Vol 3 Issue 10 Nov 2013

ISSN No : 2230-7850

International Multidisciplinary Research Journal

Indian Streams Research Journal

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RNI MAHMUL/2011/38595 **ISSN No.2230-7850**

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Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.isrj.org

Indian Streams Research Journal
Volume-3, Issue-10, Nov-2013
ISSN 2230-7850

Available online at www.isrj.net

COST EFFECTIVE POWER GENERATION USING AGRICUTURAL BIOMASS

Suman
PUSSGRC, Hoshiarpur.

Abstract:-The need to generate thermal and electrical energy, rising fossil fuel prices & global warming caused by increased emission of green house gases encouraged the need to find alternative energy sources. Biomass can be burned for fuel by itself or co-fired with other fuels. But in recent years Biomass and Coal co-fired based systems are receiving more attention due to high Power Generation Efficiency and reduced Green House Gas (GHG) emissions. This paper critically analyzes the scope, potential and implementation of agricultural -Biomass conversion to Energy in India context. Brief descriptions of potential conversion routes have been included, with their possible and existing scope of implementation. As far as possible, the most recent statistical data have been reported from various sources. The discussion reveals that a large potential exists for the Biomass feed-stocks from the various kinds of waste Biomass. The analysis to identify irreversibility and the ways to improve the performance of Power Generation systems is discussed. The Energy generated from various kinds of Biomass products is analyzed and its role to improve the Power Generation systems is also presented.

Keywords: Greenhouse gas (GHG), Biomass, Electrical energy, Efficiency, Power Generation .

1.INTRODUCTION

In recent years, the World is facing Energy crisis, Economic, Green & clean Environmental problems. A lot of research efforts are put to find economically viable and sustainable energy resources to reduce this energy crisis with green and clean environment. With growing population, improvement in the living standard of the humanity, industrialization of the developing countries, the Global demand for energy is expected to increase. India rank fifth in the world in total energy consumption (with installed capacity 228.722 GW up to March 2013). Coming to Power production in the country, India ranks sixth in the world with increased installed power capacity from 1362MWh to 855.3 billion kWh (up to 2012). This achievement is impressive but not sufficient. The country still encounters peak and energy shortage of 9 % & -8.7 % respectively (up to March). The major sources which meet the energy requirement of India are coal and oil. The use of these fuels is a problem because of the reasons: a) The natural formation of Coal and Oil is a very slow process which takes long time .b) Emission of Green house gases. c) These are fast depleting sources of Energy. Moreover, India is dependent on the imports for Oil requirements. In 2004–05, 72% of India's total oil consumption was dependent on the imports [2]. This figure reached to 76.5% during 2009–10, 78% for 2010–11, and the tentative figure for 2011–12 is 80.5% [3]. These imports are increasing year after year with the growing economy of the country and contribute in continuous increase of the import bills. By 2025, it will be importing 90% of its crude oil from OPEC countries. Therefore, Utilization of renewable energy sources is one of the best ways to meet the objectives as: a) These are the energy sources that will never run out. b) These sources are Environmental friendly means reduce Green house effect and provide clean Environment. c) Social –cost benefits. The major Renewable sources of Energy available freely are Solar energy, Wind energy, Small Hydropower, Biomass, Biogas, and Energy recovery from Municipal and Industrial wastes.

2. STATUS OF BIO-ENERGY RESOURCES IN INDIA

India's energy basket has a mix of all the resources available including renewable. Biomass contributes as the world's fourth largest energy source up to 14% and in developing countries it can be as high as 35% of the primary energy. Agricultural biomass has immense potential for power production in India. India has made tremendous progress not only in the agriculture sector but in the industrial, transport and household sectors. This has increased energy demand significantly. This country does not have its own resources of conventional fuels such as petroleum products. The country has to depend on neighboring countries for petroleum products. But it has plenty of renewable energy sources, such as biomass, wind and solar energy, which can be exploited to provide sustainable energy base for socio-economic development. Table 1: shows the various type of biomass available in India [3]. Table 1

S. No.	Type of biomass	Name of crop
1	Straw	Wheat , paddy , Pulses , Barley
2	Stalk	Cotton , Maize, rapeseed & mustard
3	Bagasse Tops & leaves	Surgarcane
4	Husk	Paddy
5	Cobs	Maize

3. BIOMASS CONVERSION

Due to technological developments and cost reductions, renewable solar, hydro, wind and biomass energy are gaining momentum across the globe. There are a variety of processes and technologies that convert biomass into heat, steam, electricity, and other types of fuel & products. Some of them are depicted in Table 2 [2].

Table 2: Waste Agricultural Biomass to Energy – Technology

S. No.	Type of Technology	Examples of types of waste handled	By Products	Applications
1	Direct Combustion	Crop residues such as wheat straw, rice straw, rice husk, Bagasse	Carbon Dioxide, Water & Heat	Power Generation ,Heating , Cooking
2	Gasification	Crop residues such as wheat straw, rice straw, rice husk	Syngas, Heat, Some CO_2 and H_2O	Power Generation ,Heating , Cooking , Transportation
3	Pyrolysis	Crop residues such as wheat straw, rice straw, rice husk	Bio- Ethanol	Power Generation, Transport-ation
4	Fermentation	Sugarcane & starch substrates like wheat, maize, sugar beet	Solids (charcoal), Liquids (Pyrolysis oils) and a mix of Combustible gases	Power Generation ,Transportation
5	Esterification	Rape-seed	Glycerine and RME (RapeMethyl Ester)	Power Generation , Transportation

Above mentioned technologies which are already installed must be upgraded keeping requirements in mind while those which are presently running Global like Fermentation, Esterification. Brazil recovered from oil crisis because of development of Cars powered by 100% Ethanol or Petrol or combination of both, such technologies are awaited to be modeled for India's Energy Policy.

4. BIOMASS AS A COAL SUBSTITUTE

Biomass Power technologies compete in niche applications as well as in direct competition with Conventional Electricity sources in Centralized Electricity supply. In large scale grid based applications, cost is the primary determinant of competitiveness. A power plant with the capability of producing 8 MW of electricity could cost up to 40 crore INR. While annual maintenance (done for 1week twice a year) costs 50 Lakhs INR. Variable expenses are related to price of Biomass cost (approx. 3500-5500 INR per metric ton) is highly variable, depending upon the source, location etc while other expenses include manpower wages [1]. Operating life of Biomass Power plant lies between 25 to 30 years. since the cost of setting a biomass plant is high as compared to thermal plant but it has many advantages over thermal power plant such as--a) Biofuels can be transported and store and allow for heat and power generation on demand. b) The energy balance of biomass plants indicates that biomass energy is 10 to 30 times greater than the energy input for fuel production and transport. c) Accessibility in rural areas where commercial fuels and centralized electric grid are not available. d) Greater employment for local populations. e) Restoration of deforested and degraded lands by energy plantations. f) Near-zero fuel costs (paid in local currency), commercial use of a waste product, decentralized supply and increased fuel efficiency leading to an increase in the economic. g) Cost of electricity per unit from biomass power plant is lower than coal plan.

5. ENVIRONMENTAL CRITERIA

Expanding the share of Renewable Energy in its Energy mix is one of the key pillars of India's low-carbon development strategy. The Biomass fuels are more suitable & promising than coal due to its low carbon, sulphur and nitrogen content as depicted in Table 3. Since CO2 and acidification of SO2 & NO2 are primarily responsible for global warming & coal contain maximum value of these elements (Carbon, Nitrogen & Sulphur) as compared to other Biomass.[1] So coal contributes more towards the Global warming. Moreover depending upon the content of Carbon & Sulphur there is Environmental taxes (High Tax & Low Tax). High tax scenario with $50 per ton of carbon tax and $400 per ton of Sulphur dioxide tax. Low tax scenario with $25 per ton of carbon tax and $200 per ton of Sulphur dioxide tax. The cost of delivered Electricity under the Low tax and High tax cases for Coal Power increases by 1.4 and 2.8 cents/kWh, respectively.

Table -3: Estimated Analysis: (Where C-carbon, H-hydrogen, O-oxygen, N-nitrogen, S-sulphur)

Biomass	C	H	N	O	S	Ash content (%)
Coal	75	58	1.5		0.5	10
Rice Husk	38.35	5.08	36.24	0.56	0.16	14.9
Wheat straw	48.58	5.73	40.71	0.81	0.17	8.5
Rice Straw	43.36	5.44	39.03	0.87	0.10	19.2
Bagasse(dry basis)	49	6.5	42.7	0.2	0.1	1.5
Maize(stalk+cob)	51	4.9	43.87	1.00	-	6.68

Further Biomass fuels have less reactive character as compared to Coal & Cogeneration applications in

agriculture processing industries typically achieve fuel efficiency of 40 to 45% compared to 30% efficiency of the conventional technologies . Although the conversion of Biomass to Electricity in itself does not emit more CO2 than is captured by the Biomass through photosynthesis. This analysis suggests that under, these advantages, together with more efficient and versatile Biomass Electricity Generation with Modern Technologies, have led to the transition of re-emergence of Biomass as a competitive and Sustainable Energy option in the Future Energy Scenarios.

6. CONCLUSION

Significant conclusions of this paper are as follows:

a) India has abundant capacity to produce reliable, price competitive and ecologically sustainable Bio-energy to meet the energy demand of domestic and commercial sector. A number of such Power Generation project have not only solved the rural electrification problem for the remote villages, where infrastructural costs could have been quite high for conventional electrification, but also the power generation cost has also been relatively low.

b) In Biomass, Carbon, Nitrogen & Sulphur contents are low, which favours in lesser or Zero Global warming. Moreover their quantity decides the Environmental tax, so for biofuel we have to pay less tax as compared to Coal. Further, it is analyzed that replacement of each KWh of Coal–based electricity by Biomass-based electricity is likely to reduce CO2 by 1Kg.

c) Biomass based decentralized generation is likely to generate direct or indirect & skilled or unskilled employment to about 84 people in rural areas.

d) Biomass based power plants helps in reducing the bio-waste disposal problem in effective way.

e) Cogeneration applications in agriculture processing industries achieve fuel efficiency up to 40 to 45% as compared to 30% efficiency of the conventional technologies.

Apart from having so many Economical & Environmental benefits, it also opens a new door for future innovations in our Country.

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