

BIOENERGY-A SOURCE OF RENEWABLE ENERGY- A REVIEW

Abstract

This review discuss about uses of bioenergy and biomass and their availability in the future. The review is based on earlier studies on this subject. Energy derived from biomass and biomass products plays important role in the worldwide energy system. Bioenergy makes important contributions to reduce the carbon emission, from transport, and manufacturing. But land-intensive bioenergy required reducing the carbon emissions from land-use and finding alternative ways to reduce carbon emission from production, harvesting, and transportation. In addition, land-intensive bioenergy scales only with the utilization of vast amount of land, a resource that is fundamentally limited in supply. This review provided an overview of the bioenergy and its challenges associated with its increased development. This review discusses about the opportunities and their problems, risk in related to the resources, technologies, practices, markets.

Keywords: Bioenergy, Biofuel, Renewable energy, Biomass

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I. INTRODUCTION

Bioenergy is energy produced from biomass of living organisms mainly plants which are dead. Bioenergy is the form of renewable energy which is obtained from living organic materials. It is also a viable alternative to fossil fuels because its renewable energy source. It includes dung, grass, wood, food crops, forest waste etc. Bioenergy having several forms biofuel, biogas, biomass power, bioenergy in heating and cooling. Biomass is organic matter that comes from animals and plants. Organic waste, food waste, crop waste, animal waste and wood waste are used as source of bioenergy. Bioenergy is an important for making a substantial contribution in global energy demand. It is a vital component that utilizes carbon dioxide during energy production (Ausilion bauen *et al.*, 2004).

Now a day bioenergy is known as world's biggest energy source which can be present in renewable form of energy form having up to 9.6 per cent of worlds total energy supply (55.6 EJ in 2018). In human history biomass plays important role to provide source for the basic needs like food, feed, fuel, feed stock, fiber, and fertilizers. The main energy source in early 19th century was biomass for industrial country (Rosillo Calle and hall 2002, Hall et al.1994). About 2500 years ago it was found that charcoal-based iron melting was responsible for large scale deforestation in various countries like central Africa, United states, and other country of Europe. The biomass energy and biomass resources were the first step towards the industrialization. (Hall and overend 1987).

Some researchers stated that Revolution in industrial was only possible due to accessibility of biomass resources. In 19th century industrial Revolution and fuel industrial development was possible due to wood and charcoal (Schubert, 19 57). Worldwide biomass fuel was used in many industries like brick making and tile industry, metal working, food processing, wearing in recently biomass is used directly or in combined heat with power (CHP), facilities or formation of ethanol.it also utilize for three different purpose population growth, improvement in living standard and increasing environmental concerns.

Now a day in many developing countries a bioenergy is most important source of energy especially conventional forms of bioenergy providing on an average 35 per cent energy need of three-quarters of the world's population. This Percentage increase up to 60 to 90 percent in the non-developing countries. Hence use of bioenergy and its application are rapidly increase in both industrial and developing countries. In world wild bioenergy and biomass is the largest source of renewable energy it contributing about 55 per cent of renewable energy and over 6 per cent of global energy supply. Day by day the bioenergy uses were increased on an average 3% per year between 2010 to 2030. (IEA 2023 report).

The world's biggest and most acceptable energy source is biomass. The biomass is Potentially and infinitely renewable source having annual primary production of 220 oven dry tonnes (odt) or about 4500 exajoules (EJ). And from forest 2900 EJ approximately 1700 EJ, from Grasslands 850 EJ and from Agricultural area350 EJ is about the annual bioenergy potential (Hall and Rio 1999). In recent agricultural land contributed more than 800 EJ without any adverse effect on Worlds food supply (Faaij et al. 2002).

II. DIFFERENT TYPES OF BIOENERGY

Bioenergy is a renewable form of energy which is generated from biological sources like food crops, grasses, and edible vegetable oil. This includes biogas, bioethanol, and biodiesel.

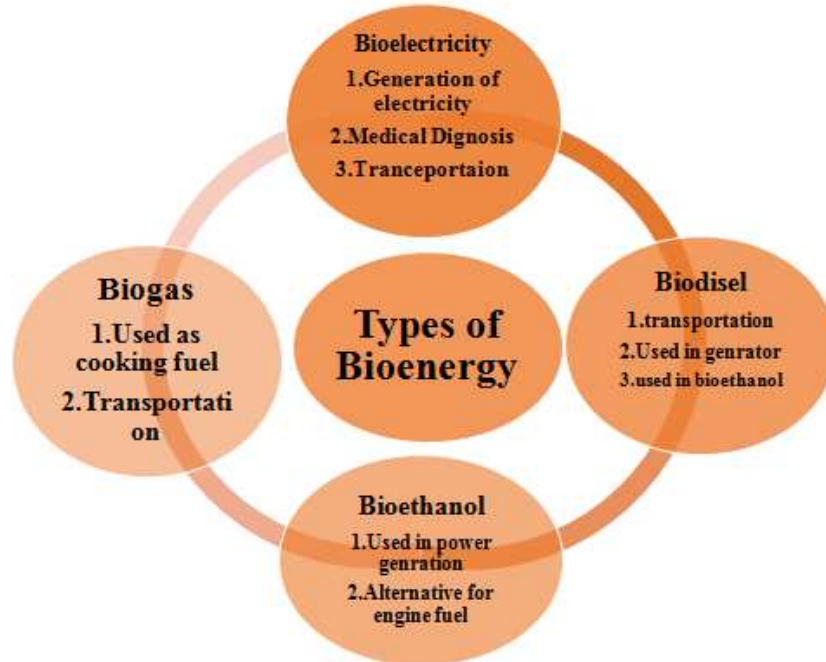


Figure 1: Showing Types of Bioenergy

Bioenergy Technologies: Raw form of biomass is used traditional it is incompetent and significantly negative impact on environment. Modern application of bioenergy is rapidly replacing the traditional uses mainly in developing country for example in India increase the use of bioenergy but in China use of bioenergy decrease rapidly (Rosillo-calle2006). modern bioenergy was increase in world due to increase in modernization of biomass technology it includes 3 major categories

- **Thermochemical Processes:** combustion, gasification, pyrolysis, CBP.
- **Biochemical:** Anaerobic Digestion, Fermentation.
- **Other Processes:** Transesterification

1. Thermochemical Processes

- **Combustion:** In this technology from biomass 90 per cent energy are produced and converts biomass fuels into usable energy like hot air and water, steam, and electricity for industrial and commercial plants burn in different types of biomass woody biomass to MSW. The simplest forms of this technology are use of chamber for burning the biomass which is specially made for combustion. Large scale combustion can increase system use low-quality fuels but in small application system high-quality fuels used frequently (Kaltschmitt and Bridgwater, 1997; Kaltschmitt et al, 1998; Walter et al, 2000).

- **Gasification-Gasification:** is most important research for production of power and it provide alternative way to direct combustion. Gasification is the heat-ansorbing process in this process solid fuel was used and it convert into combustible gas this gasification technology is used from old days it is not new for the world has been used from two centuries.
 - **Pyrolysis:** From pyrolysis multiple products obtained like liquid fuel it can be easily stored and transported and it include mainly chemicals which produce on large scale like (e.g. adhesives compounds, organic chemicals and flavouring agents) that give good possibilities for increasing profit. in many countries carried out research on pyrolysis and many researchers reported about pyrolysis. (Kaltschmitt and Bridgwater, 1997).
 - **CHP (Combine Heat and Power):** this technology is well-known technology in late 19th century CHP system is used by many manufacturing plants CHP is usually executed by addition of heat exchanger that absorb exhausted heat from generator which is wasted this captured energy is used in electrical generator.
2. **Biochemical Process:** In biochemical process high temperature, high pressure acid, enzyme and other techniques are used to breakdown of lignin and hemicellulose. hydrolysis enzyme are used to break down of cellulose in to sugar. This sugar is further used in fermentation to produced ethanol (Sass Byrnett et al.,2009).
- **Anaerobic Digestion:** This process involves decomposition of organic wests (biological wests) with the help of microorganisms in the absence of oxygen. From this anaerobic digestion methane and carbon dioxide are produced. Methane is generally used in production of electricity.
 - **Fermentation:** In this process sugars are converted into alcohol. Basically, starchy plants are used in biochemical Fermentation. Corn and Sugarcane are commonly used for this process.
3. **Other Processes:**
- **Transesterification:** in this process oils or fats are converted in to biodiesel.It involves removal of water and other contaminates from feedstock by using alcohol and sodium hydroxide. Fatty acid methyl esters and glycerin are biproduct of this process. Glycerin used in pharmaceutical and cosmetic industries and ester are used as biodiesel.

Modern bioenergy and use of biomass was responsible for the half of all renewable energy consumed in 2017. Bioenergy is utilized for electricity is about 3 per cent and around 4 per cent of energy is in transport in 2023(International energy Agency 2018). The bioenergy production is more affordable and cost for bioenergy production was low and it is known for low emission source of energy. but land intensive bioenergy sources are limited due to arability of land. In the production of liquid biofuels sugar, grain and vegetable oil crops are used in small quantity but in recently forest, agricultural, municipal residue and west are mainly used for the production of electricity and heat.

Now a day 50 EJ biomass was supplies globally there are many bioenergy routs used in to convert raw biomass in to final energy product.

IEA in 2017 reported usage of bioenergy differentiated into various types traditional use, use of modern construction heat electricity and co-generation, transport, industry heat, commercial heat and other uses. Out of these, 90 per cent of transport is mainly dependent on oil. Worldwide the use of energy for transport was increase in China the demand of energy was increased in 1980 it was 5 per cent and in 2005 it was 11 per cent. In India it was 27% oil is used for transport currently the demand for the primary oil, and this will increase to 47% by 2030, in Europe and UK it increases up to 60% (IEA2007). To full fill this demand of energy lignocellulosic biomass (plant west material) is best alternatives for fossil fuel (Daioglou, V et al 2015). Best alternative for fossil energy is bioenergy produced which is derived from biomass and it contributed total 9% energy globally (IEA2017). According to the International Energy Agency biomass is derived from organic matter and that comes from biological sources and is available on a renewable basis. It uses sources came from animal and plants like forest wood and crops came from agricultural fields, and organic waste which is came from municipal and industries. For production of plant-based biomass scientist suggested energy crop it include woody crops from crop land and grasses from forest, herbaceous plants from agricultural field, plant-based starch and carbohydrate and oilseeds. Mainly for production of first-generation biofuel Maize and sugarcane is used other plant also used by different countries. In World wild biofuel production is increased. Europe was major country in production of biodiesel and the USA is the leading country in the production of ethanol. USA produce Ethanol and biodiesel on large scales these two are the major fuels to replace gasoline and diesel. from corn and sugar cane ethanol is produced and this ethanol is known as 1st generation bioethanol. In 2015, USA produce 25.6 billion gallons of bioethanol with contributing 14.81 billion gallons and Brazil produce 7.09 billion gallons, between them, 85 per cent of the worlds' bioethanol was produced by the USA and Brazil. for the production of bioethanol USA depends on corn while Brazil depends on sugar cane (IEA2017).

1st generation biodiesel is generally obtained from Agricultural crop plants like rapeseed, canola barley, corn, soya, sugar cane oil, sunflower, animal fats and cooking oil. Use of biodiesel has beneficial for environmental because it is obtained from renewable resources. Atmospheric levels of CO₂ and greenhouse gas was not increased by using and burning of biodiesel [Due W et al 2004]. Biodiesel is biodegradable produced form recycling waste oils, and produces less air pollution than fossil diesel [Miao. X and WU. Q 2006].

Second (2nd) generation in this generation lignocellulosic biomass is used for the production of biofuels like cellulose, hemicellulose and lignin. Lignocellulosic biomass is an alternative to sugarcane and maize. The lignocellulose biomass that are more significant in use that are Agricultural crops like corn stover, rice husk, wheat straw, and sugarcane baggase. 2nd generation biofuels can be used with different types of technologies like gasoline, which can be used in combustion engines and distributed through existing infrastructure or engines that are slightly modified for internal combustion. cellulosic ethanol example of 2nd generation biofuel.

Third (3rd) generation biofuels this biofuel is obtain from algal biomass. Production of algae biofuel totally depends on the lipid content present in the algae. Generally (20–50%) lipid content present in algae and it having high growth rates, it can grow in adverse' conditions due to this reasons alga are important for biofuels. (Christin Y 2008, Larden L 2009). *Chlamydomonas reinhardtii*, *Dunaliella salina* and various *Chlorella* species of algae are fast growing species, Species of *Botryococcus braunii*, which grow slowly but large quantities of lipids accumulation occur (Scoot S A et al. 2010). on the basis of raw material used 1st, 2nd and 3rd generation of biofuels are classified that is either of biomass by origin or as waste. Due to their limiting application on a global scale classification of biofuels are always difficult.

In 4th generation biofuels are produce from raw materials that are cheap and widely available are used to convert solar energy to solar biofuels (Hays, S.G.and Ducat, D.C 2015, Scaife, M.A. et al. 2015).

III. CURRENT STATUS OF BIOENERGY

Globally Denmark, Finland, and Endonia use more than 15% of bioenergy (produced from CHP) for production of electricity, followed other countries like UK, Sweden, Germany and Brazil. (IEA Report 2021). In 2022 China was the leading country in production of bioenergy near about 34.1 gigawatts it is highest bioenergy capacity in the world. Brazil is the second rank in the production of bioenergy having 17.2 giga watts. By comparison, Germany ranked fifth with 9.9 gigawatts. (Lucia Fernandez 2023). Globally Economic, environmental and energy security are the main concerns of many countries resulting forcing countries to find other ways like biofuels in the form of ethanol and biodiesel (Farrell A E. et al. 2008). hence from various crop plants biofuels can be produced each country is adopting a strategy to take advantages of these crops. For example, in Brazil and US use sugarcane and maize are the main crops for production of ethanol, in Malaysia biofuel are produced from oil palm. In world largest production of biofuel is carried out by US near about 41 percent of global biofuel production in 2021 is about 1.64 billion gallons. Brazil and Indonesia ranked second and third produce 840 and 312 petajoules in those years (Jessica Aizarani2023). United status is leading the world in production, consumption and exporter of ethanol. India rank 5th in ethanol production ethanol is used as biofuel for many purposes in India Sangrur, Punjab having largest biofuel production unit with 33 TPD (tonnes per day). The Indian government committee share non-fossil fuel in total capacity to 40% by 2030. India produce per year about 450-500 million tonnes of biomass. government of India has been increasing the use of bioenergy or clean energy sources for better feature, according to the ministry of New and Renewable Energy (MNRE2022) installed capacity of renewable energy is 90 GW excluding hydropower.it stats that 27.41GW energy will be added.

Some researchers concluded that use of bioenergy having some drawback due to large scale of bioenergy we can reduce food production and use of bioenergy lead to loss of biodiversity 1 (DeCicco & Schlesinger, 2018; European Academies Science Advisory Council, 2019; Searchinger, Wirsenius, Beringer, & Dumas, 2018). the primary source of bioenergy is plants like crops, trees, grasses which is cultivated or harvested. Land intensive bioenergy are substantial carbon emission from and land use change production, harvesting and transportation but land intensive biomass utilization is limited. Bioenergy crops are limited they cannot grow on large scale the utilization of bioenergy is more as compared to

production. Biofuel is not used alone it require another fuel to use it blended with petrol and diesel to bring efficiency up to speed.it means it not available to use on large scale. Wood Is used as biomass for bioenergy production increased demand of wood lead to deforestation. monoculture crop grown for the biomass production it shows adverse effect on biodiversity. for large scale production of biomass, it requires construction plants that are costly and harvesting, transportation, storage of organic matter it is costly. It also requires large space mainly because of they grow their won plants or small forest. Biomass fuels also release many gases like nitrogen oxides, carbon monoxide, and methane.

Use of bioenergy negatively impact on environment when plants used as biomass energy it increases use of fertilizers and pesticides its adverse effect on surrounding ecosystem.

IV. CONCLUSION

from above study it can be concluded that the bioenergy demand and its uses may increases in future up to several hundred exajoules per year. From this review it can be reported that the demand of bioenergy is increased day by day and it is sensitive not only to supply of biomass potentials, but also to total energy demand and competitiveness of alternative energy supply options. At the same time, the reviewed focused on the studies that have come out at widely concluded that in the future how much biomass that can be available for bioenergy.

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