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# Municipal Solid Waste Management: Proposing WTE facility in Bilaspur (Chhattisgarh)

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***Abstract*** *This paper includes the discussion about how much municipal waste generated in Bilaspur city and what can be the alternative route to treat those wastes ( other than landfills).The proposed alternative which can yield some useful outputs has been discussed. The paper gives an idea about the type and amount of wastes generated by different income groups and then calculating the total amount of municipal waste generated. This study proposes a WTE facility for the municipal waste produced to encourage waste treatment and electricity generation, in turn, will create a closed loop of waste generation and safe disposal. The burden on the landfill will be distracted.*

**Keywords** Municipal solid waste management, income groups, calorific value, WTE facility.

## 1. INTRODUCTION

Since many years the waste generated in any city is being disposed of/ dumped off in a barren land when the landfill site became full of its capacity, the waste use to get suppressed or bulldozed and then it was left to settle producing a very unsightly area dumped with waste. In fact, landfill disposal of waste not only creates ugly view also it affects the human health very badly. One of the main reasons stated is the emission of the greenhouse gases (GHG). Municipal residential waste production and categorisation have become a paramount issue of public concern worldwide. Chhattisgarh state is also facing some serious waste management drawbacks. Waste management challenges and the proposed solid waste management system are to be studied. The quantity of MSW generation depends on various factors such as food habits, living cultures, the degree of commercial activities and seasons. Data on amount variations and production are useful in planning for collection and disposal systems. Indian cities generate around eight times more municipal solid waste than they did in 1947 because of increasing urbanization and changing living standards. Thus an alternative to waste incineration (WTE) has been proposed to distract the waste from landfills and to help generate electricity/power from the wastes.

## 2. METHODOLOGY

To calculate the total amount of waste, households (wards), commercial and institutional waste needs to be calculated separately. The wards were taken into consideration.

Residential or domestic waste is emanated from premises used wholly or mainly for residential or household wastes and may include recyclable materials or non recyclable materials. The residential or household waste consists of all the household waste such as kitchen waste, food scraps, plastic wastes, papers, garden trimmings with other waste such as wood, leather, sanitary napkins, etc. The residential wastes divided into following main categories:

Vegetable waste – Peeling waste, discarded vegetables, food waste, discarded, food seeds, etc

Paper – paper scraps, packing papers, discarded papers from student's bags, etc.

Plastic – plastic articles, polyethylene, and other items made of primarily plastic

Glass – scrap of glass, bottles, glass containers, broken kitchen items made of glass and ceramics, etc.

Cardboards – non-recyclable paper, cardboards, cartons, etc.

Others – metallic items, can, jars of metal, dirt and other inert materials.

## 2.1 RESIDENTIAL WASTE

Three different income levels were considered (high, middle, low) in every ward.

- To estimate, families with average of four members with income ≥30000 /- per month was taken as high income group, between 30000-10000 /- was taken as middle income group and < 10000/- per month was taken as low income group.
- The randomly selected houses were asked to collect the day's waste in two different polybags, one for biodegradable and other for non biodegradable wastes.

**Table-1: Waste in wards (kg/cap/day)**

| Income group | 3 | 14 | 33 | 40 | 42 | Average |
|---|---|---|---|---|---|---|
| **High** | 0.385 | 0.450 | 0.490 | 0.450 | 0.475 | 0.450 |
| **Middle** | 0.395 | 0.400 | 0.335 | 0.370 | 0.390 | 0.378 |
| **Low** | 0.215 | 0.245 | 0.175 | 0.190 | 0.265 | 0.218 |
| | | | | | **Average** | **0.350** |

**Table-2: Percentage of components after weighing**

| Income group | Paper | Plastic | Veg | Glass | Board | Others |
|---|---|---|---|---|---|---|
| High | 5.09 | 8.00 | 80.07 | 0.07 | 1.27 | 5.5 |
| Middle | 5.00 | 9.01 | 79.03 | 0.52 | 2.04 | 4.40 |
| Low | 3.06 | 6.76 | 83.04 | 1.03 | 2.02 | 4.09 |

The Bilaspur municipal corporation is divided into (all the wards in the city) four administrative zones to manage the works related to the Government and administration under the local Government bodies. An administrative area, administrative unit, the constituent unit is a portion of a city or other region delineated for the purpose of Administrative administration zones are provided some level of functioning and operation and are usually required to manage themselves through their local Government bodies.

Bilaspur has 55 wards; divided into four such administrative zones with Vikas Bhawan as the head office. Each ward has 12 wards with four such administrative areas. Each zone has a population equal to the total of 12 each. The approximate total population was estimated, with respective amount of waste generated per day.

**Table-3: Waste in administrative zones**

| Zone no. | Address | Total wards | Ward no. | Population | Waste (kg/d)* |
|---|---|---|---|---|---|
| **1** | Vikas Bhawan ,BMC | 12 | 1,2,3,4,5,6,7,8,9,10,11,12 | 84047 | 29417 |
| **2** | Vikas Bhawan, BMC | 12 | 13,14,15,16,17,18,19,20,21,22,23,24 | 57106 | 19987 |
| **3** | Vikas Bhawan, BMC | 12 | 25,26,27,28,29,30,31,32,33,34,35,36 | 57086 | 19980 |
| **4** | Vikas Bhawan, BMC | 12 | 37,38,39,40,41,42,43,44,45,46,47,48 | 106352 | 37223 |

*Source: Census 2011

- Ward 49-55 with corresponding population 31801 generates around 11130 kg/d.
- **Total residential waste = 120 TPD approximately**

### 2.2 COMMERCIAL WASTE

Amount of commercial waste included the wastes from the business centres such as restraints, hotels, community centres, shopping malls, offices, market place etc. A survey carried out in year 2010 shows the following figures of commercial waste generated.

**Table-4: Commercial waste generation**

| Source | Amount in kg/d (approx.) | Percentage |
|---|---|---|
| Restaurants | 9560 | 26.55 |
| Shops | 6350 | 17.63 |
| Marriage halls | 2091 | 05.80 |
| Hotels | 3700 | 10.28 |
| Markets | 11800 | 32.84 |
| School/office | 1000 | 02.70 |
| Gardens | 1500 | 04.20 |

Source: Field survey, 2010

- The total commercial waste (recent) generated would be around 36 tons/day.
- Wastes generated from the hospitals (APOLLO with 300 beds, CIMS with 350 beds, around 60-70 clinics and dispensaries) would roughly be estimated around 240 tonnes/year.
- Total (residential, commercial and institutional) approximately waste generated would be around 160 TPD.
- Wastes from some nearby rural areas may also add to the waste for WTE input. This would also help waste management in rural areas (within 50 kms) which largely includes agricultural wastes ideal for incineration and electricity production.
- The approximate amount of urban and rural solid waste generated is around 70000 tonnes/ year ( taking higher value due to rapidly increasing population and hence amount of waste).

In Bilaspur city, there is huge amount of waste being generated in the present times which would be a great burden on the landfill. Hence a WTE facility has been proposed in this paper for Bilaspur with consideration of the existing amount and nature of the waste. . WTE plant not only helps treat the waste but also produce electricity/ power by incinerating the high calorific value components from the generated waste.

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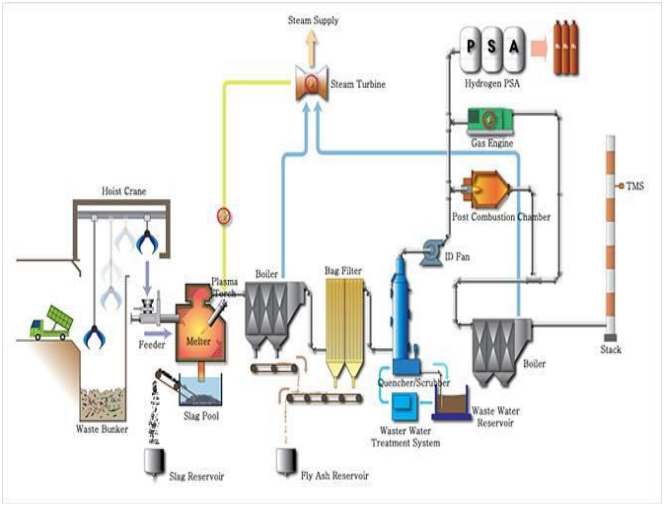
WTE is a proven, environmentally sound process that provides reliable electricity generation and sustainable disposal of post-recycling MSW.

## 3. Basic requirements of a WTE plant

- For bigger plants, the nominal amount of wastes required is around 100000 TPY.
- Calorific value of the incoming waste should not be less than 6MJ/Kg.
- Community should be willing to pay for the management charges, high electricity feed-in tariffs and collection and transport charges.
- The proper operation of the plant needs skilled labourers.
- The operation planning should be long term. Ex- > 15 years. After this time period the capital cost is recovered.




For the implementation of WTE facility, the calorific value of the wastes is to be calculated.

**Table-5: Approx CV of waste in city**

| Constituent | % age in sample | CV(MJ/ Kg) | Contribution to CV |
|---|---|---|---|
| Plastic | 7.92 | 32.80 | 2.6 |
| Glass | 0.54 | 0.20 | 0.01 |
| Textiles | 1.20 | 18.51 | 0.22 |
| Paper | 4.38 | 15.81 | 0.69 |
| Cardboard | 2.02 | 16.38 | 0.33 |
| Organics | 80.46 | 4.18 | 3.36 |
| Wood | 1.07 | 15.44 | 0.165 |
| Inert | 0.10 | 0 | 0 |
| Leather/Rubber | 0.72 | 21.39 | 0.154 |
| Sanitary Napkins | 1.34 | 9.81 | 0.131 |
| Ferrous material | 0.25 | 0 | 0 |
| | | TOTAL | 7.66 |

## 3.1 CAPACITY AND CAPITAL ESTIMATION

**3.1.1 Reference WTE plant** --One of the reference considered for the proposal is the two line ( two furnace) WTE plant( Tynes Bay) presently running in Bermuda, self governing overseas territory in the UK. This plant uses two furnace incineration at the rate of 6 tons/hr( each line) and generating around 3.6 MW with 9-11 MJ/kg calorific value every year.The plant incinerates around 68000 tonnes per year by working 6600 hours per year( 90% availibility of the year). The waste incinerated in this plant consist of around 45% commercial waste, 35%domestic waste, 20% wood.It

generates electricity to the account of 18000KWh per year. It was made possible bt Government financing.

### 3.1.2WTE facility for Bilaspur

Population of the city (urban plus nearby rural area) can generate waste around tonnes of waste per year( domestic, commercial,institutional). For the WTE plant to produce a significant amount of electricity, the population of the nearby rural area of the city is also considered. This population is generating around 70000 tonnes per year of waste. The sample collected produced a calorific value of 7.66( variable based on seasons).

**3.1.3 Electricity generation:** The calorific value of MSW of the sample collected in the Bilaspur city is 7.66 MJ/kg that is 2.13 MWh/ton. It is assumed that heat losses in the furnace, ash and stack gases are around 10%.Then the heat in the steam entering the turbine is around 1.91 MWh per ton of waste .Assuming a temperature of 400 degrees and pressure 40 bar, the efficiency is around 28%. Hence 0.5 MWh electricity will be produced per ton by incinerating one ton of waste. Assumed that 15% of the produced electricity will be used by the plant itself, so around 0.45 MWh electricity will be produced to the grids. The plant is expected to incinerate around 64000 tonnes every year. Single furnace facility with capacity of treating 8 tonnes/hour with about 92% availability of the year (approx.8000 hours), the capacity becomes 64000 tonnes/year. Around 192 tonnes per day. If the example of WTE plant is taken (with 10.27 MJ/kg and incinerating 640000 TPY), the proposed facility in Bilaspur city (7.66 MJ/kg and incinerating around 64000 TPY) would produce 0.45-0.60 MWh of electricity with seasonal varied calorific values.

- The financial capital structure of the facility are designed by business model selected for the plant.Therefore for detailed analysis, one must develop a business model.However it is difficult to generate a business model for Bilaspur city as there are no WTE plants in this region and hence no evidence on how a WTE plant could be financed. Therefore the analysis is done on general guidelines for the financial feasibility assessment of the possible installation.

- As there are no other WTE facility working in the city , the capacity of the plant is taken from a reference plant already in operation. The capital required for the plant is based on various other factors such as:
  - civil structure and erection
  - mechanical parts supply and installation
  - Electrical supply and installation
  - EPC costs and contingencies
  - Transportation cost, owner's cost etc.
  - O&M (operation and maintenance cost)
  - Labour cost

With reference to other active WTE plants in the country with their respective capacity and cost the proposed plant would need around 2 acres of land with capital cost of roughly 10-12 crores along with various subsidies.However the plant would reach its breakeven in a calculated period of time, then will serve the ciy for a long time with waste management and electricity generation.

## 4. Environmental benefits

With energy benefits, WTE avoids the transformation of greenfields to landfills. Under specified regulations (daily cover, etc.), it would have filled in around 20-25 years. Since WTE facilities are a point source of emissions, they have been subjected to very stringent environmental regulations. Landfill emitting gas contains about 50 percent of methane gas which is 21 times more stable as a greenhouse gas than carbon dioxide.

Comparative studies of WTE and landfills have shown for each ton of MSW incinerated not landfilled, the overall CO2 reduction can be as high as 1.3 tons of CO2 per ton of MSW when both the avoided landfilling emissions and the restricted use of fossil fuel taken into consideration. WTE processing of MSW has the additional advantage of reducing the transportation of MSW to far away landfills and the attendant emissions and fuel consumption which also reduces interstate truck traffic.

## 5. Conclusion

Bilaspur city posses very unsystematic waste management facility. The only disposal way out is the dump yard. Because of the rapidly growing urbanisation and hence population, the burden on the dump yards is increasing at an alarming rate. Also dumping all kinds of wastes (hazardous, hospital wastes etc.) in the dump yard hinders human health. The recycling sector is weak in this region as very small amount of wastes are being recycled.

The main issue with the waste management in the city is the improper and irregular collection of wastes in the city, which leads to dumping of wastes on the roadsides and other residential areas. The proposed WTE plant may well manage the growing wastes and in turn will produce electricity for the area. The capital cost is high but after breakeven, there will be clear profit by electricity generation. Proper planning and organisational teams must be framed out to work on the technicalities and financial feasibility should be studied in detail.

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