Waste to energy – challenges and opportunities in India

One of the components of Swachh Bharat Mission undertaken by the Ministry of Urban Development is scientific management of Municipal Solid Waste (MSW) generated in the country. The concept of waste to energy (WtE) is still in the nascent stage in India, as such many initiatives were not successful and faced severe opposition from public in locating WtE plant in their neighbourhood due to pollution concerns. In addition poor financial performance of these plants, lead to unsuccessful ventures. Presently, the responsibility for disposal of waste in the country lies with Urban Local Bodies (ULB), which continue to struggle, due to lack of adequate financial resource, technical capability, appropriate business model and conducive environment.

As per estimates, more than 1.5 lakh metric tonnes per day (TPD) of waste is being generated thereby a potential of about 200 number of such WtE plants to be set up throughout the country. In order to reap this renewable energy resource and achieve – clean India mission, it is imperative to demonstrate a state-of-the-art technology meeting all the stringent environmental norms and prevent further damage to the environment that requires minimum land and emits minimum pollutants so as to gain confidence in the area of waste management and support government's effort in improving the people's health and welfare.

Most of the successful technologies in the waste to energy sector were designed in developed countries and that was suitable to handle segregated waste. Presently in India, source segregation is not being practiced, which makes complexity in identifying a suitable technology. Hence, segregation of waste at source plays a vital role in deciding the success of a project. Even if the technology is imported, a lot of systems need to be customized.

At the same time, it is imperative to develop a technology in India which is suitable for Indian kind of waste and promote technology in an integrated way for scientific disposal of waste. This initiative is essential at this juncture as such earlier efforts were not successful and also found WtE technology is highly capital intensive. It is also expected that promoting a technology development in India will not only promote Make in India concept and also ensure sustainability in scientific disposal of waste.

Further, it is found that there is enough potential for disposal of waste in a distributed manner without involving transportation into larger distance, suitable for towns and non-metro cities which generates waste in smaller volume of less than 100 to 300 TPD, to avoid pollution due to multi fold handling.

With the recent amendment in Electricity Act of 2003 by MoP, ensuring power produced from WtE is mandatorily procured by power Discoms, will pave a long way in promoting WtE plants in the country and for making India Clean.

At the outset, a WtE plant shall be aimed at scientific disposal of waste in an environmentally friendly way and any electric power thus generated from these plants needs to be considered as a by-product only.

Keywords: waste to energy, MSW, waste disposal, municipal solid waste, clean India, WtE

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1.0 Introduction

The solid waste under Municipal Solid Waste (MSW) is generally considered as organic and inorganic waste materials which are produced by various activities of the society. In general these wastes need to be disposed as per scientific method without environmental pollution.

The urban local body (ULB), is responsible agency for ensuring appropriate disposal of waste, with necessary planning and forecasting. Due to lack of regional development concept in India, people starts to relocate to nearby metro cities for their lively hood. These rapid urbanisation process posed many challenges for planners. The governments make their best efforts to provide all basic amenities and services for meeting the demand. But the rapid growth poses challenge before the administration for managing the huge quantity of waste generated by this large size of population. Moreover the waste disposal always found in least priority among all other services rendered by

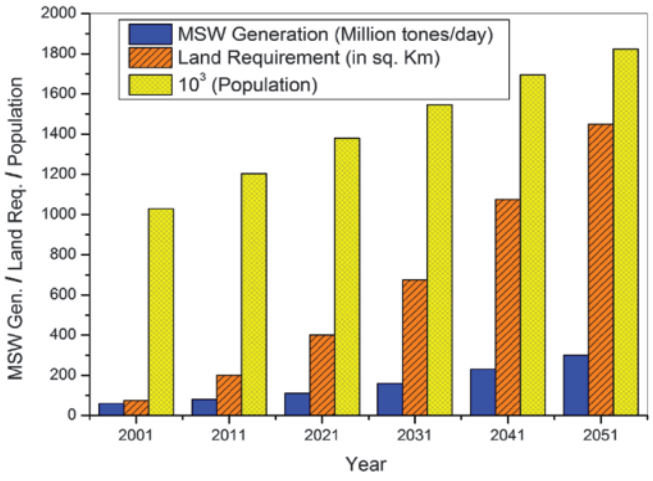

Fig.1: Predicted MSW generation, land requirement, and population from 2001 to 2051 [1]

the ULB. In particular, people are also not appeared to be bothered about the necessity of waste management until it creates a major impact on them.

Consequently, the waste collected in the city is generally dumped in a place which is far away from the main city. As the city expands drastically in a faster scale at all the directions, a point came, when people find they live near a landfill. The problem becomes more critical in metro cities, as such the living style, the level of development has led to generate more and more waste, rather than sharing and conserving any resource.

Hence, it is the part of both government and public, who in general, lacks basic understanding about the real impact of waste management and their indirect impact. Due to rapid population growth, the government's agenda focuses mainly on the providing most important amenities like roads, water etc., and waste management did not find enough ranking. This kind of issue has been observed mostly in developing countries rather than in the developed countries. People in developing country especially in metro cities can afford to and tend to observe the living standard of developed country without knowing their limitation in present infrastructure. As a result, there is considerable increase in waste generation in India during last few decades, due to rapid growth of urbanization and economic activities.

India generates about 143449 metric tonnes per day of MSW, as per the Central Pollution Control Board CPCB 2014-2015 and these figures increase every day with an increase in population. This tremendous increase in the amount of MSW generated is due to changing lifestyles, food habits and living standards of the urban population. The collection efficiency is below 70 per cent [2].

All the ULB's are required to plan, implement and monitor all systems of urban service especially that of MSW. With limited financial resources technical capacities and land availability ULB are constantly striving to meet this challenge.

MSW management continues to remain one of the most neglected areas of urban development in India. In many cities almost more than half of the solid waste generated remains uncollected. This large quantity of uncollected waste becomes cause for the environmental pollution as well as contaminates the groundwater resource. Several studies indicate that an ineffective disposal of solid wastes pollutes the environment (i.e., land, water and air).

Cities are now facing the problem of air pollution and handling of solid waste. According to World Health Organization (WHO) five million people die due to disease caused by faulty disposal system and poor collection practices of waste over the years [3]. As per the report of WHO, there are twenty two diseases which are directly related to improper management of solid waste. The rodent and vector insects transmit various diseases like dysentery, cholera, plague, typhoid, infective hepatitis [4].

Although most of the earlier governments, understand the importance of waste management, little effort has been made in an integrated way to address the problem. Problems and issues of MSW management deserve immediate attention. Most of the ULB's are merely concentrating on collection and transportation of waste alone without any due importance for scientific disposal.

With the launch of the flagship programme by he Government of India, Swachh Bharat Mission in 2014, that aims to provide basic infrastructural and service delivery with respect to sanitation facilities to every family, including toilets and adopting the scientific methods to collect, process and disposal of municipal solid waste.

One of the components of Swachh Bharat Mission (SBM) undertaken by the Ministry of Urban Development is scientific management of Solid Waste generated in the country. Under this SBM scheme, it is proposed that 200 Waste to Energy (WtE) plants are set up all over India by various private players.

The recent initiatives of government such as amendment in Electricity Act of 2003 by MoP, ensuring power produced from WtE is mandatorily procured by power Discoms, will pave a long way in promoting WtE plants in the country and for making India Clean. Moreover, these waste to energy plants not to be considered under merit order dispatch programme.

This paper intends to analyse the challenges and opportunities in the waste to energy sector in India, so as to device a right kind of approach to solve the burning issue of waste disposal.

2. Discussion

A reasonable level of estimation with reliability on the amount and quality of waste generation over a period is a

critical factor which decides success of any waste management initiative.

2.1 Quantum of Waste Generated

Generation of waste is an inevitable human activity and it is positively correlated with the level of income and standard of living similar to electric power consumption in any country. Developed countries generate higher levels of waste and in turn higher the per capita solid waste.

In order to address any problem, first and foremost thing is to quantify the problem so as formulate an effective strategy. Similarly to address the waste disposal issue, the information about the quantity of waste generation in any part of the country is very much useful for formulating the plans and strategy. The right kind of reliable information about the waste generation needs to be established in this country. It is often found the data varies a lot with different source of information. The misleading information may pose threat to a planner to device appropriate evaluation methodology to apply, financing model, technology, budgeting, transportation system, collection system etc.,

The discrepancy in data published by different organizations in India can be very well organized by promoting research in the area. There is a pressing need to analyse the waste generation pattern between urban and rural areas acknowledging the regional and geographical differences across the country. Often researchers/technology developers/policy makers rely on the very limited unorganised data, which introduces a sense of risk on their proposal [1].

Hence, data base needs to be created based scientific study on the waste generation in the country with a provision to update the same at regular interval, which serve as a basic information for any further study, policy frame work etc., In general, the per capita generation of waste in Indian cities ranges from 0.17-0.62 kg/capita/day, depending on the size of the city as well as the socio-economic profile of the population [5].

2.2 Composition of Waste

Composition of waste plays a vital role in deciding the nature of technology required to ensure scientific disposal of waste.

In general, technology is being developed considering the quality of raw material. Hence in order to develop a right kind of technology, the composition of raw material is very much required. The success of any technology entirely lies on the reliability of input data such as raw material. There is dire need of a system to develop a data on nature of waste is being generated in each part of the country. Moreover the composition of waste can vary based on life style of a country. Being a diverse in nature, India, the quality of waste generated varies from location to location and season to season. So there is a lot of variability involved in the waste generation. These variability needs to be taken into account.

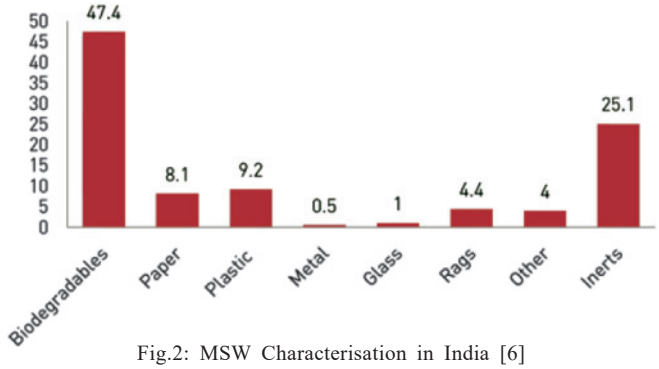

Fig.2: MSW Characterisation in India [6]

As shown in the Fig.2, in Indian context, considering the nature of MSW being generated, the technologies like recycling and composting has right kind of potential to dispose the MSW in an environmentally friendly manner due to higher contribution from biodegradables. In the absence of a comprehensive study on characterization of waste, policy makers/technology providers are forced to rely on limited source of information that prevents them from providing a right kind of solution. This kind of generalization of data, results into many start up problems which ultimately leads to a wrong precedence and affect all the future endeavors.

Some earlier studies have brought out a clear change in composition of waste being generated and found that burnable composition improves with improvement in standard of living. The composition of MSW depends largely on number of factors such as culture, tradition, climate, food habit, lifestyle and income. These kinds of study provide useful information for a designer to foresee and accommodate the changes to deliver a successful technology.

2.3 Segregation of waste at Source

Segregation of waste at source plays an important role and is of paramount importance, as such all the presently available successful technologies are designed to operate with segregated waste as an input fuel. Hence, segregation of waste plays a very crucial role in deciding the success of any waste disposal project.

In view of low level of compliance of MSW Rules 2000 by the ULB, segregated municipal solid waste is generally not available at the plant site, which may lead to non-availability of waste-to-energy plants. Incinerating organic waste (uncontrolled combustion) in the garbage by not segregating it can cause worst environmental damage due to deadly pollution levels. Segregation of garbage must take place in the first place. Segregation of waste by use of machinery even with elaborative equipment in place often found not viable and create an unhygienic working condition.

Fig.3: Multimedia campaign to mobilize the public [MoUD]

Segregation of waste is possible only with an active participation of the people. This needs a change in the mind set of the people with adequate enforcement. Especially in India, the rag-pickers role needs to be augmented in segregation of waste and its recycling. For a sustainable waste management, an integrated way of waste disposal needs to be evolved with due importance for source segregation and cost effective un organised sector for cost effective solution. There is urgent need to promote an integrated way of waste management involving source segregation, recycling and ultimately energy generation from burnable materials.

Composting is best suited for high moisture content organic waste. But composting becomes a difficult process for a waste arrives in a mixed form and contains a lot of non-organic material. When mixed waste is composted, the end product, the compost fail to meet the required quality makes it difficult to find user/market [7].

The Fig.3 shows, a campaign launched by Ministry of Urban development to educate the waste generators on the importance of reducing waste generation and practicing segregation of biodegradable and non-biodegradable waste at source to facilitate optimum utilization of reusable material and recycling of various components of waste. In this respect MoUD initiated a national level multimedia campaign to bring about behaviour changes in the citizens of the country.

Still other elements downstream the source segregation needs to be improved. Several factors such as collection efficiency; lack of appropriate collection systems, lack of and/or inadequate collection facilities such as waste disposal bins, collection vehicles, lack of funds, lack of and enforcement of appropriate regulations etc needs to be strengthened to reap the full potential of this initiative.

2.4 Technology Selection

An effective disposal of waste with adequate environmental measures under Waste-to-Energy concept is still a new concept in the country. Most of the proven and commercial technologies are required to be imported. Also, these technologies need to be customized to suit Indian conditions.

Many earlier initiatives were failed due to in appropriate technology selection and still struggling to make waste-to-energy project a success story. There is a need to develop economically feasible and proven technologies considering Indian kind of waste. Most importantly, segregated waste needs to be provided to WtE plants as per its requirement.

Most of the successful technologies in the waste to energy sector were designed in developed countries and that was suitable to handle segregated waste. Presently in India, source segregation is not being practiced, which makes complexity in identifying a suitable technology and hence many earlier initiatives were found not successful.

All the technologies available for waste disposal such as composting, gasification, controlled combustion, bio methanisation etc., require segregated waste as an input material. Hence, segregation of waste at source plays a vital role in deciding the success of a project.

In India, it is estimated that approx. 56 per cent of MSW is organic matter. Organic matter is suitable for aerobic digestion where the waste can be used to create compost, or anaerobic digestion and fermentation under controlled conditions, where it can be diverted to produce biomethane in turn for electricity generation. Anaerobic digestion is an ideal method for exploitation of electric power from the organic part of MSW.

But for technologies involving biological methods require uniform raw material without inorganic content. Hence high degree of segregation is highly desirable. To achieve this, sorting and separating organic and inorganic waste must be done at the first stage, i.e., where waste is generated, called source segregation. This is why it is important to incentivise segregation at the citizen level. Several waste segregation initiatives have been attempted, with little success [8].

2.5 Creating Awareness

Awareness and public participation to segregate waste at source, door-to-door collection, and disposal in appropriate collecting bin is paramount importance. This awareness plays a vital role in waste management and ensure scientific disposal without emission. Segregation of waste at source needs to be included in the school curriculum for better penetration among youths.

Unlike any other initiatives, the participation of public is very much essential to achieve a desirable result in the waste disposal. Necessary steps needs to created to educate and to realize the importance of source segregation at source as biodegradables, burnable, inert and recyclable material for proper waste management in the country.

Some WtE plants in Sweden are importing waste from neighboring countries (mostly from UK). It clearly shows the people acceptance level in Sweden about WtE plants. They allow WtE plants to be located near city centers and even allow to burn waste to be imported and processed.

Hence it is clear that best pollution control is a must and a key to success of any WtE plant. Gaining confidence and acceptance among public about the WtE plant is very much important in the present Indian context. This is possible only be employing adequate pollution control devices/systems those are not only meet all the necessary emission level and perform better and reach far low emission value.

2.6 Devising right kind of business model

In developed countries, WtE plants are generally owned by municipal corporations. OEM's are involved in O&M of plant. These plants are supported by sufficient level of tipping fee from the public. These plants are treated as waste disposal facilities only rather than energy plants. Waste disposal in a scientific manner needs adequate financial assistance. Presently in India, ULB's are capable enough and utlising their fund just to collect and transfer the waste up to landfill facility only. Hardly any money spent on disposal of waste. With the present system ULB's are not in a position to arrange fund for disposal of waste. A system of collecting waste disposal fee from the public needs to be developed to ensure sustainable waste disposal. In order to sustain a waste disposal initiative public participation is very much essential including awareness and financial support in the form of waste disposal fee.

The Fig.4 shows the expenses and revenues of a typical WtE plant in developed counties. It is pertinent to mention that almost 85% of the revenue comes from tipping fee. Hence the viability of a project is rather solely depends on the amount of tipping fee.

But in India, these plants are awarded based on energy price and without sufficient level of tipping fee, the viability of plants are in great danger, not solving the very basic purpose of scientific disposal of waste in an environmentally friendly manner.

Due to non-viability of WtE business in India, finding financial assistance or bankability of any WtE project is very difficult at this juncture, which totally jeopardise the entire waste management sector.

2.7 Bench marking

Locating a WtE plant in any part of the city is a major hurdle due to NIMBY syndrome. People often protest not to locate a WtE plant in their neighborhood. People believe that a WtE plant without any financial viability always a non-

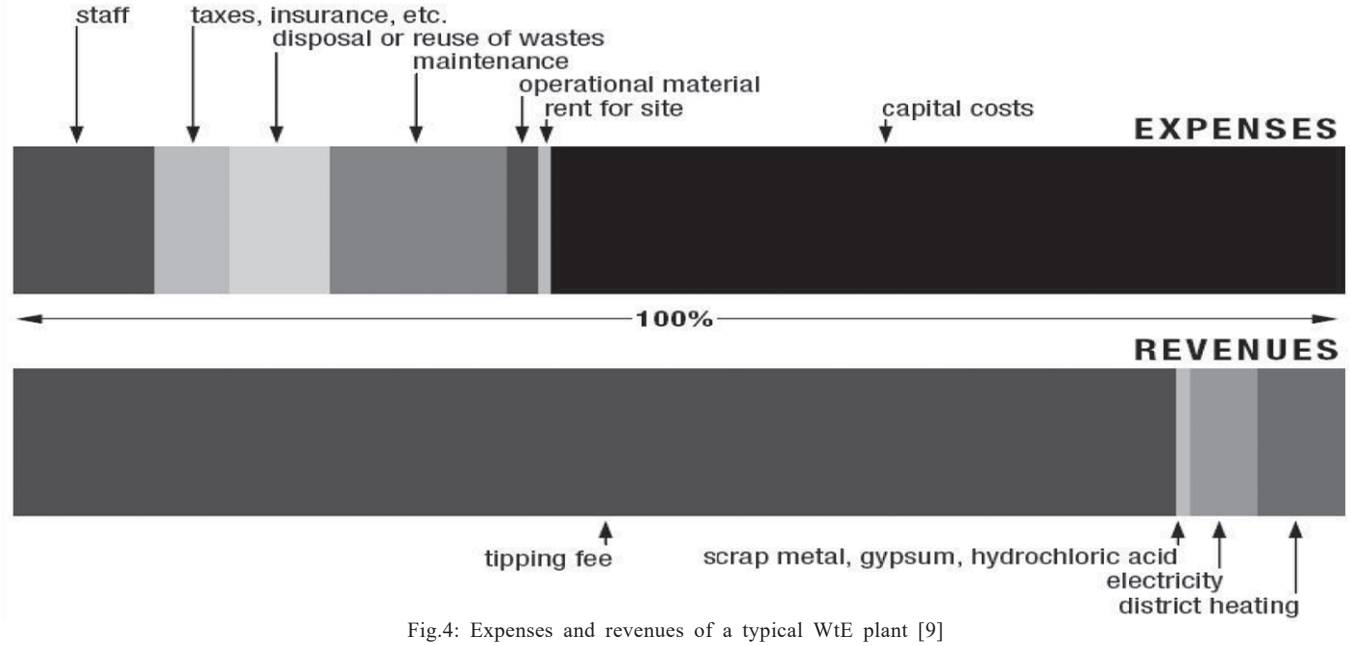

Fig.4: Expenses and revenues of a typical WtE plant [9]

performer in terms of environmental norms. In the present scenario, the government is focused on establishing a state of the art WtE plant and determined to bench mark various activities related to setting up of a waste to energy plant in India. Once bench marking is done, it will pave a long way for the government to promote developers seamlessly, based on the realistic picture.

2.8 Success Criteria for Waste to Energy plants

In developed countries the WtE plants are successful ventures because of the following factors such as

- Primary focus and increased efforts to prevent, reduce, reuse and recycle the waste, an appropriate management of MSW.
- Segregated Waste – Source segregation is mandatory
- Complete ban on landfilling of organic waste
- Landfilling tax is approx. 50 Euro/Tonne.
- Waste disposal fee in the tune of 50 – 100 Euro/Tonne (as a major revenue)
- Combined Heat & Power (CHP) mode of operation - Higher efficiency (90%)
- District heating as a major source of earning
- Electricity generation (not lucrative due to low energy price)
- Higher acceptance level for WtE plant from Public
- Plants are located near city – lower transportation
- Earning from Recyclables can cover ash disposal cost.
- Most of plants are owned by Municipality (Transparent in function)
- Best emission performance – Top priority

2.9 Challenges in Indian condition

The following challenges needs to be overcome in order to ensure a success of any WtE initiative in India.

- Lack of general awareness on waste management
- Unsegregated waste
- High moisture content
- Low calorific value (Approx 1200 kcal/kg)
- Most of the recyclable material is already removed from waste stream by
- Unorganized sector.
- High wear and tear of equipment due to foreign materials
- Only electricity demand (No heat demand – District heating/cooling)
- Cycle Efficiency is low (max 25 %)
- Lack of enforcement of rules/regulations
- Lack of acceptance level of WtE plants among people (NIMBY Syndrome)
- Lack of Transparency in WtE plant management
- Lack of adequate waste disposal cost
- Consider WtE plants as Business Model rather than Disposal plant.
- Lack of customization of plant and machinery to suit Indian condition

3.0 Opportunities

In view of the above challenges in the Indian WtE sector, there exists a lot of potential to develop a right kind of technology considering Indian kind of waste. With fair level of segregation at source, decentralized composting plants should be installed to reduce the load on ULBs for collection and transportation of MSW, which subsequently culminates in reduction of the pressure exerted on the landfills.

At the same time, it is imperative to develop a technology in India which is suitable for Indian kind of waste and promote technology in an integrated way for scientific disposal of waste. This initiative is essential at this juncture as such earlier efforts were not successful and also found WtE technology is highly capital intensive. It is also expected that promoting a technology development in India will not only promote Make in India concept and also ensure sustainability in scientific disposal of waste.

Further, it is found that there is enough potential for disposal of waste in a distributed manner without involving transportation into larger distance, suitable for towns and non-metro cities which generates waste in smaller volume of less than 100 TPD, to avoid pollution due to multi fold handling.

In this perspective, gasification technology, a proven option for utilisation of biomass can be explored in the waste to energy sector so as to harness the already available expertise in Indian industry. Launching targeted efforts for development of technologies for resource and energy recovery from waste is the need of the hour in India. In the context of promoting in-house technology suitable for Indian kind of waste, demonstration projects needs to be established. Demo scale plant not only builds confidence among domestic players and also helps in developing a cost effective technology. The combination of source segregation, composting and gasification in a distributed manner will solve present issue of waste management in India.

Further, a system of analyzing the waste generation and waste characterization needs to be established in India to encourage location specific appropriate solutions for waste disposal considering ever changing nature of waste.

According to the MNRE there exists a potential of about 1,700 MW from urban waste, this potential needs to be harnessed in a cost effective manner. Recently the Govt. of India has come up with measures like the following to promote waste to energy plants to ensure scientific disposal of waste. Central Electricity Regulatory Commission (CERC) on 07.10.2015 has notified generic tariff for waste-to-energy of Rs 7.90 per unit of power for RDF (Refuse Derived Fuel).

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