Evolution of Waste-to-Energy Technology—An Indian Perspective Projects

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Abstract Waste-to-Energy (WtE) is still at a preliminary phase in the developing countries have a large population like India. Despite the fact that WtE is as expected to develop at an acceptable rate due to an essential part of the waste management program (WMP). Under WMP, Govt. investing a substantial amount of money for the growth of the WtE industrial technology but past WtE projects have got a low success rate. Several earlier projects got failed due to LACK OF EXPERTISE of the plant operation, selection of the wrong set of technology, the mismatch between plant design and waste characteristics, lack of Govt. support, poor project development, financial viability, and pollution concerns. The collapse of WtE industrial technology plants in India due to the earlier mentioned cause. This has made Govt. and supporters attentive of taking up WtE projects. Based on that, the paper presents several steps for the development of WtE and suitable cause for which the WtE industrial projects in India step on to a declined path. Also, the necessary recommendation for the future path.

Keywords Air pollution control · Emissions · Energy recovery · Project development · Waste-to-Energy (WtE)

1 Introduction

Waste-to-Energy (WtE) is the process of energy generation from waste materials through various thermal and biological treatments of nonrecyclable waste mass into usable heat or electricity. Most of the countries (worldwide) are adopting WtE as an

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integral option of their waste management programs (WMP). When it comes to the mass treatment of Municipal Solid Waste (MSW), WtE offers a better and scientific solution of reducing the waste mass quantities and thus saving the valuable land area. Further, the energy recovery becomes an additional advantage from waste mass through WtE project. It is a well-proven technology in most of the countries, but could not provide a single successful project till now, no matter it is Mass Incineration (MI) of MSW or the combustion of Refuse Derived Fuel (RDF). In fact, the RDF process is considered to be more useful for the Indian waste rather than mass incineration because of the mixed and heterogeneous nature of the Indian waste with a considerable proportion of dust and dirt, debris and moisture [1]. However, the past projects showed that even the projects based on the RDF technology were unable to run for a long time because of numerous reasons. These are

- Lack of expertise of the plant operators for the concept of WtE.
- Selection of the wrong set of technology no standardization for the process.
- Mismatch between waste characteristics and plant design inefficient combustion.
- Poor project development by the authorities benefited flyby-night operators.
- Lack of regulatory support from the Govt. and financial viability.
- Pollution of the various types of toxic emissions—inefficient flue gas treatment.

All the above-mentioned reasons resulted in a “BAD TRACK RECORD” of WtE projects and formed a negative image in India [2]. The “Not In My Back Yard —NIMBY” syndrome further added up into these drawbacks. Consequently, a mindset has been developed for the non-willingness of the Govt. and promoters to set up good projects based on MSW. This paper will review the journey of WtE industry in India and figure out the key reasons for their nonperformance. Since there is not enough literature available on this sector, therefore, information and the data available on the websites and published reports of various Govt. departments, news articles, and internal corporate research are used as the references to authenticate the documented material in this paper.

2 Global Evolution of WtE

The evolution of WtE globally is a long story of learning and experience.

a. The first destructor in England, built in Manchester in 1876, was reported to be operating 30 years.
b. The second country to use waste combustion was built in the United States of America (USA) in the year 1885 [3].

By 1910, hundreds of combustors had been built in the USA, UK, and other developed countries also followed suit. After about 1950, as land became more expensive, and the population blossomed, local Govt. began to hire engineers to build refractory chambers to burn the waste and even wash down the smoke considerably. In 1961, New York issued a law ensuring each apartment house has its waste burning facility. Around 17000 small combustors were installed without any Air Pollution Control (APC) measures, and subsequently, the law was withdrawn in 1966. Till the 1970s, large incinerators installed without APC measures, by the time when the detection of dioxins and other harmful pollutants in the waste combustor filter ashes caused violent public opposition, especially in European countries. The issue of the toxic effects of dioxins on human health had become the subject of research throughout Europe. Significant technological advancements to deal with the pollutants (including dioxins) and further tighten up emission limits, thus initiated with the start of the 1980s. In 1986, Germany produced an amended regulation (TA Luft 86). It took further few years to develop a complete understanding to deal with the enormous range of pollutants in stacks of different WtE plants. The effects of the new regulations and the newly developed technology become visible in the tests of the numerous waste combustion plants, e.g., the results of experiments in a US waste combustor in 1989 [4]. The results of this technical progress for the further stiffen of the emission limits formed the basis of the EU Waste Incineration Directives (WID) issued in 2000 (European Parliament and Council, 2000) and is today the international air emission guidelines. Soon, these plants were transformed from a pollution source into a pollution sink, and more projects start coming, especially in developed countries for the efficient management of solid waste. As per an approximation, there are around 1000 WtE Incineration based plants worldwide till now.

3 Development of WtE in India

This section will present the Indian historical perspective on WtE projects covering details of all past projects attempted in India, outlining their key features and reasons for nonperformance. For a better understanding, the projects have been divided into two parts, i.e., the first generation and the second generation projects as shown in Fig. 1.

3.1 First Generation WtEs

The first generation of WtEs of the developed India is as follow:

(i) Timarpur MSW Processing Complex, Delhi (1987): India's first commercial WtE plant was established in the year 1987 by Municipal Corporation of Delhi (MCD) with financial assistance from Govt. of Denmark with the aim to address the dual problems of the waste disposal and the electricity shortage faced by the city. The capacity of the plant was 300 tons per day (TPD) to generate 3.75 MW electrical power. It was set up at the cost of Rs. 25 crores by M/s Volund Miljoteknik of the Denmark that also supplied the incineration technology.

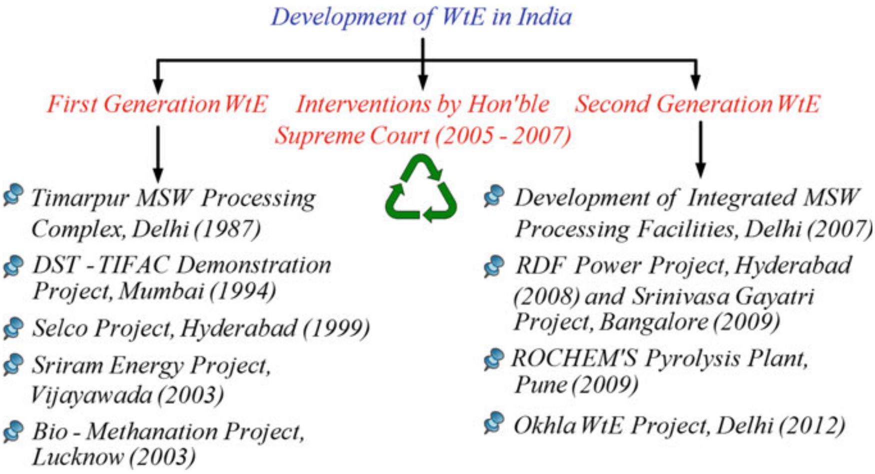

Fig. 1 One process of development of WtE in India

The MSW plant started operation on a pilot basis but the shut down three years later in 1991 (Public policy team, Athena infonomics, May 2012).

The main reason for the poor performance of the Timarpur Project was a mismatch of the calorific value (CV) of incoming refuse (600–700 kcal/kg) with the plant design of 1460 kcal/kg net CV. Further, the plant was designed for screened garbage, and unscreened garbage affected the performance of equipment, as the mixed waste led to the incomplete combustion. A screening plant of 100 TPD capacity was installed in 1989 to get over the design defect, and the plant commenced its operation again, but did show some improvement and had to be shut down in 1990 (Department of Economic Affairs, GoI, 2009). India lost the arbitration case at the Hague because the "suitable waste" to be provided by the city was not defined in the agreement. Apart from the low heat value, shortcomings of the Solid Waste Management (SWM) systems in vogue at that time also reported for failure [5].

(ii) DST-TIFAC Demonstration Project, Mumbai (1994): In 1994, the Department of Science & Technology (DST) analyzed the reasons for the failure of the Timarpur project. It developed a technology that was suitable for Indian waste. A demonstration project of 150 TPD capacities was commissioned at the Deonar dump yard of the Mumbai Municipal Corporation (MMC) for converting MSW to fuel pellets in 1994. RDF pellets with a moisture content around 10–15% and CV in the range of 2500–2800 kcal/kg were indigenously produced by MSW processing. The processing operation consists of various unit operations, viz. screening, shredding, drying and air classification (DST, GoI). The pellets produced were test marketed in and around Bombay, and the separated soil containing delicate organic matter was used as a soil enricher. The experience of this plant was used to develop a model that indicated the suitability of the design for a commercial scale MSW processing plant. Initially, RDF plants based on DST-TIFAC were setup in

mid-nineties [6]. After that, DST, through its autonomous wing Technology, Information, Forecasting, and Assessment Council (TIFAC) transferred this technology to M/s SELCO International and M/s Sriram Energy Systems (SES).

(iii) Selco Project, Hyderabad (1999): Selco International Ltd. set up a plant of 700 TPD capacity in Gandamguda village of Saroornagar Mandal, Rangareddy district, Hyderabad in 1999, which was later upgraded to 1000 TPD in 2003. A power plant to generate 6.6 MW power through the RDF combustion route was also set up at Elikatta village, Shadnagar Mandal, Mahboobnagar district Mahboobnagar district, Hyderabad in 2003 [6].

Dryers, Hot Air Generator (HAG), and air density separators were used as per DST-TIFAC recommendations. However, screening and shredding operations were absent. Boiler used was traveling grate, stoker fired boiler supplied by Walchand Nagar Industries Ltd., and Electrostatic Precipitators (ESP) was used for flue gas treatment during its initial years of operation, the facility produced above 6.6 MW (more than design power). The plant was burning mixed fuel with a CV of 12 MJ/kg (25% addition of rice husk in RDF), which is sufficient for self-sustained combustion. However, the plant was last operated in November 2009, and now it is running twice every month to keep the machines working [2].

Malfunctioning of the low-quality boiler and air-cooled condenser made the operations unviable. The maintenance cost of the equipment had increased tremendously, resulting in its non-operations. But, apart from that, the key reason for its failure was the poor institutional framework for the project by the Govt. authorities. After installation of the RDF plant, when the plant operator decided to set up a captive power plant, as the sale of RDF to the nearby industry was not proving to be satisfied, the said permission of power plant was given at a separate site at an entire distance of 50 km. The transportation of RDF to the 50 km distance affected the financial model of the plant. Also, the plant was using 20% biomass, the cost of which had increased, making operations unviable, as a unit was already paying Rs 10 per ton of waste delivered to Municipal Corporation. Further, the Andhra Pradesh Transmission Company (APTRANSCO), with which Power Purchase Agreement (PPA) had been signed, reduced the power tariffs mentioned in the PPA due to which company had also suffered substantial financial loses (Planning Commission Report, 2014).

(iv) Sriram Energy Project, Vijayawada (2003): Simultaneous to the implementation of SELCO plant, M/s Shriram Energy Systems, in 2003, also commissioned a 6 MW power plant in Vijayawada based on the DST technology. The plant was built to handle waste from Vijayawada and Guntur districts around 40 km apart. RDF plant in Vijayawada (400 TPD fluff) along with palletization plant at Guntur (300 TPD), pellets transported to Vijayawada followed by the combined power generation of 6 MW. The plant was using approx. 30% of biomass with the fuel [6].

RDF plant had installed only local make shredders only, and dryers, HAG & Air Density Separators (ADS) were not installed. Traveling grate boiler using Alstom Germany design was built with ESP for flue gas treatment [2].

The quality of the RDF produced was reduced due to the absence of drying operations, as the plant has by-passed the rules of the DST-TIFAC recommended process. The absence of a drying system led to low calorific value in the fuel because of the moisture, which in turn caused inefficient boiler operations. A few technical shortcomings in other equipment like condenser and turbine also arose because of poor maintenance. Financial viability also got effected; first, because of increased in the prices of biomass, and; second because of the two toll booths which came up between Vijayawada and Guntur—each way vehicles had to pay around Rs 100–150/—as toll charges. Another reason behind the failure of the Vijayawada plant is believed to be a problem with the supply of poor quality waste to the facility. The plant operated for only 5 to 6 years, and operations shut down in 2008.

(v) Bio-Methanation Project, Lucknow (2003): Another WtE initiative based on bio-methanation technology was tested in 2003, by Lucknow Nagar Nigam (LNN). LNN invited Chennai based Enkem Engineers to be the project promoters, and the SPV called Asia Bio Energy India Ltd. (ABIL) was floated for the project. The ENTEC, an Austria-based firm, provided the BIMA digester technology, which has over 50 WtE plants worldwide. The plant was to use 300 MT of solid waste daily to produce biogas, which was to be used to generate 5 MW power by using biogas as fuel for five gas generators. The estimated project cost is Rs 76 crore (LNN, 2002).

Unfortunately, the plant did not operate successfully and shut down in 2005. There is nothing wrong with technology as such. However, unreliable pretreatment of mixed solid waste (MxSW) for anaerobic digestion and high soil content (around 35 to 50%) made the digestion process difficult, as these plants are susceptible to impurities in the feed. No technical feasibility study was carried out by the LNN w.r.t the waste characteristics viz. a, viz., plant design. Eventually, the plant ceased operations in 2005 after an operational history of 6 months characterized by hiccups [2]. The issue had gone into arbitration under the jurisdiction of Hon'ble High Court. Various high-level meetings were held between LNN, ABIL, MNRE, and Financial Institution (IDFC), but no concrete solution was worked out [7].

The failure of Lucknow plant in 2005 was the second major failure of WtE industry in India after the Timarpur project in 1987, and these failures continued till the closure of SELCO Hyderabd Project in 2008 and Sriram Energy Vijaywada plant in 2009. However, closure of the Lucknow plant specifically (though based on bio-methanation technology) attributed to the rise of mass opposition to the entire WtE facilities in the country and put a big question on the applicability of these technologies w.r.t Indian waste.

4 Interventions by Hon'ble Supreme Court (2005–2007)

The failure of the two major plants (Timarpur and Lucknow) and subsequent oppositions by various environmental organizations, led to the interference of the largest legal institution of the country to ascertain the future WtE industry in India.

The Supreme Court had, on May 6, 2005, prohibited the Govt. to sanction any further subsidies to such plants. The decision had cameup in the hearing of well-known case of Almitra Patel vs. Union of India, where an additional petition had been filed to stop the support of such WtE projects in India. Hon'ble Supreme Court noted that the bio-methanation based WtE plant at Lucknow had not lived up to its promise and had ordered the Govt. to constitute a committee to inspect the Lucknow plants and submit report. Accordingly, a 14-member body was constituted, chairing Dr. D. K Biswas, former head of the Central Pollution Control Board (CPCB). The decision of the committee could be the major downfall for the WtE industry, as many of the Govt. financial institutions stopped supporting such projects [8].

Pursuant to the Hon'ble Supreme Court order, a detailed report was submitted by the expert committee on January 2, 2006. The broad recommendations of the committee were as follows:

- The projects based on bio-methanation should be taken up only on segregated/uniform MSW plant unless it is demonstrated that in Indian conditions, the waste segregation plant can separate waste suitable for bio-methanation.
- The essential point to processing and treatment of nonrecyclable waste as an integrated system of segregation/collection/transportation of waste mass to promote pilot projects.
- The technology set should be based on the quantity and quality of waste and local conditions for treatment of MSW.
- The judgment point of view about the capability of the particular technology should not be based on the operational problems of one plant (Lucknow) and therefore, petitioner's objection may not be justified to providing support (subsidy) to WtE projects.

Having regard to the relevant facts mentioned in the Committee's report, the court on May 16, 2007 modified the order passed earlier and permitted Ministry of New & Renewable Energy (MNRE) to go ahead with five pilot projects, keeping in view the recommendations made by the expert committee. Accordingly, MNRE formulated a scheme to produced power using MSW and to providing financial assistance for setting up five Pilot projects. The main objectives of the "Programme on Energy Recovery from MSW" were: (1) To set up five Pilot projects for recovery of energy from MSW; and (2) To create conductive conditions and environment, with fiscal and financial regime, to develop, demonstrate and disseminate utilization of MSW for recovery of energy.

For reference, those 5 projects are: RDF Power Project (Hyderabad), Srinivasa Gayatri Resource Recovery (Bangalore), Rochem Pyrolysis Plant (Pune), Jindal's Okhla Plant (Delhi) and IL & FS Ghazipur Plant (Delhi) (MNRE).

4.1 Second Generation WtEs

The second generation of WtEs of the developed India is as follow:

(i) Development of Integrated MSW Processing Facilities, Delhi (2007): After the two decades of the Timarpur failure and willingness of Hon'ble Supreme Court to set up WtE projects, Delhi Govt. along with the MCD (Now trifurcated into 3 zones) again initiated a proposal to set up projects for the processing of MSW. Two projects were conceptualized in 2007; first at Okhla (in South Delhi) and the second at Ghazipur (in East Delhi). It was recommended by the Govt. in the bid conditions to use DST-TIFAC technology for both these projects. The bid of the Okhla plant was won by M/s Jindals Ecopolis, and that of Ghazipur plant was won by a consortium of M/s DIAL (GMR group of companies) and M/s SELCO International. The plant at Okhla was to produce 16 MW power by using 450 TPD RDF produced at Okhla and 225 TPD RDF produced at Timarpur and transported to Okhla (Environmental Clearance, Okhla Plant, MoEF). However, it was later changed by the company, and a power plant based on the MI technology was established at Okhla [5]. The plant is currently in big discussions as the nearby residents filed a complaint about the pollution against the plant in Delhi High Court in 2009, which was later transferred to National Green Tribunal (NGT) in 2013.

During this time, closure of the SELCO Hyderabad plant in 2008 reduced the confidence of DIAL on its partner company in setting up the Ghazipur project. As a result, DIAL lost interest, and the project was left by the company. Later on in 2009, on request of Delhi Govt., M/s IL&FS Environmental Infrastructure & Services Ltd. took over the Ghazipur project and did internal R&Ds to improve the RDF preparation and boiler technology.

(ii) RDF Power Project, Hyderabad (2008) and Srinivasa Gayatri Project, Bangalore (2009): In the years 2008 and 2009, two new entries entered in the list. The first was in Hyderabad (at Nalgonda District) by M/s RDF Power Projects Ltd. and second, was in Bangalore (at Mandur District) by M/s Srinivasa Gayatri Resource Recovery Pvt. Ltd. The Hyderabad plant was to process 800 TPD MSW to produce 11 MW power. On July 16, 2000, this project was initially sanctioned and revived on February 2, 2005, and claiming operations since 2008 as per their official websites and project-related documents. However, as per the visit conducted by the fact finding team formed by the Delhi High Court on August 1, 2011, in the case of Okhla plant hearing, the plant at Nalgonda was found nonoperational, and even the civil work was not completed. The project has now been taken over by IL&FS Environmental Infrastructure & Services Ltd as the promoter company is showing its inability to complete the project.

The other project of Srinivasa Gayatri (Bangalore) for generating 8 MW power from 800 TPD waste is still in the implementation phase. As per MNRE, the proponent has backed out from the project. The reasons for non-implementation of both these projects were exactly not known, however, abovementioned two projects are the clear examples of "Fly by Night—FbN" operators to grab the capital subsidies and heavy loan amounts from the Govt. and financial institutions due to poor structuring and loose contracts and then eventually backed out leaving the responsibility on the authorities.

(iii) ROCHEM'S Pyrolysis Plant, Pune (2009): In between so many glitches of WtE projects throughout the country, Pune Municipal Corporation (PMC) was planning their luck with a new experiment. It was a special project in which fuel was planned to convert into Syn gases using the pyrolysis technology to produce green power. Something that had not been tried ever on MSW in India and even not in the World. Both the PMC and MNRE were having high hopes with the technology. M/s Rochem Green Energy Pvt. Ltd. was selected to set up the plant with a capacity of processing 700 TPD MSW to produce 378 TPD RDF and subsequent pyrolysis of the same to produce 12 MW power.

The RDF line with 35 TPH capacity was imported from Bollegraaf, Netherlands, and Shredders were procured from Metso, Finland. The gasification technology for this project was procured from Concord Blue Towers, Germany. In the processing plant side, the RDF line with capacity 35 TPH was commissioned and presently running at the capacity of 150–200 TPD for 4–5 days in a week. The maximum load of the plant to date is 260–80 tons for 12 h. and results not satisfactory. In the power plant side, only one tower completed out of three to date, and gases from the plant is currently being flared since the power plant based on the pyrolysis technology has not been commissioned yet. The company claimed that the first phase of a 2.99 MW capacity is already commissioned and operating for meeting the auxiliary requirements. However, as per the visit of the MNRE officials, only the RDF plant is operational, and RDF is being palletized and sold into the market. The first phase is not completed at present, and the plant is meeting its auxiliary requirement by running a diesel generator (DG) sets.

(iv) Okhla WtE Project, Delhi (2012): The dispirited e.g. of so-called second-generation projects in Hyderabad, Bangalore, and Pune, as mentioned in the above sections, once again started making a negative image of the WtE industry throughout the country. All these plants either stopped working because of technical and financial shortcomings, poor project planning, or backing out of the promoters leaving the project and authorities in a gray. There was again a big question on the feasibility and success of these kinds of projects. But, with positive hope, the plant at Okhla (Delhi) was made operational by M/s Jindals Ecopolis in 2012.

The Okhla WtE plant started processing around 2050 tons of waste to generate over 16 MW power. The project cost was estimated at 175 crores, later escalated to 240 crores (Planning Commission Report, 2014). The boiler uses moving grate, mass incineration technology from HBG China. Flue gas treatment system incorporates Semi-Wet Reactor (SWR) and bag filter from Wuxi GHPE China. With the operation of the Okhla WtE Plant, again, the Govt. authorities had high expectations to come with a foolproof solution for the waste problems. However, the path of the WtE industry in India still consisted of many more difficulties. Since its initiation, the Okhla plant had faced a massive public protest by the environmental

NGOs and local residents due to NIMBY syndrome. Further, the proponent had violated the primary conditions issued by MoEF in its environmental clearance letter and changed the configuration by adopting mass incineration technology instead of RDF, which was also mentioned to be used in the project DPR approved by MNRE [5].

The project is presently in operation, but there are a few problems with the incineration process, especially poor quality combustion due to the presence of moisture, inerts, and construction debris in the waste. As a result, two parameters—SPM and Dioxins were continuously being found beyond range during inspections by monitoring authorities. On June 03, 2013, the Indian Express article mentioned the pollutant level from Okhla WtE, 25 times higher. In other instances, due to higher SPM, some filter bags got damaged [9]. The plant was immediately taken under maintenance and cleaning. In a hearing of the Jindal's plant, NGT, has already cleared its view on the need for preprocessing of MSW as far as Indian waste is concerned. NGT on 28/05/2013, directed the proponent to install a segregation plant before subjecting the waste to incineration [10]. On February 25, 2014, the TOI article mentioned the stand of the Parliamentary Standing Committee on Urban development to seek a countrywide ban on WtE due to the massive protest against the Okhla plant [11].

These factors hugely contributed to making up an adverse scenario for the WtE industry in India. Especially, the case of Okhla WtE plant boosted up the negative image of WtE and initiated a country wide discussion on the banning of such kinds of projects and instead establish projects based on composting, recycling, etc. Though it is evident from the worldwide scenario that WtE is the only solution for large countries like India having no land area. Other technologies can always work in integration with the WtE facilities.

5 Status of a Few Upcoming Plants

The status of upcoming WtE plants in India has been presented in Fig. 2.

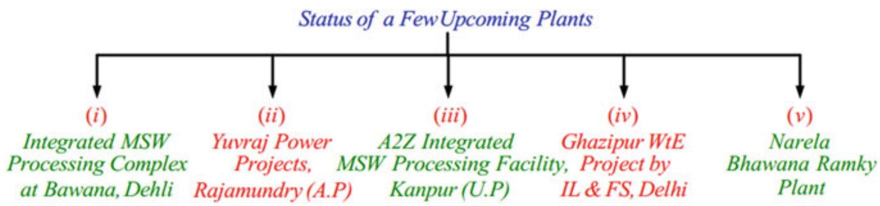

Fig. 2 Different upcoming plants

5.1 Integrated MSW Processing Complex at Bawana, Delhi

M/s Ramky Engineers Ltd. is setting up an integrated landfill site consisting of a compost plant and a WtE plant at Narela-Bawana area of Delhi. The plant capacity as per the Ministry of Environment and Forest (MoEF) is 4000 TPD of MSW to generate 36 MW power. The power plant consists of two boilers (56 tons per hour (TPH) capacity each) that can produce energy up to 40 MW. Initially, the plant will produce 24 MW power from 1200 TPD RDF left after the waste screening in the compost unit. The Boiler technology is moving grate Chinese boiler, and the Flue Gas Conditioning System (FGCS), Grabs, and the turbine have been purchased from China (Similar to the case of Okhla WtE). FGCS consists of the lime treatment, Activated Carbon Injection (ACI), and bag filters. Almost 80% work has been completed for the WtE. However, further work has been put on hold for the last few months due to a legal dispute between the company and North Delhi Municipal Corporation (NDMC). The authority is now saying (after completion of 80% of work) that the clause of establishing the WtE plant at the site was not in agreement; however, as per the company, the energy recovery from screened waste material is in the project scope. As per the company, the National Environmental Engineering Research Institute (NEERI), as a third party, already authenticated the view of the company, but they are not getting the green signal from the NDMC to start the work (IAAD, 2014).

5.2 Yuvraj Power Projects, Rajahmundry (A.P.)

The company is setting up three RDF plants—one each at Rajahmundry, Tadepalligudem, Samalkota districts of Andhra Pradesh, which will be capable of processing about 1100 TPD of MSW. A 13 MW power generation unit at Rajahmundry will also be proposed to be established, and RDF will be transported to Rajahmundry from the other two locations. There are two boilers: 30 TPH for 5 MW and 50 TPH for 10 MW power generation. The PPA for the project is signed with Tata Power. The cost of the project is Rs 1000 million approx., and the land area is 18 acres. The estimated RDF yield will be 650 TPD with GCV of 2200 to 2500 kcal/kg and moisture contents around 30%. Mixing of 15% rice husk of around 3200 kcal/kg CV is also proposed as per Detailed Project Report (DPR) (CDM Project Design Document, UNFCC, 2011).

Thought the work of the power plant is partly completed, however, work for processing plants not started yet and the status is as follows:

a. Rajahmundry Processing Plant—Land not allotted.
b. Kakinada Processing Plant—3 acre land allotted in samalkot, but work not started yet.

c. T.P. Gudam Processing Plant—Land not allotted.

The work of the power plant was started in 2010 and now on grasp since 2012. The 30 TPH boiler work is 80% complete, and for 50 TPH boiler, only order has been placed to the thermo-dyne, till now. The work for the Balance of Plant (BOP) not completed. There are a few issues in the PPA and needs revision.

5.3 A2Z Integrated MSW Processing Facility, Kanpur (U. P.)

The company proposed to set up a 700 TPD RDF to 15 MW power project as a part of their integrated collection, transportation, processing, and disposal mandates with the Kanpur Nagar Nigam (KNN), Uttar Pradesh. One 75 TPH CFBC boiler was installed for steam generation by M/s AV&UE Ltd., which has supplied a second-hand Chinese boiler, turbine, and generator to M/s A2Z Ltd. ESP was installed for flue gas cleaning.

The WtE facility started trial runs of boiler, ESP, and auxiliaries last year in 2014, but was having troubles as RDF moisture content was high. Subsequently, dryers were installed, but successful commissioning is not achieved till now due to poor quality fuel. The boiler was originally designed for rice husk and coal with drum feeders and screw conveyors as fuel feeding arrangements. Later, it was modified to gravity feeding with punch feeding arrangements using flap gates and chutes for fuel distribution. These modified arrangements again had various shortcomings for RDF feeding and needed to be improved (IL&FS research). Further, processing plant operations were also not satisfactory because of the used of local equipment. The collection & transportation services of the company were also got affected due to financial viability. Presently, the facility is in an abandoned stage, and KNN has canceled the contract with M/s A2Z Ltd. and looking for new vendors to run the facility.

5.4 Ghazipur WtE Project by IL&FS, Delhi

The IL&FS Environmental Infrastructure & Services Ltd. (IEISL) Delhi is establishing the 12 MW WtE project based on RDF technology. As mentioned in Section III-C1, the project was taken over by the IL&FS environment in 2009, when the consortium of DIAL and Selco backed out. The project will process 2000 TPD of MSW coming to the Ghazipur dump site in the East Delhi area and produce 12 MW power. The project is purely based on the DST-TIFAC recommended process for MSW preprocessing and has also got the technology approval from MNRE.

The boiler and flue gas technology for the project have been procured from M/s Keppel Seghers (Belgium), and the turbine generator has been supplied by M/s Siemens. M/s ISGEC Heavy Engineering Ltd. is doing the manufacturing of the boiler, and M/s Clair Engineering is fabricating the flue gas treatment system as per the Keppel Seghers design. The total project cost is around 316 crores, and the land area is 5.73 acres. Presently, the commissioning activities are going on, and the project will start producing power by December 2015. The company has taken care of all the measures learned from past failures, like preprocessing, proper quality equipment, specialty, boiler, gas cleaning systems, etc. However, the actual performance can be justified only when the plant will start operations.

Apart from the positively affecting the health and hygiene of the nearby household by processing new MSW project. The MSW projects enterprises for the generation of employment. Alternatively, maintenance and functionality literacy are producing societal benefits. The project will also help to save at least 260 acres of limited urban land valued at over Rs 2000 crores by December 2016.

5.5 *Narela-Bhawana Ramky Plant*

MCD corporation launched India’s largest WtE plant at Narela-Bawana, by March 2017, made operational. Built on 100 acres of land valued at over the Rs 456 crores plant, however, seems to be failing on almost all counts.

The plant will process nearly 2500 MTPD and generate 24–25 MW of electric power. This will help Rohini and Civil Lines areas, most of the garbage is offloaded at the Narela-Bawana landfill, which is the new and only engineering/sanitary landfill in the city. Nowadays, Delhi generated about 9000 MT of solid waste filth per day. Here, the process of nearly 1200 MT is appropriate by the Ghazipur WTE plant producing 12 MW of electrical energy, while the Okhla WTE uses almost 1300 MT of waste generating 1600 MW of the electricity.

The Okhla WTE plant is currently under controversy in the National Green Tribunal (NGT) with the household of the Sukhdev Vihar having a question the court for administration to relocate it.

For the opening of the new Narela-Bawana WTE is not only good news; someone from Delhi can be expected. The NMCD administrators declared that it would be run by the Hyderabad-based company, which is known as Ramky, which is declined to collect garbage from each household and segregate, it is biodegradable and nonbiodegradable, fertilizer the organic materials into the muck, and then, process only the nonorganic into the WtE plant.

A new Bhalswa WtE plant is also in the pipeline to arrest the phenomenon of fires, said the official.

6 Conclusion

WtE is a proven waste handling technology world over but has very less success in India. The reason behind is the Indian waste is highly heterogeneous in composition and size, and also, the way it gets collected makes it very dirty, mixed with soil, road sweepings (dust), drain desilting, etc. along with the moisture. The use of Chinese, European, and other technologies, in a replicated manner, had not given any successful model in India. As it is learned from the above analysis that there cannot be a single-handed solution that will work for the treatment and disposal of this kind of mixed waste. Hence, customized, tailor-made, and integrated solutions are the need of the hour should be adopted. Most of the past, WtE initiatives/ interventions were driven by "A TECHNOLOGY", resulted in improper design to handle Indian wastes. As such, there were no issues with the efficiency of these particular technologies, but the mismatch of the quality for the incoming decline with the plant designed caloric value, and the high percentage of inerts led to the closure of most of the plants. Further, the use of poor grade of critical equipment decreased the quality of the final product and increased the maintenance costs. In the absence of Govt. support, financial viability also got affected. At some places, failures were due to poor project planning, ineffective project structuring, lack of interinstitutional cooperation, week regulatory mechanism, and lose of execution of contracts and laws. Finally, pollution concerns and NIMBY syndrome made the path of the WtE industry very difficult. In this way, "POOR TRACK RECORD" track record of WtE facilities in India acted as its most significant obstacle for further development.

It is pertinent to mention that these previous failures can act as a practice to expected WtE projects, but it will not be a reasonable argument against recent facilities. The first WtE plants in India is started since 1987, in India has been undergone two decades of extraordinary economic growth, which can change the lifestyles, in turn to the change. The nature of waste increased its quantity. The change in nature of the MSW developed in a higher percentage of recyclables system and increased in calorific value of wastes. The improvement in the collection of MSW decreased, the fraction of inserts that end up in the MSW stream. During the same time, the WtE industrial technology has been undergone a revolution in technology and from pollution control worldwide. However, for the adequate development of this industry in the Indian context, the following suggestions are strictly recommended for future projects:

i. Elaborate processing is imperative for Indian MSW, which will decrease dependency on the biomass or other supplementary fuel.
ii. Development of the customized, tailor-made and high-grade indigenous solutions for incineration process, and flue gas treatment for better performance and also to reduce the high capital cost of the imported equipment.
iii. Internal R&Ds by the project personnel's in this field developing a knowledge base for the characteristics of Indian waste and choice of right technologies to deal with it.

iv. Adoption of an Integrated approach, which broadly involves; organic fraction should go for composting, or bio-methanation, combustible (fuel component) should go for the incineration; recyclables should be collected, and Inserts including C&D wastes can be converted into usable building products. In the end, only the rejects (10–15% of the total amount) should go for disposal.
v. State-level institutions and ULBs need to strengthen their capabilities with adequate staff and technical capacity in this field to develop knowledge for structuring public-private partnerships in waste management.
vi. Authorities should give the prime importance to the project development work and strict evaluation of technical bids, maybe with the help of appointing third party transaction advisors.
vii. Policies at the national and state-level need to be strengthened with regard to carrying outsource segregation and improving the service level benchmarks of the ULBs in the collection, transportation, processing, and disposal of MSW.
viii. Need for standardization of technology and emission standards for WtE that is developed and approved by the Govt. and framing of monitoring mechanisms to verify and ensure the performance of WtE faculties.
ix. These projects are capital intensive, as they are primarily meant for the scientific disposal of MSW, and should not be given significance linked to the power generation. Hence, support from the Govt. is very much necessary to make success models in this field. For this, tipping fees and product-based subsidies should be encouraged instead of upfront grants to ensure the continuous operations by the project promoters.
x. Strengthening of the regulatory mechanism by the authorities and offering a single-window clearance process to avoid interinstitutional issues.
xi. Transparency plays a key role in avoiding NIMBY syndrome and reducing mass public protests and opposition and therefore, should be given prime importance in every WtE facility.
xii. Generation of credible information by academic institutions and Govt. authorities can boost up the mass awareness in this field.

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