Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 10; October, 2014 pp. 89-94

http://www.krishisanskriti.org/jbaer.html

Waste to Energy in India and its Management

Dipanshu Chinwan[1], Shubhangi Pant[2]

[1,2]G.B. Pant University of Agri. & Tech., Dehradun

Abstract: **The high volatility in fuel prices in the recent past and the resulting turbulence in energy markets has compelled many countries to look for alternate sources of energy, for both economic and environmental reasons.**

With growing public awareness about sanitation, and with increasing pressure on the government and urban local bodies to manage waste more efficiently, the Indian waste to energy sector is poised to grow at a rapid pace in the years to come. The dual pressing needs of waste management and reliable renewable energy source are creating attractive opportunities for investors and project developers in the waste to energy sector.

Biomass and waste power encompasses a range of technologies that generate electricity from various biomass feed stocks and either municipal or industrial waste from incineration, gasification or anaerobic digestion technologies. The most common organic feed stocks are residues from the forestry industry, but specially-grown crops, such as willow or elephant grass, are becoming increasingly important. In sparsely wooded areas, agricultural residues like straw or husks are predominantly used. Other means of generating power in this sector harness the methane created from the decomposition municipal or industrial waste. Biomass power economics are more closely related to those of traditional thermal generation, due to their reliance on feedstock inputs. They can also be subject to significant economies of scale.

Waste-to-energy can fetch significant monetary benefits that are: Profitability, Government Incentives, Related Opportunities, and Emerging Opportunities. In this paper the various types, processes and policies are considered and explained.

1. INTRODUCTION

Energy recovery from waste is the conversion of non-recyclable waste materials into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE).

Energy recovery from waste is part of the non-hazardous waste management hierarchy. Converting non-recyclable waste materials into electricity and heat generates a renewable energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills.

Renewable energy source is defined as separated yard waste or food waste, including recycled cooking and trap grease, and other materials. Final regulations allow separated municipal solid waste (after all recyclable materials have been removed) to qualify as "separated yard or food waste.

2. WASTE TO ENERGY

Most wastes that are generated find their way into land and water bodies without proper treatment, causing severe water and air pollution. The problems caused by solid and liquid wastes can be significantly mitigated through the adoption of environment-friendly waste to energy technologies that will allow treatment and processing of wastes before their disposal. Waste to energy generates clean, reliable energy from a renewable fuel source, thus reducing dependence on fossil fuels, the combustion of which is a major contributor to GHG emissions. These measures would reduce the quantity of wastes, generate a substantial quantity of energy from them, and greatly reduce pollution of water and air, thereby offering a number of social and economic benefits that cannot easily be quantified.

In addition to energy generation, waste-to-energy can fetch significant monetary benefits. Some of the strategic and financial benefits from waste-to-energy business are:

1. ***Profitability*** - If the right technology is employed with optimal processes and all components of waste are used to derive value, waste to energy could be a profitable business. When government incentives are factored in, the attractiveness of the business increases further.

2. ***Government Incentives*** - The government of India already provides significant incentives for waste to energy projects, in the form of capital subsidies and feed in tariffs. With concerns on climate change, waste management and sanitation on the increase (a result of this increasing concern is the newly formed ministry exclusively for Drinking Water and Sanitation), the government incentives for this sector is only set to increase in future.

3. ***Related Opportunities*** - Success in municipal solid waste management could lead to opportunities in other waste such as sewage waste, industrial waste and hazardous waste. Depending on the technology/route used for energy recovery, eco-friendly and "green" co-products such as charcoal, compost, nutrient rich digestate (a fertilizer) or bio-oil can be obtained. These co-product opportunities will enable the enterprise to expand into these related products, demand for which are increasing all the time.

4. ***Emerging Opportunities*** - With distributed waste management and waste to energy becoming important priorities, opportunities exist for companies to provide support services like turnkey solutions. In addition, waste to energy opportunities exist not just in India but all over the world. Thus, there could be significant international expansion possibilities for Indian companies, especially expansion into other Asian countries.

According to MNRE estimates, there exists a potential of about 1460 MW from MSW and 226 MW from sewage

Table 1. India - Potential of Energy Recovery from Urban and Industrial Wastes

State/Union Territory	From Liquid Wastes* (MW)	From Solid Wastes (MW)	Total (MW)
Andhra Pradesh	16.0	107.0	123.0
Assam	2.0	6.0	8.0
Bihar	6.0	67.0	73.0
Chandigarh	1.0	5.0	6.0
Chhattisgarh	2.0	22.0	24.0
Delhi	20.0	111.0	131.0
Gujarat	14.0	98.0	112.0
Haryana	6.0	18.0	24.0
Himachal Pradesh	0.5	1.0	1.5
Jharkhand	2.0	8.0	10.0
Karnataka	26.0	125.0	151.0
Kerala	4.0	32.0	36.0
Madhya Pradesh	10.0	68.0	78.0
Maharashtra	37.0	250.0	287.0
Manipur	0.5	1.5	2.0
Meghalaya	0.5	1.5	2.0
Mizoram	0.5	1.0	1.5
Orissa	3.0	19.0	22.0
Pondicherry	0.5	2.0	2.5
Punjab	6.0	39.0	45.0
Rajasthan	9.0	53.0	62.0
Tamil Nadu	14.0	137.0	151.0
Tripura	0.5	1.0	1.5
Uttar Pradesh	22.0	154.0	176.0
Uttarakhand	1.0	4.0	5.0
West Bengal	22.0	126.0	148.0
Total	226.0	1457.0	1683.0

***Liquid wastes in this case refers to total sewage sludge viz., sewage sludge generated at STPs and untreated sewage.**

According to the Ministry of New and Renewable Energy, there is a potential to recover 1,300 MW of power from industrial wastes, which is projected to increase to 2,000 megawatt by 2017. Projects of over 135 megawatt have been installed so far in distilleries, pulp and paper mills, and food processing and starch industries. (2011)

2.1 India Waste to Energy Tapped Potential

From the above section one can infer that there exists an estimated potential of about 225 MW from all sewage (taking the conservative estimate from MNRE) and about 1460 MW of power from the MSW generated in India, thus a total of close to 1700 MW of power. Of this, only about 24 MW have been exploited, according to MNRE. Thus, less than 1.5% of the total potential has been achieved.

Table 2: Current Waste-to-Energy Installed Capacity

GRID-INTERACTIVE POWER		**(CAPACITIES IN MW)**	**Contribution (%)**
Waste to Power			
	Urban	20.20	27.4
	Industrial	53.46	72.6
	Total	73.66	
OFF-GRID/ CAPTIVE POWER		**(CAPACITIES IN MWEq*)**	**Contribution (%)**
Waste to Energy			
	Urban	3.50	4.6
	Industrial	72.30	95.4
	Total	75.8	

MWEq: Megawatt Equivalent;

Source: MNRE, 2011

Major Constraints Faced by the Indian Waste to Energy Sector

The growth of this sector has been affected on account of the following limitations/ constraints:

- Waste-to-Energy is still a new concept in the country;
- Most of the proven and commercial technologies in respect of urban wastes are required to be imported;
- The costs of the projects especially based on biomethanation technology are high as critical equipment for a project is required to be imported.
- In view of low level of compliance of MSW Rules 2000 by the Municipal Corporations/ Urban Local Bodies, segregated municipal solid waste is generally not available at the plant site, which may lead to non-availability of waste-to-energy plants.
- Lack of financial resources with Municipal Corporations/Urban Local Bodies.
- Lack of conducive policy guidelines from State Governments in respect of allotment of land, supply of garbage and power purchase / evacuation facilities.

2.2 India – Waste Generation Scenario

Every year, about 55 million tonnes of municipal solid waste (MSW) and 38 billion litres of sewage are generated in the urban areas of India. In addition, large quantities of solid and liquid wastes are generated by industries. Waste generation in India is expected to increase rapidly in the future. As more people migrate to urban areas and as incomes increase, consumption levels are likely to rise, as are rates of waste generation. It is estimated that the amount of waste generated in India will increase at a per capita rate of approximately 1-1.33% annually. This has significant impacts on the amount of land that is and will be needed for disposal, economic costs of collecting and transporting waste, and the environmental consequences of increased MSW generation levels.

2.3 India Waste to Energy Potential

According to the Ministry of New and Renewable Energy (MNRE), there exists a potential of about 1700 MW from urban waste (1500 from MSW and 225 MW from sewage) and about 1300 MW from industrial waste. The ministry is also actively promoting the generation of energy from waste, by providing subsidies and incentives for the projects. Indian Renewable Energy Development Agency (IREDA) estimates indicate that India has so far realized only about 2% of its waste-to-energy potential. A market analysis from Frost and Sullivan predicts that the Indian municipal solid waste to energy market could be growing at a compound annual growth rate of 9.7% by 2013.

3. TYPES OF WASTE

Waste can be broadly classified into:

1. Urban Waste:

(a) Municipal Solid Waste: Paper, Glass, Metals

Synthetic polymers (cables, wires, toys and plastic goods), Inerts (stones, sand, pebbles etc), Hides and leather discards Pharmaceutical wastes (tablets, ointments, lotion etc), Kitchen wastes (Fruit and vegetable peels, raw and processed food ingredients)

(b) Sewage: Bulk excretory matters (Feces and urine), Body wastes (Sweat, oil, nails, dead tissue, saliva, tears and hairs etc), Laundry wastes (Detergent and soap precipitates.

(c) Fecal Sludge: Sludge removed from all kind of on-site sanitation systems such as septic tanks (settled solids, scum and liquid), bucket latrines, pit latrines etc.

2. Industrial Waste: In a broad sense, industrial wastes could be classified into two types:

(a) Hazardous industrial waste

(b) Non-hazardous industrial waste

3. Biomass Waste

4. Biomedical Waste: Urban waste includes Municipal Solid Waste, Sewage and Fecal Sludge, whereas industrial waste could be classified as Hazardous industrial waste and Non-hazardous industrial waste.

3.1 Technologies for the Generation of Energy from Waste

Energy can be recovered from the organic fraction of waste (biodegradable as well as non-biodegradable) through thermal, thermo-chemical, biochemical and electrochemical methods.

(i) Thermal Conversion: The process involves thermal degradation of waste under high temperature. In this complete oxidation of the waste occurs under high temperature. The major technological option under this category is incineration. But incineration has been losing attention these days because of its emission characteristics.

(ii) Thermo-chemical conversion: This process entails high temperature driven decomposition of organic matter to produce either heat energy or fuel oil or gas. They are useful for wastes containing high percentage of organic non-biodegradable matter and low moisture content. The main technological options under this category include Pyrolysis and Gasification. The products of these processes (producer gas, exhaust gases etc) can be used purely as heat energy or further processed chemically, to produce a range of end products.

(iii) Bio-chemical conversion: This process is based on enzymatic decomposition of organic matter by microbial action to produce methane gas, and alcohol etc. This process, on the other hand, is preferred for wastes having high percentage of organic, bio-degradable (putrescible) matter and high level of moisture/ water content, which aids microbial activity. The major technological options under this category are anaerobic digestion (bio-methanation) and fermentation. Of the two, anaerobic digestion is the most frequently used method for waste to energy, and fermentation is emerging.

(iv) Electrochemical conversion: Electrochemical conversion in the context of waste to energy refers typically to microbial fuel cells (MFC). These systems are developed to trap the energy from wastes, where the reduction-oxidation machinery of immobilized microbial cells is catalytically exploited, for the accelerated transfer of electrons from organic wastes, to generate electricity and bio-hydrogen gas. However this methodology needs extensive evaluation studies on bulk scale liquid waste treatments and stands at a nascent level in India as well as worldwide.

4. INDIAN GOVERNMENT SUPPORT FOR WASTE TO ENERGY

The Indian Government has recognized waste to energy as a renewable technology and supports it through various subsidies and incentives. The Ministry of New and Renewable Energy is actively promoting all the technology options available for energy recovery from urban and industrial wastes. MNRE is also promoting the research on waste to energy by providing financial support for R&D projects on cost sharing basis in accordance with the R&D Policy of the MNRE. In addition to that, MNRE also provides financial support for projects involving applied R&D and studies on resource assessment, technology up-gradation and performance evaluation.

4.1 Biomass to power and heat:

India has a potential to generate an additional 20 GW of electricity from biomass residues. In order to realize the potential effectively, various fiscal incentives are being provided by the Government. Below is the description of key incentives like capital subsidy, renewable energy certificates and Clean Development Mechanism (CDM) which can be utilized effectively to make the project economically attractive.

The government provides a onetime capital subsidy based on the installed capacity of the project. The entire capital subsidy amount is released directly to the lead bank / lending financial institution for the purpose of offsetting the loan amount after successful commissioning of project. In case the project is set up by the promoters through their own resources, the CFA would be released directly to promoters after successful commissioning of the project

Table 3. Government Incentives for Biomass Power Projects in General (National Level and State Level)

Project Type	Capital Subsidy -Special Category States (NE Region, Sikkim, J&K, HP & Uttaranchal)	Capital subsidy-For other states
Biomass Power projects	25 lakh X (C MW)^0.646	20 lakh X (C MW)^0.646
Bagasse Co-generation by private sugar mills	18 lakh X (C MW)^0.646	15 lakh X (C MW)^0.646
Bagasse - Co-generation projects by cooperative/ public sector sugar mills		
40 bar & above	40 lakh *	40 lakh *
60 bar & above	50 lakh *	50 lakh *
80 bar & above	60 lakh *	60 lakh *
	Per MW of surplus power **	Per MW of surplus power **
	(maximum support `8.0 crore per project)	(maximum support `8.0 crore per project)

**For new sugar mills, which are yet to start production and existing sugar mills employing backpressure route/seasonal/incidental cogeneration, which exports surplus power to the grid, subsidies shall be one-half of the level mentioned above.*

*** Power generated in a sugar mill (-) power used for captive purpose i.e. net power fed to the grid during season by a sugar mill.*

4.2 Biomass to fuels

4.2.1 Bio fuels

The national biofuel policy of India adopted in December 2009 aims at facilitating development of indigenous biomass feedstock for production of biofuels. The Indian approach to biofuels is based solely on non-food feedstock to be raised on degraded/waste lands that are not suitable for agriculture, thus avoiding a possible conflict of fuel versus food security" (MNRE, 2009). The new biofuels policy will incentivize plantation of non-edible oilseeds, such as jatropha and karanjia over about 11.2 million hectares of land, which is 30 times of present cultivation, resulting in 13.38 million tons of biofuel to meet its policy target of 20% blending of biofuels in transportation fuel by 2020. The new policy offers financial incentives such as subsidies and grants for biofuels production apart from declaring Minimum Support Price (MSP) for non-edible oil seeds. The policy also envisages setting up of a National Biofuel Fund.

Features of India's Biofuel policy

- Strengthening India's energy security through a supplemental blending of 20% transport fuel (Bio-ethanol and biodiesel) with conventional fuel.
- Meeting the energy needs of a vast rural population in India to stimulate rural development and create employment opportunities.
- Addressing global concerns about containment of carbon emissions through the use of environment friendly bio-fuels.
- Optimization in development and utilization of indigenous biomass feedstock for the production of bio-fuels.
- Promotion of highly efficient, new generation bio-fuel conversion technologies based on new feed stocks.
- Proposal from oil marketing companies to procure bio-ethanol and bio-diesel at the Minimum Purchase Price (MPP)
- Consideration by GOI to initiate National Bio fuel Fund to provide financial incentives, subsidies and grants for new and second generation feed stocks, advanced technologies, conversion processes, and production units.
- Declaration of bio-fuels under the ambit of "Declared Goods" so as to ensure its unrestricted movement within and outside the States.
- Except for a concessional excise duty of 16 percent on bioethanol, no other central taxes and duties are proposed to be levied on bio-diesel and bio-ethanol.
- Thrust for innovation, (multi-institutional, indigenous and time bound) research and development on bio-fuel feedstock production including second generation biofuels.
- 100 percent allowance in bio-fuel technologies and projects (E.g. FDI participation in Plantations of non-edible oil bearing plants) for foreign direct investments (FDI) through automatic approval route.

4.2.2 Biodiesel

National Biodiesel Mission (NBM): The National Biodiesel Commission was set up to look exclusively into issues pertaining to biodiesel and the development of Jatropha curcas as the feedstock for biodiesel production (Planning commission, 2003). The blending targets for ethanol and biodiesel were proposed to be set at 10% and 20% respectively by 2011/12.

Table 4. Developments in NBM

Period	Action
April 2003	Demonstration phase 2003 to 2007: The Ministry of Rural Development appointed as nodal ministry to cover 400,000 hectares under jatropha cultivation. This phase also proposed nursery development, establishment of seed procurement and establishment centres, installation of a trans-esterification plant, blending and marketing of bio-diesel
October 2005	MoPNG announced a bio-diesel purchase policy in which OMC"s would purchase bio-diesel across 20 procurement centres across the country to blend with high speed diesel w.e.f January 2006. Purchase price set at Rs 26.5 per litre
2008	Self Sustaining Execution phase 2008 to 2012: Targeted to produce sufficient biodiesel for 20 percent blending by the end of the XIth (2008-12) five year plan
2010	An estimated 0.5 million hectares has been covered under jatropha cultivation of which two-thirds is estimated to be new plantation, requiring two to three years to mature
2011/12	Ambitious plans to ensure sufficient feedstock by 2011/12 for 20% mandate fuel blends

4.2.3. Bio ethanol

Ethanol Blending Program (EBP)

EBP is an ambitious plan from GOT involving a mandatory 5% blend of ethanol derived from sugar molasses with petrol.

Table 5. Developments in EBP

Period	Action
January 2003	Ministry of Petroleum and Natural Gas (MoPNG) made 5 percent ethanol blending (Gazette on EBP) in petrol (gasoline) mandatory across 9 States and 5 Union Territories
September 2006	Resurgence in sugarcane production in 2005/06 and 2006/07 led the GOI to mandate 5 percent ethanol blending in gasoline across 20 states and 8 Union Territories subject to commercial viability
September 2008	The Union Cabinet approved the National Biofuel Policy. Five percent

	blending became mandatory across all states in the country. The third phase of implementing EBP envisaged the blending ratio to be increased to 10 percent, with a targeted 20 percent blending by 2017.
July 2010	Establishment of an expert committee by GOI to recommend a long term formula for fixing the price of ethanol.

5. CONCLUSION

Biomass has the highest potential for small scale business development and mass employment. Characterized by low cost technologies and freely available raw materials, it is still one of the leading sources of primary energy for most countries. With better technology transfer and adaptation to local needs, biomass is not only environmentally benign, but also an economically sound choice. Bio-based energy can be expected to grow at a faster pace in the years to come. Opportunities are diverse, and are present in such different sectors as, R&D, agriculture (biomass cultivation and processing), transport services, bioenergy production, manufacturing of core equipments and EPC.

R & D: As a part of the renewable energy program in India, biomass energy is being considered as an important resource and has been a research focus for a number of institutions within the country. Major activities of focus are towards the advancement of research on biomass conversion technologies and their end use devices. The work could focus on evolving suitable strategies and management approaches, training and networking among biomass users and academic activities relating these aspects. In addition to them, R&D efforts in biomass energy have also been focused on the following aspects.

Consulting/Planning Opportunities: The growing volume of biomass resources production and exploitation requires highly-trained and experienced professionals to farmers, investors, decision makers, biomass companies and, virtually, anybody interested in biomass related activities, thus providing opportunities to a large number of consultants and consultancies to provide expert assistance in the biomass sector.

Training/ Coaching Services: Training and coaching in almost all fields of interest in biomass sector seem a profitable business opportunity for entrepreneurs, because existing SMEs and upcoming entrepreneurs face manpower, technology and budget restraints they usually cannot solve in adequate time frame.

REFERENCES

[1] F. Davis, S.P.J. Higson / *Biosensors and Bioelectronics* 22 (2007) 1224–1235

[2] G. Knothe / *Progress in Energy and Combustion Science* 36 (2010) 364–373

[3] Knothe G, Krahl J, Van Gerpen J, editors. *The biodiesel handbook*; 2005. Champaign, IL, USA

[4] Knothe G. *Biodiesel and renewable diesel*. INFORM 2008;19:149–52.

[5] *The Ministry of New and Renewable Energy report*

[6] *India Biomass Energy* (http://www.eai.in/ref/ae/bio/bio.html)

[7] M. Lapuerta et al. / *Progress in Energy and Combustion Science* 34 (2008) 198–223

[8] de Bruijn, 2005; Bagotzky et al., 2003.