Everant Journals/ETJ

Research Article

Engineering and Technology Journal ISSN: 2456-3358
Impact Factor: 4.449

Solid Waste to Energy Status in India: A Short Review

Surajit Bag[1], Rambharosh Dubey[2], Niladri Mondal[3]

[1]Research Scholar University of Petroleum& Energy Studies, Dehradun
[2]Research Scholar Indian Institute of Engineering Science & Technology, Shibpur
[3]Scientific Officer Eureka Forbes Ltd, Kolkata

ARTICLE INFO

corresponding Author:
Rambharosh Dubey
Research Scholar Indian Institute of Engineering Science & Technology, Shibpur

ABSTRACT

In recent years managing solid wastes has been one of the burning problems in front of state and local authorities. This is due to scarcity of lands for landfill sites. Thus conversion of solid waste to energy is the best approach to reduce space related problems. This has to be managed by technologies that prevent pollution and protect the environment and at the same time minimize the cost through recovery of energy. Energy recovery in the form of electricity, heat and fuel from the waste using different technologies is possible through a variety of processes, including incineration, gasification, pyrolysis and anaerobic digestion. These processes are often grouped under "Waste to Energy technologies". The purpose of the study is to assess the current status of solid waste management practices in India. Effort has also been taken to explore in depth the solid waste to energy programs currently followed in the country. Discussion has also been done on the solid waste to energy policies in India

KEYWORDS: ***Solid waste management (SWM), Waste to Energy technology, SWM Policy***

1. Introduction

With the boom in urbanization we are in great need to ponder over the solid waste management (SWM) scenario in India. The population of India has increased by more than 181 million during the decade 2001-2011 (Census 2011). Urban India generates 188,500 tonnes per day (68.8 million tonnes per year) of municipal solid waste at a per capita waste generation rate of 500 grams/person/day (SWM India 2011). Municipal Solid Waste Management involves activities associated with generation, storage, collection, transfer & transport, processing, recovery and disposal of solid waste, which are environmentally compatible adopting principles of economy, aesthetics, energy and conservation. It encompasses planning, organisation, administration, financial, legal and engineering aspects involving inter-disciplinary relationships. This article asses the current status of Solid Waste Management (SWM) in India. Energy is in short supply due to resource constraints and hence evolved the idea of producing energy from waste. Thorough review of Literature review is done based on secondary data available from websites and research papers. Finally conclusions and directions of future research have been drawn.

2. Literature Review

2.1 Worldwide status of Solid Waste converted to Energy

Municipal solid waste generation in Asia in 1998 was 0.76 million tons per day (Jin *et al*., 2006), with an annual growth rate of 2– 3% in developing countries and 3.2–4.5% in developed countries.

Starting in the 1990s, Asia has been host to a number of national and regional initiatives in solid waste management. The World Bank's Metropolitan Environmental Improvement programme is credited for solid waste management improvements in large cities in Asia, such as Beijing, Bombay, Colombo, Jakarta, Metro Manila and, later, Kathmandu. Between 1994 and 1998, the South-East Asia Local Solid Waste Improvement Project, a Canadian International development agency (CIDA) assistance programme, successfully assisted communities in the Philippines, Thailand and Indonesia in various aspects of SWM, including organizing waste-pickers and junk shops; setting up a 'waste bank' for recyclables; sitting landfills; and providing training on hazardous waste management. Densely populated cities in Singapore, Japan, Thailand, Malaysia, South Korea, Indonesia, China and the Philippines are under pressure to upgrade their solid waste systems, bring their waste streams under control, and shift from pure disposal to recovery of both energy and materials (Lilia Casanova, 2010).

In United States the city of Antonio will be the first city to harvest methane gas from human waste on a commercial scale which is really impressive. Very soon people will see the conversion of sewage into fuel for power generation. This is a great concept and is the future of clean and sustainable energy.

Ahmmad and Haque (2014) recommended that solid waste produced in the Dhaka city of Bangladesh can be used as a renewable energy source. By adopting gas collection process instead of incinerator process more energy can be extracted from waste.

Woch et al., (2015) has conducted a case study of one forest division of Poland. The objective was to determine the potential of forest woody waste biomass as a source of renewable energy an the findings show that energy output would allow energy for large number of people.

As per June 2013 Report of 'ecoprog GmbH', there are 2,200 W to E plants in the world. They have a disposal capacity of about 255 million tons of waste per year. By 2017, another 180 plants with a capacity of 52 million tons will be added. Modern Waste to Energy technologies has been commercially deployed, especially in Europe, Japan, Australia, China and the USA.

2.2 Energy potential from Solid waste management in India

There is enormous potential of solid waste to energy potential in India. Various components of municipal solid waste (MSW) have an economic value and can be recovered, reused or recycled cost effectively. Currently, the informal sector picks up part of the resources from the streets and bins to earn their living. However, a sizeable portion of organic waste as well as recyclable material goes to landfills untreated. Over 81% of MSW annually is disposed at open dump sites without any treatment. With planned efforts to Reduce, Reuse, Recover, Recycle and Remanufacture (5Rs) and appropriate choice of technology, the country can profitably utilize about 65% of the waste in producing energy and/or compost and another 10 to 15% to promote recycling industry and bring down the quantity of wastes going to landfills/ dumps under 20% (Planning Commission report 2014). Technology choices can be incineration, pyrolysis and biomethanation. The selection of waste to energy technologies therefore offers different approach of managing waste. However bimethanation is the most efficient technique compared to incineration

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and pyrolysis. Incineration is mainly criticized due to emission of toxic air and ash which pollutes air. Biomethanation involves anaerobic digestion and generates methane by breaking down the organic waste using bacterial in confined spaces. The criterion of biomethanation is supply of organic waste of high quality. Thus involvement of waste pickers is important to segregate organic and inorganic waste before the organic waste is taken as an input in biomethanation process. The output of this process yields sludge which can further be used for making compost (Forsyth 2006). Ongoing research in the area is coming up with other techniques such as (Brar et al., 2014) presents methodology of power generation using methanol fuel cells and the environmental and socio-economic aspects of biogas plant in a small community.

2.3 Solid Waste to Energy status in India

The composition of MSW generated in Indian cities mainly dominated by the biodegradable portion in the bulk of MSW. This is mainly due to food and yard waste. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition has been changing.

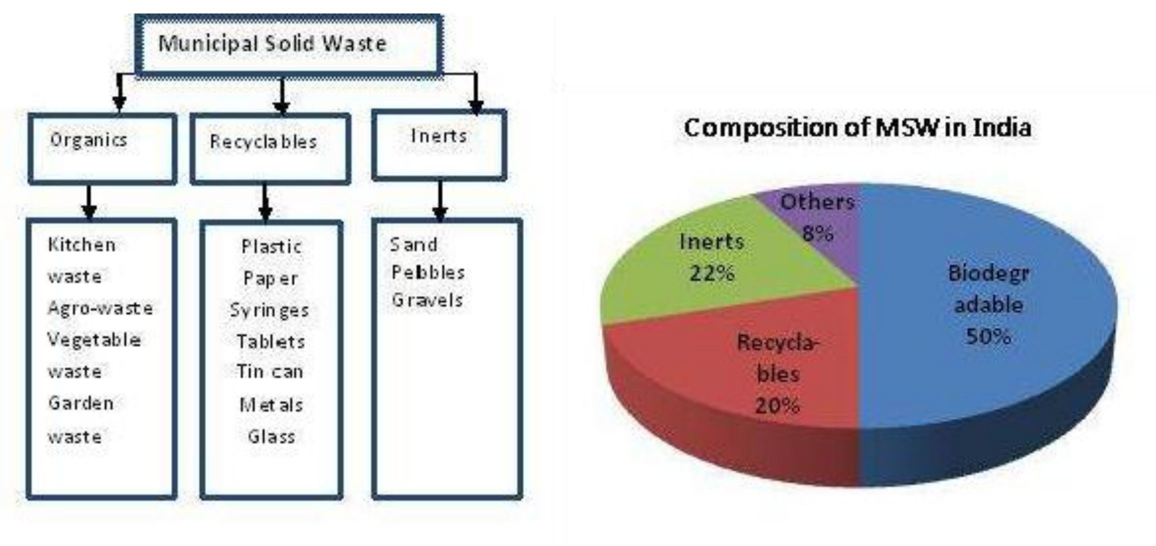

Fig 1. Composition of MSW in Indian cities (Source: Planning commission of India report, 2014)

The Ministry has been promoting the use of technologies for energy recovery from municipal, industrial and commercial wastes and solar energy, for meeting certain niche energy demands of urban, industrial and commercial sectors in the country. The programmes being implemented during the year include: i) Energy Efficient Solar /Green Building Programme; ii) Energy Recovery from Urban, Industrial and Agricultural Wastes; and iii) Bioenergy and Cogeneration in Industry. (Ministry of new and renewable energy annual-report 2014-2015). During the current year, the Ministry has continued the implementation of the Programme on Energy from Urban, Industrial and Agricultural Wastes/Residues aimed at a variety of materials, such as municipal solid wastes, vegetable market and slaughterhouse wastes, cattle dung, agricultural residues and industrial wastes. Financial assistance being provided for projects of various types is as follows:

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- Setting up five pilot projects on energy recovery from Municipal solid wastes
- Power generation/production of bio CNG from biogas generated at Sewage Treatment Plants
- Power generation and production of Bio CNG from other Urban Wastes and their mix with Agricultural/Agro-industrial Wastes/ Residues
- Power generation/production of bio CNG from industrial wastes
- Biomass Cogeneration (non-bagasse) in industry

The scheme is applicable to both, Private as well as Public Sector entrepreneurs and organizations as well as Non-Governmental Organizations (NGOs), for setting up of waste-to- energy projects on the basis of Build, Own & Operate (BOO) and Build, Own, Operate & Transfer (BOOT) etc.

Some of the salient features of the progress made during the year 2014-15 are as follows:

- A total of nine projects with an aggregate capacity of 9.54 MW based on Urban and industrial wastes have been completed during the year up to 31.12.2014.
- Agricultural Wastes/Residues based 1.00 MW capacity grid connected power project has been commissioned at Fazilka- Punjab.
- Work is in progress at 11 MW, 10 MW and 12 MW power generation projects based on municipal solid wastes at Hyderabad, Pune and Ghazipur – Delhi respectively. These projects are expected to be commissioned during the year 2014-15.
- A total of twenty one projects based on urban/ industrial wastes with an aggregate capacity of about 21 MW are under installation. These include projects based on Paper, starch industry wastes, poultry litter and biogas at distilleries.
- As part of the new initiative taken for development of biogas up gradation systems for converting biogas into Natural Gas (Bio-CNG) quality fuel for commercial use, two projects of 2.76 MWeq. for production of 14.5 tonnes/day Bio-CNG have been commissioned in Satara, Maharashtra and Anand, Gujarat.
- Twelve projects of about 5.65 MWeq. for production of bio-CNG based on mix of urban and agricultural wastes are in progress at Pilibhit, Kolkata, Surat, Hanumangarh, Barnala, Amritsar, Kanpur and Ambala are expected to be completed during 2015.

Table 1. Waste to Energy Projects installed during the year 2014-15

S. No.	States	Grid Connected	Off – grid (MW)	Projected achievement during 2014-15
1	Rajasthan	-	0.70	0.70
2	Punjab	1.00	1.20	3.20
3	Maharash	-	1.60	1.60
4	Andhra	-	1.70	22.20
5	Tamilnad	-	1.68	1.68
6	Gujarat	-	1.16	1.16
7	Uttarakha	-	0.50	1.00
	Total	**1.00**	**8.54**	**31.54**

The criteria for waste to energy process are:- (1) Any non recyclable waste having high calorific value of 1000 Kcal or more shall be utilised for generating energy and shall not be disposed of on landfills. (2) High calorific value waste shall either be directly utilized for energy production or by preparing refuse derived fuel for energy production or give away as feed stock for preparing refuse derived fuel. (3) High calorific wastes shall be used for co-processing in cement plants or for power generation in independently installed waste to energy power plants. (4) The urban local body or an operator of facility or an agency designated by them

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or an independent operator shall submit a proposal on the setting up of 'Waste to Energy' plant to the State Pollution Control Board or Pollution Control Committee for consideration. (5) The State Pollution Control Board or Pollution Control Committee, on receiving a proposal from urban local body or an operator on behalf of these authorities for setting up waste to energy facility other than small facility, treating less than 5 tonnes per day waste, shall examine the same and grant permission. (6) If the proposal includes the technology other than the one for which standards have been prescribed by the central pollution control board, the State Pollution Control Board or Pollution Control Committee shall forward the proposal with its recommendations to Central Pollution Control Board for prescribing suitable standards.

Planning commission report (2014) has suggested population based Technological options to Manage MSW in a Variety of Towns and Cities

2.4 Solid Waste to Energy policy in India

Policy interventions in this sector began as early as in 1960s but focused initiatives were taken in 1990's after the outbreak of plague in Surat. The Ministry of Health and Family Welfare initiated a National Mission on Environmental Health and Sanitation in 1995. A draft policy paper was prepared on funding issues and requirements for Municipal Solid Waste Management by Central Public Health Engineering Organisation (CPHEEO). The 12th schedule of the Constitution (The 74th constitutional amendment of 1992) clearly assigns solid waste management as the primary function of municipal authorities. State laws governing the municipal authorities also stipulate management of solid waste as an obligatory function of the municipal authorities. It was only after the direction issued by Hon. Supreme Court of India in a public interest litigation spl CA No 888 of 1996, the Municipal Solid Waste (Management and Handling) Rules was finalized by the Ministry of Environment and Forests (MoEF and notified in 2000). These rules define MSW, mandate that all municipal authorities in the country shall manage MSW in a time bound manner and the State Government ensure implementation of the rules. The Ministry of Environment & Forest is now in the process of issuing the Municipal Waste (Management and Handling) Rules, 2014.

The Ministry of Urban Development also plays a prime role in SWM and supports various projects under the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) schemes. JnNURM was launched by the Government of India in 2005, envisaging an investment of more than Rs.1,00,000 crore during a period of 7 years from 2005-06 to 2011-12 with a Central Government share of Rs. 66,000 crore. JnNURM is a reform driven, fast track programme to ensure planned development of identified cities with focus on efficiency in urban infrastructure/service delivery mechanisms and covers 65 cities and towns. For the remaining urban areas, the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) has been launched.

These rules were followed up by the National Environment Policy (NEP) in 2006. A set of rules on plastic waste management were notified under the E(P) Act, 1986 to regulate littering and manufacturing of plastic carry bags.

Conclusions

- Most of the State/ULBs have yet to understand the benefits of integrated waste management which facilitates efficient utilization of different components of waste management and select suitable developers or

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agencies for collection, transportation, processing & disposal of waste.

- Awareness amongst the States/ULBs about the benefits of integration of various technologies for MSW processing is lacking. This is necessary as different technological options are required for treating the different components of waste, such as Composting/ Biomethanation process for Organic component, incineration/ gasification/ Refused derived fuel (RDF) process for combustibles portion of waste, inert management facility for Construction and Demolition (C&D) waste, etc.
- SPCBs and PCCs do not have adequate infrastructure including personnel to maintain regular interaction with ULBs.
- Fear amongst sanitary workers/private sweepers/ rag-pickers of losing their job/ livelihood if private developer a takes over waste management.
- Municipal authorities fail to appreciate the concept of PPP. They treat the partner as any other contractor.
- Non supply of the quantity / quality of waste committed to and presence of inerts such as street sweeping, silt and construction and demolition wastes in a high proportion in the wastes delivered at the processing plant.
- Municipal authorities making their PPP partner responsible for collection of user fees from the beneficiaries and linking their payment with the fees collected without extending any regulatory support.
- The municipal authorities fail to extend support to the concessionaire by invoking penal provisions for collection of user charges from the defaulters leading to poor recovery making the PPP project unsustainable.
- Tariff structure that does not adequately cover the risk of increase in the fuel price and wage structure resulting in non viability of the project.
- Absence of ESCROW account mechanism resulting in inordinate delay in release of payment to the concessionaire and serious financial crunch.
- Absence of supervision by a professional. Multiple agencies supervising the concessionaire lead to complications in assessment of performance.
- Selection of appropriate site and all necessary clearances (such as EIA, Consent to Establish etc) should be ensured by the Municipal Authority before the bidding process.s
- Dispute resolution mechanism must be a part of the contract Agreement clearly binding both the parties for resolution of dispute through a mutually agreed arbitrator.
- Evaluation of different W to E technologies based on the patterns of energy consumption, production, and different levels of material recovery and on the cost– benefit analysis is necessary to arrive at a suitable technology that will be economically viable and energetically efficient.

Future Research Directions

The present research opens the path for further research. Various case studies and empirical studies are available in the area of managing solid waste. However the underlying reasons are not very much clear why most of the waste to energy plants are non-operational or shut down. Authors propose mixed research methodology using ISM and confirmatory factor analysis to find out the major factors and interrelationships influencing waste to energy plants.

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