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Energy recovery in solid waste management through CDM in India and other countries

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ABSTRACT

This paper looks into the clean development mechanism (CDM) projects involving energy recovery from municipal solid waste (MSW). The paper looks into the municipal waste management problems, regulatory framework in place and the CDM opportunities in India. A comparative assessment of the Indian CDM projects vis a vis projects worldwide is also presented. One hundred and nineteen worldwide CDM projects, including 16 from India, based on MSW and implemented across the developing countries in the world were studied to assess the various processes and methodologies used and the green house gas (GHG) reductions estimated. RDF, composting and landfill gas recovery methods have been explained in brief. Two case studies from India and Brazil have also been outlined. Brazil has the highest number of CDM projects of MSW origin (25) followed by China (16), India (16), Chile (10), Mexico (10) and Argentina (8). Rest of the non-Annex-1 countries have one, two or three projects each. It was observed that out of the 119 projects, 88 projects were using ACM0001 methodology where electricity is being produced and supplied to a grid. Out of the 16 Indian projects, only one of the projects has electricity being supplied to the grid. Nine out of the sixteen projects are based on AMS.III.E. methodology that is RDF. To conclude, India does not have well designed sanitary landfills where methane can be captured. India needs to make conscious effort towards developing more scientific landfills, capture methane and take carbon credits.

1. Introduction

A rapid population growth, urbanization and change in life style in India have increased MSW generation significantly. About 90 million tones of MSW is generated per year. Daily per capita generation of MSW in India ranges from about 100 g in small towns to 500 g in large towns. The amount of MSW generated per capita is increasing at a rate of 1–1.33% annually. MSW in cities like Mumbai showed a growth of 67% where as population grew only by 49% from 1981 to 1991 (Singhal and Pandey, 2001).

MSW is normally collected from households by sweepers and deposited in storage bins (movable and fixed). The collection is the responsibility of the corporation/municipality. The average collection efficiency of MSW in India is 72%. Fifty percent of the garbage is collected manually and 50% is collected in trucks. Collection and transport constitutes 80–95% of total budget of MSW management (Sinha, 1998).

MSW in India differs from MSW in Western countries. MSW composition is given in Table 1. The C/N ratio ranges from 20 to 30. Calorific value ranges between 800 and 1000 kcal/kg. In cities, the major fraction is compostable materials (40–60%) and inerts (30–50%). The organic fraction increases while moving from rural to urban areas. The percentage of recyclables (paper, glass, plastic and metals) is very low as these are picked up by rag pickers from houses (indiastat.com, 2009).

Treatment and disposal methods in use in India for MSW mainly include landfilling, composting (aerobic and vermicomposting) and very few waste to energy initiatives (incineration, RDF and biomethanation) (Sharholy et al., 2008).

Open, uncontrolled and poorly managed land filling is commonly the practice in most cities. Usually no segregation of waste takes place. MSW dumping appears to be the most widely used practice. About 70% of the cities lack adequate waste transport capacities (TERI, 1998). The unsanitary methods adopted for disposal of solid wastes is, therefore, a serious health concern. The poorly maintained landfill sites are prone to groundwater contamination because of leachate production. Open dumping of garbage facilitates the breeding for disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests (CPCB, 2000).

Aerobic composting was encouraged by the Government in Indian cities with population over 0.3 million. Large-scale composting plants (150–300 t/day) were set up in several cities during

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Table 1
Composition of municipal solid waste in India.

Description	Percent by weight
Vegetable, leaves	40.15
Grass	3.80
Paper	0.81
Plastic	0.62
Glass/ceramics	0.44
Metal	0.64
Stones/ashes	41.81

Source: Status of solid waste generation, collection, treatment and disposal in Indian cities, www.indiastat.com.

1975–1980. About 9% of MSW in India is composted. Vermicomposting is being used to treat MSW in India at central locations, in buildings and localities.

Incineration is not very much practiced in India, due to high organic content (40-60%), high moisture content (40–60%) high inert content (30–50%) and low calorific value (800–1100 kcal/kg) in MSW. There are only two units of gasification in India developed by NEERI and TERI in Rajasthan and New Delhi.

A waste hierarchy is often suggested and used in waste policy making. Different versions of the hierarchy exist but in most cases the following order is suggested: (Finnveden et al., 2005a,b). 1. Reduce the amount of waste, 2. reuse, 3. recycle materials, 4. incinerate with heat recovery and 5. landfill.

The TERI 'Green India 2047' study made the following observations on the situation of MSW management in the country (TERI, 1998):

- Increasing urbanization and changing lifestyles has led to, the solid waste generated in Indian cities having increased from 6 million tonnes in 1947 to 47.8 million tonnes in 1997.
- The production and consumption of plastic increased over 70 times between 1960 and 1995.
- The collection of MSW is inefficient (more than 25% of the total is not collected at all), its transport is inadequate, and its disposal is unscientific.
- More than one-fourth of the MSW is not collected at all, and the landfills to dispose of the waste are neither well equipped nor managed efficiently [There is a need to work towards a sustainable waste management system, which in turn will lead to environmental, institutional, financial, economic and social sustainability (Sarika Rathi, 2006].

1.1. MSW (management and handling) rules 2000

The Ministry of Environment and Forests (MoEF) Government of India has issued the MSW (management and handling) rules in the year 2000, which identifies the Central Pollution Control Board (CPCB) as the agency to monitor the implementation of these rules. Schedule II of the rules covers collection, segregation, storage, transportation, processing and disposal. It states that Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on landfill. Following criteria shall be adopted, namely:

(i) The biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule-IV.
(ii) Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the CPCB to get the standards laid down before applying for grant of authorization.

1.2. Disposal criteria

CPCB has been assigned to monitor the implementation of these rules, and the municipalities will be required to submit annual reports regarding the status of MSW in their areas to the CPCB. Table 2 shows the status of municipal solid waste treatment and

Table 2
Status of municipal solid waste treatment and disposal in metro cities.

Metro city	Solid waste collection (tonnes/day)	Treatment (tonnes/day)	Mode of disposal (%)		
			Dumping	Composting	Others
Ahmedabad	1,683	84	95.00	5	–
Bangalore	2,000	200	90.00	10	–
Bhopal	546	100	82.00	18.0	–
Bombay	55,355	500	91.00	9.0	–
Calcutta	3,692	Nil	100.00	–	–
Coimbatore	350	Nil	100.00	–	–
Delhi	4,000	300	93.00	7.5	–
Hyderabad	1,566	100	94.00	6.0	–
Indore	350	50	86.00	14.0	–
Jaipur	580	Nil	100.00	–	–
Kanpur	1,200	300	75.00	25.0	–
Kochi	347	Nil	100.00	–	–
Lucknow	1,010	Nil	100.00	–	–
Ludhiana	400	Nil	100.00	–	–
Madras	3,124	Nil	100.00	–	–
Madurai	370	Nil	100.00	–	–
Nagpur	443	Nil	100.00	–	–
Patna	330	Nil	100.00	–	–
Pune	700	50	93.00	2	7.0
Surat	900	225	75.00	25.0	–
Vadodara	400	100	75.00	–	5.0
Varanasi	412	Nil	100.00	–	–
Visakhapatnam	300	–	100.00	–	–

Source: Status of solid waste generation, collection, treatment and disposal in Indian cities, www.indiastat.com.