A review on Municipal solid waste management

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Abstract*: *Urbanization contributes to upgrading the production of municipal solid waste (MSW) and non-scientific waste dealing with MSW degrades the natural climate and raises health threats. Whereas fossil fuels are right now the most energy assets, they are restricted and their combustion causes natural contamination. Subsequently, elective energy sources should be considered. For this reason, biogas can be a helpful renewable energy choice, which can be created from natural wastes. This review summarized the MSW generation, collection, its characterization, treatment choices, enhancement, technological progression, and uncovering current research and improvement patterns for the biogas from anaerobic digestion (AD). A discussion on the challenges and prospects for creating improved AD technologies is provided.

***Keywords*:** Municipal solid waste, Bio-mass, Anaerobic digestion, Waste management

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I. Introduction

In recent years, Municipal Solid Waste Management (MSWM) is one of the major issues in Society. MSW is the combination of non-homogenous or has factors that aren't similar that are collected from commercial industrial and residential areas. The increase in population rise and financial growth is producing an increasing the volume of solid waste in India. At present, more than 100 million tons of solid waste has been produced from various regions in India. According to the Government of India figures have risen by around 5% per year. It is forecasted that by 2031, The MSW level expands to 165 million and 436 million tons by 2050 [1]. In India mostly the waste is getting collected even under Swatch Bharat mission, the major target was to clean the city and from 2014 onward most of our city's getting cleaned and where the number of cities has become awarded also because of cleaning but never mentioned once any cities getting clean means entire waste is getting accumulated but this waste they are disposed of in low line area and most of the cities issue like improper land filling of solid waste attributes to water pollution and also Inappropriate release of solid waste attributes with air pollution by the release of greenhouse gases. As a consequence, countries have adopted new ways of waste management strategies, consisting of the recycling of resources from aerobic gas capture and the composting of the organic matter of municipal solid waste [2].

II. Solid waste in India

In the current scenario, solid waste development is important due to the increase in the waste production rate and the difficulty of managing the same. Due to inadequate or obsolete waste handling technologies, urban solid waste dump sites have different harmful effects on the natural environment. Swachh Bharat Mission (SBM) Urban estimates that 0.143 million tons per day (TPD) of solid wastes are produced in India. Out of these, 0.111 million TPD i.e. 77.6 per cent are received and 24.8 percent are processed [3].

III. Generation and composition of waste

As the composition of MSW influences the feasibility of waste disposal, the classification of MSW is an important factor. According to the Center for Science and Environment (CSE) assessment of urban waste, the biodegradable fraction-40-70 per cent of the total is the largest. The non-biodegradable fraction (including both recyclable and non-recyclable dry waste) is 20-40 percent for different Indian cities in 2018 – up from 16-20 percent in 2011. Small cities typically have a higher fraction of biodegradable waste relative to big cities. Waste separated in the cities of Delhi, Patna, Gurgaon and Gaya is less than 33% of the time in India (2018). Owing to inadequate source isolation, outdated handling, and unmonitored disposal practices introduced, the natural environment and human well-being are vulnerable to impacts.

IV. PRESENT STATUS OF MSWM IN INDIA

The real aim of the MSWM strategy is to recognize the safety, environment, site use, and commodity and policy factors associated with excessive environmental contamination. MSWM comprises three activities i.e. collection, transport, and disposal of waste. According to the Central Pollution Control Board (CPCB), a recent study of 1.18 lacs metric tons of waste development (82 percent) is accumulated and the unused 18 per cent is collected. Further, it has been reported that only 0.33 lacs metric tons (28%) is being operated out of the total waste collected [4].

A. Production of waste

Treatment of solid waste has three main components, including storage, transport, and disposal of waste. According to the CPCB, the average specimen coverage ranges from 50% to 90%, [5]. The primary waste collection system is literally non-existent, as the waste disposal source is yet to be established. The removal of waste from homes, shops, and hospitals is minimal, while it is being carried out by residential or departmental sweepers. In the budgetary year 2019, more than 23,000 tons of MSW per day was produced by the state of Maharashtra in India. It was the largest quantity produced by any state of the country. Other major contributory states were West Bengal, Tamil Nadu, and Uttar Pradesh. [6] However, according to CPCB in 2009, crucial Hazardous Waste Generation States in India is shown in Table I.

B. Recycling

In India provided there is nothing about the way that government reuse, recycling or disposal and recovery strategies are usually imposed by the informal industry, which puts waste selector at all stages and at any point of waste disposal, and that's the kind of activity that significantly promotes the movement of waste in comparison to emerging countries, there are broad regions in the dumpsites. A significant number of developing countries are using curbside recycling schemes [7].

C. Sanitary landfill

Sanitary landfills are the last means of disposal of sludge and hazards from the collection of garbage. Most dumpsites are not just environmentally and economically friendly because they are landfill sites. Sharholy et al. [8] has found out free, unregulated, and improperly regulated dumping in many metropolitan cities, which is widely practiced, leading to significant environmental destruction and social discomfort in many Indian cities.

D. Incineration

Incineration leads to the burning of waste products like industrial waste, recyclable materials, solid resulting in residues of ash, air pollution. Incineration does not remove waste, it is directly produced. Indian waste is not suitable for combustion because it has a low calorific value between 700 and 1,000 kilocalories.

TABLE I. QUANTITY OF HAZARDOUS WASTE GENERATION (MTA) [9]

Name of State	Quantity of Hazardous Waste generation (MTA)			Total MTA
	Landfillable	Incinerable	Recyclable	
Andhra Pradesh	211,442	31,660	313,217	556,319
Chhattisgarh	5,277	6,897	283,213	295,387
Gujarat	1,107,128	108,622	577,037	1,792,787
Jharkhand	23,135	9,813	204,236	237,184
Maharashtra	568,135	152,791	847,442	1,568,368
Punjab	13,601	14,831	89,481	117,913
Rajasthan	165,107	23,025	84,739	272,871
Tamil Nadu	157,909	11,145	89,593	258,647
West Bengal	120,598	12,583	26,597	259,777

Incineration equipment is not available domestically and the import option is very expensive. In Delhi, an incinerator plant was built in 1980s and is assumed to produce coal-fired electricity [10].

V. BIOMASS AVAILABILITY

Biomass contains a variety of fields, including timber by natural trees and forests, forest, forest residues, crop residues which including green agricultural waste, straw, banana trash, sugar cane, animal waste, rice husk, manufacturing waste, black paper liquor, water treatment, municipal solid waste [11]. Biomass products received for generating electricity involve a rice envelope, straw, cotton stem, bagasse, coconut shell, coconut cakes, coffee waste, soy envelope, Jute waste, sawdust, peanut shells, etc.

Approximately 10 types of waste are created throughout the collection and treatment of crops, which can be utilized for power generation. The classification of crop residues and their respective properties such as residue-to-product ratio (RPR) and lower calorific value (LCV) are shown in Table II (CC includes Bajra, Maize, and Barley etc.). According to the Directorate of Economics and Statistics India (2014), cereals have an important contribution (about 68%) to the overall formation of residues in the region, forwarded by sugar cane (about 18.83%) and cotton (about 8.135%). It is important to note that there is great unevenness in the production of Agri-waste residues in the country while the overall production of agricultural waste in the country is about 600mt/year.

TABLE II: CLASSIFICATION OF CROP RESIDUES AND THEIR PROPERTIES [12]

Group	Crop	Residue Type	RPR (kg/kg)	LCV(Mj/kg)
Cereals	Rice	Straw	1.5	15.54
		Husk	0.2	15.54
	Wheat	Stalk	1.5	17.15
		Pod	0.3	17.39
	CC	Stalks	1.3	18.00
SN	Sugarcane	Bagasse	0.33	20
		Top & Leaves	0.05	20
CN	Cotton	Stalks	3.8	17.4
		Husk	1.1	16.7
		Boll Shell	1.1	18.3

VI. BIOGAS GENERATION OF MUNICIPAL SOLID WASTE THROUGH ANAEROBIC DIGESTION PROCESSES

Anaerobic digestion is considered as a biological mechanism that degrades organic materials through the intervention of microbial communities in the lack of oxygen. This method creates a combination of gasses mainly methane, some carbon dioxide, and a minor portion of other gases. Biogas produces green energy and recycles organic waste into digested biomass. This can be used as fertilizer and methane-rich biogas can also replace natural gas. Biogas is seen as the future of green and clean electricity. This anaerobic digestion process plays an important a key role in the treatment of untreated sludge and biodegradable waste. Anaerobic digestion helps minimize the release of landfill gas into the atmosphere. Biogas is generated by this process consisting of carbon dioxide, methane, and other contaminant gases. Biogas produced by this process can be modified to bio methane, which is of natural gas value. The production of bio methane through anaerobic digestion is shown in below figure 1. It can also be used as fuel directly in combined heat and power engines. For a fractional amount of water vapor, biogas often includes water vapor. Energy problems in India are multidimensional. Increased demand for an energy infrastructure dominated by fossil fuels and modernized energy carriers needs the production of high-quality energy mobility for a vast population deprived of energy stability. [13]. The complete biological cycle has been shown in figure 2.

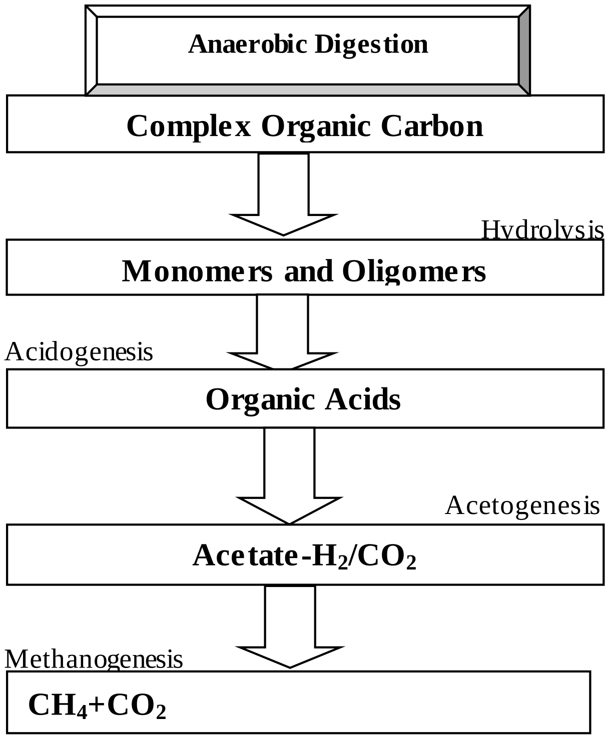

Fig.1.The Production of bio methane through anaerobic digestion.

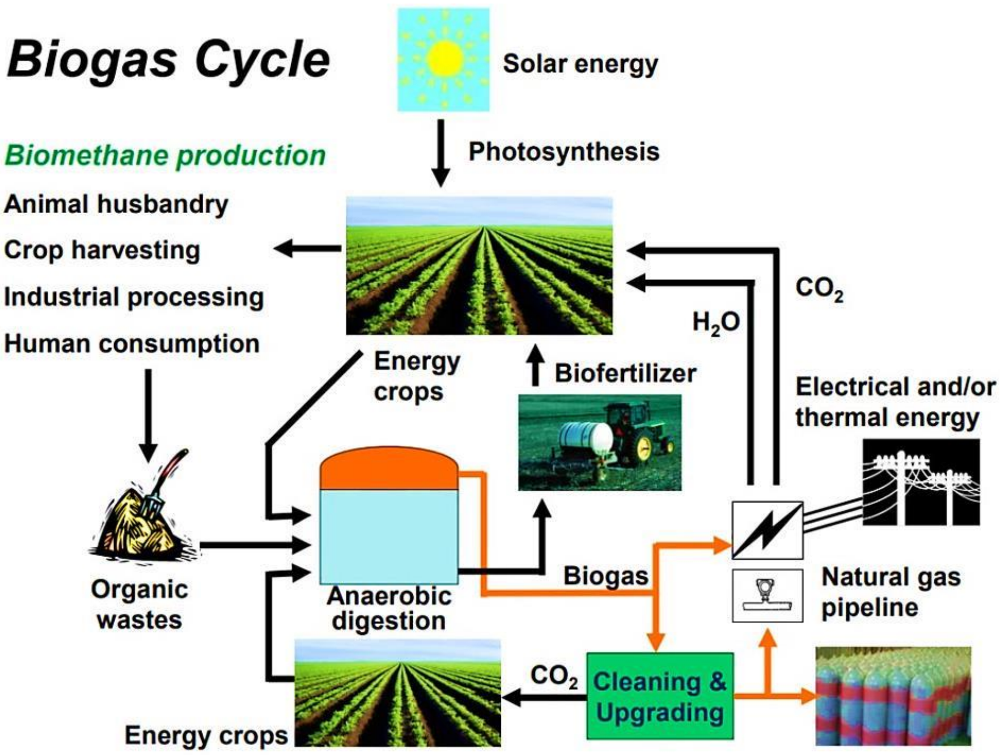

Fig.2. Biogas Cycle

VII. UTILIZATION OF BIOMASS IN INDIA

The primary source of energy production is the use of renewable energy at the nationwide biomass level (using all residues such as rice husk) and cogeneration plants (using Bagasse).In India, almost 4.9 GW is generated by the use of bio-resources, out of which 56.28 percent of bagasse cogeneration, 27.43 percent through biomass gasification, 11.27 percent by non-bagasse cogeneration, and 3.07 percent by biomass gasification is generated in a rural area [14] as shown in figure 3.

Approximately 32% of the country's total primary energy intake also comes from biomass, and more than 70% of the country's population relies on it for their energy needs. The Government of India has an exciting goal of 175 GW of renewable energy capacity by 2022; 100 GW for solar power (57 percent); 60 GW for wind power (34 percent); 10 GW for biomass and 5 GW for small hydropower plants are the sector's reasonable capacity goals. The breakup of renewable energy sources (RES) is shown in Table III. Reserve Bank of India (RBI) and the ministry of new and renewable energy are empowering financial institutions to expand their renewable vitality lending portfolios [15].

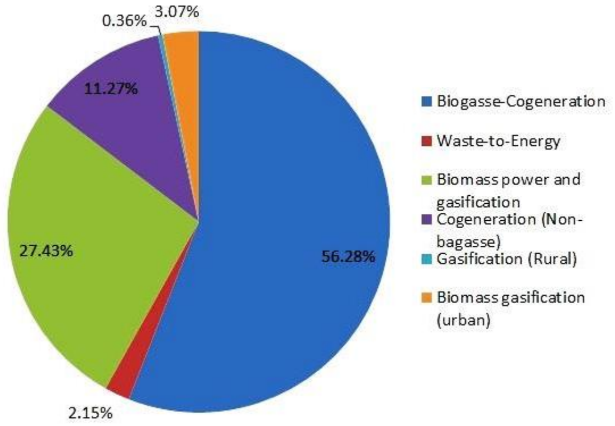

Fig.3. Source wise break-up (%) of bioelectric generation (4.9 GW) as on 2016 [16]

VIII. ENERGY FROM WASTE (EFW) : CHINA VS INDIA

China has the largest installed EfW capacity in the world (7.3 GW), with 339 plants in operation at the end of 2017. EfW has increased by an average of 1 GW per year over the last five years and is now the largest form of bioenergy capacity capable of handling just over 100 Mt of solid waste per year (almost 40 percent of national production).

As a result, EfW's potential in China has risen to more than 13 GW by 2023 in the Renewables from 2018 key case projection and could accommodate 260 Mt of MSW by 2025.

On the other hand, EfW's execution in India has been slow, with 300 MW of efficiency had been constructed by the end of 2017, and the country's biggest plant (24 MW) was established in New Delhi. Figure 4 shows year-wise cumulative Bio-Power installed capacity. Further implementation of EfW includes the provision of tax benefits and financial risk-reduction initiatives [17].

TABLE III.BREAK UP OF RENEWABLE ENERGY SOURCES OF INDIA AS ON 31.12.2015 IN MW [18]

Small Hydro Power	Wind Power	Bio Power		Solar Power	Total Capacity
		BM Power/Cogen.	Waste to Energy		
4176.82MW	25088.19MW	4550.55MW	127.08MW	4878.87MW	38821.51MW

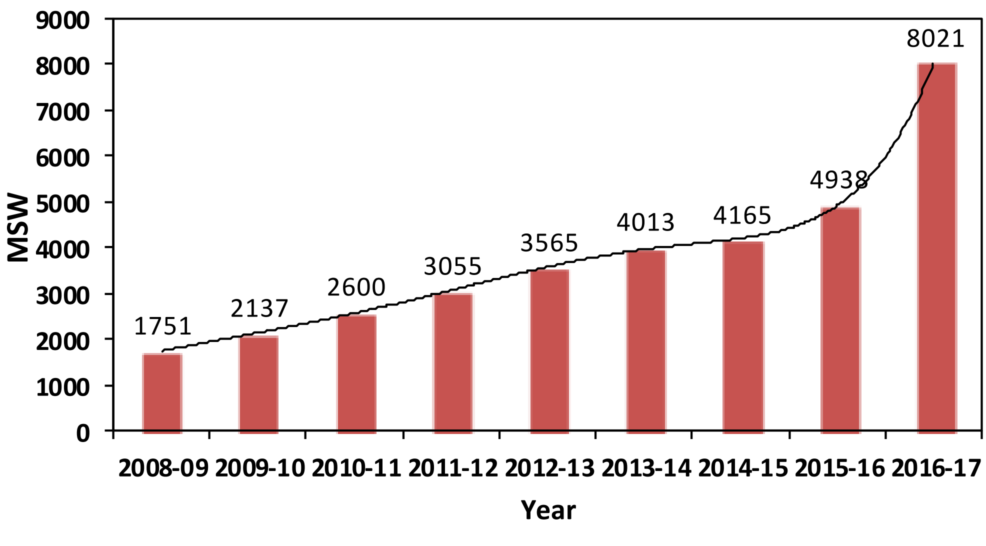

Fig.4. Year-wise Cumulative Bio- Power (Biomass/Cogen, Waste to Energy) Installed Capacity (MW) [19]

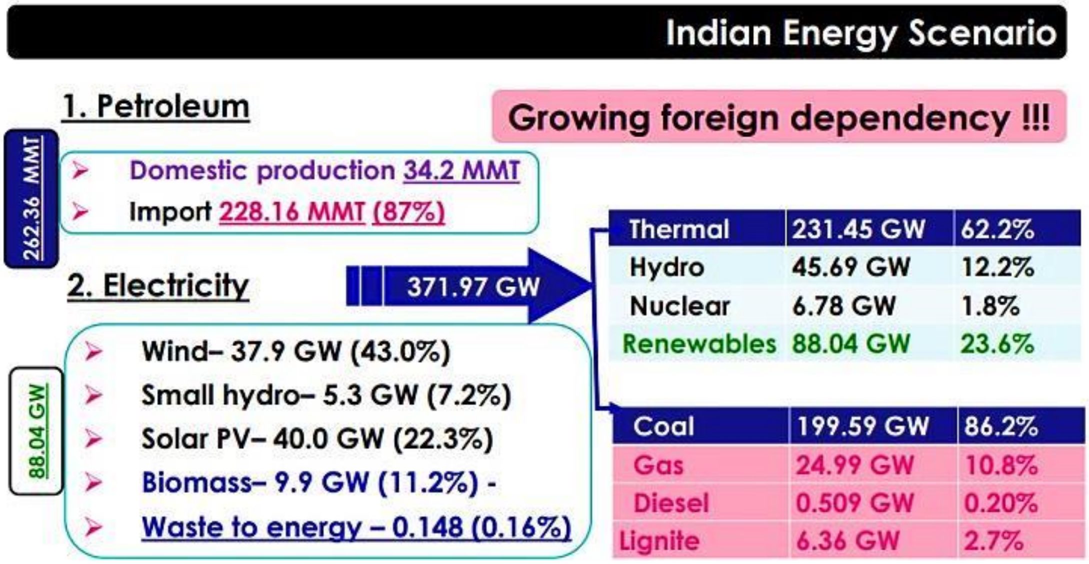

Fig.4. Indian Energy Scenario [20]

IX. PROSPECTS AND CHALLENGES FOR EXPANDING OF SUSTAINABLE ENERGY IN INDIA

Bioenergy is the most common and trend-setting approach for green energy requirements. This includes biogas, efficient biomass stoves, biomass gasification, and combustion and refining of liquid and heat fuels. Many initiatives and groundbreaking initiatives for the development and proper use of bioenergy and its technology being devised and enforced by the Government of India. But according to some surveys and analysis, the success rate is much lower based on the capacity available [21]. Figure 4 shows the Indian energy scenario.

From figure 4, it is observed that the electricity generated from bio mass is 11.2 % out of the total energy generation (88.04 GW). Further, Figure 5 presents the various alternatives available.

X. ADVANTAGES OF BIOGAS BASED POWER GENERATION

- Useful by-products from the biogas process
- Reduces Greenhouse Gas emissions
- Could fulfill the gap in the peak electricity demand and supply
- Sustainable Resource as long as we have wastes
- Highly possible in community and institutional biogas plants.

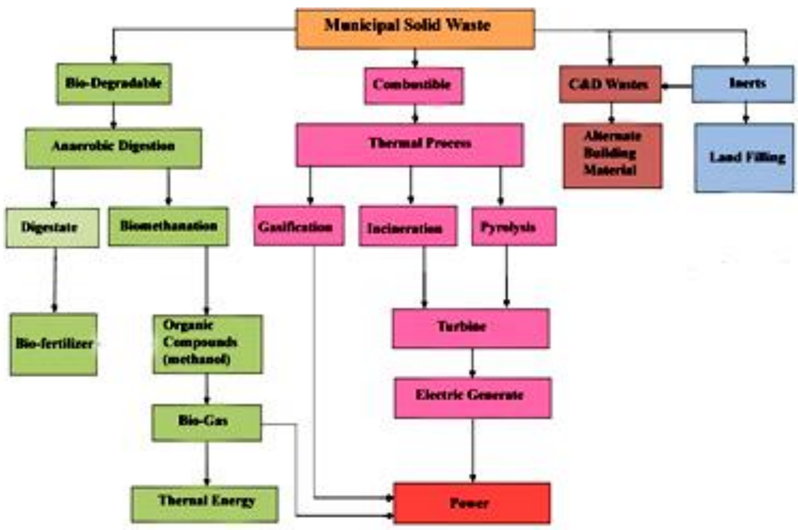

Fig.5. Various Alternatives available for Municipal Solid Waste treatment and utilization

XI. CONCLUSION

In the last two decades, more solid waste has been produced in India as a consequence of rapid urbanization, industrial progress, and population density in India. While the production of the newest technologies has taken on a different graph in recent years, it has not all been the same.

Countries like the US, Australia, European Union nations like Germany, Austria, etc are spending millions on the processing of solid waste, countries like India, Sri Lanka, Nigeria, and so on are still relying on traditional waste disposal methods. However, it is very critical that solid waste is effectively disposed of without damaging the environment. New methods such as incineration, pyrolysis, aerobic and anaerobic digestion, plasma gasification, etc have been implemented.

Encouraging a research and development project for appropriate technologies to resolve MSWM challenges and increasing management performance through research institutes and cooperation among stakeholders is a significant method, especially towards the point of perspective of the implementation of the MSW Rule in India.

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