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Solid waste in India

With changing lifestyles and increase in population, the quantity of India's waste is growing exponentially, and its composition is changing.

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About 50 per cent of the municipal solid waste collected in Indian cities ends up in dumpsites.

The Swachh Bharat Mission (SBM) Urban estimates that 1.43 lakh tonnes per day (TPD) municipal solid waste (MSW) is generated in India. Of this, 1.11 lakh TPD (77.6 per cent) is collected and 35,602 TPD (24.8 per cent) processed.[1] In addition, according to the Central Pollution Control Board (CPCB), India generates close to 25,940 TPD of plastic waste of which 15,342 remains uncollected.[2]

These figures show poor compliance with the Solid Waste Management Rules, 2016, which emphasize on recycle and reuse to achieve the desired objective of zero waste going to landfills. Waste generation in urban India is increasing by 5 per cent every year because of increasing population (3–3.5 per cent per year) and consumption. It is estimated that half the Indian population will be living in cities by 2050; the increase in quantum of waste can be imagined. As per the Ministry of Environment, Forest and Climate Change (MoEF&CC), MSW generation will reach 4.5 lakh TPD by 2031 and 11.9 lakh TPD by 2050.[3]

COMPOSITION OF WASTE

As the composition of MSW affects the applicability of waste-processing technology, its characterization is an important aspect. As per a Centre of Science and Environment (CSE) assessment of waste generated by cities, the biodegradable fraction—40–70 per cent of the total—is the highest. The non-biodegradable fraction (comprising both recyclable and non-recyclable dry waste) is 20–40 per cent for different Indian cities in 2018—up from 16–20 per cent in 2011. In general, small cities have a higher fraction of biodegradable waste compared to large cities (see *Table 1: Composition of waste in Indian cities)*.

The change in the characteristics of the waste in India mimics global trends. According to the 2012 World Bank report *What a Waste*, as a country urbanizes and its population becomes wealthier,

Table 1: Composition of waste in Indian cities

Biodegradable content of waste in Indian cities is high; non-biodegradable content shows a rise.

City	State	Biodegradable (%)	Non-biodegradable (%)	Inert (%)	Domestic hazardous (%)
Cities with population of 1 million-plus					
Bengaluru	Karnataka	64	28	5	3
Hyderabad	Telangana	55	40	5	-
Delhi	Delhi	50	35	15	`
Indore	Madhya Pradesh	50	35	15	-
Patna	Bihar	51	27	15	-
Bhopal	Madhya Pradesh	57	30	11	-
Mysuru	Karnataka	50	35	15	-
Cities with population of 0.1-1 million					
Thiruvananthapuram	Kerala	60	35	4	1
Gaya	Bihar	55	34	11	
Muzaffarpur	Bihar	55	25	18	2
Imphal	Manipur	55	35	5	
Alappuzha	Kerala	75	20	5	-
Gangtok	Sikkim	51	28	21	-
Cities with population below 0.1 million					
Balaghat	Madhya Pradesh	70	25	5	-
Bobbili	Andhra Pradesh	50	26	20	4
Vaijapur	Maharashtra	50	45	5	-
Panchgani	Maharashtra	70	25	5	-
Vengurla	Maharashtra	54	40	5	1

Source: CSE, 2018.

consumption of inorganic materials increases, while the relative organic fraction decreases[4] (see *Figure 1: Waste composition on the basis of income of countries*).

CALORIFIC VALUE AND MOISTURE CONTENT

Calorific value is the measure of heat produced by the complete combustion of a specified quantity of a product. Moisture content is usually calculated as the percentage of water in solid waste. In India, the study of waste has repeatedly shown that the content of high-calorific-value waste is low—most of the fraction is biodegradable in nature, with low calorific value. Countries that are heavily dependent on waste-to-energy (WTE) plants have high calorific value of waste. The calorific value of garbage in Sweden, Norway, Germany and USA is 2,868–3,824 kcal/kg, 1,912–2,868 kcal/kg, over 2,500 kcal/kg and 1,673–2,629 kcal/kg, respectively—in comparison the calorific value of waste in India is 1,411–2,150 kcal/kg.[5]

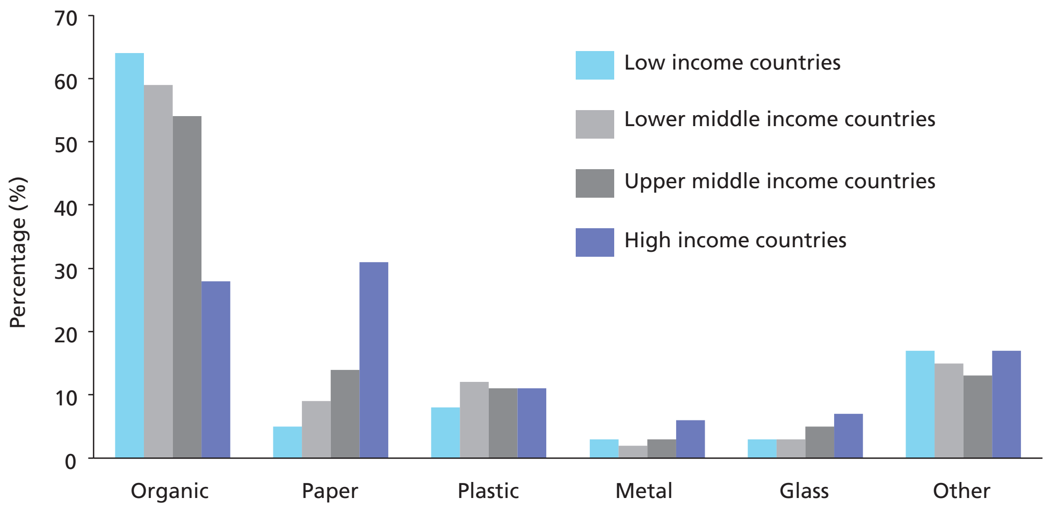
A 2017 study by the Shriram Institute for Industrial Research on municipal waste in South Delhi found that the net calorific value of waste was 1,274 kcal/kg and the gross value was 1,324 kcal/kg.[6]

Calorific value and moisture content of waste in India varies widely from city to city. According to a 2004–05 study by the Central Pollution Control Board (CPCB) with assistance of the National Environmental Engineering Research Institute (NEERI) in 59 cities (35 metro cities and 24 state capitals), the average calorific value of waste was in the range of 1,411–2,162 kcal/kg. The average moisture content in the waste of cities assessed ranged from 41 to 52 per cent[7] (see *Table 2: Calorific value and moisture content of MSW in Indian cities*).

Most cities in northeast, south and west India have MSW with relatively high net calorific value and high moisture content. Cities in north, central and east India have waste with low calorific value and high moisture content.

Figure 1: Waste composition on the basis of income of countries

High-income countries produce more inorganic waste like plastic, paper, metal etc.



Sources: Anon. 2012, 'Waste composition'; *What a Waste: A Global Review of Solid Waste Management*, World Bank.

Table 2: Calorific value and moisture content of MSW in Indian cities

Indian municipal waste has low calorific value and high moisture content.

	Net calorific value (kcal/kg)			Moisture (%)		
	Min	Max	Mean	Min	Max	Mean
Capitals with population less than 1 lakh	1,234	3,414	2,149	42	65	52
Capitals with population of 1–5 lakh	591	3,766	2,162	24	63	50
Cities with population of 5–10 lakh	591	2,391	1,481	17	64	48
Cities with population of 10–20 lakh	520	2,762	1,411	25	65	41
Cities with population above 20 lakh	834	2,632	1,772	21	63	47

Source: CPCB-NEERI, 2006,

It is important to note that most estimates concerning waste composition, calorific value and moisture content are made at dumpsites. About 40–50 per cent of recyclable waste is managed by the vast informal sector in India. Workers in this sector make a living by selling dry recyclable waste (with high calorific value)—paper, plastics, cardboard, etc.—to dealers, who further channelize it for recycling. Hence, the overall calorific value of waste when it reaches a processing site is further reduced (see *Table 3: Calorific value of different fractions of waste*).

TREATMENT OF MSW IN INDIA

The Solid Waste Management (SWM) Rules, 2016 classifies waste into three categories—biodegradable, non-biodegradable and domestic hazardous.[8] As per the Rules, biodegradable waste has to be treated by means of aerobic and anaerobic technologies as close to the source of generation as possible. Recyclables have to be channelized for recycling and non-recyclable waste with calorific value of 1,500 kcal/kg or more is not be disposed of in landfills but used to generate energy either through WTE or co-processing in cement kilns. Domestic hazardous waste should be sent for safe disposal or for incineration (see *Figure 2: Pathways for waste management in India)*.

Major technologies for processing waste in India include composting—centralized and decentralized—biomethanization, WTE, recycling (both formal and informal) and alternative use such as the use of plastic

Table 3: Calorific value of different fractions of waste

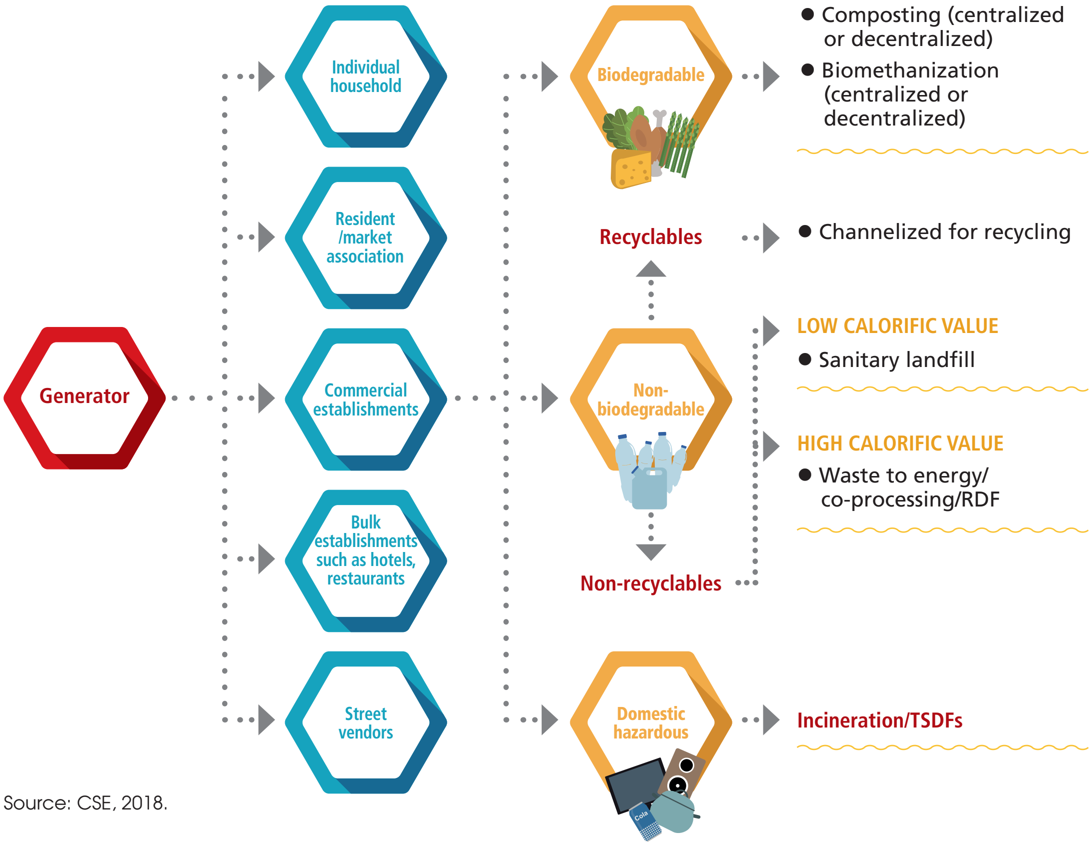
Plastic, paper and cardboard have the highest calorific value of the inorganic waste fraction.

Fraction	Net calorific value (kcal/kg)
Paper and cardboard	3,821
Organic material	955
Plastic	8,359
Glass	0
Metal	0
Textile	4,538
Other material	2,627

Source: International Solid Waste Association, 2013, *ISWA Guidelines: Waste to Energy in Low and Middle Income Countries.*

Figure 2: Pathways for waste management in India

The 2016 SWM Rules say that non-recyclable waste with calorific value of 1,500 kcal/kg or more should not be sent to landfills but should be used to generate energy.



Source: CSE, 2018.

in road making. According to the Swachh Bharat Mission, current waste-to-compost production is 13.11 lakh tonnes per annum (TPA) while WTE capacity is 88.4 MW[9] (see *Table 4: Generation, processing and disposal of different waste streams in India*). Waste not treated finds its way to not-so-sanitary landfills and dumpsites across the country. A large amount of waste is burnt openly as well.

As can be seen, composition, waste quantity, calorific value and moisture content are the deciding factors in the technology used in waste processing. Collection of segregated waste is the most critical issue in managing solid waste. In the last few years, there has been a paradigm shift, with focus on segregation at source and processing. Processing methods vary from city to city, depending on the level of segregation. Cities with higher percentage of segregation at source are able to reduce the amount of waste going to landfills.

Table 4: Generation, processing and disposal of different waste streams in India

Most waste streams in India are collected as mixed waste and dumped.

Stream	Fraction in total waste (%)	Quantity of waste generated* (TPD)	Processed or disposed by	Quantity of waste processed/disposed** (TPD)
Organic waste	40–70	75,000–80,000	• Composting (individual, community, windrow, mechanical) • Biomethanization (small and big)	17,000–20,000
			• Dumped in landfills, dumpsites or roadsides as mixed with other waste fractions	55,000–60,000
Paper, cardboard	6–7	8,000–9,000	• Recycling in the paper industry • Waste to energy (WTE)	2,000–2,500
			• Dumped in landfills, dumpsites or roadsides as mixed with other fractions of waste • Open burning	6,000–7,000
Recyclable plastic (PET, HDPE, PP etc.)	6–10	15,000–16,000	• Pelletization for recycling industry/informal recycling • Pyrolysis for fuel recovery • WTE	5,000–10,000
			• Open burning • Ground levelling	5,000–11,000
Non-recyclable plastic (low-value plastic, multilayered packaging etc.)	5–10	9,000–10,000	• Refuse-derived fuel (RDF) • Used in road making • Co-pressing in cement kilns • WTE	3,000–4,000
			• Dumped with mixed waste • Open burning/ground levelling	4,000–5,000
Metal (tin, aluminium, iron etc.)	1	1,000–1,500	• Recycled • Dumped with mixed waste	No information available
Glass (glass bottles, mirrors, glassware)	1	1,000–1,500	• Recycled • Dumped with mixed waste	No information available
Domestic hazardous waste (batteries, expired medicines, paint containers, tube lights etc.)	1–3	1,000–3,000	• Sent to Treatment, Storage and Disposal Facility (TSDF) or Common Biomedical Waste Treatment Facility (CBMWTF) • Lead acid batteries sent for recycling • Dumped with mixed waste • Open burning	No information available
Sanitary waste (sanitary pads, diapers etc.)	0.2–0.4	300–500	• Sent to a CBMWTF for incineration • Sent to dumpsites/landfills • Open burning	No Information available
Textile waste (cotton, khadi, polyester)	3–5	4,000–5,000	• Recycled and resold in markets • WTE/RDF • Dumped with mixed waste	No Information available
Rubber (tyres etc.)	1–2	3,000 (Close to 275,000 tyres)***	• Refurbished • Reused and recycled • Pyrolysis for fuel recovery • Dumped and open burning	No Information available

* Approximation based on the MSW generation figure at 52 million tonnes per day

** Based on data from government reports and estimations, *** Data from Chintan, 'Circulating tyres from economy'.

Source: CSE, 2018.

2 Status of waste to energy in India

First-generation WTE plants have performed abysmally. However, they are being promoted in most cities, despite low-calorific-value feed.

ESSEL INFRA

The Jabalpur waste-to-energy plant takes in unsegregated mixed feed. It can take in waste of up to 600 tonnes every day.

Waste to energy (WTE) are technologies of energy recovery from waste that cannot be recycled or composted. Simply put, this means generation of energy from high-calorific value rejects. Energy can be harnessed from MSW either by directly incinerating it (thermal) or by converting it into fuel (thermo-chemical/biochemical) and using it (see *Figure 3: Available technologies for WTE*). Given that most WTE plants worldwide run on incineration-based technologies, the terms waste incineration and WTE are used interchangeably.

STATUS OF WTE PLANTS IN INDIA

The Standing Committee Report on Energy, Power Generation from Municipal Solid Waste, MNRE, 2016, claimed that there were seven functional WTE plants of 92.4 MW capacity, four non-functional plants of 40.6 megawatt (MW) capacity, 31 plants of 241.8 MW capacity are under construction and 21 plants of 163.5 MW capacity are in the tendering stage.[1] A report of the Parliament session