Requirement of Government Support for Sustainable Waste-to-Energy (WtE) Projects in India

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Abstract: Waste problems are becoming critical day by day and thus it becomes imperative to adopt better technologies for its treatment and disposal. In the absence of any concrete solution, open garbage dumping is leading to generation of GHGs and pollution of ground as well as surface water resources. Waste to Energy (WtE) can be a good option as these projects scientifically dispose considerable amount of garbage and the energy generation becomes an additional advantage. However, the positive attributes of generating electricity from these energy sources cannot be commercially competitive with the projects based on conventional fuels, as WtE projects require huge investment and O&M costs leading to higher cost of power generation. Further, the revenue streams from sale of power are also not sufficient to cover up the cost and provide sufficient returns. Worldwide many countries have made firm policies to support WtE industry for the effective management of municipal solid waste. But, in India, absence of suitable policies is making WtE industry financially unviable. This paper seeks to establish necessity of Government support for sustainable WtE Projects in India.

1. INTRODUCTION

Waste-to-Energy (WtE) technology in India was first experienced in 1980's, when country's first plant, based on the Incineration, was setup at Timarpur, Delhi. Unfortunately it was turned out to be a failure. Since then few more projects came up, but none of them could provide long-term solution to the country's emerging municipal solid waste problems. After more than two decades, still this area is facing ups and downs in terms of technology and financial viability. Lack of support from the Government and over stringent rules & regulations have made project promoters chary of taking up WtE projects and left this industry in a dilemma. Our ex-Finance Minster in his Budget speech for FY 2013-14 has also indicated that Government of India (GoI) will support Municipalities to implement Waste to Energy Project through different instruments such as Viability Gap Funding, Repayable Grant and Low Cost Capital. The Corpus of Rs. 15000 Crore in the National Clean Energy Fund (NCEF) could be tapped for the concessional financing of WtE Projects.

In order to examine the requirement of Government support for sustainable WtE project in India, we need to find answers to the following questions:

a. What are the levels of Municipal Solid Waste (MSW) generations? What options are available to deal with the MSW? Is WtE inevitable?

b. What are the various technologies for WtE? Which is preferred option for WtE in Indian context?

c. What are the costs involved?

d. What are the current national and international practices of supporting WtE projects?

e. Recommended support from Government to WtE projects and why should Government give such support?

Although there are pros and cons of various WtE technologies and the authors support all technologies, however, RDF technology has been suggested as the best option in Indian context for the following reasons:

a. There is no source segregation of MSW in India.

b. High moisture content of MSW.

c. Road sweepings, drain silt, construction and demolition debris also forms part of MSW in India.

d. Recently, National Green Tribunal (NGT) of India has directed one of the WtE plant operating in Delhi to incorporate pre-processing of MSW in their process [23].

2. RELATED LITERATURE

Worldwide experience of WtE projects and related policies for the financial support to WtE industry are discussed in succeeding paragraphs.

2.1. Worldwide scenario of WtE projects

2.1.1. United States (US). As on 2007, the United States (US) was having 87 WtE Plants in 26 States. Total energy from WtE Plants in the U.S is nearly 2700 MW per year [14].

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2.1.2. Europe. As per Confederation of European WtE Plants, in 2006, the total renewable energy of 38 TWh was generated from the WtE facilities in Europe. By 2020, this is expected to reach at least 67 TWh (or may be potentially to 98 TWh). This much amount will be enough to supply renewable electricity to 22.9 million inhabitants and renewable heat to 12.1 million inhabitants. By 2020, the total energy from WtE will increase by 40% although it has a potential to increase by even 100%.

2.1.3. China. In the past three decades, with the rapid development of economy and industry, MSW generation in China increased by five times, from 31 million tons in 1980 to 157 million tons in 2009. There is a 10 times increase in the WtE capacity in China from 2001 to 2009 and there is a proposition for around 140 WtE plants within next 5 years. Further, number of WtE plants has been tripled in these years and the average capacity of WtE plants has also increased 4 times. [22]. From the above examples, it can be seen that US, Europe and China have adopted WtE in a big way for mass management of MSW. Out of all options for MSW management, WtE has advantage of least land requirement vis-à-vis quantity of MSW. Further the energy recovery becomes an added advantage from these projects. Most of the developed and developing countries, having larger population are making WtE industry as an integral part of their waste management programs. For a populous country like India, WtE can surely prove to be a better option for the treatment of humongous waste.

2.2. Policies for WtE development

2.2.1. National practices. The WtE technologies are being promoted through various policies and programs of the Ministry of New & Renewable Energy (MNRE). However, these policies are in the form of capital subsidies in the early stages of development, and do not provide the long-term sustainable solutions. MNRE capital subsidy barely covers approximately 5% of the huge capital cost and risks involved in such projects. It is observed that in the overall renewable energy generation scenario, the utilization of WtE for electricity generation has remained very marginal. As per the report published by TERI in the year 2006, the utilization of Urban and Industrial Wastes under the “Program of energy recovery from Urban and Industrial Waste” is only 45.7 MW against an overall estimated potential of 1700 MW [29].

The Electricity Act 2003 (EA 03) [21], National Electricity Policy (2003) [19] and National Tariff Policy (2006) [20] notified by Ministry of Power, GOI, have also emphasized the importance of setting renewable energy quotas and preferential tariffs for renewable energy procurement by the respective State Electricity Regulatory Commissions (SERCs). However, the high cost of electricity generation from MSW continually discouraged the distribution licensee and other investors from taking up WtE projects. Central Electricity Regulatory Commission (CERC) has notified Regulation on Renewable Energy Certificate (REC) [2, 3] to give a push to renewable capacity addition in the country and created a national level market for such generators to partially offset their cost. But the said REC policy is again common for each renewable source and does not extend any specific support to WtE projects, therefore not proving to be sufficient to develop this industry at its initial stages. Hence, there is a need for specific policies for WtE projects.

2.2.2. International practices. The international experience across different countries highlights the fact that the implementation of favorable energy policies has been helpful in promoting and expanding renewable energy technologies. The dominant renewable energy based policy instruments that have an important bearing on the pricing of renewable energy power are Feed-In-Tariffs, Quotas/ Renewable Portfolio Standards/ Renewable Energy Credits and Tendering Schemes.

Feed-in tariffs are a commonly used policy instrument for the promotion of renewable electricity production. The term feed-in tariff can be used either in the context of a minimum guaranteed price per unit of produced electricity as approved by the regulator, to be paid to the producer, or as a premium in addition to market electricity prices. The level of the tariff is commonly set for a number of years to give investors security on income for a substantial part of the project lifetime.

Quotas/Renewable Portfolio Standards/Renewable Energy Credits are expanding at the state/provincial level in various countries like United States, Australia, UK, Japan, Poland and Thailand.

Under **Tendering System,** regulators specify an amount of capacity or share of total electricity to be achieved, and the maximum price per kWh. Project developers then submit price bids for contracts. Governments set the desired level of generation from each resource, and the growth rates required over time. The criteria for evaluation are established prior to each round of bidding. In some cases, governments will require separate bids for different technologies, so that solar PV is not competing with wind projects or with WtE, for example. Generally, proposals from potential developers are accepted starting with the lowest bid and working upwards, until the level of capacity or generation required is achieved. Those who win the bid are guaranteed their price for a specified period of time; on the flip side, electricity providers are obligated to purchase a certain amount of renewable electricity from winning producers at a premium price. The government covers the difference between the market reference price and the winning bid price.

3. CURRENT MSW SCENARIO IN INDIA

Rapid urbanization and development in India has led to the generation of thousands of tons of Municipal Solid Waste

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(MSW). The MSW amount is expected to increase significantly in the near future as the country strives to attain a developed and industrialized nation status by the year 2020 [7, 27]. It is reported that 70% of MSW is being collected and 12.45% is being processed or treated and rest quantities remain untouched. Studies also reveal that about 90% of the collected MSW is disposed of unscientifically in open dumpsites, creating problems to public health and environment. The management of MSW is going through a critical phase, due to the unavailability of suitable facilities to treat and dispose of the larger amount of MSW generated daily [9, 13, 15, 16, 17, 24, 25].

3.1 Generation of solid waste

The current annual generation of MSW in India is approximately 50 million tons (@500grams/capita/ day). Majority of this waste comes from the urban areas that account for nearly 32% of the total population of the country. Due to the rapid development, the per capita waste generation is increasing by 1.3% each year and at the same time; population growth can also be observed between 3–3.5% per annum due to the usual growth rate and migration of people from rural areas to cities. The cumulative effect of these two is increasing the waste quantities by around 5% every year. At this growth rate, it is estimated that per capita waste generation in India will go up to 800 – 900 grams per day by the year 2047 [4, 5, 8, 18]. Corresponding effect of the increasing waste quantities on land requirement for the dumping of waste suggests requirement of 16, 960 hectares land by 2047, as against 3, 915 hectares land, which was being used as dumpsites in 2010 [1, 6].

3.2 Composition of MSW

The composition of MSW generated from various sources forms the basis on which the management system needs to be planned. The characteristics of the MSW depend on a number of factors such as food habits, standard of living, growth rate, degree of commercialization and of course seasonal variation. On an average, its composition on wet weight basis may be given as: 50–60 % biodegradables, 10–12% combustibles, 30–40% inert components (silt, dust and fine earth) and recyclables (less than 1%). The C/ N ratio ranges between 20 and 30, and the lower calorific value ranges between 800 and 1000 kcal/kg [26]. However, the average composition varies widely from class-I to class-IV cities. Maximum moisture content is due to kitchen and food waste, which forms part of biodegradables. Therefore, considering composition on dry basis would lead to a conclusion that combustible fraction forms the major part of MSW as far as waste generated from the metro cities is concerned. Therefore treatment options need to be planned accordingly.

3.3 WtE Technologies

Various WtE technologies for waste treatments are listed in Table 1 below [10].

Table 1. WtE technologies (CPHEEO Manual on MSW Management, 2010 – Chapter 15)

<table>
<tr><th>Waste Treatment Method</th><th>Basic Principle</th><th>Desirable range of important waste parameters</th></tr>
<tr><td>Thermo-chemical conversion:</td><td rowspan="4">Decomposition of organic matter by action of heat</td><td rowspan="4">Moisture < 45%
Organic/VM > 40%
Fixed Carbon< 15%
Total inert < 35%
CV(Net) >1200Kcal /Kg</td></tr>
<tr><td>Incineration</td></tr>
<tr><td>B. Pyrolysis</td></tr>
<tr><td>C. Gasification</td></tr>
<tr><td>Bio-chemical conversion:</td><td rowspan="2">Decomposition of organic matter by microbial action</td><td rowspan="2">Moisture > 50%
Organic/VM > 40%
C/N ratio 25-30</td></tr>
<tr><td>Anaerobic digestion or Bio-methanation</td></tr>
</table>

3.3.1. Incineration. Incineration has almost 125 years old history. Worldwide over 1000 units are installed based on Incineration. Three types of combustors are used for MSW incineration – grate incineration or moving grate combustors, circulating fluidized bed and rotary kilns. Rotary kiln is old technology and is almost obsolete. Circulating fluidized bed combustors were not so successful in Europe and USA, however, in China, Zhejiang University is working on developing good model of fluidized bed combustors for MSW. Grate incineration is the most common type of combustor and hence in this paper incineration will refer to grate incineration. It is a well-proven, efficient and prevalent technology that has been tested on a large scale. The thermal energy generated through incineration is utilized for the production of electricity and/or for district heating purposes. However, due to the pollution concerns, post 1995 incinerators are required to operate according to new European Commission (EC) requirements of emission controls by appropriate combustion control methods [11].

Mass incineration (MI) is prevalent form of waste disposal/treatment in the Europe, US, China and Japan. It implies burning MSW as it is received. According to the classification of MSW carried out by the Incinerator Institute of America for US Waste, both Trash (type-0) and Rubbish (type-1) mixed wastes have heating values as good as 4720 and 3610 kcal/kg respectively [12]. This is because of the high standard of living that the quality of waste for combustion becomes far better than that in developing countries. Further, the source segregation, systematic collection and transportation add to the CV of waste. Therefore in their case, there is no need to have extensive pre-processing plants as the waste can be directly burnt in to the boilers to generate energy.

MSW consists of organic/biodegradable fraction, combustible fraction and inert material. When MSW is subjected to pre-processing through screening, shredding/sizing, drying and air classification, we can separate combustible fraction of MSW, which is known as RDF. Segregated biodegradable material can be used for aerobic/anaerobic digestion and inert disposed of at landfill. In order to carry out effective combustion of low quality waste (low CV, high moisture content and highly mixed waste), it is preferable to carry out pre-processing and incinerate RDF in boiler instead of entire MSW as received. Incineration of RDF for power generation also helps mitigate efficiency and environmental issues associated with incineration of MSW. Pre-processing of MSW and converting it into RDF, ensures good quality combustion of RDF. Good quality combustion also reduces generation of pollutants.

Since in India the waste is highly mixed and heterogeneous with an appreciable proportion of dust and dirt, debris and moisture, therefore RDF process is considered to be more effective for the Indian waste rather than mass incineration.

3.3.2. Gasification/Pyrolysis. Gasification is done in the presence of partial oxygen or air to produce syngas or producer gas, respectively, whereas the Pyrolysis occurs in the absence of oxygen to obtain the fuel gas. Waste gasification has almost 10 years old history. There are around 100 waste gasification plants worldwide. These are mainly for Industrial/Homogeneous waste, coal, lignite (High CV fuel). Waste pyrolysis has only 30 years old history and less than 10 plants worldwide. It is mainly used for industrial waste, lignite (High CV Fuel).

3.3.3. Anaerobic-digestion. Also called bio-methanation, the process comprises of waste digestion by anaerobic bacteria to break complex organic matter and produce biogas (with high methane content). The gas can be used for the energy recovery through heat or power generation with additional production of high-grade soil conditioner from the digester.

4. DISCUSSION

This section presents WtE plant economics and subsequently highlights the recommendations for the support from the Govt. to WtE Industry in India and the Social and Environmental Benefits of this support.

4.1 WtE plant economics (with pre-processing)

Economically, it is much costly to setup a WtE plant in comparison to a conventional thermal power plant. A financial analysis has been shown in Table 2 for a 1000 TPD WtE plant, based on RDF technology, generating 8 MW power. The capital cost of such facility comes out to approximately Rs. 1750 million.

Table 2. Financial Analysis of a 1000 TPD WtE plant (based on RDF Technology) producing 8 MW power *

Particulars	Amount (Rs In Mns)
Land	15.00
Civilwork	298.22
Plant & Machinery	1111.48
Consultancy	89.22
Initial Debt Cost	63.51
DSRA	131.50
Upfront Fees and Other Financial Charges	41.17
Total	1750.10

**** Figures obtained from a reputed company setting up a WtE plant, based on RDF process, in Delhi.***

Following financial assumptions have been made while estimating these costs:

- Power tariff @ Rs. 12 per KWH 5% YoY increase.
- 5% YoY increase on fuel & operating cost.
- Debt equity ratio is kept as 70:30.
- Interest rate 12 % per annum.
- IT MAT rate and General IT rate are assumed as 20% and 33.99%, respectively.
- Service concession agreement is taken as 25 years.
- Plant load factor 80% with and internal consumption of 26%. (Slightly higher due to pre-processing unit).
- Calorific value (CV) of the RDF produced is 3000 kcal/kg.

From the above analysis, it can be observed that the cost for the production of power is quiet high in WtE facility. Even with Rs. 12 per unit tariff, the IRR comes out to be only 13%. It is thus concluded that WtE projects in India do need support in order to be financially viable and sustainable.

4.2. Recommendations for the support from the Government of India (GOI)

4.2.1. Upfront Support. The upfront support may be extended in terms of Gate fee or tipping fees. The concept of tipping fees is already being implemented by some of the municipalities in India, but the amount is not fixed and varies from state to state as per their respective SWM programs. Further the amount is not sufficient to make projects financially viable. Therefore, in this regards, there is a need of firm policies to fix the amount of tipping fee for WtE projects. It can be based on the justifications that the processing of waste in the WtE plants saves the disposal cost incurred by various municipalities in dumpsite management, as also the avoidance cost of developing a scientific landfill.

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4.2.2. End product based support. The overall approach in India through the Electricity Act 2003 and the National Tariff Policy indicates the competitiveness through the quota and competitive bidding. This approach is known as Marginal Cost Approach (MCA). In India, the pricing of the renewable energy technologies (including WtE projects) is also being carried out on the same principle. But the use of marginal cost methodology is actually making the WtE projects to compete with the conventional power based projects, which cannot be taken as a fair approach. The approach of the pricing for these projects should be rational keeping in mind the need and purpose for setting up these projects. It will be preferable to adopt a Cost Based Approach (CBA) that can be used in short term as well as in long-term strategy.

4.2.3. Other Supports

Emission norms formalization: Since these projects are in early development stage, the emission norms should be formalized based on the type and technology of the individual project.

Help in getting clearances: The regulatory compliances are also acting as major obstacles in the development of WtE projects and thus require a single window clearance method till the stabilization of the industry.

Awareness Campaigns: Beside the extensive use of WtE technology worldwide, the industry poses a negative image in the eyes of Indian citizens. Various public protests against these kinds of projects, due to less understanding of the field, are a big threat for the WtE industry. In this regard, proper awareness campaigns should be carried out by the Government authorities to impose the better learning and knowledge amongst the common man for understanding the need of these projects.

Strict technical evaluation of bids: While evaluating the bids for any WtE project, more weightage should be given to the technical part. There are instances where promoters quote very low just to grab the project and make away with up from subsidies. A high quality check of the technical proposals would reduce the risks associated with forged technology providers.

4.2.4. How long is this support needed? The support would be required till the industry stabilizes in terms of technological development and indigenization. The support price can be calculated depending up on the number of factors and existing scenarios of each state, however the duration for the support is recommended for at least 5 years. It can subsequently be reviewed.

4.3. Social and Environmental Benefits of Support to WtE Industry

4.3.1. Saving of Land. As mentioned earlier, WtE projects require much less land area for managing MSW as opposed to the land filling. This is because the rejects, which need to be land filled after treatment in WtE is a very small fraction of incoming MSW. Apart from the adverse social impacts of creating a MSW landfills in ever expanding cities, there are significant costs of acquisition of land, which can be reduced by setting up WtE projects.

4.3.2. GHGs Mitigation. Typically open dumpsites generate a large quantity of methane and carbon dioxide due to anaerobic decay of waste, which would be avoided by setting up these plants. It would lead to avoidance of GHGs and toxic gases generation from the open dumpsites.

4.3.3. Air Pollution. Open dumpsites generate a number of toxic gases that have various detrimental effects on the health and environment of the surrounding area. It includes gases like SOx, NOx, CO, CO_2, etc. Also due to frequent incidences of fire, the dumpsite generates highly toxic dioxins and furans.

4.3.4. Water Pollution/Leachate. Leachate, generated due to the moisture content in the waste, has a tendency to percolate in to the underground soil strata and contaminate the ground water, and surface water due to the run-offs in rainy season. It is a highly toxic substance, which contains number of heavy metal contaminants.

4.3.5. Health Benefit. The incidences of open dumping have huge impacts on the health and hygiene of the nearby communities.

4.3.6. Social Inclusion. The WtE projects could offer employment to a large number of populations that would be required to carry out various plant activities related to waste sorting, processing, shift workers, etc.

5. CONCLUSION

With respect to the increase in waste quantities day by day and the limited land availability, it is imperative to adopt the waste treatment methods, which can reduce the waste quantities and dispose it in a scientific manner, thus reducing the pressure on the various environmental resources. WtE plants have a high potential to treat the humongous waste quantities and upgrading the environmental conditions in comparison to dumpsites. It is, thus, a better option for scientifically disposing considerable amount of garbage for Indian cities. Further to this generation of electricity is an additional benefit from these plants.

The WtE projects are very much capital intensive with high O&M cost, leading to higher cost of waste processing and power generation. The returns are also limited in the absence of preferential tariff or tipping fee. Though there is a very limited operational experience on commercial scale in case of WtE projects in India. However, as per the estimated financial model mentioned earlier in the paper, even with a sale price of Rs. 12 per unit, the IRR comes out to be 13% only. Further the

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industry is in development stage in India and striving to grow towards sustainability. Thus, these plants need to be promoted with attractive policies and proper support.

The WtE industry in India is still evolving and there are very high risks associated with WtE projects in terms of technology, regulatory compliances, pollution norms, etc. This makes a strong case for the institutional/government support to the WtE industry, at least till the industry stabilizes in terms of technology, policies etc.

A number of policies for the financial support in terms of feed-in tariffs, subsidies, upfront fees, etc. are available in the developed countries like Germany, Sweden, UK, USA etc. as well as in developing countries like China, Malyasia and Thailand. In India, given the state of municipal finances and the relatively low priority accorded to the treatment and disposal (80% of municipal solid waste management programs budget are for collection and transportation), it is recommended that some incentives may be provided till the stabilization of WtE Industry. Apart from it, the upfront support will help in making the projects financially viable for ensuring private sector participation and the long-term health of these projects. This will make a successful model for the development of WtE in India and help in reducing the volume of waste to be land filled, thus releasing pressures on the scarce land and avoiding overflowing dumpsites.

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