Biomass Energy

1. Introduction:

Biomass has become one of the most commonly a used renewable source of energy, refers to organic matter that has stored energy through the process of photosynthesis see **Figure (1)**. It exists in one form as plants and may be transferred through the food chain to animals' bodies and their wastes, all of which can be converted for everyday human use through processes such as combustion, which releases the carbon dioxide stored in the plant material. Many of the biomass fuels used today come in the form of wood products, dried vegetation, crop residues, and aquatic plants, second only to hydropower in the generation of electricity. It is such a widely utilized source of energy, probably due to its low cost and indigenous nature, in cooking and heating.

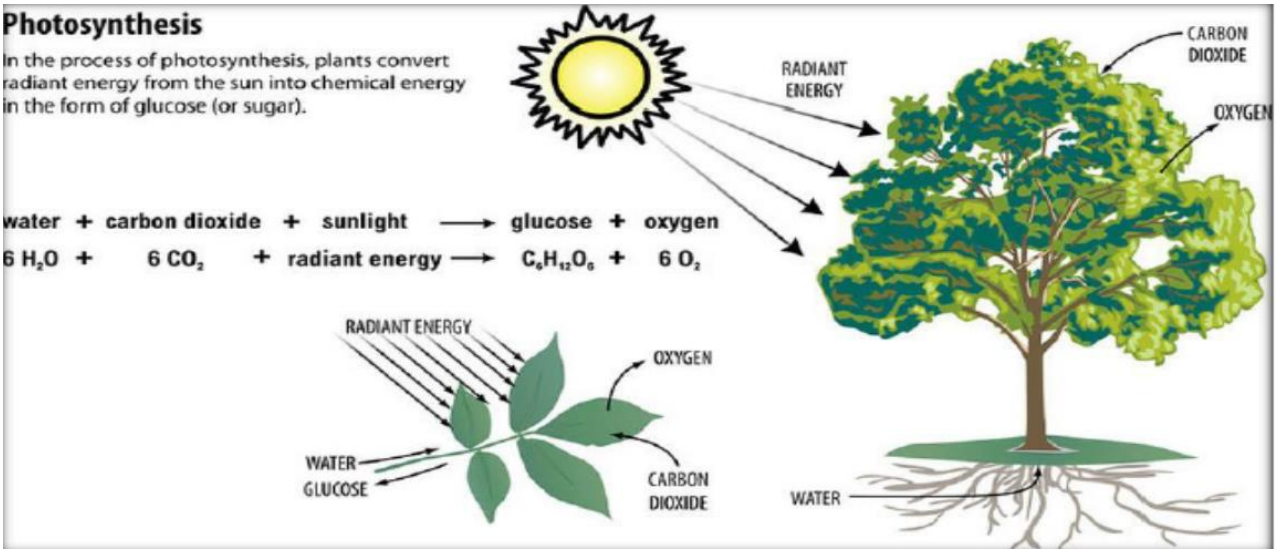

Figure 1: How Biomass gets its energy

2. What is Biomass Energy?

Biomass Energy Definition –Biomass is a renewable and sustainable source of energy, it can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Biomass is an industry term for getting energy by burning Organic material that comes from plants and animals. Plants or plant-based materials that are not used for food or feed, and are specifically called lignocellulose biomass **Figure (2)**.

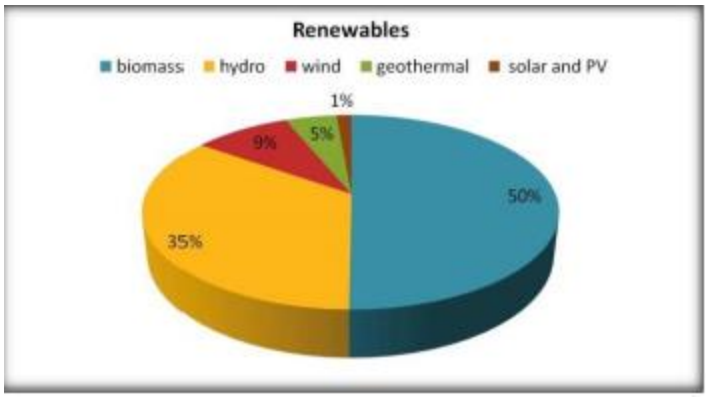

Figure 2: Biomass energy

3. Properties of Bioenergy:

• Bioenergy is the energy retrieved from biomass sources. It is the largest used renewable energy resource in the world.

• Large bioenergy potential: Biomass resource is widely available and diversified in livestock waste, municipal and Industrial effluents (paper, plastic, food, etc.), Poultry waste, Sewage sludge.

• Bioenergy is a significant mean for waste disposal to prevent environmental pollution and allow economic stability.

4. Bioenergy Production Routes:

The main bioenergy production routes are illustrated in **figure (3)** below:

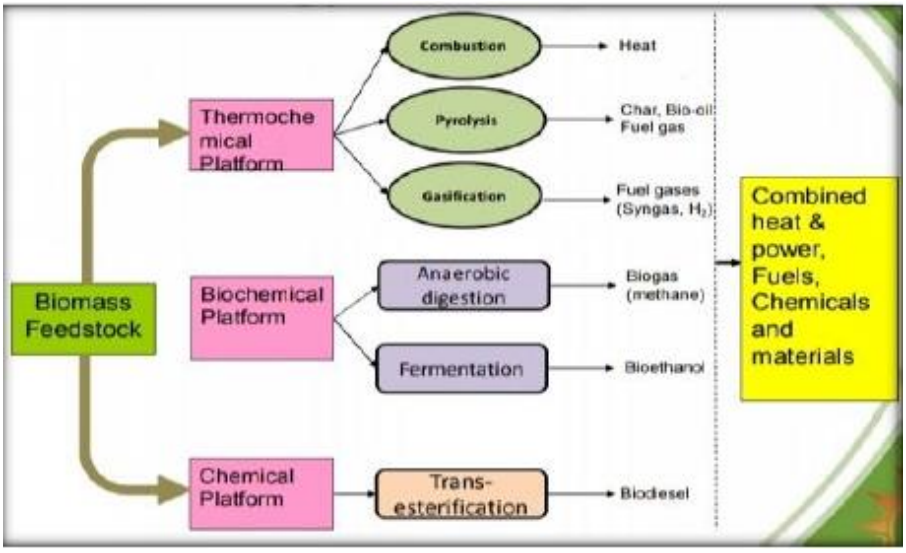

Figure 4: Bioenergy Production Routes

4.1 Thermochemical processes:

One of the most important processes used to convert biomass into energy can be used in daily life and industry is the thermochemical platform. **Figure (4)** illustrates the most important processes of this method.

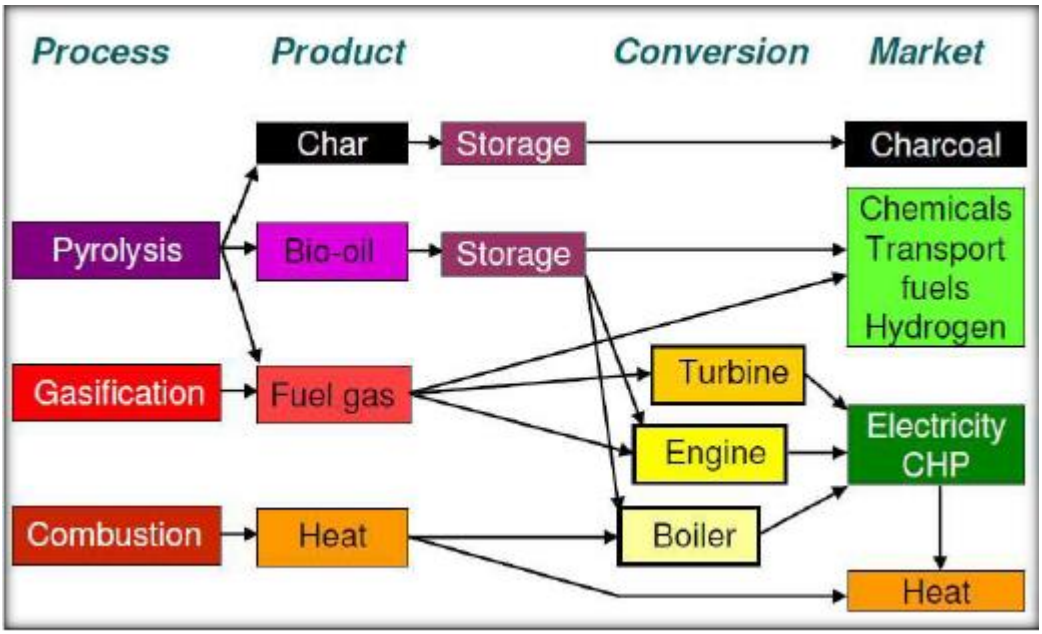

Figure 4: **Thermochemical conversion options**

4.1.1 Combustion:

This is where organic matter is burned in the presence of oxygen to generate heat. The heat can be used for heating purposes in homes. The heat can also be used to produce electricity by heating water to produce steam. The steam is then directed to turn a turbine. The turbine turns a shaft, which connects it to a generator. The motion of the shaft triggers the generator to produces electricity see **figure (5)**.

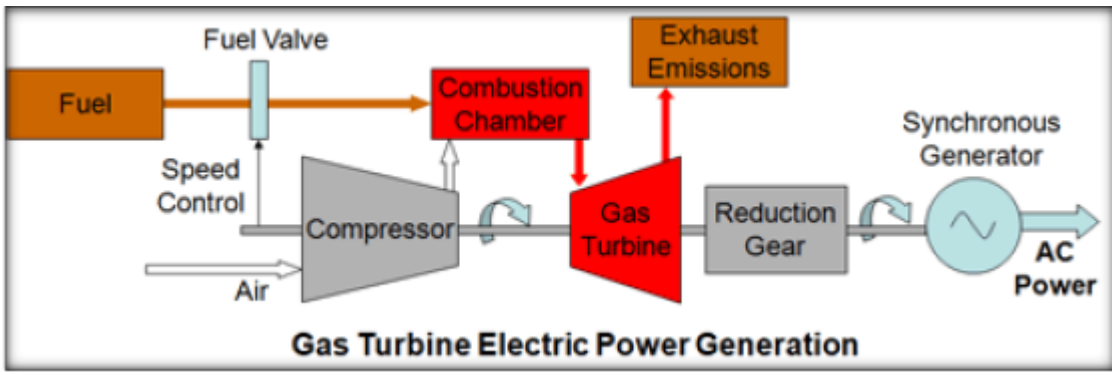

Figure5: Combustion process

4.1.2 Gasification:

This is a process that converts organic matter into carbon dioxide, hydrogen, and carbon monoxide. To achieve this, organic materials are reacted using heat without combustion, with a limited amount of steam or oxygen. The result is a gas mixture called syngas or producer gas, which is also a form of fuel. The energy resulting from gasification and burning of the produced gas is classified as renewable energy if the elements that were gasified originated from biomass. The syngas can be used for heating, generation of electricity and many other functions see **figure (6)**.

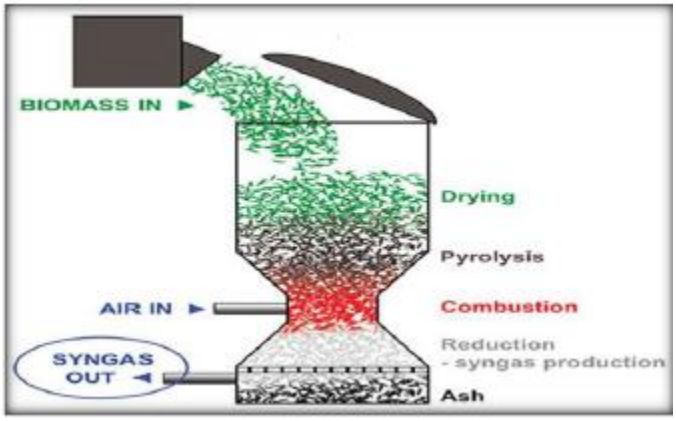

Figure 6: Gasification process

4.1.3 Pyrolysis:

Pyrolysis is the process of decomposing organic material at high temperatures without oxygen. Because oxygen is not present during this process, the organic matter doesn't burn. Instead, it decomposes into 3 forms; a liquid known as bio-oil, a solid known as bio-char and syngas, see **figure (7)**.

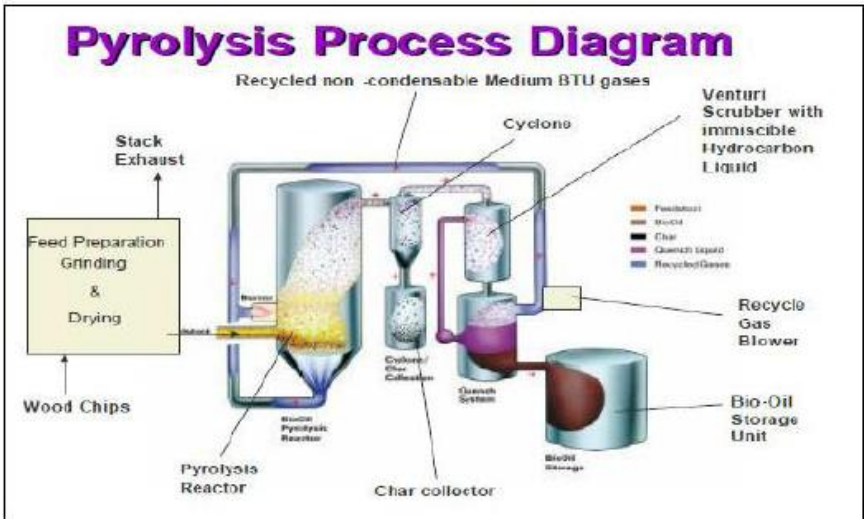

Figure7: Pyrolysis process

4.2 Biochemical Processes:

Other processes used to convert biomass into energy is the Biochemical platform. It contains the following processes:

4.2.1 Bio-Digestion:

This process is also known as anaerobic digestion. It's where bacteria break down organic material in the absence of air to produce biogas. The biogas is then captured and combusted to generate energy, see **figures (8)**.

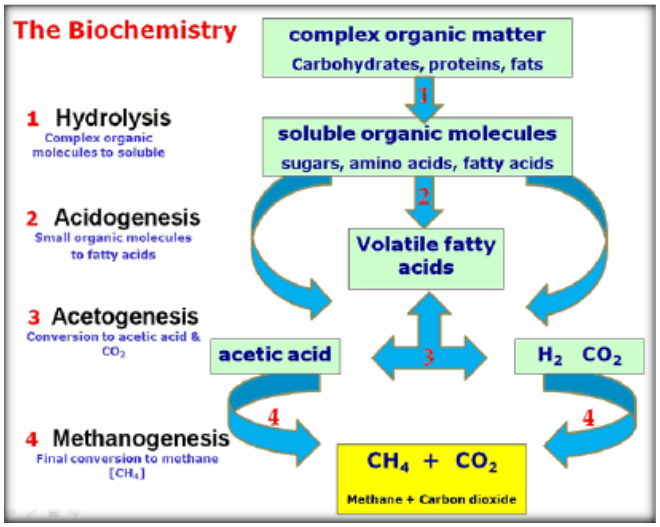

Fig. (8) Bio-digestion process

5.4.2.2 Fermentation:

Fermentation is the process of converting sugar from organic material into alcohol, commonly known as ethanol, with the help of yeast. The ethanol derived can be used as a source of fuel to power automobiles, see **figure (9)**.

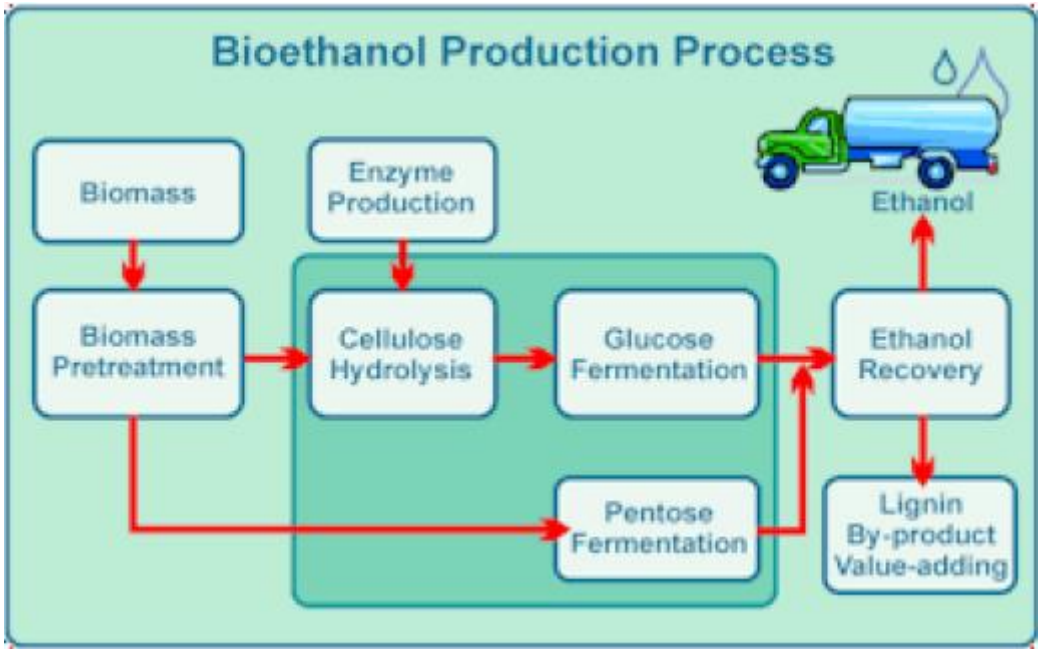

Figure9: Bioethanol production process

5. Materials used to makeup Biomass fuel are:

The main resources of Biomass energy are:

- Animal manure and human sewage
- Agricultural crops and waste materials
- Food and wood waste in garbage
- Forest Residues and wood processing wastes

Burning biomass releases carbon emissions, around a quarter higher than burning coal, but has been classed as a **"renewable"** energy source of fuel because:

- Plants can be regrown.

 We will always have Forest Residues, wood processing wastes, Agricultural crops and waste materials.

 Easily available animal manure and human sewage along with the Food waste in garbage can be used in a fruitful manner.

Burning Biomass is the only one way to release its energy. Biomass can be converted to other useable forms and used for energy such as:

 Agricultural crops and waste materials—burned as a fuel or fermented to produce liquid biofuels such as ethanol.

 Animal manure and human sewage—converted to biogas such as Methane, which can be burned as a fuel.

 Food, yard, and wood waste in garbage—burned to generate electricity in power plants or converted to biogas (Methane) in landfills

 Wood and Wood processing wastes—burned to heat buildings, to produce process heat in industry, and to generate electricity.

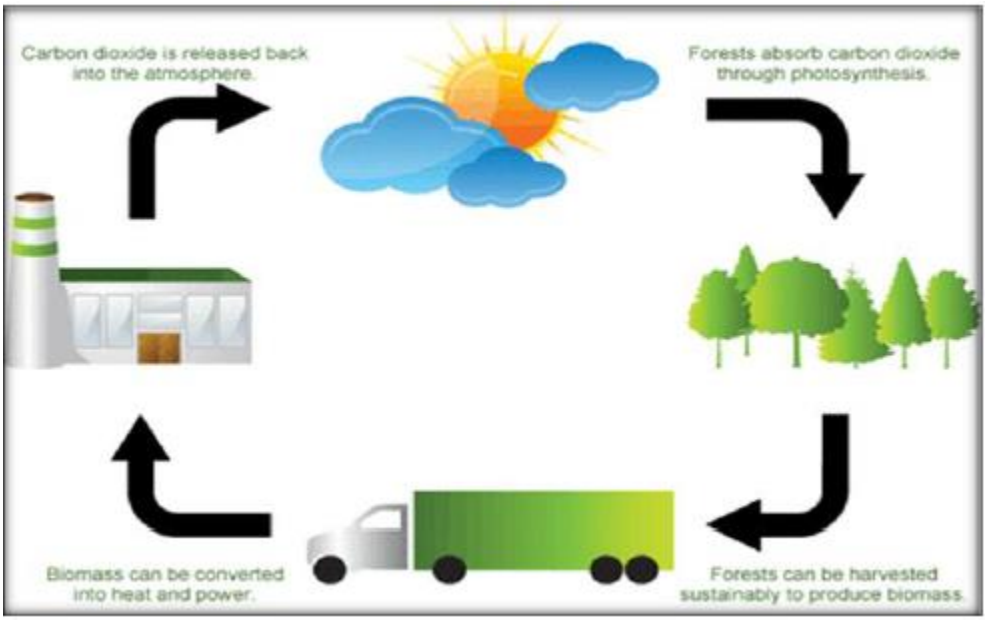

Figure: (10) biomass energy resources

6. How much energy does biomass contain?

A kilogram of cut grass contains about 4 million joules, also known as mega joules (MJ). That's slightly more electricity than the kilowatt hour used in the energy retail market. And wood, the most commonly used biomass, contains around 15 MJ/kg. But if it's dried before it's burned, that's boosted to around 18 MJ/kg. Squaring up to fossil fuels But when you consider coal, with an energy content of around 25 to

30 MJ/kg, and crude oil, with about 42 MJ/kg, it's clear that biomass isn't as efficient. Biofuels, like sunflower oil and castor oil, fair a little better compared to petrol – with sunflower oil having an energy content of 33 MJ per liter, and petrol at around 32 to 35 MJ per liter.

7. Environmental reliability:

Biofuels offers several environmental benefits over fossil fuels. Biofuels from lignocellulos biomass have reduced emissions and fixed CO2 (a greenhouse gas). When a new bio-refinery is established, several technologies will be assembled based on their impact on the environment, such as:-

 Air pollution caused by particulate emission during biomass harvesting and grinding.

 Noise pollution from explosive pre-treatment processes.

 Methods for producing pre-treatment chemicals that produce greenhouse gas emissions.

 Release of pre-treatment chemicals to the environment after processing.

8. Physical reliability:

Biomass materials can reliably provide electricity, but due to their naturally high water content, biomass materials burn less efficiently than coal because they require more energy input to produce a given amount of energy. Biomass producers can increase the energy efficiency of biomass materials by dandifying them, though doing so is costly. Energy crops compete for land that would otherwise be used for food crops and wood, but agricultural and forest residues can be a practical use of waste resources. The availability of residues, however, can be unpredictable. In addition, residues can be expensive to collect. Biomass can predictably generate electricity, differentiating it from other renewable electricity sources, but its reliability can be affected by costs of biomass materials and the ability of power facilities to effectively use biomass fuel.

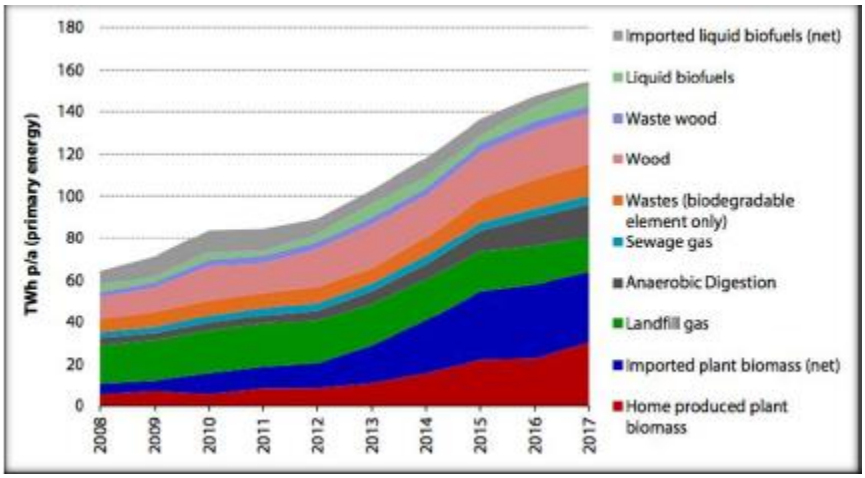

Fig. (5.18) Biomass supply diagram

9. Advantages of Biomass Energy:

Biomass has been in existence before people started talking about renewable energy sources and energy efficiency. This long term use would not be possible if biomass didn't have any benefit. As most governments are leading campaigns to find alternative sources of fuel to fossils, biomass energy continues to make headlines as a possible alternative. Here are the advantages that make biomass energy a perfect alternative to fusel fuel.

a) **it's a renewable form of energy**

Biomass energy is considered a renewable form of energy because the organic materials used to produce it are never-ending. The organic materials including wood, crop waste, garbage, sewage sludge, and manure are continually produced by society. In a nutshell, regrowth of these organic materials supports the fact that biomass is renewable.

b) **Its carbon neutral**

We all know that release of vast amounts of carbon contributes greatly to. Biomass energy takes care of this since it is a natural part of the carbon cycle as opposed to fossil-based sources of fuel such as oil, natural gas, and coal. Researchers say that the only carbon emitted to the environment from biomass fuels is the amount that was absorbed by plants in the course of their life cycle. In the process of replenishing the used plant materials, the new ones that spring up absorb equal quantity of carbon, hence, developing neutrality that witnesses no new carbon generated. This aspect renders biomass uniquely clean.

c) Widely available.

Just like sun and wind energy, biomass energy sources are bountiful in supply. You can find them virtually in every nook and cranny of the world. The fact that it's Bountiful in supply means that we may never encounter problems that we are presently with fossil based sources of fuel. Nonetheless, it's vital that we maintain the abundance of this natural resource by being responsible in its use

d) It's cheaper compared to fossil fuels

Producing biomass does not involve heavy capital outlay. Fossil fuels production, on the other hand, involves high upfront capital costs such as drilling to reach oil wells, constructing gas pipelines and collection of biomass fuel. The low cost resulting from the production of biomass fuel is passed on to customers. This means that customer's energy bills will not depend on aspects such as availability and knee jack decisions of energy production and supply firms. Low biomass cost makes this form of energy attractive to manufacturers and producers since they are able to generate higher profits from extremely low output.

e) Minimizes overdependence on traditional electricity

Virtually anyone can produce biomass energy because the raw materials are available everywhere. Traditional forms of electricity can sometimes be unreliable due to power outages. Biomass energy produced at home can be a good backup for traditional electricity.

f) Reduces amount of waste in landfills

Most waste produced in homes is either plant matter or biodegradable. This kind of waste can be channeled to more profitable use. Biomass energy generation utilizes any waste that would have otherwise found way into landfills. This minimizes the impacts of waste in landfills to the environment. This impact may be compounded by contamination of local habitats and destruction of wildlife ecosystems. Minimized waste means reduction of land intended for landfills, hence, more space for human habitats.

g) Can be used to Create Different Products

Biomass energy is also versatile, as different forms of organic matter can be used to create different products. Ethanol and similar fuels can be made from corn and other crops. With so many living things on the planet, there is no limit to how many ways it can be found and used.

10. Disadvantages of Biomass Energy:

While the upsides to biomass energy are plenty, it's not exactly a perfect source of energy.

Here are the downsides to biomass energy:

a) Not entirely clean

Using animal and human waste to power engines may save on carbon dioxide emissions, but it increases methane gases, which are also harmful to the Earth's ozone layer. So really, we are no better off environmentally for using one or the other. And speaking of using waste products, there is the smell to consider. While it is not physically harmful, it is definitely unpleasant, and it can attract unwanted pests (rats, flies) and spread bacteria and infection.

b) Risk of deforestation

Biomass energy sources are renewable, but they have to be utilized sustainably. Uncontrolled biomass production can result in deforestation. If deforestation is allowed to happen, scores of animal and bird species would be rendered homeless, not to mention the drought as a result. In fact, this is the main reason for slowing down the large scale use of biomass fuel. Governments feel replanting efforts may not match the rate of cutting down of trees.

c) Requires a great deal of water

This is the most invisible disadvantage of biomass fuel. All plant matter need sufficient amount of water to get by, meaning water sources must be abundant. If enough water

Is not available, irrigation systems would have to be developed, which could prove to be costly? Irrigation may also limit the availability of water to humans and wildlife

d) Inefficient as Compared to Fossil Fuels

Despite the fact that biomass energy is natural in many ways, it doesn't get close to fossil fuels in regards to efficiency. In fact, some renewable sources of energy like biofuels are fortified with fossil fuels to increase their efficiency. Although opinion is divided about the overall sustainability of biomass energy, the fact is that it is a cheaper alternative and a good subsidy to the traditional electricity and other forms of energy gives it an edge.