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Bioenergy: The Potential for Rural Electrification, Rural Development and Poverty Alleviation in India

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Abstract—*Any biological material which can be used as fuel is referred to as Biomass. Mostly biomass fuel is burned and also can be changed in form which can be used to generate heat, electricity or both by different conversion processes. In India, there is significant potential to produce energy from biomass derived from farming and forestry residues. According to MNRE's report, total installed capacity through renewable resources in India is 28.1GW and out of which biomass contributes 12.8% that is 3.6GW approximately as of 31 March, 2013. Though estimated potential through biomass is 22.5GW which means there is a huge untapped potential of biomass in India. Unavailability of biomass is the major problem which is overcome by second generation biofuels derived from non-food sources such as Jatropha, Karanja and microalgae addressing energy security and environmental concerns. Also with the help of government policies and initiatives much work has been done in this field showing a remarkable growth in biomass utilization, poverty alleviation and provides additional information on the use of bioenergy to bring about socio-economic improvements in our country.*

1. INTRODUCTION

Biomass, a vital energy source, has a share of more than 14% of global energy supply. In India, per year availability of biomass is anticipated at about 500 million tons out of which 120-150 million tons is on hand for power generation. The predictable power generation from agricultural based residues by MNRE is 18 GW. However, by raising crucial plantations on 2 million hectares of forest and non-forest tainted land, additional potential to generate 5GW power can be achieved.

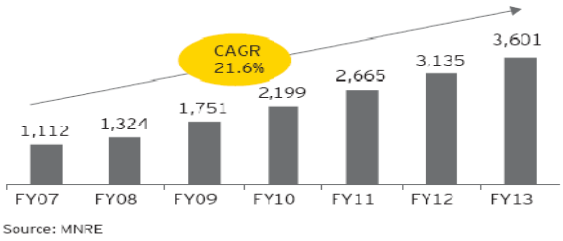

Fig. 1: Growth of biomass based power generation installed capacity in India (MW)

In Indian perspective, as of March 2013, total grid-interactive installed capacity has reached 3601 MW. According to CAGR report, Biomass based power generation installed capacity in India has grown by 21.6% from 2007-2013. Bagasse-based co-generation in sugar industries has a share nearly 65% to biomass power generation

2. DIFFERENT BIOMASS SOURCES

Common sources of Biomass are compost, garbage, agricultural residues, landfill gases wood and alcohol fuels. Biomass has three key components carbon, hydrogen and oxygen. Major source of biomass is energy obtained from wood, black liquor, a waste product from the processes of pulp, paper and paperboard industry.

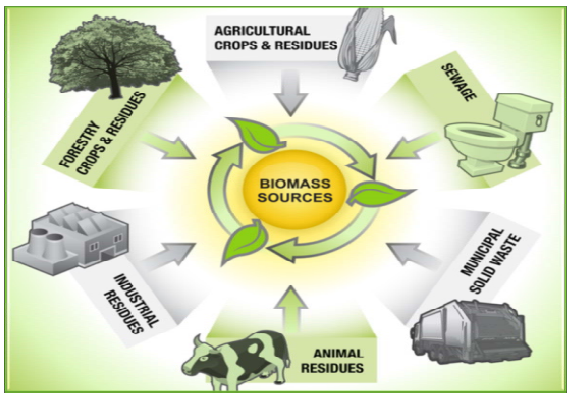

Fig. 2: Various biomass resources

Second widely used bioenergy source is Waste enegy which is present at waste sites e.g. landfill gases, manufacturing waste and municipal waste. Methane gas is produced from garbage waste which is a biogas.The first generation biofuels procured from sugarcane and corn consecutively produce bioethanol by a process called fermentation. These type of wastes are commonly found in Mauritius and South east Asia (rice husk).

Highest amount of forest waste is produced in United States. Animal waste is a good source of biomass e.g. poultry waste which UK is the leading country.

3. DIFFERENT PROCESSES USED FOR CONVERSION OF BIOMASS INTO ELECTRICAL ENERGY

There are different scientific ways to generate electricity from biomass. These are as follows:

Pyrolysis–It is a process in which heat is applied to the biomass feedstock in the presence of catalyst to convert it into biofuels which is generally liquid in nature.

Combustion–In this process, various burner/boiler technologies are used to direct burn the feedstock like coal, natural gas and convert it into energy.

Gasification–In this process, the biomass feedstock is partially oxidised and then decomposed in a reactor vessel to produce a synthetic gas.

Gasification and direct combustion technologies are commonly used to produce energy from biomass.

Approaches in combustion technologies:

Various approaches used in combustion technologies are Stoker Boiler Combustion, Biomass Co-firing and Fluidized Bed Combustion.

Biomass Co-firing: In this method biomass fuel is burnt with coal products. It has been developed in Europe and US is trying to take it on for its improved efficiency and reduction in net carbon emission during power generation.

Fluidized Bed Combustion: This combustion process employs a mixture of silica and limestone, a special form of biomass fuel along with air application.

Biomass Gasification

Wood or Biomass gasification is the reliable energy based system which had been widely used during world war II for transportation. It is simply an incomplete combustion of biomass feedstock leading to production of combustible gases which are Carbon monoxide (CO), Hydrogen (H_2) and in very less proportion methane (CH_4). This mixture of gases is known as producer gas.

This gas can be used:

- To run internal combustion engine
- As substitute for furnace oil in direct heat application
- To produce methane which is used both as fuel for heat engines plus as chemical for industries.

This process can be applied to any type of biomass material therefore, is more reliable and viable than ethanol production where only selected materials can produce fuel but the problem lies in the fact that all the solid biomass waste is not available in the readily usable form e.g., wood waste can be used in hog fuel boiler but the equipment is very costly and less efficient. Therefore, it should be converted into a readily usable form like producer gas. Thus beneficial is the gasifier.

4. CASE STUDIES OF BIOMASS UTILIZATION IN INDIA

Case study 1: Energy plantation, biomass gasifier plants, and evacuation of power Tumkur district of Karnataka

In Tumkur district of Karnataka, this project was initiated in 2001 in 5 village clusters consisting of 28 villages. This project provides a platform for the latest bioenergy technologies like bioelectricity produced from biomass gasification, community biogas plant and proficient cook stoves. This approach was made in order to produce bioelectricity using biomass from energy plantations cultivated for the purpose.

It was expected that for a 1000-kv biomass gasifier plant, about 3000 ha of land and a biomass yield projected at 12,000 tonnes per year were necessarily a requisite. Tree plantations were grown to hold up the biomass necessities of the power plant. It had helped in providing a source of income to over 240 women in 81 self-helping groups.

Fig. 4: Jasmine crop grown through irrigation facility provided under BERI project in Kabbigere village.

A 500-kW capacity gasifier plant was installed in Kabbigere in three clusters– two gasifier of 100kW each and one of 200 kW using 100% producer gas and other with 100kW with dual fuel. As of June 2012, a total of 1,520,000 kWh of energy has been generated together by these plants.

Case study 2: Generating biogas from waste in Kerala.

Biogas digesters, that capture food and other organic waste along with waste water at the source and generate biogas has been developed by an NGO named Biotech, in Kerala. This technology is called bio-methanation.

In this process, organic material is break down by bacteria in air tight containers to produce biogas, a mixture of methane and carbon dioxide. The gas produced can be used as both cooking fuel and to generate electricity after purification. The solid left can be used as organic compost. Plants of different

sizes have been developed by Biotech to furnish the needs of different sectors say Domestic sector, institutions and market places.

Fig. 5: Bioelectricity lighting up streets

Usually the domestic plants of volume $1m^3$ make approximately $1m^3$ of biogas each day with the input of 25 kg of solids and 20 L of water on daily basis. The cost of a standard domestic plant of $1m^3$ capacity is around Rs 9500. Approximately 88,000 plants have been installed reducing the dependence on LPG upto 50%, thus saving about Rs 2280 per year for a family. In addition to this, it helps in generation of employment.

Case study 3: Project Surya- Improved cookstoves intervention

In developing countries, about 3 billion people use mud stoves, burn firewood and cattle dung in traditional way to cook their food. Smoke released from burning wood and cow dung is toxic for both women and children because it raises the risk of chronic bronchitis in women and pneumonia in children.

Fig. 6: Demonstration of a stove

But there available new and improved technologies for cooking food that are hygienic, produce less smoke as compared to traditional cooking stoves or chulhas, are fuel efficient and generate better heat.

Use of these technologies leads to reduced health risks, lesser environment impact, save forest because of less fuel consumption and last but not the least slow down global warming.

5. CONCLUSION

Energy through biomass offers the most attractive alternative source for power generation as there is a huge untapped potential of it. There are many limitations to the extension of the electricity grid as well as supply of electricity through the central grid in India; therefore small scale biomass-based projects proved successful in providing sustainable energy solutions to millions of rural folk for meeting their lighting, cooking and other energy requirements, above and beyond enhancing their livelihoods. Thus, the renewable energy technologies allow local control of the energy resources and power generating systems a doable means of providing electricity and clean fuel to the currently un-served people, further, creating employment and entrepreneurship opportunities, leading to rural development and power alleviation.

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