BIOMASS : A SUSTAINABLE SOURCE OF ENERGY

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Abstract- Biomass is a primary source of energy. This paper discusses about the vital role played by biomass energy in meeting the energy demand. The paper also presents the brief description of technologies involved in extracting energy from biomass. Biomass is very versatile in terms of variety of forms and number of options available for its utilization.

Key words: Biomass, Pyrolysis, Incineration, Fermentation, Embedded Generation.

1. INTRODUCTION

Due to rapid industrialization and growing population, demand for electricity is increasing day by day. But there is a gap between demand and supply for limited reserves of coal and fossil fuels and constraints of financial resources and environmental factors.

The final world energy consumption scenario is changing day by day towards the utilization of renewable energy resources.

The energy policy of India focuses on [1]:

i.) Rapid development of all forms of energy, both conventional and non-conventional (renewable).
ii) Promoting energy conservation and efficient management of demand.
iii) Environment conservation and sustainable development
iv) Development of decentralized energy systems based on renewable sources especially for use in rural areas.

2. BIOMASS ENERGY

Biomass is a renewable energy sources derived from various humane and natural waste products.

Biomass can be defined as organic matter produced by plants, both terrestrial and aquatic and animals. It includes forest crops and residues and animal manure. Biomass is considered as renewable source of energy because the organic matter is generated every day. Biomass energy is well known from 5000 years B.C., i.e. from the agricultural age [2]. It is also a form of solar energy as the sun helps indirectly to grow plants by photosynthesis.

2.1 Biomass Energy is Environmental friendly:

Bio-energy obtained from biomass is environmental friendly because biomass cycle maintains the environmental balance of oxygen, carbon dioxide, rain etc. Biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel.

This form of energy is free from environmental impact such as acid rain, open pits, radioactive waste disposal or the damming of rivers. The products obtained from biomass such as alcohol and other fuels are clean burning.

2.2 Scope of Biomass:

The scope of biomass energy is considered in three categories:

(i) Rural application of biomass energy.
(ii) Urban and industrial application.
(iii) Biomass can be used to generate electricity.
(iv) Waste disposal.
(v) Environmental balance.

3. BIOMASS POTENTIAL IN INDIA

Present contribution of biomass energy is between 4% and 18% of total primary energy consumption of various developed and developing countries respectively. By 2015 A.D. the situation is likely to change with increase in the biomass energy consumption to 25%-40% [2].

India has a vast supply of renewable energy resources. India is blessed with a suitable climate which offers an ideal environment for biomass production. Further India has vast land based, aquatic, forest, rural, agricultural biomass resources of every type. The tea factories using coal as a fuel consumed 1.25 to 1.50kg of coal per kg of made tea in northeast India. There are over 850 tea gardens covering 2,29,428 ha area and producing 408 million kg of tea in Assam. Utilization of briquettes which is a bio mass based renewable source of energy is non polluting unlimited and environment friendly. The brequettes manufactured from waste of uprooted old tea plants, shed trees, rice husk is a better substitute for coal.

With an estimated production of about 350 million tones of Agricultural waste every year, residual biomass is capable of mitigation of harmful emissions to the extent of 300 million tones per annum. The estimated potential of

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Biomass based renewable energy options in India are as follows [1]:

Biomass energy - 16,000 MW
Biogas Co-generation - 3,500 MW
Total - 19,500 MW

Table 1.1 shows the periodic variation of bio mass energy resources [2].

Table-1.1

Type of biomass	Periodicity of renewal
Urban waste	daily
Rural waste(animal dung)	daily
Agricultural waste and crops	Yearly, six monthly
Forest crops	Three to six years
Aquatic crops	Three months to one year

In India 3700 MW are currently powered by renewable energy sources. This is projected to be 10,000 MW from renewable energy by 2012 [9].

Biomass energy is an important alternative for providing energy in the rural sector. The Ministry of Power has accelerated the Rural Electrification Program with a target of 100,000 villages by 2012 [9]. The inherent advantages in utilization of biomass are that employment opportunities are created even for cultivation, collection, transportation and storage of biomass.

The States which are rich in biomass potential are:Andhra Pradesh (200 MW), Bihar (200 MW), Gujarat (200 MW), Karnataka (300 MW), Maharashtra (1000 MW), Punjab (150 MW), Tamilnadu (350 MW), Uttar Pradesh (1,000 MW).

Globally, India is in leading position in generating power through biomass. With an enormous potential India is on the edge of becoming a world leader in utilization of biomass.

Table 1.2 presents the principal biomass energy resources [2].

Table-1.2: Principal biomass energy Resources

Category	Name of biomass source
Cultivated energy resource	1. Trees, (Wood chips, saw dusts) 2. Aquatic crops, algae , green plants 3. Agricultural crops. 4. Fruit farms
Waste biomass resources from farms and bio industry	1. Rice and wheat husk 2.Baggase of sugar cane 3. coconut husk, groundnut shell 4. waste of furniture industry 5. waste of poultry industry, fishery industry, food industry etc. 6.Carbohydrates, glucose, fructose etc.

4. ENERGY FROM BIOMASS

Biopower is the use of biomass to generate electricity [7]. The major technologies involved in biopower systems are direct combustion, co-firing, gasification, pyrolysis, anaerobic digestion and fermentation.

i) Direct Combustion (Incineration):

The simplest method of extracting energy from biomass is direct combustion. Combustion is the process of burning the solid, semidried biomass including wood, agricultural residues, sugar cane baggase and municipal solid waste. The heat obtained from combustion of biomass can be used for several useful processes such as cooking, industrial heat, steam generation, generation of electrical energy from steam etc. Wood, trees, farm products are burnt to produce electricity and process heat/steam. Such plants are located near farm site or forests. The biomass is converted to electrical energy in a biomass thermal electrical power plant.

ii) Gasification:

Gasification is a process that exposes a solid fuel to high temperatures and limited oxygen to convert biomass into a gaseous fuel. The gas is a mixture of carbon monoxide, carbon dioxide, nitrogen, hydrogen and methane. The fuel gas then can be used in a piston driven engine, high efficiency gas turbine which runs an electric generator for producing power. Biomass gasification can be used for both thermal and electrical application. Biomass gasifier converts the solid biomass which are basically wood waste, agricultural residue, sugar cane baggase etc. into a combustible gas mixture. In India there is wide range of gasifiers available with capacities varying from 20 KW to 500 KW for electrical applications. Gasification of biomass and using it in place of conventional direct burning devices will result in savings of at least 50 % in fuel consumption.

iii) Pyrolysis:

Pyrolysis is a process through which biomass can be converted into solids, liquids and gases heating in a closed vessel at temperatures of 500-900 degrees centigrade. Pyrolysis represents heating the biomass to drive off volatile matter and leaving behind the charcoal. This process has doubled the energy density of the original material. The volatile material collected produces a gas which is rich in hydrogen and carbon monoxide. The gases produced are a mixture of nitrogen, methane, carbon monoxide, carbon dioxide and other hydrocarbons. In addition to gas, liquid fuels can be produced from biomass known as pyrolysis oil, which can be burned like petroleum to generate electricity. Pyrolysis can also convert biomass into

phenol oil, a chemical used to make wood adhesives, moulded plastics and foam insulation [8].

iv) Digestion:

Anaerobic digestion is a type of biochemical conversion involving microbial digestion of biomass. The process and end product depend upon the microorganisms cultivated and culture conditions [1]. The feedstock used for anaerobic digestion is urban (municipal waste), straw of rice, wheat, sugar cane baggase etc., animal dung and human sewage etc. In the presence of moisture and absence of oxygen, most organic materials will undergo natural fermentation in which 60-80% of the carbon in the organic material is converted to a mixture of carbon dioxide, methane, traces of hydrogen sulphide and nitrogen. Anaerobic digestion processes have been used for many years for conversion to gases and liquids. The sewage treatment facilities have used generally for producing fuel gas and in some cases for producing electrical power from such biogas. In India anaerobic digestion plants are commonly known as biogas plants and or Gobar gas plants. In such plants slurry of cow dung and water is fed to the digester and is allowed to ferment for a few weeks. The biogas released contains about 55% of methane which is used as a fuel [1].

v) Fermentation:

The fermentation is a process of decomposition of organic matter by microorganism such as bacteria and yeasts. Fermentation decomposes grains, sugar to form ethanol and carbon dioxide by yeast. Ethanol can be blended with gasoline (petrol) to produce gasohol (90% petrol and 10% ethanol).

Ethanol has greater potential for use as an industrial solvent and chemical than as a liquid fuel. Ethanol fermentation of biomass occurs at 20 to 30 degree centigrade. The process takes about 50 hours. Yield is about 90% liquid. This contains about 10 to 20 % of alcohol depending upon the tolerance of yeast to alcohol [1].

The heating values for the alcohols are significantly lower than for the petroleum fuels with that of ethanol being about two-thirds that of gasoline [2].

5. ELECTRICITY FROM BIOMASS

Electrical energy can be obtained from biomass using one of several processes such as direct combustion, gasification, pyrolysis, anaerobic digestion etc.

One of the popular methods is direct combustion. In this method biomass is converted into steam and the steam is used to rotate a turbine that is connected to a generator. In some industries steam is also used in manufacturing process or to heat building. Co-generation improves the viability and profitability of sugar industries.

Now-a-days co-firing is also becoming very popular for generation of electricity. In co-firing biomass can be used with coal to produce electrical energy in existing thermal power plant. This is one of the economical method and also less polluted since it lowers the air emissions especially sulphur dioxide from coal fired power plant.

Electricity from biomass reduces our dependence on fossil fuels. Being renewable source of energy there is no threat of running out of resources. Electricity produced by biomass reduces the threat of global climate change. Clearing biomass from forest areas help to prevent forest fires. Biomass by-product methane gase eliminates odor and reduces air pollution. Use of biomass waste for electricity generation eliminates the need to place it in landfills.

6. BIOMASS POWER AS EMBEDDED GENERATION

Embedded generation has becoming increasingly popular and it has been installed in distribution system in recent years [6]. To meet the growth in demand embedded generation play a vital role. Combined heat and power (CHP) is considered as the most significant type of generation embedded in distribution system. CHP is also some times known as co generation which can be installed in villages and small towns supported by bio mass.

It has been estimated that more than 2 billion inhabitants in the world live without electricity and its services such as- education, telecommunications, entertainment and social security. On the other hand there are a large number of rural villages that have limited electrical service or without electricity. The grid connected villages also receive a poor quality of service due to large voltage drop and high distribution losses. The application of renewable energy technologies offers a better solution for electrification in rural areas. Installing embedded generators to the distribution network can solve the problem faced by the rural electrification system. As a result the demand required from the grid could be reduced.

Table1.3: Biomass Electricity Production in Industrialized Countries- 1999 [8]. (Source:IEA, 2001)

Table 1.3

Country	Biomass Electricity (TWh)	% of total Electricity
US	63.5	1.6
JAPAN	16.2	1.5
GERMANY	9.4	1.7
FINLAND	8.7	12.5
BRAZIL	8.5	2.6
UK	7.7	2.1
CANADA	7.1	1.2
NETHERLANDS	4.0	4.6
AUSTRALIA	3.7	1.8
SWEDEN	3.4	2.2

Table 1.4 :Biomass Based Power Generation in Developing Countries [8]: (Source:IEA, 1998)

Country	1995	2010	2020
China			
Biomass based power generation (TWh)	--	0.4	0.7
Total electricity generation	--	1.7%	1.8%
Biomass used in power generation (Mtoe)	--	0.1	0.2
East Asia			
Biomass based power generation (TWh)	0.3	10.6	1.5
Total electricity generation	0.0%	0.0%	0.1%
Biomass used in power generation (Mtoe)	0.3	0.7	1.7
South Asia			
Biomass based power generation (TWh)	--	4.6	7.3
Total electricity generation	--	0.4%	0.4%
Biomass used in power generation (Mtoe)	--	2.0	3.1
Latin America			
Biomass based power generation (TWh)	9.6	13.1	17.1
Total electricity generation	1.2%	0.9%	0.8%
Biomass used in power generation (Mtoe)	3.3	4.5	5.8
Africa			
Biomass based power generation (TWh)	0.3	0.6	0.6
Total electricity generation	0.1%	0.1%	0.1%
Biomass used in power generation (Mtoe)	0.4	0.8	0.8
Total developing countries			
Biomass based power generation (TWh)	10.2	19.3	27.1
Total electricity generation	0.3%	0.3%	0.3%
Biomass used in power generation (Mtoe)	4.0	8.1	11.7

7. CONCLUSION

Biomass energy is an important alternative for providing energy in our everyday life. Being a renewable source of energy modern biomass can be a sustainable source of energy, also encouraging the cogeneration scheme. Being environmental friendly, it meets energy needs at all times. Biomass power generation schemes could be a boon for rural areas, especially in developing countries. Biomass is a perennial type of energy. Biomass energy use in industrialized countries is expected to increase in the future. With this potential energy resource, world will not suffer due to depletion of fossil fuels if these potentials are properly tapped and used.

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