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Technologies involved in biomass to energy conversion and its utilization in India

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Abstract - *The sudden rise in the oil prices on global scale and continuous increasing of green house gas emissions, Global warming and etc are the issues lead the researchers to march towards green energy technologies. Global warming is the major issue to be addressed all over the world because of the uncontrollable and dangerous effects. These are the issues create threat to human existence and animals too. In available green energy technologies Bio energy is the carbon neutral and abundant resource. There are several technologies available to convert the bio mass in to energy. In this review the major technologies used in India and current installation capacity of particular technology for conversion of bio mass into energy are discussed. It also covers the, different sources for biomass and its availability in India.*

Key Words: **Green energy, Green house gasses, Bio gasification, Bio gas, Organic waste.**

1. INTRODUCTION

Energy is the one of the factors to be considered for measuring the growth of the nation, though we are generating energy by various ways still there is lot of crisis in developing countries. World energy generation almost reached to the 24,000 TWh. India had electricity coverage of 81% and which includes an installed capacity of 330.26 GW [1].Currently in India power production major source was coal it accounts an installed capacity of capacity of 195602.88MW(59.2%) followed by hydro(14.8%)[2]. By considering global warming, availability of fuels and other problems related to environment, researchers are interested to take the steps towards renewable energy sources. India had installed capacity of 94,431.43MW of renewable energy sources which accounts 30% of India's installed capacity [3]. It is important to note that bio energy plays significant role in mitigating green house gases and for substituting fossil fuels in the better way. There are several technologies involved for conversion of bio mass in to bio energy. It is observed that it can contribute almost 10% of the energy of global scale utilization [4]. It is important to understand that bio energy is the third largest renewable energy source in the world had electricity generation capacity of 493 TWh after wind which is of 717 TWh. Hydro power plants are generating the maximum power among the available renewable sources holds a capacity of 3983 TWh as reported by world bio energy association. Bio energy is the largest heat source in the global scale [5]. One can say un doubt ably that Bio energy one of the promising option for heat, electricity and for other applications.

2. COMPOSITION OF BIOMASS

Biomass is a decomposable organic content. The different available sources are plant, Agricultural, and other crops waste. In trees by using the photosynthesis process with the support of solar energy biomass is generated. Bio mass also includes the animal waste. The some of the organic waste generated from the municipalities and Industrial waste also, we can extract bio energy. As reported by Tommi Räisänen et al the normal Chemical composition of woody biomass consists of cellulose, hemicelluloses, lignin and e.t.c[6]. Since wood materials may be hard as well as soft, based on the hardness the above mentioned composition may varies. Generally the unused land can be used to produce biomass. There are techniques like energy farming to increase the growth of the biomass and it also helps the environment to make carbon neutral.

Table- 1: Composition of biomass

`Components of biomass								
Biomass	Ash	Holocellulose	Cellulose	Hemicellulose	Lignin	Extractives	Total (Holo)	Total (Hemi)
Bagasse	2.9	65.0	41.3	22.6	18.3	13.7	99.9	98.8
Coconut coir	0.8	67.0	47.7	25.9	17.8	6.8	111.7	99.0
Coconut shell	0.7	67.0	36.3	25.1	28.7	8.3	98.7	100.1
Rice husk	23.5	49.4	31.3	24.3	14.3	8.4	96.5	101.8
Rice straw	19.8	52.3	37.0	22.7	13.6	13.1	98.8	106.2
Subabul wood	0.9	65.9	39.8	24.0	24.7	9.7	101.2	99.0
Wheat straw	11.2	55.8	30.5	28.9	16.4	13.4	96.7	100.4

Source: Raveendran K, Ganesh A, Khilar KC

3. TYPES OF BIOMASS

In general we are using the four types of biomass repeatedly till today. They are as fallows wood and agricultural products, solid waste, land fill gas and biogas, and alcohol fuels (like Ethanol or Biodiesel)[7]. Apart from the above animal farming also contributes a lot, which includes Poultry, cattle, and pig droppings. The waste which is coming from the slaughterer houses is also can be taken in to consideration.

3.1 Wood and Agricultural products

Wood and agricultural products contributes the major share for the biomass. It includes all type of agricultural crop waste, rice husk. The forest wood, logs, chips from the lumber mills, saw dust also plays important role in the biomass to energy conversion. There are different technologies involved in the conversion of the wood and agricultural products to energy. By the reports of the National Energy Education Development (NEED) 46% of the biomass consists of the wood and agricultural products. This includes corncobs, residues or fruit waste, fruit pits e.t.c

Fig -1: Pits, Wood, Corn cobs

3.2 Solid waste

Solid waste is one of the major problems in the developing as well as in developed countries. It is important to understand that most of the solid waste was disposed on the road sides. People are encouraging commonly open dumping as well as open firing. Since both are harmful in environmental point of view, it is mandatory to take necessary action against to this disposal of waste. Based on the survey conducted by central pollution control board on Municipal solid waste generation, it is observed that during the period of 2004-2015 the average waste generation rates were 1,43,449 TPD and the average municipal solid waste generation rates were mentioned as 0.11 kg/capita/day. In connection to this the study says around 22.9% of the waste was treated scientifically, and 82% of the waste was collected which accounts 32,871 TPD and 1,17,644 TPD respectively. The number itself implies we can effectively use this un treated waste as the source of the energy.

3.3 Landfill gas and Bio gas

It is a well known fact that there are plenty technologies available for municipal solid waste treatment, but landfills are the only way to take care of the municipal solid waste generated at the cheapest cost not only in developing countries but also for the developed countries. The name itself describes that Landfill gas generates from the landfills by the decomposition of MSW. Bio gas is normally generated from the aerobic and anaerobic digestion, for the effective gas generation we need to concentrate on the parameters like solid to liquid ratio, P^H value, C/N ratio, Temperature in the digester and other parameters.

It is observed that the landfills are capable of generating 45-55% of methane, generally the landfill gas generation will starts after the few months of the disposal of the waste, which usually collected through the leak proof network of pipes. It is noticed in the foreign countries that 5-40 litre/kilogram of landfill gas is generating and 15-25 litre /kg of gas in India, this gas generation is only because of abundant availability of biodegradable waste [8].

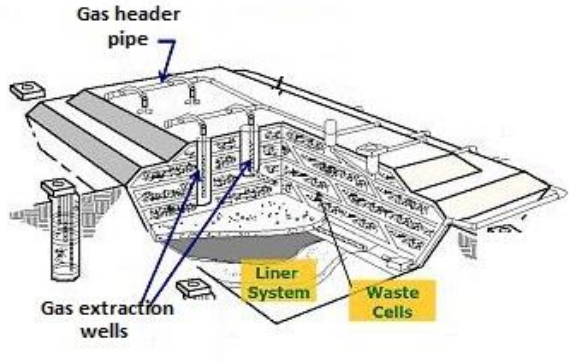

Fig -2: Landfill gas collection system

3.4 Bio fuels

Transportation sector in India is very vast and still it is growing. It is a well known fact that though public transportation is available now a day's everyone is interested in private transportation only. It is important to note that from reports [9] during the period of 1951 to 2011 the length of the roads increased from 4 lakh km to 4.7million km. This number shows the growth of transportation field. It is a well known fact that because of continuous dependence on crude oils for various applications (i.e. Power, Transportation) the price of the crude oil is increasing day by day from past few years on global scale. In this situation utilization of bio fuels is one possible way to overcome the oil crisis. Bio fuels are renewable, carbon neutral. If we trap the fuel in proper way from these bio sources they will be the best supporting blends of petrol and diesel engines. Bio ethanol and Bio diesel are comes under the category of bio fuels. Bio ethanol can be defined as[10] the fuel derived from sugar, starch containing

materials. Sweet sorghum, Sugar cane are the good examples for sugar containing materials. Corn and Algae are comes under the type of starch containing materials. It is stated that [11] Bio diesel are generally produced from the vegetables oils, animal fats and etc. These are methyl or ethyl ester of fatty acids. The target of government of India by 2017 is to substitute minimum of 20% of bio fuels in Transportation sector as a blend for gasoline and diesel engines[12]. It is one of the major steps taken by the government of India to bring era of bio fuels.

4. AVILABLE TECHNOLOGIES IN INDIA ON MASSIVE SCALE

Technologies involved for energy conversion are as follows. Direct combustion processes, Thermo chemical processes, Biochemical processes. The Direct combustion processes includes co firing, while coming to the Pyrolysis, Carbonization, Gasification, Catalytic Liquefaction will falls under thermo chemical conversion technology. The bio chemical processes include Anaerobic Fermentation, Ethanol Fermentation, preparation of Biodiesel and Methane Production from the sources like Landfills [13]. Among these available technologies only few are very popular in usage on large scale. Their usage in India was explained as below.

Table- 2: Biomass based Power production

Programme/scheme wise physical progress	
Sector	**Achievements (capacity in MW) (as on 31.03.2016)**
I. Grid Interactive Power (Capacities in MW)	
Biomass Power (Combustion, Gasification and Bagasse Cogeneration)	**4,831.33**
Waste to Power	115.08
Sub-total Grid Interactive	**4,946.41**
II. Off-Grid / Captive Power (Capacities in MWe)	
Biomass (non bagasse) Cogeneration	651.91
Biomass Gasifiers	
Rural	18.15
Industrial	164.24
Waste to Energy	160.16
Sub-total Off-Grid	994.46
Total Biomass Based Power	**5940.87**

Source: Ministry of New and Renewable Energy (MNRE)

4.1 Co firing

Co firing the name itself indicates that combustion will take place in the presence of the additional material, along with the existing material. Example generally in the coal based power plants exclusively coal is the fuel, along with coal now subsidiary fuel with the help of biomass combustion will takes place. This will improve the heat energy liberated. From the literature reports [14] it is observed that the reduction of carbon dioxide is possible by the implementation of co firing of biomass with the coal and it also mentioned by the same literature reports that because of low sulfur content in the biomass co firing with coal will reduce the sulphur dioxide which significantly reduces the acid rains. While coming to the availability of the biomass it is always preferable to have the source as near as possible to the power generation unit.

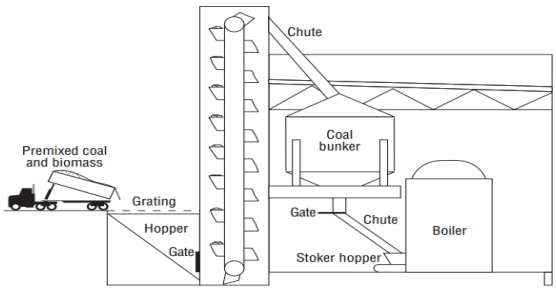

Fig -3: Premixed coal and biomass
Source: J. Cobb et al., June 1999

The installation capacity of biomass and cogeneration plants in state wise are as shown in following bar chart.

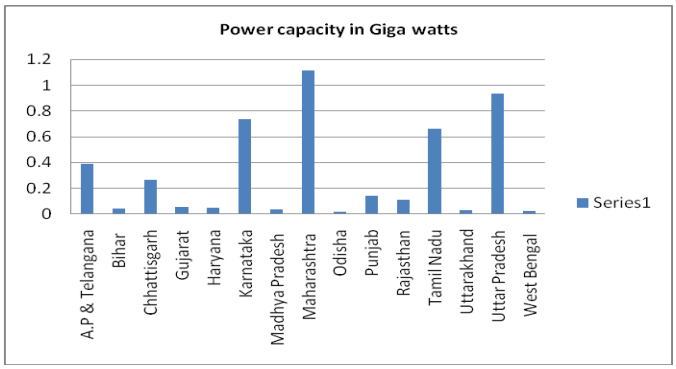

Chart -1: Biomass and Cogeneration plants (State wise)

4.2 Gasification

Gasification is the technique of the conversion of solid biomass fuels in to the gaseous phase by treating the biomass above 700^0C with the controlled supply of air which is less than the air required for complete combustion. The output producer gas will be use full for the heat and electricity application, from the statistics of the MNRE, says that India was equipped with the biomass gasifiers of 150MW. Gasification is one of the flexible technologies, among the available options for achieving sustainable development as energy needs are concerned. The usage of gasification technique provides the solution for problems in importing the coal and other resources from aboard and helps in

providing permanent solution as national energy security as concerned at low cost.

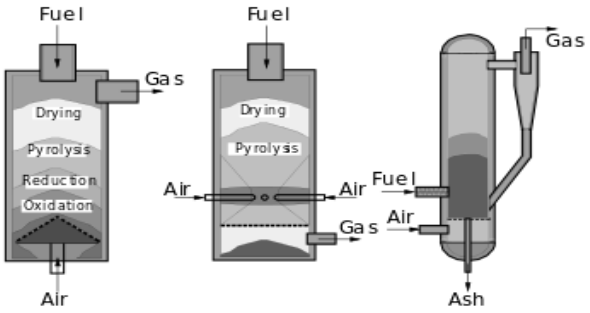

Fig -4: Updraft, Downdraft, Fluidized bed gasifiers

4.3 Anaerobic Fermentation

Anaerobic Fermentation the name implies that the decomposition takes place in the absence of Oxygen. The biogas produced will be used for the heating or power application. Aerobic comes under the category of decomposition in the presence of Oxygen. General example for aerobic is wine preparation. While coming to anaerobic fermentation the some of the factors to be considered for effective gas generation are as follows substance type, pH, Hydraulic Retention time(HRT),Nutrients available, Temperature, Carbon to Nitrogen ratio. One of the main factor is the pH it is depends on the bicarbonate alkality, production of carbon di oxide, and volatile fatty acids. The gas production rates will be optimum at the pH value of 7.0 to 7.2. [15]. 25-30:1 is observed as the optimal Carbon to Nitrogen ratio [16].

5. PROBLEMS ASSOCIATED WITH BIO ENERGY CONVERSION TECHNOLOGIES

Forests are one of the sources of biomass. In general the forests can be seen with the view of environmental supporting systems, normally the exploitation of forests was going on the name of paper production, Infrastructure facilities and e.t.c. In this current situation if we unable to balance the usage of biomass for energy production it results in further consequences. Generally the growth of biomass can be encouraged by using pesticides and fertilizers this will affect water quality.

Bio mass is the cooking fuel in some of the under developed and developing countries, which will leads to the death of the child under five years old as reported by World health organization. It very clear that from the above statement combustion of biomass leads to air quality problems also. On one hand it supports employment and cultivation of wide variety of crops on the other side one has to find solution for the issues mentioned above. There is lot of research currently going in all directions for the issues mentioned above. Bio diesel for some of the blending combinations with diesel, the NO_X emissions releasing chances are more and there are chances of the improper combustion of the fuel mixture if the biodiesel percentage was increases in blend, but all these failures can be rectified with proper research. Biogas generation through anaerobic digestion on massive scale had problems like variation in the quality of the gas based on the food waste used and also sometimes it is difficult to maintain the digester with all required parameters like temperature, pH, Nutrients availability and other factors, but can be recovered with proper monitoring and care.

6. CONCLUSIONS

It is undoubtable fact that the usage of bio mass as energy source always produces better results in meeting future energy requirements of the India. The bio energy is serving in wide variety of forms. In the form of solid it is use full for the co generation, as a liquid bio fuels serves for the application of internal engines and finally the Bio gas, producer gas are use full for the heating and electricity application. It is also should be noted that there are some of the minute issues related to environment, by combustion of biomass and its other forms, but can be resolved with proper research. Since biomass availability is abundant and had the feature of renewable with techniques like energy forming and other ways, it is one of the best options for the India to meet its future energy needs.

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