Biomass Power Generation: An Indian Prospective

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ABSTRACT:
T*he status of biomass power generation technologies in Indian context is investigated. In particular strength, weakness, opportunities and threat aspect of the technology and its commercial realization is considered. The underdevelopment of technology and lack of commercialization as well as the uses of fodder biomass as a fuel are considered as the possible weaknesses to be overcome in future efforts. Furthermore, it is pointed out that in a developing country like India, key threat issue could compete with food and fodder production. An optimum approach could be to promote small power units (30-300 kW) fueled by agro residues. In this regards the design and performance characteristic of steam based units developed at Australian National University are outlined.*

Keywords: *Biomass power generation, Strength, weakness opportunities and threats analysis, Decentralized power supplies, Captive power generation.*

1. INTRODUCTION

Electricity is most convenient form of energy. All sectors of economy, agriculture, industry, transport, commercial and domestic, need inputs of electrical energy. The economic development plans in the developing as well as developed countries have accelerated the consumption of electrical energy. Consequently the gap between the demand and supply for power is widening around the world. For example, in India many state electricity boards are entrapped in a demand and supply gap of 9% and peak hour shortage in access of 16%. Conventional methods of electricity generation involve the use of fossil fuels such as coal, oil, and gas as a consequence of which there is a significant depletion of these energy resources. Furthermore the use of these fuels has alarming adverse effect on the environment. This has diverted the research towards power generation using renewable energy sources. In this regard solar, wind, biomass, minimicro hydel, ocean gradient as well as waves have been seriously counted upon to bridge the gap between global demand and supply of power. The principal emerging technologies are in areas of solar, wind and biomass resources.

Biomass is a renewable energy resource. It results from the solar bioconversion processes and is derived from living biological matter. It has environmental benefits because its combustion leads to lower (or zero) emission of greenhouse gases. It emits lesser amount of noxious pollutants, e.g. sulphur compounds and particulate matter. It contributes significant amount in the world's total electricity generation as shown in Table 1 (EDF&IEA report). In India biomass has an estimated potential of 24500 MW and on 30.09.2007 nearly 1307 MW grid interactive biomass power was operational (MNRE, India). Despite such a vast potential, the biomass power generation is far from mass scale adoption. It therefore seems appropriate to investigate the strength, weakness, opportunities and threat aspect of biomass electricity generation to identify barriers in biomass power generation.

Table 1: Worlds total electricity generation

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Country	**Production (TW h)**
United State	64.6
Japan	25.9
Germany	12.3
Finland	10.6
Brazil	10.4
Canada	8.3
United Kingdom	6.2
Rest of the world (developing country)	55.4
Total	193.6

2. AVAILABILITY OF BIOMASS RESOURCE

Biomass is defined as any plant and plant-derived material like woody plants, residues from agriculture or forestry etc. It contains stored solar energy and is obtained from photosynthetic reaction of carbon dioxide with water vapour to solid forms consisting mainly of cellulose, hemi cellulose and lignin. For the energy purpose biomass also includes the organic component of municipal and industrial wastes among renewable energy sources. Biomass is one of the few resources, whose availability does not depend on weather conditions, seasonal variations and can be stored for use on demand. The use of biomass as fuels provides environmental benefits because it does not produce net CO_2 in the atmosphere, as it consumes the same amount of CO_2 from the atmosphere, during growth as is released during combustion. The current global availability of biomass is abundant for example in India, its availability is estimated at about 120-150 million tonne per annum covering agriculture and forestry residues corresponding to an electricity generation potential of 16,000 MW. Biomass is available in various forms which can be classified in following two categories.

2.1 Woody Biomass

Woody biomass is the one whose average density is larger than about 200 kg/m^3 and maximum ash content is 2% e.g. fire wood, cotton stalk, corn cobs, coconut fronds and shells and weeds like eupatorium etc. In practical terminology, fire woods include several agriculture wastes.

2.2 Powdery Biomass

Powdery biomass is in loose form and its density is identified as powdery. This includes several or most agricultural wastes like sawdust, rice husk, straw, bagasse, sugarcane trash, groundnut shell etc. The advantage of powdery biomass is that for most of above mentioned residues, pulverization with a low power device is done (0.04-0.07 kW h/kg), which can bring it into the powder form thereby increasing the bulk density at low cost. The density can be brought down to as low 50-15- kg/m^3 but the ash content is about 20%.

In conclusion biomass is a pollution free resources and available in abundance in several forms.

3. WEAKNESSES

The use of biomass for power generation has various weaknesses which include logistic barriers, technological barriers and economic barriers. In what follows we present a brief account of these barriers.

Biomass can be converted into solid, liquid and

gaseous fuels with the help of thermo-chemical, physio-chemical or biological process [1]. Thermo-chemical process is the most widely used process for power generation. It is the direct combustion where the biomass is burnt in the boiler to raise steam or hot air which is used to generate heat and electricity using conventional turbines. Whereas gasification involves the conversion of biomass like fuel wood, crop residue and agro-industrial waste into producer gas which is used as gaseous fuels in engines for electricity generation. The choices of technologies involved in these processes drastically affect the economics of biomass and limit the size of the plant producing the electricity. The calorific valve of the producer gas is about 4200-5040 kJ/m^3, it is rather low and the prime mover generally suffers large wear and tear.

In direct combustion, the efficiency of the high pressure boilers depends on the compositions of biomass for a particular design of a boiler. For example the efficiency of a rice husk feed biomass boiler drops down significantly when the boiler is used with such other biomass as baggasse, mustard husk or rice straw.

4. OPPORTUNITIES

Pellitization of MSW (Municipal Solid Wastes) involves the processes of segregating, crushing and mixing high and low heat value organic waste materials and solidifying the same to produce fuel, pellets or briquettes. These are referred to as Refused Derived Fuel (RDF). This can be conveniently stored and transported and used as a supplementary fuel for combustion processes in utility boilers. The calorific value of RDF is about 16800 kJ/kg, and depends upon the contents of combustible organic materials in the waste, additives and binder materials, if any, used in process. Several types of biomass power or combined heat and power generating system are now available. On commercial scale several types of biomass power plants have been proposed and tested. For example captive biomass power plants meant only for self use with power supplies of nearly 10-50 kW range were tested by Australian National University, Canberra. The schematic diagram of one such power supply is given in Fig. 1.

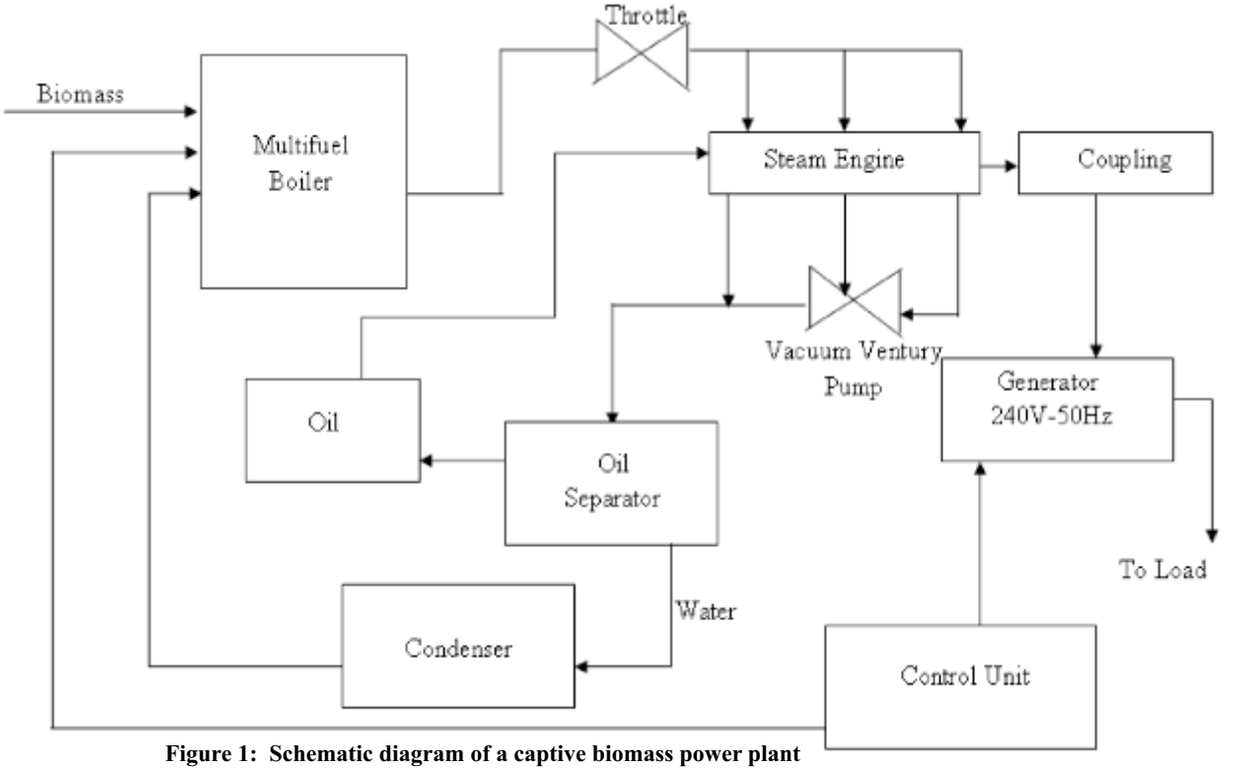

Figure 1: Schematic diagram of a captive biomass power plant

This power supply uses a high efficiency uniflow reciprocating steam engine as the prime mover. Yet another configuration for biomass power supplies is the captive with the surplus power sale to the grid. Such power supplies have been developed and operate by Mawana Sugars limited, India [2].

Third category of biomass power plants involves independent power producers with total power sale to grid. These power supplies are mostly the large scale deployment of gasifier systems. In India these systems received a boost from MNRE, Government of India and several MW range power stations were setup in southern and eastern states of India [3].

4.1. BIOMASS HYBRID COGENERATION PLANTS

Cogeneration of processes heat and power is an important energy saving approach. It is particularly suitable for paper, chemical, textile, food and petroleum refining industries. To counter balance the problem related to seasonal variation and scattered availability of biomass [4] suggested a solar biomass hybrid cogeneration plant and indicated that the sub system in such plants can indeed be performance matched.

4.2. CDM BENEFITS

Under the carbon credit programme the biomass power plants have been categorized to be eligible for CDM benefits in the international market and it has been experienced that many projects which are otherwise cost intensive become viable due to the cash flow emerging from CDM benefits.

5. THREATS

The most important threat to biomass power generation is the cost. The gasification based power supplies are still under development and near commercialization. Their average cost comes out to be quite high [5]. The direct combustion based power supplies are relatively better developed advanced and commercialized but their investment cost is still higher.

Another threat of large scale biomass use is that to the agricultural and fodder products. In many developed and developing countries it has been observed that biofuel plants have been grown on the land used for growing agricultural and fodder products.

6. CONCLUSION

Biomass is an important energy resource for the third world and it can play vital role in their sustainable development. Many different technologies are available for the use of biomass into heat and power. Some of these technologies are not yet mature and need more research to make the process commercially adoptable. Economic problem also exists because of higher investment and operational cost in comparison to fossil fired plants. Hence the government's subsidy is also necessary to improve the economic viability. In case of sugar mills it has been reported that the power produced from biomass is often much more than consumption level of sugar mills. The excess power is sold to electricity boards. The tariff fixed by these state electricity boards have now become outdated and need revision. The energy audit of various power plants has established that there is tremendous scope of energy efficiency in various stages of the system.

REFERENCES

[1] A. Demirbas, Combustion characteristic of different biomass fuels, Progress in energy and combustion sciences, Vol. 30, pp. 219-230, 2004.

[2] G N agrawal, Biomass Power Generation, Identification and removal of Barriers, Mawana Sugars, Proc. of Business Meet on Biomass Power Generation, pp.73-78, New Delhi, 2009.

[3] VVN Kishore and Sanjay Mande, Barriers for Scaling up of Biomass Gasifier Power System for Distrubuted Generation, Proc. of Business Meet on Biomass Power Generation, pp. 21-27, New Delhi, 2009..

[4] N. D Kaushika, A. Mishra and M.N. Chakravarty, Thermal analysis of solar biomass hybrid cogeneration plants, Int. J. of Sustainable Energy, Vol 24 (4), 175-186, 2005.

[5] N. D Kaushika and S. Kaneff., Small power unit fueled by agro residue and Industrial waste heat, Heat Recovery System and CHP, Vol. 11 (5), 335-339, 1971.