Biomass Energy Potential in India: A Review

Uddipta Ghosh
Assistant Professor
Civil Engineering Department
JIS College of Engineering Kalyani, India

Debasish Das
Assistant Professor
Civil Engineering Department
JIS College of Engineering Kalyani, India

Debargha Banerjee
Assistant Professor
Civil Engineering Department
JIS College of Engineering Kalyani, India

Susrita Karmakar
UG student
Civil Engineering Department
JIS College of Engineering Kalyani, India

Jagriti Das
UG student
Civil Engineering Department
JIS College of Engineering Kalyani, India

***Abstract:*-Energy consumption is increasing on a daily basis as the global economy expands. As a result, power generating planners, policymakers, and governments, among others, must concentrate on the issue of rising energy consumption. Fossil fuels are thought to be limited, while renewable energy sources are plentiful in nature. As a result, renewable energy sources should be encouraged in order to protect the environment and human health. The study takes into account a variety of problems concerning biomass potential and biomass power generation. Because bioenergy is one of the most important sources of renewable energy, a variety of factors were considered when assessing the literature on biomass-based power generation. The current research examines the current state of biomass energy in India. Biomass energy is less expensive and does not pollute the environment. In some aspects, it also regulates environmental contamination. Biomass energy has the potential to be a good renewable energy source for India's rural areas. Biomass energy production provides a lot of room for innovation and application in remote and rural regions. We will require efficient resources for this, as well as sustainable, renewable, nonconventional, and equally important energy resources to fully realize India's future potential. Biomass produces ethanol, which is regarded as one of the world's most valuable sources of renewable energy.**

Keywords: Biomass energy potential, Energy Demand, Health hazards, Non conventional Energy, Renewable Resources and Biofuel

I. INTRODUCTION

India accounts for 17.5 percent of the global population, making it the world's second most populated country (Maurya *et al.*, 2015). India is the world's second-largest economy. Due to its significant and continuous economic expansion throughout the years, India has placed a massive demand on its energy resources. To meet the country's energy needs, the Indian government plans to generate electricity from renewable energy sources (solar, wind, biomass, etc.) that are available for free or at a cheap cost. Renewable energy sources are beneficial to the country since they may lead to energy security. India is currently the world's fourth largest user of LPG gas, trailing only the United States, China, and Japan, and the world's third largest consumer in the household sector, trailing only China and the United States (Chandra *et al.*, 2010). To compete with such a large demand for energy resources in the future, India will need to set up an efficient system that generates energy from biomass that corresponds to the country's energy needs. Biomass is the result of green plants converting sunlight into plant material through photosynthesis, and it comprises both land-based and water-based biomass. Organic materials in which the energy of sunlight is stored in chemical bonds is referred to as biomass resources. When the bonds between neighboring carbon, hydrogen, and oxygen molecules are broken by digestion, combustion, or decomposition, the energy that has been stored in chemical form is released. Biomass has long been an important source of energy for people and nature, and it now accounts for 10-14 percent of the energy consumed in our country (McKendry, 2002 & Yuanchun, 2013). The current biomass availability in India is expected to be over 500 million metric tonnes per year. The biomass availability is anticipated to be between 120 and 150 million metric tonnes per year, equal to a potential of around 18000 MW, according to the Ministry. With the over 0.5 million automobiles on the road, India's per-vehicle usage are 450 kilograms per year, compared to the global average of 1428 kilogrammes per year. Each year, India produces between 450 and 500 million tonnes of biomass. Biomass currently accounts for 32 percent of total primary energy use in the country. The power generated by biomass in India is estimated to be over 18000 MW. The biomass scope is defined as high as 50000 MW. The current share of biofuels in overall fuel use is extremely low, with ethanol blending in gasoline limited to 5%, which the government has made mandatory in ten states. Biodiesel is not currently available on the Indian fuel market, but the government intends to use it to meet 20% of the country's diesel needs by 2021. (Anonymous[1]).

II. MATERIALS AND METHODS

Biomass and the sources

Biomass energy resources are organic materials that can be used to generate energy and is renewable. Agricultural

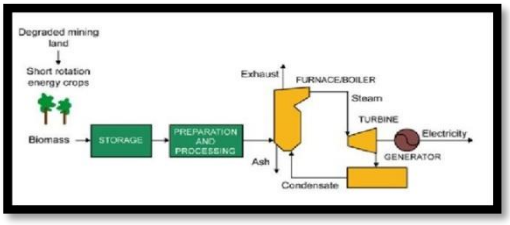
crop residues, wood and wood wastes, animal wastes, aquatic plants, municipal trash, and other biomass sources are all available. Biomass has been used as a fuel since ancient times and is generated locally all over the world. They are frequently available in sufficient quantities, but their economic worth has decreased due to poor use. CO_2 neutrality, reduced emissions of pollutants such as SO_x and NO_x, improved water and soil quality, biodiversity, landscape, job generation, and rural rehabilitation are only a few of the advantages. The development of novel technologies for successful biomaterial exploitation is emphasized. Biomass has the ability to be converted into liquid, solid, or gaseous fuels via a variety of conversion methods, allowing it to be used in a wider range of applications. Because of its economic and technical viability, biomass could become a key component of future sustainable energy supply. In a mainly agricultural country like India, the potential for biomass power generation is enormous. The power generating capacity is in the order of 17,000 MW, based on an annual biomass availability of roughly 500 million tonnes. The installed power generation capacity of biomass conversion technology is around 500 MW. Biomaterials can be converted to useful energy sources using a variety of processes. Thermo chemical and biochemical conversion technologies are the two main categories. Microorganisms have a significant role in energy generation in biochemical conversion pathways. Thermo chemical conversion procedures, on the other hand, involve the introduction of heat during the process.

Biodiesel can be made from plants such as jatropha, curcas, neem, mahua, taad, barley, and other wild plants. In India, there are around 63 million hectares of undeveloped land, of which 40 million hectares might be used for jatropha and curcas plantations. The Indian government had previously intended to grow Jatropha trees on 11.2 million hectares of land by 2012. The Ministry of New and Renewable Energy (MNRE) provides biomass energy projects in India with central financial assistance (CFA) in the form of subsidies and financial incentives. CFA is given to projects that have the highest efficiency, energy generation, and usage, among other things (Seth *et al.*, 2015). The two types of bioenergy production processes are dry and wet processes, respectively. Combustion and pyrolysis are two types of dry processes, while anaerobic digestion, fermentation, and gasification are three types of wet processes.

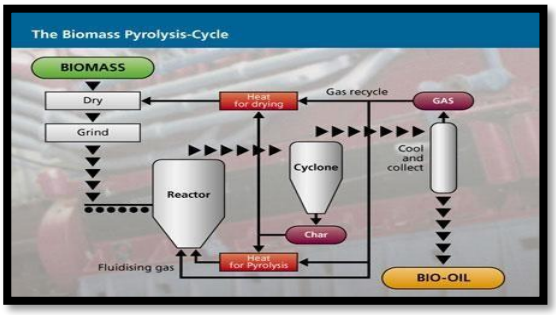
Combustion

The term "biomass combustion" refers to the act of burning organic matter. This simple technology has been utilised by humans to generate heat and, later, power through steam. While wood is the most typical fuel, a broad variety of materials can be productively burnt. These include sawmill residuals and byproducts like straw, bark residuals, sawdust, and shavings, as well as so-called "energy crops" like switch grass, poplar, and willow that are planted expressly for feedstock. Pelletized agricultural and wood wastes are also becoming more popular due to their ease of handling.

Combustion is an efficient approach to extract energy from biomass, and direct combustion technology is well understood. It is also economically less expensive and commercially available. In such systems, the majority of the heat is squandered and is not used to cook or for any other purpose. Building stoves out of mud and scrap iron is one technique to improve such approaches in underdeveloped countries (Seth *et al.*, 2015).

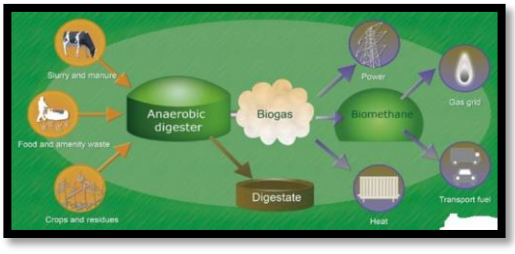


Pyrolysis: The heat degradation of biomass in the absence of oxygen is known as pyrolysis. It is the fundamental chemical reaction that occurs naturally in the first two seconds and is the precursor to both combustion and gasification. Biochar, bio-oil, and gases such as methane, hydrogen, carbon monoxide, and carbon dioxide are among the byproducts of biomass pyrolysis.



Anaerobic Digestion

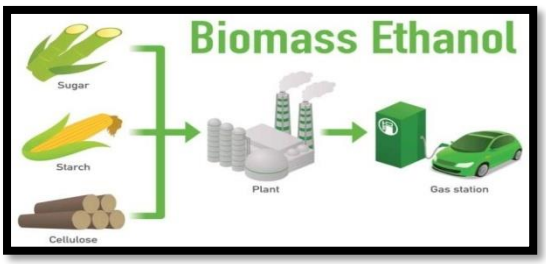
Wet sewage, sludge, animal dunk, or green plants are allowed to degrade in a sealed tank to produce biogas in the absence of oxygen. Wood chips, straw, hay, and husk can be used as well, although digestion takes significantly longer. 450-500 litres of biogas can be expected from 1 kilogramme of organic material. After decomposition, the residue is a good fertiliser or manure.



Fermentation

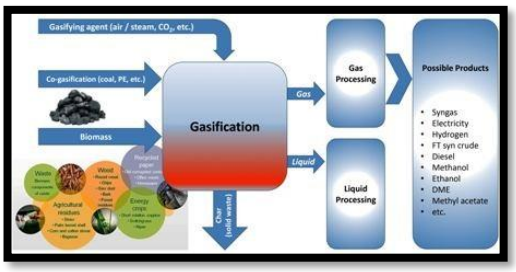
The fermentation of sugar solution and natural yeast produces ethyl alcohol. Crushed sugar beet and fruit are examples of feedstock. Sugar can be made from cellulose and vegetable starches through pulping or boiling, or from cellulose through acid treatment. After 30 hours of fermentation, the solution contains 6-10% alcohol, which can be separated via distillation and used as a fuel. After the sugar has been fermented, yeast can be added to it. As a result, the fermentation process creates alcohol, which has

large energy reserves and may be utilised as a vehicle fuel. After the sugar has been fermented, yeast can be added to it. As a result, the fermentation process creates alcohol, which has large energy reserves and may be utilised as a vehicle fuel.



Gasification:

Biomass gasification is the incomplete combustion of biomass that produces combustible gases such as carbon monoxide (CO), hydrogen (H_2), and methane traces (CH_4). Producer gas is the name given to this mixture. Producer gas can be used to fuel internal combustion engines (both compression and spark ignition), can be used to replace furnace oil in direct heat applications, and can be used to produce methanol – an extremely appealing chemical that can be used as a fuel for heat engines as well as a chemical feedstock for industries – in an economically viable manner (Rajvanshi, 1986)



III. RESULTS AND DISCUSSIONS

Power Generation from Renewable Sources: Indian Scenario

Total gross power capacity will increase from 284 GW in 2015 to 670 GW in 2030, with annual electric power production more than tripling from 1100 TWh to 3450 TWh. However, the predicted increase in renewable energy capacity is modest. India had targeted 175 GW of alternative energy by 2022, but advances have been uncertain since then (IRENA, 2017)

Biomass potential/resources

Kumar *et al.* (2015) conducted a study on the potential of biomass as a source of energy. In India, there is a lot of biomass that can be used to generate electricity. Many biomass-based power projects are operating in the country and doing successfully, particularly in rural areas. According to Singh *et al.*, (2008), the state has a large amount of agricultural biomass that can be utilised for electricity generation. Biomass availability is spatial in nature. The costs of collecting and transportation have been calculated using various vehicle carrying capacities. According to McKendry (2002), the environmental impact of burning crop leftovers can be reduced by properly replanting biomass. All biomass can be used to generate steam, which can then be used in turbo-generators to generate electricity. Biomass from agricultural leftovers of various crops is accessible in several states of the country, according to Hiloidhari and Baruah (2014). The study computed an expected amount of biomass; various crops such as rice, wheat, and cotton are classified as the main sources of agricultural residue in India.

Biomass based power generation

Even if there are abundant agricultural leftovers in many agricultural-based states across the country, according to Singh *et al.*, (2011), power production projects must be thoroughly studied. GIS was utilised in this work to plan a biomass power plant in the research area. There has been optimization of power plants as well as collection centres. The goal of this research is to reduce the different expenses involved with crop residue management for power plants and collection centres. The goal of this research is to reduce the different expenses involved with crop residue management in power plants. This study proposes a cost-effective power generating strategy based on the number and size of power plants. For a set amount of electric power generation (20 MW), this article provides possible combinations of varied capacity of power plants and collection centres. According to Singh *et al.*, (2020), the total generation of electricity from biomass in the district of Bhatinda is 367.69 MW/year which is a considerable amount of electricity to serve the consumers. Two to four biomass-based power plants have been proposed by the authors at their optimal locations. This study employs the Ant lion optimizer. Paddy and wheat are the most important crops, accounting for 96 percent of total biomass produced in Bathinda district. According to the proposed research, generating electricity from agricultural waste is a better choice than burning it in open fields. This will not only help to reduce air pollution, but it will also help farmers increase their revenue. It will also ensure future generations' energy security.

Barriers in biomass power generation

According to Jain (2016), relatively little effort has been done in Rajasthan on biomass power generation. The author of this study attempted to discover the issues that power generators encounter. This document also discusses the future scope and tactics for the organizations' success. Various factors such as biomass product quality, handling of large materials, weather- related variability, localised agricultural capacity, seasonality, and demand can be addressed by implementing new technologies, and the government can take steps to assist power utilities and new entrepreneurs with financial and social assistance. Singh (2016) focuses on providing facilities to farmers for the delivery of biomass and to plant owners for the efficient utilisation of biomass. According to the author, one-third of total biomass is available for power generation, which can be expanded by enacting appropriate legislation. The author has also seen how local entrepreneurs might be motivated to supply biomass to the plants. The author proposes a decentralized system of collecting centers, with each collecting centre covering 2-3 communities nearby. In the event of crop failure, power plant operators are also

required to employ energy crops as a substitute for crop waste. According to the text, the government should also provide appropriate infrastructure and financial rewards to society as a whole.

Renewable Energy Education in India

After that, India is a developing country that meets its energy needs through export (conventional energy resources). India's national government is now focusing on generating energy from renewable sources. These were included in their five-year strategy. India's technical institutes provide one or two semester courses on renewable energy. In India, some technical institutes have begun to offer undergraduate and postgraduate programmes in renewable energy. The government is also financing student projects that use sustainable energy sources (Khare *et al.*, 2015).

IV. CONCLUSION

India has vast biomass reserves, estimated to be around 500 million metric tonnes per year, with between 120-150 million metric tonnes utilised for energy production. The government intends to generate 50000 MW of electricity from biomass. In the 2013-14 fiscal year, total LPG output was at 13123.29 TMT, while demand was around 16824.72 TMT. The alcohol produced by biomass fermentation has a large energy reserve and can be utilised as a fuel in automobiles, as has been done in Brazil. Up to 2021, the Indian government intends to produce biodiesel to meet 20 percent of the country's diesel needs. Modernization of biomass energy production in India could assist both rural and urban areas in terms of social and economic benefits. If biomass energy systems are properly constructed, they can be used as part of an energy source that is both ecologically friendly and contributes to long-term development. If biomass is to provide any substantial energy to development in the current scenario, it must be generated in higher amounts. Biomass is also a cost-effective and ecologically friendly energy source. This ensures more conventional techniques of production while also ensuring an efficient and sustainable method of manufacturing. The demand for biomass energy is predicted to increase significantly until 2025, according to projections. Because of population growth, increased industrial use, and technological advancements that improve biomass fuel or the conversion of biomass fuel into effective energy carriers, it is projected that the demand for biomass energy would increase significantly until 2025.

REFERENCES

[1] Anonymous[1]:https://economictimes.indiatimes.com/small-biz/productline/power generation/national-policy-on-biofuels-2018-here-are-key-things-you-should-know/articleshow/71922729.cms?from=mdr
[2] Chandra, A., & Secretary-Marketing, J..(2010). Indian LPG market prospects. World LPG forum.
[3] Hiloidhari M, Das D and Baruah DC.(2014).Bioenergy potential from crop residue biomass in India;(32)504-513.
[4] IRENA (2017). Renewable Energy Prospects for India, a working paper based on REmap, The International Renewable Energy Agency (IRENA), Abu Dhabi. www.irena.org/remap.
[5] Jain,G. (2016).Biomass Power Generation: A Frame Work And Study Of Current Problems And Future Scope With Special Reference To Kota Region Of Rajasthan. *International Journal of Science Technology and Management*, (5):168-177.
[6] Khare, S., Bajpai, S. & Bharati, P. (2015). Production engineering education in India. *Management and Production Engineering Review*, 6(1), 21–25.
[7] Kumar,A;Nitin Kumar; Prashant Baredar and Ashish Shukla.(2015).A review on biomass energy resources, potential, conversion and policy in India. *Renewable and Sustainable Energy Reviews*, 45:530-539.
[8] Maurya,V; Sushant Khare & Shrish Bajpai.(2015). Future Scope of Wind Energy in India .*IOSR Journal of Electrical and Electronics Engineering*, 10(1).
[9] McKendry, P. (2002). Energy production from biomass (part 1): overview of biomass. *Bioresource technology*, 83(1), 37-46.
[10] Rajvanshi, A. K. (1986). Biomass Gasification. In E. D. Goswami, *Alternative Energy in Agriculture* (pp. 83-102). Maharashtra, India: NARI
[11] Seth,R; Rohit Seth and Shrish Bajpai.(2015).Need of Biomass Energy in India. *Progress In Science and Engineering Research Journal*, 2(6): 13-17.
[12] Singh, Ram and Brar, G. S. (2020). Optimized Locations for Biomass Power Plants Using Ant Lion Optimizer in District Bathinda, Punjab, India. *International Journal on Emerging Technologies*, 11(1):469–475.
[13] Singh,J (2016).A roadmap for production of sustainable, consistent and reliable electric power from agricultural biomass- An Indian perspective, *Energy Policy*, (92):246-254.
[14] Singh,J; B.S. Panesar and S.K. Sharma (2011).Geographical distribution of agricultural residues and optimum sites of biomass based power plant in Bathinda, Punjab. *Biomass and Bio energy*, (35):4455-4460.
[15] Singh,J; B.S. Panesar and S.K. Sharma.(2008). Energy potential through agricultural biomass using geographical information system-A case study of Punjab, *Biomass and bio energy*, 32:301-307
[16] Yuanchun, S. (2013). Biomass: To Win the Future. Lexington Books.