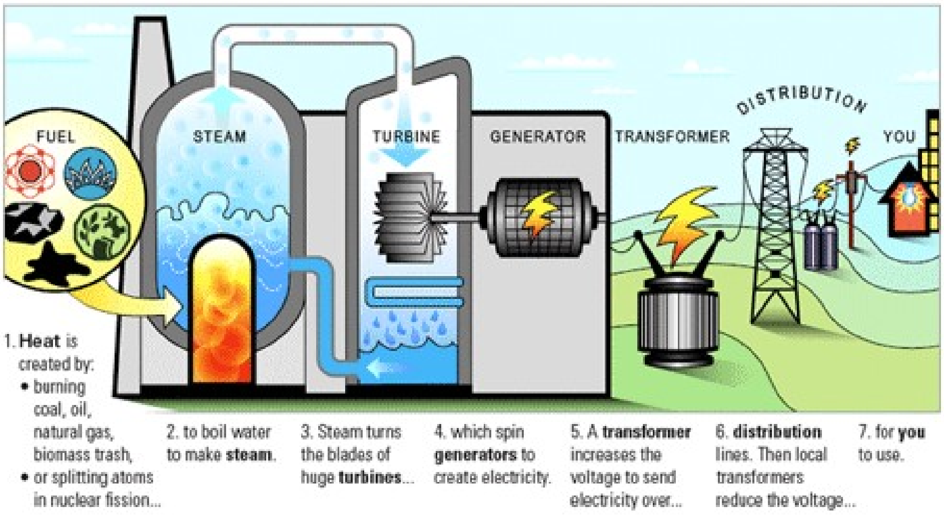
BIOPOWER

Biopower (biomass power) is electricity produced from plant materials and animal products. Biomass fuels include residues from the wood and paper products industries, residues from food production and processing, trees and grasses grown specifically as energy crops, and gaseous fuels produced from solid biomass, animal wastes, and landfills. Biopower technologies convert renewable biomass fuels into electricity (and heat) using modern boilers, gasifiers, turbines, generators, and fuel cells.

Some of the most common ways to convert biomass to biopower are listed below:

Direct Combustion and Cofiring

Most of the biomass electricity generated today is produced by direct combustion. This uses a steam cycle, as shown in Diagram 1 below. In this process, biomass is burned in a boiler to make steam. The steam then turns a turbine, which is connected to a generator that produces electricity.



Biomass can also be burned with coal in a boiler (in a conventional power plant) to produce steam and electricity. Cofiring biomass with coal is an affordable way for utilities to obtain some of the environmental benefits of using renewable energy.

***Diagram 1:** In a direct combustion system, processed biomass is the boiler fuel that produces steam to operate a steam turbine and generator to make electricity.*

Gasification

Solid biomass can be converted into a fuel gas in a gasifier such as the one shown in Diagram 2. In this method, sand (at about 800°C) surrounds the biomass and creates a very hot, oxygen-starved environment. These conditions break apart wood or other biomass and create an energy-rich, flammable gas.

The biogas can be cofired with wood (or other fuel) in a steam boiler or used to operate a standard gas turbine.

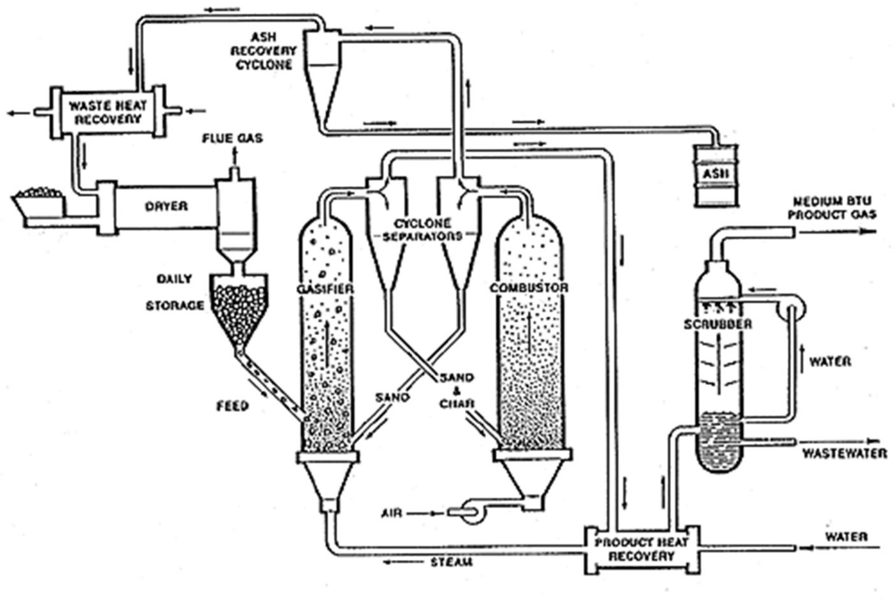
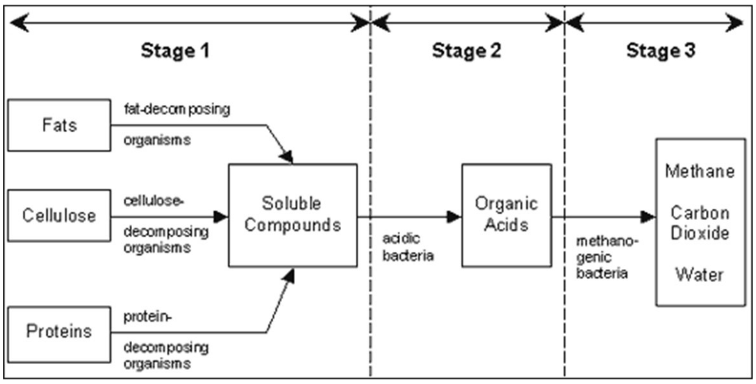


FIGURE 1. BATTELLE'S BIOMASS GASIFICATION SYSTEM

***Diagram 2:** This diagram shows one method of transforming biomass particles into biogas fuel.*

Anaerobic Digestion

Biogas can also be created by digesting food or animal wastes in the absence of oxygen, as shown in Diagram 3 & 4 below. This process, called anaerobic digestion, will occur in any airtight container containing a mixture of bacteria normally present in animal waste. Different types of bacteria work in sequence to break down complex chemicals, such as fat and protein, into progressively simpler molecules. The final product is a biogas containing methane and carbon dioxide. The biogas can be used for heating or for electricity generation in a modified internal combustion engine. However, advanced gasification technologies are necessary for converting animal waste to a biogas with sufficient energy to fuel a gas turbine.



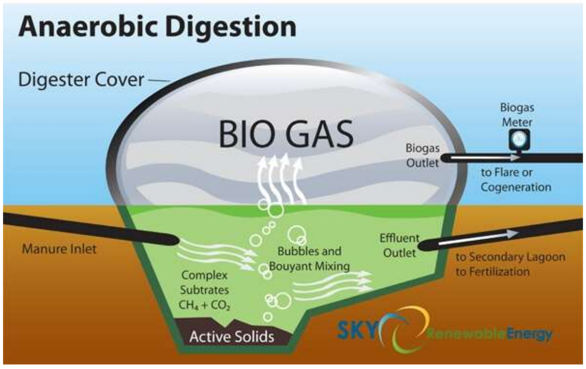


Diagram 3 & 4: Anaerobic digestion, which takes place in three stages inside an airtight container, produces biogas. Different kinds of micro-organisms are responsible for the processes that characterize each stage.

Landfills also produce a methane-rich biogas from the decay of wastes containing biomass. However, landfill gas must be cleaned to remove harmful and corrosive chemicals before it can be used to generate electricity.

Using Biomass Fuel Gases

Fuel gases made from biomass can be used to generate electricity in a gas turbine, as shown in Diagram 4, or in a combined-cycle generating unit, as shown in Diagram 5. In a simple-cycle gas turbine, compressed gas is ignited, and the hot gases rotate a gas turbine, generating electricity. In a combined-cycle unit, the hot waste gases from the gas turbine are used to create steam to run a steam turbine and generator.

Diagram 4: In a simple-cycle gas turbine, both pressurized fuel gas and hot combustion product gases operate a gas turbine and generator, producing electricity.

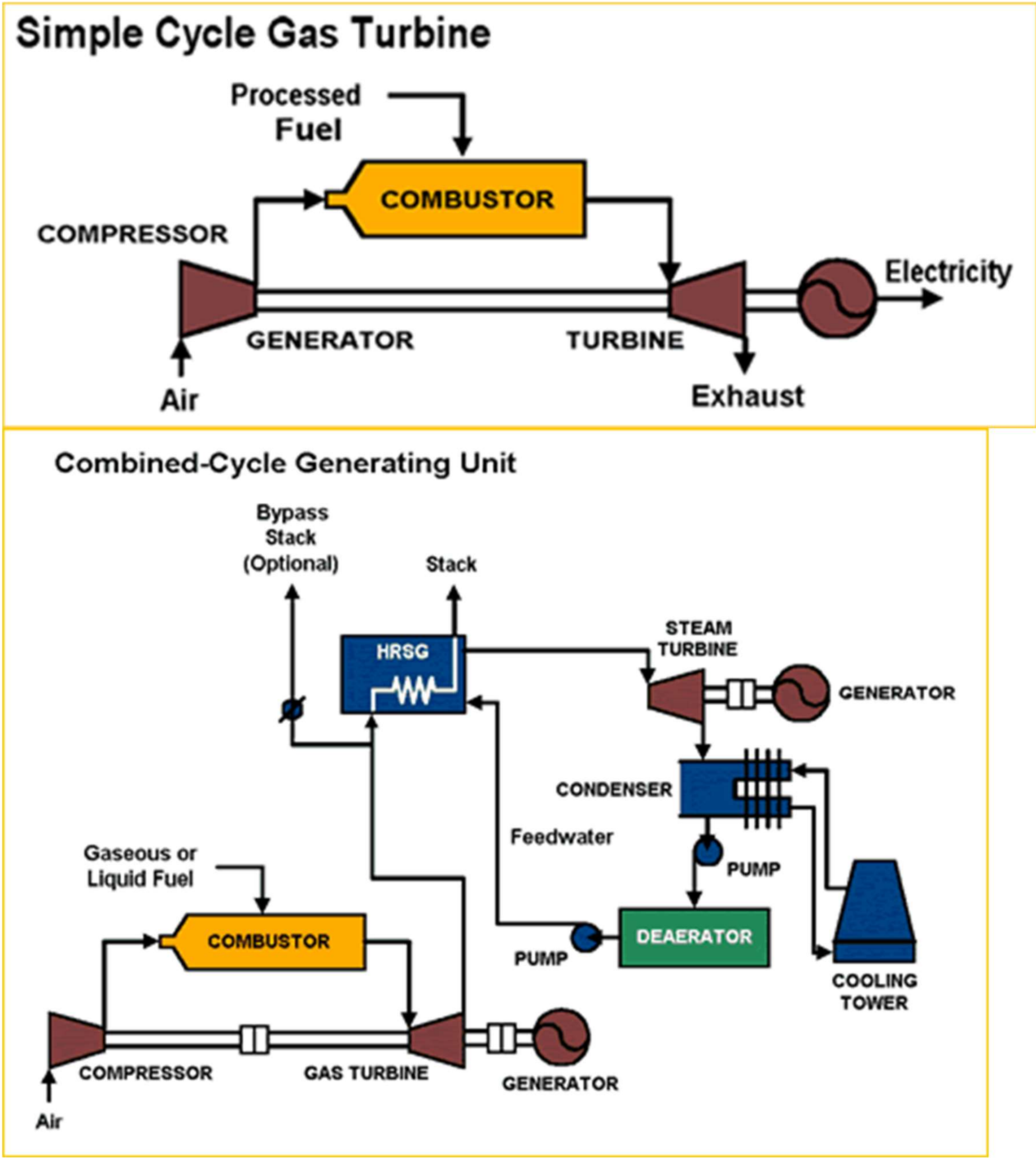


Diagram 5: In a combined-cycle generating system, hot turbine exhaust gases are used to produce steam to run a steam turbine and generator.

Advantages
Biopower provides new markets for the nation's farmers and can create jobs in rural communities. It is a natural fit for the electric power industry. Power plants that cofire biomass with coal have fewer emissions that cause acid rain. And biomass fuels share some characteristics — such as being available on demand — with coal, oil, and natural gas. Their use meshes well with an industry used to working with fossil fuels.

Biopower is good for the environment. Because biomass fuels are renewable, they can help reduce greenhouse gas emissions from fossil fuels — as long as dedicated energy crops are used. Energy crops also create habitat for wildlife and can prevent soil erosion.

Biopower makes productive use of crop residues, wood-manufacturing wastes, and the clean portion of urban wastes. These "useless" wastes would otherwise be open-burned, left to rot in fields, or buried in a landfill. Wastes that rot in the field often produce methane, a greenhouse gas even more potent than carbon dioxide. Burying energy-rich wastes in a landfill is like burying petroleum instead of using it.

Disadvantages

Today's biopower plants have generation costs higher than those of fossil fuel generation. Biomass fuels contain less concentrated energy, are less economic to transport over long distances, and require more preparation and handling than fossil fuels. These factors contribute to higher costs.

Other challenges to the increasing use of biopower include competition with natural gas, the need to develop high-yield, low-input energy-crop farming practices, and the need for more research to improve biopower technologies.

Applications

U.S. biopower plants have a combined capacity of 7,000 MW. These plants use roughly 60 million tons of biomass fuels (primarily wood and agricultural wastes) to generate 37 billion kWh of electricity each year. That's more electricity than the entire state of Colorado uses in a year. As with conventional power from fossil fuels, biopower is available 24 hours a day, seven days a week. Small, modular biopower systems with rated capacities of 5 MW or less can supply power in regions without grid electricity. These systems can provide distributed power generation in areas with locally produced biomass resources such as rice husks or walnut shells.

Modular biopower systems are a good choice for areas with limited central power grids, as long as sufficient biomass is locally available for fuel. Such small biopower systems can power communities and local industries.

Modular systems could also be hooked into existing transmission and distribution systems near the rural homes, farms, ranches, and industries likely to produce and use biopower. Biopower systems can improve power quality on weak transmission lines located far from central power plants. Examples of energy consumers that might install biopower systems include commercial hog farming operations, paper companies, and food processing plants with high energy costs and stockpiles of corn cobs or rice husks needing disposal.