the organic materials faster than crops or forests can be cultivated or naturally regenerated.
- Biomass power plants are often used to supply baseload power because they can run day and night, and their energy supply is predictable.

