BIO ENERGY TO ELECTRIC ENERGY

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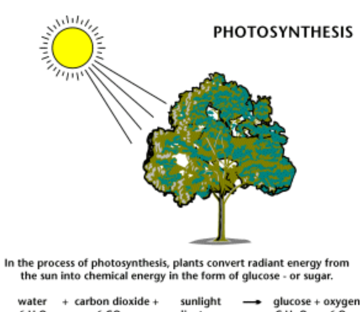
Abstract

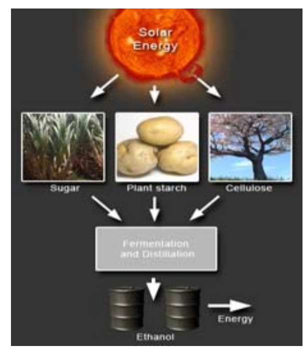
Biomass is plant matter and animal waste that can be harvested to create bioenergy in the form of electricity, heat, steam and fuels. Biomass has great potential to contribute considerably more to the renewable energy sector. It has potential to generate power to the extent of more than 50% of the country's requirements. These sources are pollution free and hence clean energy apart from being unlimited /inexhaustible. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and Biodiesel.

Key words: forestry wastes, urban wood wastes, municipal solid wastes and landfill gas, animal wastes, terrestrial crops, energy crops. anaerobic digestion, methane gas, pyrolysis.

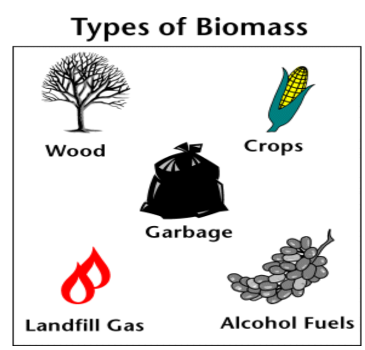
1. Introduction



Biomass is organic material made from plants and animals. Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. The chemical energy in plants gets passed on to animals and people that eat them. Biomass is a renewable energy source because we can always grow more trees and crops, and waste will always exist. Some examples of biomass fuels are wood, crops, manure, and some garbage. When burned, the Chemical energy in biomass is released as heat. Wood waste or garbage can be burned to produce steam for making electricity, or to provide heat to industries and homes. Burning biomass is not the only way to release its energy. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and Biodiesel. Methane gas is the main ingredient of natural gas also called "landfill gas" or "biogas."



2. Types of biomass



Domestic biomass resources include pulp and paper, agricultural and forestry wastes, urban wood wastes, municipal solid wastes and landfill gas, animal wastes and terrestrial and aquatic crops grown solely for energy purposes, known as energy crops.

2.1. Animal Wastes

Such as cattle, chicken and pig manure, can be converted to gas or burned directly for heat and power generation. Furthermore, most animal wastes contain high levels of methane. Utilizing the manure to produce energy properly lowers the environmental and health impacts. These wastes can be used to make many products and generate electricity through methane recovery methods and anaerobic digestion.

2.2. Municipal Solid Wastes

Residential, commercial, and institutional post-consumer wastes contain a significant proportion of plant derived organic material that constitutes a renewable energy resource. Waste paper, cardboard, wood waste and yard wastes are examples of biomass resources in municipal wastes.

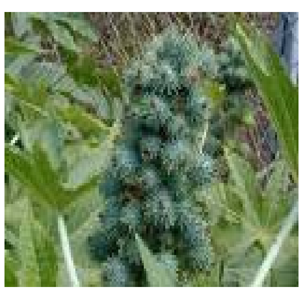
2.3. Landfill Gases

The natural byproduct of bacterial digestion of organic garbage contains vast amounts of methane which can be captured, converted and used to create energy most often through anaerobic digestion (AD).

2.4. Energy Crops

a) Industrial Crops

Industrial crops are being developed and grown to produce specific industrial chemicals or materials. Examples include kenaf and straws for fiber, and castor for ricinoleic acid. New transgenic crops are being developed that produce the desired chemicals as part of the plant composition, requiring only extraction and purification of the product.



b).Agricultural Crops

These feed stocks include the currently available commodity products such as cornstarch and corn oil; soybean oil and meal; wheat starch, other vegetable oils, and any newly developed component of future commodity crops. They generally yield sugars, oils, and extractives, although they can also be used to produce plastics and other chemicals and products.

c)Aquatic Crops

a wide variety of aquatic biomass resources exist such as algae, giant kelp, other seaweed, and marine micro flora. Commercial examples include giant kelp extracts for thickeners and food additives, algal dyes, and novel biocatalysts for use in bioprocessing under extreme environments.

d) Wood Energy Crops

Short-rotation woody crops are fast growing hardwood trees harvested within five to eight years after planting. These include hybrid poplar, hybrid willow, silver maple, eastern cottonwood, green ash, black walnut, sweet gum, and sycamore.

2.5. Forest Residues

This includes wood and wood wastes like bark, sawdust, wood chips, wood scrap; dead and dying trees, dried leafs etc...

2.6. Agricultural or Crop Residues

These are the leftovers of harvesting. They can be collected with conventional harvesting equipment while harvesting the primary crop or afterwards into pellets,

chips, stacks or bales. Agriculture crop residues include corn Stover (stalks and leaves), wheat straw, and rice straw and processing residues such as nut hulls.

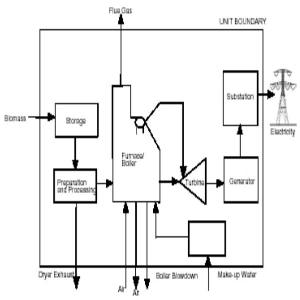


Figure 1. Direct-fired biomass electricity generating system schematic.

3. Ways to Generate Electricity

3.1 Direct-Fired or Conventional Steam Boiler

Most of the biopower plants in the world use a direct-fired system or a conventional steam boiler. Both systems burn bioenergy feedstock's directly to produce steam which in turn creates electricity. Differences in the methods lie within the boiler or furnace structure. In a direct-fired system, biomass is loaded in from the bottom of the boiler and air is supplied at the base. In a conventional steam boiler, the draft is forced in through the top but the biomass is also bottom loaded. Hot combustion gases are passed through a heat exchanger in which water is boiled to create steam. This steam is usually captured by a turbine, causing the turbine blades to rotate. The rotation is attached to an electrical generator, which then creates electricity.

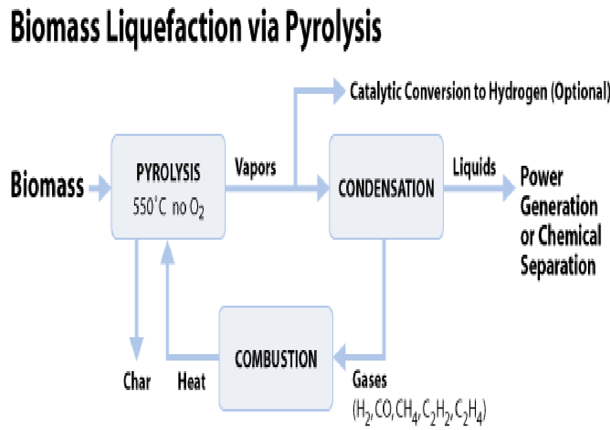
3.2. Co-Firing

Co-firing, combining biomass with coal to generate energy, is probably the most compatable way to use biomass with the current fossil fuel dependent system. Biomass is placed into the boilers and burned, as coal would be. Often the only cost associated with upgrading the system to burn both fuels is to purchase a boiler capable of doing so, and retrofitting it into the system,

which is a whole lot cheaper than building a whole other plant. There are several environmental benefits of adding biomass to coal, including decreases in nitrogen and sulphur oxides, the causes of smog, acid rain and ozone pollution. Also, the amount of carbon dioxide released is also considerably less.

3.3 Pyrolysis

Pyrolysis is a process where biomass is combusted at high temperatures and decomposed in the absence of oxygen. However, some difficulties arises when trying to create a totally oxygen free atmosphere.

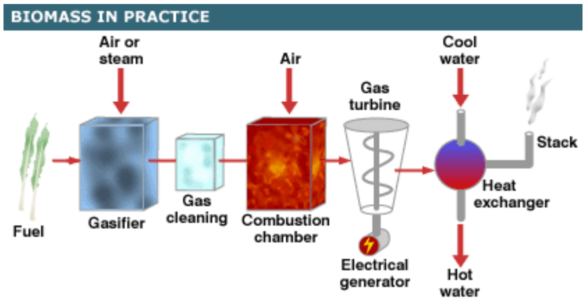


Often a little oxidation does occur which may create undesirable byproducts and also it is highly energy intensive and expensive at the moment. The burning creates pyrolysis oil, char or syngas which can then be used like petroleum to generate electricity. It does not create ash or energy directly. Instead it morphs the biomass into higher quality fuel. The process begins with a drying process in order to maximize burning potential from the biomass, similar to the direct combustion process above. When cooled, the brown liquidy pyrolysis oil can be used in a gasifier.

3.4 Biomass Gasification

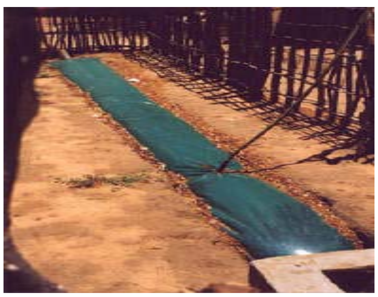
Solid biomass can be converted into a gaseous form, known as syngas. The gas can then run through "combined-cycle" gas turbine. Biomass gasifiers operate by heating biomass in an environment where the solid biomass breaks down to form a flammable gas. This offers advantages over directly burning the biomass. The biogas can be cleaned and

filtered to remove problem chemical compounds. The gas can be used in more efficient power generation systems called combined-cycles, which combine gas turbines and steam turbines to produce electricity. The efficiency of these systems can reach 60%.



3.5 Anaerobic digestion

is a biological process, where the methane released by the synergistic actions between bacteria and archaea are contained and used to create energy. Anaerobic Digestion uses biowaste such as manure and municipal solid waste (MSW) as a feedstock. The manure or waste is bagged and broken down by using bacteria and water. This process releases the methane in the bag, and it is siphoned off into another holding bag. From there, the gas is used to power turbines which generate electricity.

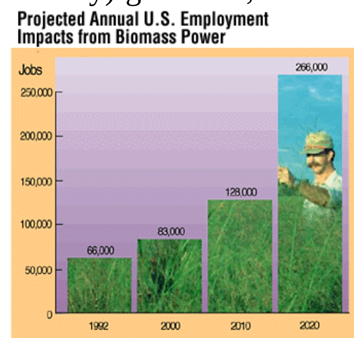


3.6 Modular Systems

Modular systems employ some of the same technologies mentioned above, but on a smaller scale that is more applicable to villages, farms, and small industry. These systems are now under development and could be most useful in remote areas where biomass is abundant and electricity is scarce.

4. Current use

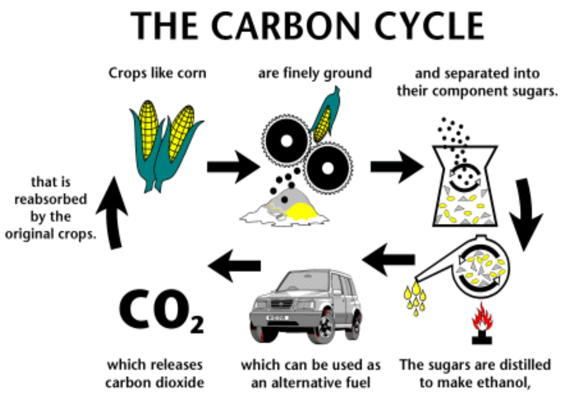
The United States is currently the largest biopower (that is biomass for electricity) generator, with over half of the world's installed capacity. Biomass represents 1.5% of the total electricity supply. There are about 7,800 MW of biomass power capacity installed at more than 350 locations in the U.S., representing 1% of total U.S. electricity generation capacity. The U.S. biomass power industry is primarily located in the Northeast, Southeast, and West Coast regions, representing a $15 billion investment and 66,000 jobs. Most states are generating at least some of their energy from biomass.



Bioenergy is currently used worldwide. According to the International Energy Agency (IEA), the world derives 11% of its energy from biomass. However, developing nations use closer to 35% biomass for power. This percentage is higher still for the poorest nations which depend on burning biomass for their cooking, heating and fueling.

5. Advantages

- The conversion biomass into electricity does not contribute to global warming, or the greenhouse effect. This is because the amount of carbon dioxide released by the biomass is the same as the amount of carbon dioxide absorbed by the biomass material during its growth.



- Biomass fuels have negligible sulphur content and therefore do not contribute to sulphur dioxide emissions which cause acid rain.

- The combustion of biomass generally produces less ash than coal combustion. Unlike coal ash, the "biomass ash" can be used as a soil additive on farm land to recycle material such as phosphorous and potassium.

- The use of agricultural and forestry residues and other waste materials for energy production is helping to reduce the significant problem of waste disposal.

- Biomass is a domestic resource which is not subject to world price fluctuations. In developing countries, the use of liquid biofuels, such as ethanol, reduces the economic pressures of importing petroleum products.

- The growth of perennial "energy crops" (such as grasses and trees that are processed for energy use) has a lower environmental impact than conventional agricultural crops.

6. Conclusion

Markets for biomass crops have been slow to develop. Electric utilities are interested in co-firing biomass as a way to meet the renewable energy mandate. In addition, there are air quality benefits from biomass fuels. Since biomass fuels are low in sulfur and nitrogen, SO_x which causes acid rain and NO_x which contributes to smog is lower in smokestack emissions when biomass fuels are burned with coal. Presently, ethanol is in demand for use with gasoline to make gasohol. As almost 80% of energy consumption is due to biomass harvest and transport, to further improve the energy ratio, future development should optimize harvest and transport logistics and improve machinery fuel efficiency.

7. References

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