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An overview of waste management in Indian perspective

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ABSTRACT

Urban, industrial, biomass and biomedical wastes are being generated in huge quantities world over causing significant environmental problems including human health. Such generation of waste is on increasing trend with the increase in population along with corresponding increase in industrialization and urbanization. In order to address such an alarming issue of such waste, it has become essential to effectively manage such wastes including transforming this waste into usable product through technological development and innovation techniques which would not only take care of environmental problems but also act as economic tools to manage wastes. An effort has therefore been made by the authors of the present paper to discuss and explain the total population of class- 1 towns in India, the total anticipated quantity of waste generated and the predicted energy generation including financial feasibility along with various technological options available to transform such wastes into energy, fuel pallets, compost, and methane gas etc.

Keywords: Waste management, strategies, waste to energy, Indian scenario, technological options.

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1.0 Introduction:

Municipal Solid Waste (MSW) is usually known as trash or garbage. MSW includes commercial and residential wastes generated in municipal areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. It consists of household waste, wastes from hotels and restaurants, construction and demolition debris, sanitation residue, and waste from streets. Municipal waste can further be classified into following:

Sewage and Sewage Sludge**:**

Sewage is defined as untreated municipal liquid waste requiring treatment in a sewage treatment plant. Sewage contains about 99.9% of water, while the remaining content may be organic or inorganic. Sewage denotes both black water and grey water at the household level, where black water refers to waste water generated in toilets and grey water to the waste water generated in kitchen, bathroom and laundry.

Sewage sludge is the semi-solid precipitate produced in wastewater treatment plants. Such sludge can also occur in untreated sewage disposed off into lakes and other water bodies. Sewage sludge generation in India is increasing at a faster rate as more and more sewage treatment plants (STP) are being developed. Sewage sludge and effluents from these STPs are frequently disposed off on agricultural lands for irrigation/manure purposes.

Fecal Sludge:

Sludge of variable consistency collected from so-called on-site sanitation systems, such as latrines, non-sewered public toilets, septic tanks and aqua privies is denoted as fecal sludge. The fecal sludge comprises varying concentrations of settleable or settled solids as well as of other, non-fecal matter. Fecal sludge from septic tanks which consists of settled solids, scum and liquid is termed as Septage.

According to the World Bank Report, cities globally produce around 1.3 billion tons of solid waste annually and this figure is expected to increase to 2.2 billion tons by 2025. Expansion in industries and production to meet the demands of the ever increasing population will result in more consumption of resources and waste disposal in unmanageable quantities in return. For better protection of ecosystem from wastes, to maintain better living conditions and reduce the spread of diseases, it has become extremely important to manage and dispose of wastes in an efficient and sustainable manner. Since waste management is a problem of global concern; more innovative and advanced ideas are required for its disposal in eco friendly manners. The present paper is aimed at finding and developing innovations involved in waste management. A typical waste disposal site is shown in figure 1

Figure:1

2.0 Municipal solid waste in India:

India is gradually converting from agricultural-based nation into industrial, urbanized and services-oriented country. It has been reported that around 31.2% population is now living in urban areas and over 377 million urban people are living in 7,935 towns/cities. India is a vast country divided into 29 States and 7 Union Territories (UTs). There are three mega cities—Greater Mumbai, Delhi, and Kolkata—having population of more than 10 million, 53 cities have more than 1 million population, and 415 cities having population 100,000 or more as per2011 census.In India, municipal waste is regulated by Municipal Solid Waste (Management and Handling) Rules, 2000 (MSWR).

It has been estimated that about 12 million tons of inert waste are generated in India from street sweeping, waste and in the landfill sites whichconsist of about one-third of total MSW. India generates approximately 133 760 tonnes of MSW per day, of which approximately 91 152 tonnes is collected and approximately 25 884 tonnes is treated. MSW generation *per capita* in India ranges from approximately 0.17 kg per person per day in small towns to approximately 0.62 kg per person per day in big cities. Waste generation rate depends on factors such as population density, economic status, level of commercial activity, culture and city/region. MSW generation in different states, indicating high waste generation in Maharashtra (115 364–19 204 tonnes per day), Uttar Pradesh, Tamil Nadu, West Bengal (11 523–15 363 tonnes per day), Andhra Pradesh, Kerala (7683–11 522 tonnes per day) and Madhya Pradesh, Rajasthan, Gujarat, Karnataka and Mizoram (3842–7662 tonnes per day). Lower waste generation occurs in Jammu and Kashmir, Bihar, Jharkhand, Chhattisgarh, Orissa, Goa, Assam, Arunachal Pradesh, Meghalaya, Tripura, Nagaland and Manipur (less than 3841 tonnes per day) as depicted in figure 2.

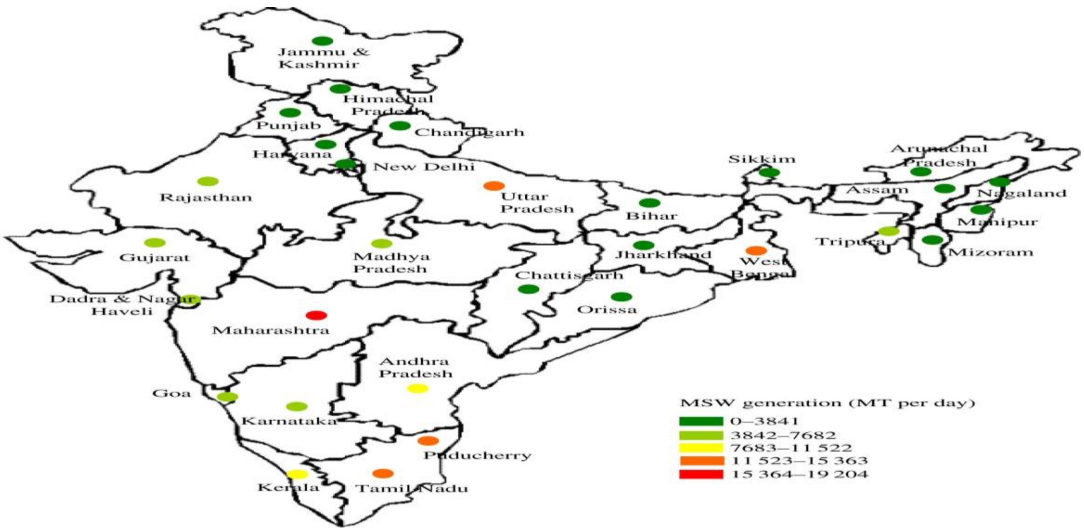

Figure: 2

3.0 Municipal solid waste in class 1 towns of India:

There are 495 class 1 cities in India having population more than 1 lack. The population of India is 122 crore out of which 22.26 crore live in class 1 cities constituting 18 percent of the population. The total estimated generation of waste is to the tune of 405 lack tons per year. The state wise generation of waste in class 1 towns along with expected generation power in MW is given in table 1 below.

Table:1

S. NO	STATE	NUMBER OF CLASS 1 CITIES	ESTIMATED WASTE GENERATION IN TONS PER YEAR	ESTIMATED POWER GENERATION IN MW
1	ANDAMAN & NICOBAR I	1	18361	4
2	ANDHRA PRADESH	42	3316320	649
3	ASSAM	4	253886	50
4	BIHAR	26	1225399	240
5	CHANDIGARH	1	175344	34
6	CHHATTISGARH	9	572670	112
7	GUJARAT	29	3254896	637
8	HARYANA	20	1086281	213
9	HIMACHAL PRADESH	1	30981	6
10	JAMMU & KASHMIR	3	329410	64
11	JHARKHAND	10	780782	153
12	KARNATAKA	26	2883481	564
13	KERALA	7	502965	98
14	MADHYA PRADESH	32	2011714	394
15	MAHARASHTRA	44	7111754	1392
16	MANIPUR	1	48360	9
17	MEGHALAYA	1	26099	5
18	MIZORAM	1	53258	10
19	NAGALAND	1	22589	4
20	NCT OF DELHI	15	2460464	481
21	ORISSA	10	548090	107
22	PUDUCHERRY	2	98879	19
23	PUNJAB	17	1081044	212
24	RAJASTHAN	29	1905850	373
25	TAMIL NADU	32	2532990	496
26	TRIPURA	1	72943	14
27	UTTAR PRADESH	63	4617784	904
28	UTTARAKHAND	6	244622	48
29	WEST BENGAL	61	3296590	645
	Grand Total	495	40563807	7938

4.0 Technological options 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.

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. However, thermal conversion process having gasification is shown in figure 3.

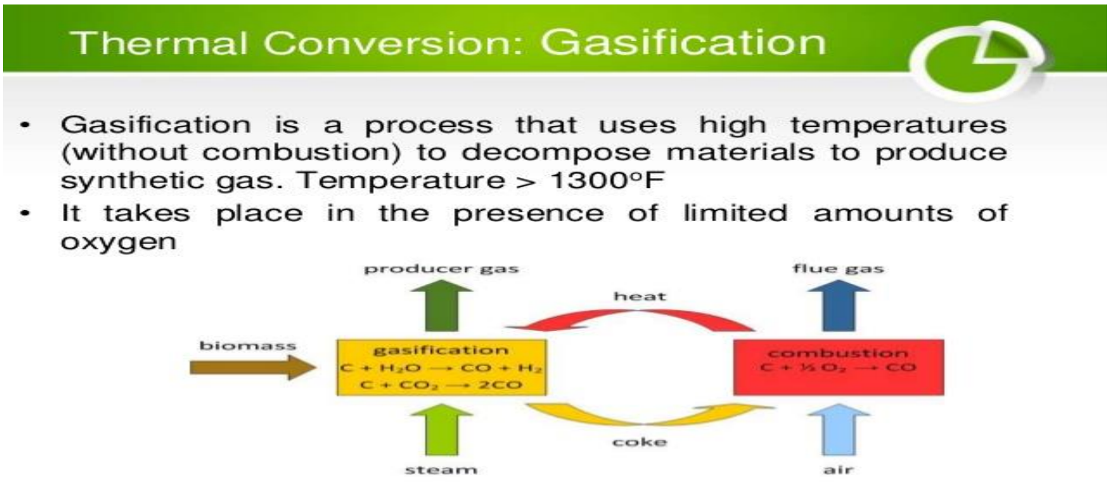

Figure: 3

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 as shown in figure 4. 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.

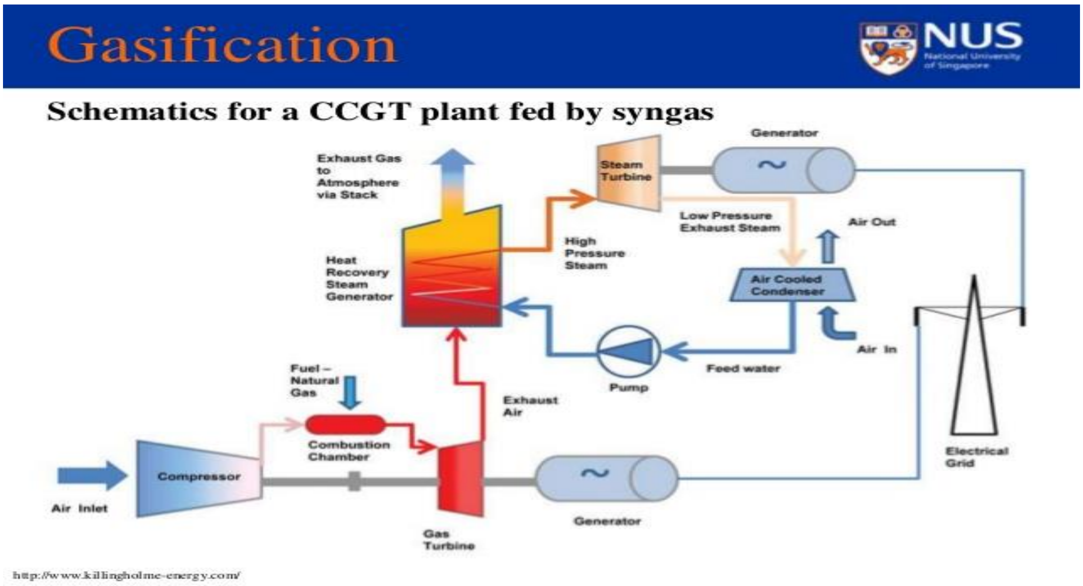

Figure: 4

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. A typical diagram of bio chemical conversion is shown in figure 5.

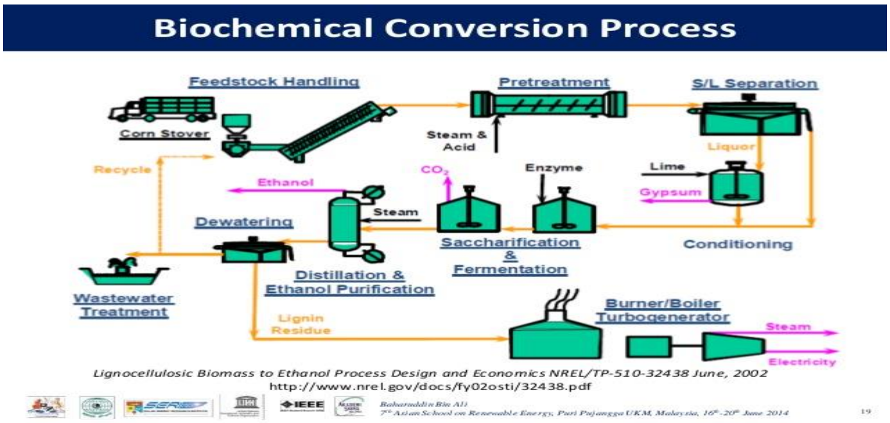

Figure: 5

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.

More on the technological routes for generating energy from waste . Indian Government Support for Waste to Energy. A typical diagram of electrochemical conversion is shown in figure 6

A typical integrated waste to energy plant with pollution control devices is shown in figure 7 below

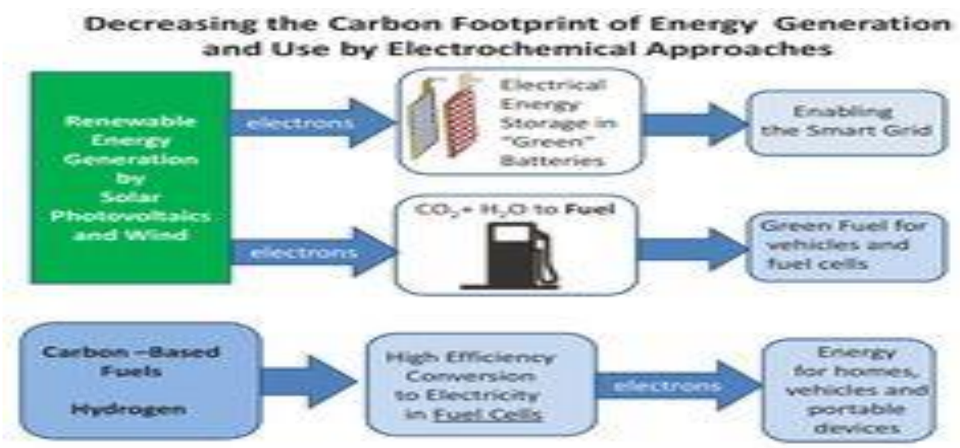

Figure: 6

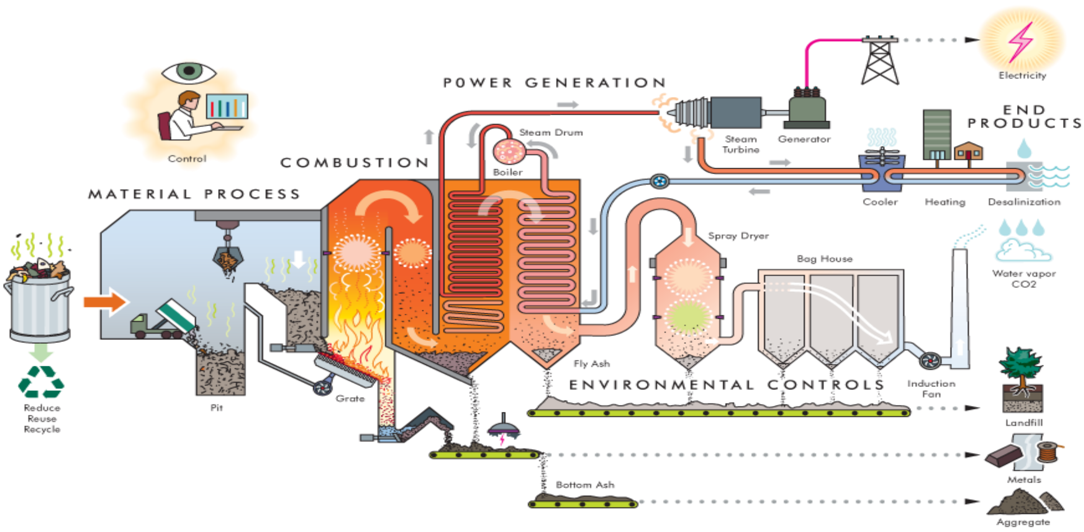

Figure: 7

5.0 India Waste to Energy scenario:

According to the Ministry of New and Renewable Energy (MNRE), there exists a potential of about 1700 MW from urban waste where in 1500 MW from MSW, 225 MW from sewage and about 1300 MW from industrial waste as reflected in table 2. 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.

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.

Table10: 2

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	0.5	1.0	1.5

Pradesh			
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

6.0 Importance of 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.The environmental benefits of waste to energy, as an alternative to disposing of waste in landfills, are clear and compelling. 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:

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.

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.

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.

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.

Conclusions:

Waste production in India is in huge quantity particularly in class 1 towns and if collected and disposed of at a notified site, it can produce significant energy, compost and fuel pallets with economic viability on one hand and control of pollution on the other. The government authorities should visualize the problem in broad perspective and should focus on transforming this waste into usable product like energy or compost. However, serious efforts need to be taken on the front of research where more economical solutions should evolved with compatible and sustainable technological options.

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