Indian Market for Waste to Energy Generation

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Abstract- **The abysmal state of and challenges in municipal solid waste management (MSWM) in urban India is the motivation of the present study. Urbanization contributes enhanced municipal solid waste (MSW) generation and unscientific handling of MSW degrades the urban environment and causes health hazards. In this paper, an attempt is made to evaluate the major parameters of MSWM, in addition to a comprehensive review of MSW generation, its characterization, collection, and treatment options as practiced in India. The current status of MSWM in Indian states and important cities of India is also reported. The essential conditions for harnessing optimal benefits from the possibilities for public private partnership and challenges thereof and unnoticeable role of rag-pickers are also discussed. The study concludes that installation of decentralized solid waste processing units in metropolitan cities/towns and development of formal recycling industry sector is the need of the hour in developing countries like India.**

I.INTRODUCTION

India is rapidly shifting from agricultural-based nation to industrial and services-oriented country. About 31.2% population is now living in urban areas. 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 . The cities having population more than 10 million are basically State capitals, Union Territories, and other business/industrial-oriented centers. India has different geographic and climatic regions (tropical wet, tropical dry, subtropical humid climate, and mountain climate) and four seasons (winter, summer, rainy, and autumn) and accordingly residents living in these zones have different consumption and waste generation pattern. However, till date, no concrete steps had been taken to analyze regional and geographical-specific waste generation patterns for these urban towns and researchers have to rely on the limited data available based on the study conducted by Central Pollution Control Board (CPCB), New Delhi; National Engineering and Environmental Research Institute (NEERI), Nagpur; Central Institute of Plastics Engineering and Technology (CIPET), Chennai; and Federation of Indian Chambers of Commerce and Industry (FICCI), New Delhi.

Municipal solid waste management (MSWM), a critical element towards sustainable metropolitan development, comprises segregation, storage, collection, relocation, carry-age, processing, and disposal of solid waste to minimize its adverse impact on environment. Unmanaged MSW becomes a factor for propagation of innumerable ailments.

In the developed countries, solid waste management (SWM) belongs to prominent thrust areas for pursuing research and economic and technological advancements have initiated responsiveness of stakeholders towards it. High population growth rates, rapidly varying waste characterization and generation patterns, growing urbanization and industrialization in developing countries are the important reasons for paying attention towards MSWM as more area is required to accommodate waste

Several studies suggest that reutilizing of solid waste is not only a viable option to MSWM. One of the significant problems in urban India is almost no segregation of MSW and disposal of construction and demolition debris (C&D), plastic wastes, commercial and industrial refuses, and e-waste.

Annually, about 12 million tons of inert waste are generated in India from street sweeping and C&D waste and in the landfill sites, it occupies about one-third of total MSW. In India, MSWM is governed by

Municipal Solid Waste and implementation of MSWR is a major concern of urban local bodies (ULBs) across the country.

II. LITERATURE SURVEY

A. SYSTEM PROCESS:

The Waste Generation Index (WGI) provides a quantitative assessment of the rate of waste production by country, considering a selection of key waste types including municipal solid waste (MSW), hazardous waste, food waste and plastic waste. Elevated rates of waste generation occur in countries with high levels of consumption. This combination can be unsustainable and leave companies operating in these locations to face reputational, physical and regulatory risks. Definition of the Issue Population, urbanisation and economic growth, in addition to increasingly unsustainable consumer behaviour, have caused rates of waste generation to rise exponentially in recent decades. These patterns of production and consumption have led rates of waste generation to become a high priority concern for both human health and preservation of the natural environment. Since a variety of business activities are either directly responsible for or indirect drivers of solid waste generation, there is a likelihood that risks can be transferred to companies in these operating environments. As economic growth continues, waste flows have diversified with new waste types presenting distinct challenges. Materials like plastic polymers are particularly alarming as environmental pollutants considering their durability, long residence times and tendency to interact with marine trophic systems upon reaching the oceans. Food waste is of concern as this highlights the inequity of the global food system, with a total of one third of produced food being lost or wasted, disproportionately in high income countries. Hazardous waste with properties that is toxic to biological organism's present significant threats to human health, biodiversity and the provision of ecosystem services. In addition to better understanding risk exposure, the index can help highlight where opportunities exist for companies to start developing action plans to mitigate risks associated with waste generation, or address problems with specific waste types that might be central to their business. Implications for business High rates of solid waste generation impose pressure on public waste management systems, increasing the likelihood that waste is not disposed of responsibly. This presents potential health and safety risks to residents, damage to ecosystem services, and management challenges for local and national governments. Consumers and NGOs are increasingly aware and vocal on issues such as waste generation, plastic pollution, overproduction and resource consumption. Companies are often linked to these issues either directly through their operations and supply chains, or indirectly through the consumption of their products. Reputational damage can arise when companies are deemed to be a key driver of high rates of waste generation and thus partly responsible for any subsequent impacts to human health and the environment. In countries where waste is produced at high rates new or more stringent regulations have a greater likelihood of being established to reduce the levels of resource consumption. If this occurs, regulatory risks would present additional costs to businesses, especially in industries considered to be primary drivers of the issue. Physical risks can arise from elevated rates of waste generation when damages occur to the environment, causing issues such as resource constraints. An example of this is plastic pollution impacting marine ecosystems and subsequently tourism industries.disrupting fishing

B.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 un organised data, which introduces a sense of risk on their proposal. 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 kg– 0.62 kg/capita/day, depending on the size of the city as well as the socio economic profile of the population.

C.COMPOSITION OF WASTE:

Fig .1. MSW Characterisation in India

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 National Seminar on Emerging energy scenario in India – Issues, Challenges and way forward NLC India Ltd., & The Institution of Engineers (India), Neyveli Local Centre 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. Figure 1 MSW Characterisation in India As shown in the Figure 1, 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 has 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 equipments in place often found not viable and create an unhygienic working condition. Segregation of waste is possible only with an active participation of the people. This needs a change in the mindset 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.

Fig.2. Multimedia campaign to mobilize the public

National Seminar on Emerging energy scenario in India – Issues, Challenges and way forward NLC India Ltd., & The Institution of Engineers (India), Neyveli Local Centre The Figure 2 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 behavior changes in the citizens of the country. Figure 2. Multimedia campaign to mobilize the public [MoUD] 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.

D.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 equipments in place often found not viable and create an unhygienic working condition. Segregation of waste is possible only with an active participation of the people. This needs a change in the mindset 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. 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.

E.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 bio methane 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. National Seminar on emerging energy scenario in India – Issues, Challenges and way forward NLC India Ltd., & The Institution of Engineers (India), Neyveli Local Centre This is why it is important to incentivise segregation at the citizen level. Several waste segregation initiatives have been attempted, with little success.

F.RECYCLING INDEX:

Definition of the Index The Recycling Index assesses a country's willingness and ability to manage solid waste in a manner which promotes circular material flows. This index identifies countries where the inability to recover and recycle solid waste is likely to result in risks to businesses. These risks are quantified by considering the proportion of a given country's solid waste that is collected, adequately managed and recycled, in addition to the level of governmental commitment measured through compliance with international waste-related treaties. Definition of the Issue The management of solid waste is one of the largest and fastest growing sustainability challenges emerging alongside global development. Economic and population growth, urbanisation, globalisation and industrialisation have caused rates of waste generation to accelerate in recent decades. However, the mechanisms that societies have put in place to properly manage and dispose of solid waste have not grown or evolved in tandem. On a global scale, it is widely recognised that an urgent transition is needed towards circular material flows or a 'closed loop' system, where raw material extraction and waste generation are minimised, and resource use efficiency is maximised. In this system, concepts like long-lasting design, repair, reuse and recycling help to achieve this narrowing of material flows. This contrasts with the existing model of production and consumption where goods and products are used and disposed of in a predominantly linear fashion. With populations projected to continue growing and becoming increasingly concentrated in urban agglomerations, it is critical that governments improve waste management systems and tailor them towards society's need for a 'closed loop' system. Waste streams in modern economies have also diversified greatly, generating larger quantities of problematic pollutants. Some of these specific waste streams, like plastic for example, can be reintegrated into the economy at what is currently the end-of-life stage of the life cycle. Implications for business In economies where a large proportion of solid waste is mismanaged rather than recycled, waste is likely to end up in environmental reservoirs or sinks where it presents significant threats to the provision of ecosystem services, biodiversity and human health. Businesses with a direct presence or an indirect association with these locations can face significant reputational risks as a result. Responsible consumers increasingly express a preference for goods and services from socially responsible companies, and hence negative brand reputation related to a lack of recycling can impact consumer perceptions and compromise revenues. Companies can also face operational risks when operating in locations with a weak propensity for recycling, as this can increase the overall costs of managing and handling waste, particularly if facing landfill taxes. Similarly, legal risks can also be presented to companies that do not meet their waste management obligations, depending on the products or services. Certain industries have a legal obligation for responsible disposal of waste. Failure to ensure compliance through measures such as recycling can result in fines, penalties or litigations.

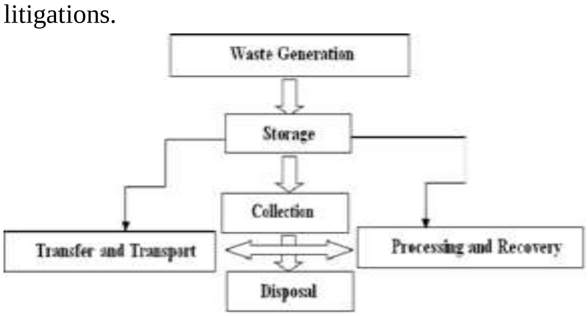

Fig.3. Block Diagram of Waste Generation

MUNICIPAL SOLID WASTE:

Fig.4.Municipal solid waste

MSW commonly known as trash or garbage consists of everyday items we use and then throw away, such as products packaging, grass clippings, furniture, clothing, bottles, foods scraps, newspapers, appliances, paints and batteries.

Organic materials such as paper and paperboards, yard trimmings and food waste continue to be largest components of MSW.

The MSW has four components recycling, composting, disposal, waste to energy via incineration.

Wi4th a population that accounts to nearly 17% of the world's overall count, the amount of waste generated in India is perhaps quite imaginable. Urban India generates 188,500 tonnes per day (TPD) of waste at an average rate of 0.5 kg of waste per person per day. It is seen that due to increased income and a change in the lifestyle of people, the per capita waste generation has considerably increased in the past decade.

India has a lot of catching-up to do in the space of Solid Waste Management (SWM); with apparently not much happening on the ground. Most of Municipal Solid Waste (MSW) in India ends up in open dumps; where they are set on fire; thereby releasing toxic greenhouse gases in the air or remain just as they are; further causing potential health threats to the inhabitants nearby. A proper system, which reroutes this waste to capture the usable parts and dispose of the unusable, is therefore the need of the hour. When we talk of waste management, there are two options that can be considered. The first is material recovery, which is fundamentally recovering usable or recyclable items from the waste such that they can be used again in their similar forms. Second is the conversion of Waste to Energy; energy recovery is a process of redemption of the energy that was used in the production of these products (now rendered as waste). Obviously, not all of the energy used can be got back in usable form, therefore material recovery comes before energy recovery in the hierarchy of waste management.

G.METHODS OF WASTE DISPOSAL:

In India, almost every city, town, or village adopted unscientific disposal of MSW. The existing practice and technology availability for MSWM for 59 cities have been indicated in Figure 4 (Kumar et al., 2009). Among these cities, 40 cities have shown increase in waste generation, 7 cities shows reduction, and it was more or less same for 6 cities. Though there was an increase in population during the decade for these cities, no significant reason was indicated by author for reduction as well as equal amount in waste generation for these cities. However, the possible reason for reduction could be that the waste generated could not reach the designated dumping site and was lost in the cities peripherals, outskirts, along the road, low lying area, along the drain, green areas, etc. Data reveal that uncontrolled open dumping is a common feature in almost all cities (Kumar et al., 2009). The following disposal practices are in use in hierarchy.

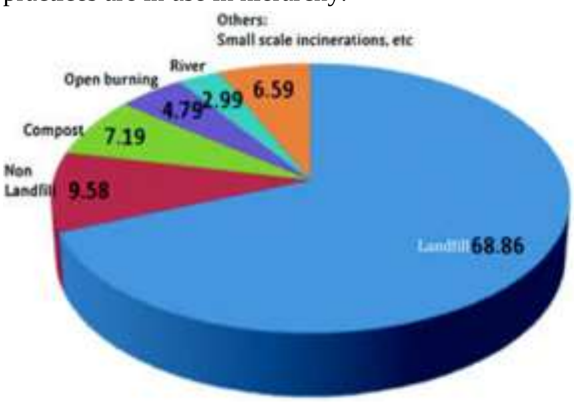

Fig.5.% Disposal of MSW

OPEN DUMPING:

In India, MSW generated is usually directly disposed on low lying area in routine way violating the practices of sanitary landfilling. Almost no ULBs have adequate sanitary landfilling facility and MSW is dumped in the outskirts of town along the roads. Unscientific dumping is prone to flooding and major source of surface water contamination during monsoon and ground water contamination due to percolation of leachate

Fig.6.Open dumping

LANDFILLING:

Landfilling would continue to be extensively accepted practice in India, though metropolitan centers like Delhi, Mumbai, Kolkata and Chennai have limited availability of land for waste disposal and designated landfill sites are running beyond their capacity (Sharholy, Ahmad, Mahmood, & Trivedi, 2008). The development of new sanitary landfills/expansion of existing landfill are reported in the states such as Andhra Pradesh (Vijianagaram), Delhi (Bhalswa, Okhla and Ghazipur), Goa, Gujarat (8 sites), Haryana (Sirsaand Ambala), Karnataka (12 sites.), Madhya Pradesh (Gwalior and Indore), Maharashtra (Nashik, Sonpeth, Ambad, Pune, Navapur and Navi Mumbai), Punjab (Adampur), Rajasthan (Jodhpur), and West Bengal (17 sites) (CPCB, 2013). According to CPCB, 2013 report, till date, India has 59 constructed landfill sites and 376 are under planning and implementation stage. Apart from this, 1305 sites have been identified for future use.

Fig.7.Landfilling

LANDFILL GAS-TO-ENERGY PLANTS

From landfills mainly methane (CH4) and carbon dioxide (CO2) gases are produced. These gases have significant greenhouse effect. CH4 emission from landfill is about 13% of global CH4 emission and is about 818 million metric tons per annum in terms of CO2 equivalent (Rachel, Damodaran, Panesar, Leatherwood, & Asnani, 2007). In India, estimated methane emission is about 16 million metric CO2 equivalents per annum through landfills (International Energy Agency, 2008). The energy potential from landfill gas available at selected sites in Delhi (Balswa, Gazipur and Okhla) is 8.4 MW, Mumbai (Deonar and Gorai) 5.6 MW, Ahmadabad (Pirana) 1.3 MW, and Pune (Urli) had 0.7 MW annually (Siddiqui & Khan, 2011). Planning

Commission Report (2014) indicated that 62 million tons of annual MSW generated in urban area can produce 439 MW of power from combustible component and RDF, 72 MW of electricity from landfill gas and 5.4 million metric tons of compost for agriculture use as CH_4 has 23 times higher global warming potential than CO_2. The utilization of landfill gas, particularly CH_4 for energy production is important as it finally converts into primary constituents (i.e. CO_2 and H_2O). A study conducted by United Nations Environmental Program (UNEP) has shown that greenhouse gas emission from landfill can be significantly reduced by following environmentally sound management of hazardous and other wastes (UNEP, 2008, 2010):

(1) Waste minimization. (2) Recycling and reuse. (3) Reductions in fossil fuel by substituting energy recovered from waste combustion. (4) Energy derived by CH_4 from landfill site can be used for in situ energy requirement.

Non-availability of requisite quality of MSW at plant site, presence of low calorific matter in MSW i.e. inert and C&D waste, reservation to use compost generated from MSW by farmers, lack of appropriate market policy for use of RDF, and compost makes such projects economically non-viable. Ministry of New and Renewable Energy (MNRE), Government of India installed 3 Mega Watt (MW) capacity plant at Solapur, Maharashtra, 16 (MW) capacity at Okhla, Delhi, and planned to support few more waste to-energy projects at Bangalore (8 MW), Hyderabad (11 MW), Pune (10 MW), and Delhi at Gazipur (12 MW) (MNRE Annual Report, 2014–2015) also in Delhi, Narela (24 MW) waste-toenergy plant is under installation.

Though, in developed countries to acquire enhanced biodegradation and gas recovery, the leachate/liquid/ supplemental water is added/ recirculates in landfill sites (Barlaz, Ham, & Schaefer, 1990; Reinhart, McCreanor, & Townsend, 2002). But unfortunately, MSWR does not permit leachate recirculation in India. Hence, a vast opportunity for enhanced energy recovery from landfill remains untapped.

H.WHAT IS WASTE TO ENERGY?

WtE describes the process of utilising waste to generate energy, in the form of electricity, heat or fuels. WtE projects involve a range of stakeholders, from local councils who manage municipal waste, through to businesses in the waste and energy sectors, energy users and generators of waste.

Broadly, WtE facilities fall into two main categories: thermal treatment and biological processing of organic waste. These processes use a range of technologies including combustion, gasification, anaerobic digestion and fermentation. The exact type of technology utilised in any project is dependent on the characteristics of the feedstock waste material. Similarly, the outputs and residues from WtE processes also vary, depending on the nature of the feedstock and the technology used.

WtE is typically considered 'renewable energy' when organic waste (biomass) is used as the feedstock. However, the use of plastic feedstock in some WtE facilities also requires the use of fossil fuels, diminishing the environmental credentials of such initiatives.

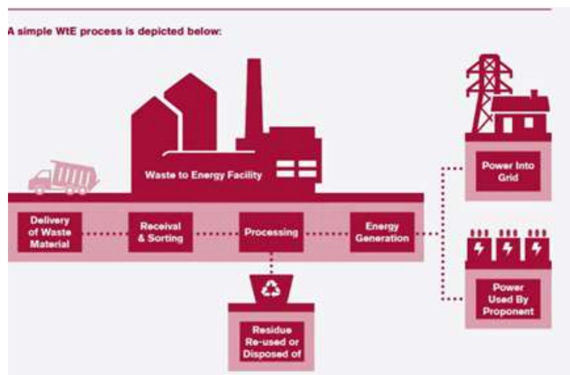

Fig.8..Diagram of WTE generation plant

I.TYPICAL CONTRACTING STRUCTURE

Before undertaking an WtE project, proponents should understand and assess the issues outlined in this article and appropriately address all responsibilities and risks through an integrated suite of project contracts.

Fig.9.Diagram of typical contracting structure

J.NOTABLE FEATURES OF THE CONTRACTING STRUCTURE ARE:

An WtE project requires secure contracts for supply and delivery of feedstock, particularly where the project relies on feedstock from an external source. Long-term supply contracts (preferably 15-20 years) may be difficult to achieve as existing market practice and preference is for contracts of significantly shorter duration, typically around two years for commercial waste contractors.

For procurement of design, construction and commissioning of the WtE plant, the proponent will need to engage consultants and a contractor (whether construct-only, design & construct, EPC or BOOT contracting structure) under clear and robust contractual terms that provide protection for the proponent.

If the proponent will not operate or maintain the plant, the proponent will need to engage a services contractor to provide operations and/or maintenance services throughout a defined contract period.

A waste disposal contractor will be required for any residue that is not re-used on site or sold to external customers.

If the project feasibility is dependent on revenue from the project output – such as energy sales into the grid or selling residues, commitments for secure long-term off take contracts will be required at the outset. As an alternative to selling energy to energy retailers, the project proponent may be able to sell WtE energy directly to industrial or corporate users or local councils. The project proponent may also have the ability to utilise the energy on site in its own operations.

Where external financing is required, robust debt and equity arrangements will need to be agreed at the project outset, with associated security mechanisms.

III. CONCLUSION

The aim of this study is to present the status of MSW and other important aspects like challenges for integrated SWM, intricacy of PPP mode, role of rag-pickers, prevailing practices of MSWM, and the rules pertaining to waste management in India. In developing countries like India, it is important to plan and implement sustainable low-cost SWM strategies. Lack of awareness, inappropriate technical knowledge, inadequate funding, unaccountability, implementation of legislation and policies are major reasons for the failure of MSWM. Issues like proper site selection, adequate financial support and improper human resource management, can be overcome with enhanced capacity, improved procedures and training. The solution to the problems associated with development and adoption of appropriate technologies and lack of trained manpower will require at realistic time frame and not only central government bodies, but state governments also have to take various actions for strengthening MSWM in the country. The intricacies that could arise during implementation should be taken into account, so that decisions and strategies can be based on ground actualities.

Rules of SWM need to be taken in such a way that these take into account the ground realities and allow time for suitable processes and mechanisms to be developed. Unfortunately, role of rag-pickers in SWM has not been adequately recognized till now, who are one of the important stakeholders of the SWM in India. Their role needs to be accommodated in the proper system to upgrade and boost their morale. However, rag-pickers are working for the unorganized sector, therefore proper organized sector for reuse and recycling of waste needs to be put in place to generate more employment and revenue, apart from reducing the load on transportation and landfill

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