Circular Economy and Sustainability to Urban Solid Waste Management

Energy production from MSW in Delhi

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• Introduction
• Solid Waste Management in Delhi
• Various processing Facilities
• 12 MW Waste to Energy Project at Ghazipur, East Delhi
  – Bid Process
  – Environmental Benefit
  – Project Contours
  – RDF Plant Process Flow
  – Power Plant Process Flow
  – Environment Management System
  – Flue Gas Treatment System
  – Leachate Treatment Plant
  – Social Inclusion
Launch of Clean India Mission

This campaign was officially launched on 2 October 2014 at Rajghat, New Delhi, where Prime Minister Narendra Modi himself wielded broom and cleaned a road.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Local Body</th>
<th>Area in Sq Km</th>
<th>Population in million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NCT Delhi</td>
<td>1484.46</td>
<td>Over 18</td>
</tr>
<tr>
<td>2</td>
<td>MCD</td>
<td>1399.26 (94%)</td>
<td>17.3</td>
</tr>
<tr>
<td>3</td>
<td>NDMC</td>
<td>42.4 (3%)</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>DCB</td>
<td>42.8 (3%)</td>
<td>0.2</td>
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</tbody>
</table>

Also floating population

- MCD 94%
- NDMC 3%
- DCB 3%
12 MCD ZONE, NDMC & DCB
SCENARIO OF SOLID WASTE MANAGEMENT

• As per MSW (M&H) Rules, 2016
• Every Municipal Authority is responsible for :-
  – Collection
  – Storage
  – Segregation
  – Transportation
  – Processing and Disposal of Municipal Solid Waste (MSW)

IN AN ENVIRONMENT FRIENDLY MANNER
SCENARIO OF SOLID WASTE MANAGEMENT

- Municipal Solid Waste - heterogeneous mixture of various constituents
- Due to Rapid urbanization/uncontrolled growth rate of population Municipal Solid Waste Management (MSWM) has become acute
  (i) The Per Capita Waste generated in a typical Indian Metro City increases by 1.3% per year (TERI)
  (ii) and the urban population increase is around 3.5% per annum (World Bank Report)
- These two factors (i) and (ii) have led to a yearly 5% increase in Solid Waste burden
- The quantity of Solid Waste generated shall reach 17000-19000 MT/day by 2021-2024 in Delhi
• 49% of the total population of Delhi lives in
  – Slum areas
  – unauthorized colonies

• A sizeable population therefore lives in unplanned areas having no proper system of collection, transportation and disposal of Municipal Solid Waste.

• There is also the floating population visiting Delhi in connection with business activities Delhi being a major distribution centre of retail business in North India.
The links of various notifications for Waste Managements are;

- Plastic Waste Management Rules 2016

- e-waste (Management) Rules, 2016

- Construction and Demolition Waste Management Rules, 2016

- Solid Waste Management Rules, 2016


- Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2016
  [http://www.moef.gov.in/sites/default/files/Final%20HWM%20Rules%202016%20%28English%29.pdf](http://www.moef.gov.in/sites/default/files/Final%20HWM%20Rules%202016%20%28English%29.pdf)
OBJECTIVES OF MUNICIPAL SOLID WASTE MANAGEMENT

• 100% MSW Collection Efficiency
• Segregation of Garbage
• Hygienic & Efficient Transportation to Processing / Landfill Site
• Vehicle Tracking System of Transport Vehicles
• New Technologies for Collection, Processing & Treatment of MSW
• Reclamation and Value Extraction from Existing Dumping Yards
• Citizen Friendly Complaint Redressal & Monitoring System
• Public Awareness & Training of Staff
EXISTING MSW MANAGEMENT

Residential

Other sources (roads, pavements, drains, etc.)

Commercial (shops, community centres, hotels and restaurants)

Wheel barrow
Cycle rickshaw
Auto Tipper
Tractor trolley

Wheel barrow
Cycle rickshaw
Tractor trolley
Auto Tippers

Wheel barrow
Cycle rickshaw
Tractor trolley
Auto Tippers

Dhalaos

- Roadsides
- Drains
- Vacant plots,
- Central verge
- Non-designated areas

Processing facility

Trucks

Landfill
INTEGRATED WASTE PROCESSING

Construction & Demolition Debris

Municipal Solid Waste

Collection & Transportation

C&D Processing Facility, Burari

Compost Plant, Okhla

Segregation of Waste

Bio-degradable

Receives (inert)

Landfill

RDF & WtE, Ghazipur

Combustible

Recyclables

Inert transferred To landfill as soil cover

Recyclables
Total Waste Collected/Generated: 12600 TPD

Existing Processing Facilities:
- Composting at Okhla: 200 TPD
- Waste to Energy at Gazipur: 2000 TPD
- Waste to Energy at Okhla: 2000 TPD
- Integrated Waste Facility at Narela-Bawana: 2000 TPD

Total: 6200 TPD

C&D WASTE:
- C&D facility at Burari: 2000 TPD
- C&D facility at Shastri park: 500 TPD

Total: 2500 TPD

In addition, many other processing facilities are in pipeline.
LOCATION OF FACILITIES

- Narela-Bawana Road
  - SLF/ Compost

- Bhalswa
  - SLF/ Compost

- Burari C&D
  - Waste

- Ghazipur
  - SLF

- Okhla
  - SLF
  - WTE/ Compost

- Existing SLF/ WTE/ Compost
- Existing C & D Plants
OKHLA COMPOST PLANT, OKHLA

- Plant Capacity : 200 TPD of MSW
- Compost production : 40- 44 TPD
- Technology : Open windrow Aerobic composting
- Term period : 25 years
- Sources of revenue : Selling of compost
- First time Carbon Credit earned for Waste to Compost Project in 2008
GHAZIPUR WASTE TO ENERGY PROJECT
PROGRESS FIGURES

- Till date over 2.5 Million Metric Ton Garbage Processed
- Over 500 Million Units Power generated and supplied to Grid.
- Average plant load factor 95-98%.
- Received Various Awards in the year 2010, 2013
- Successfully Operating Since last Four Years.
The plant is having following facilities:

- 2000 TPD Processing Plant (Material Recycle Facility (MRF), Composting, and Refuse Derived Fuel (RDF))
- Engineered Sanitary Landfill facility
- Leachate Treatment Plant
- Other Ancillary facility as per MSW Rules, 2000/2016
- WtE to generate 24 MW Electricity
- Facility is operational since August, 2011
INTEGRATED MSW PROCESSING & DISPOSAL PLANT BAWANA
C&D WASTE PROCESSING PLANT AT SHASTRI PARK
OUT PUT OF C&D PROCESSING

MIXED WASTE

CONCRETE WASTE

Aggregate
- 3mm

Aggregate
10mm to 20 mm

Aggregate
3mm to 10mm

Aggregate
3mm to 10 mm

Aggregate
10 to 20 mm
• **Monitoring of Movement of Trucks and Other Vehicles**

EDMC has started GPS / RFID based tracking system to locate the position of its refuse removal trucks and other vehicles to increase their efficiency and productivity and to ensure regular and timely collection and garbage reached at Ghazipur SLF.

This can be viewed online at [www.edmctracking.com](http://www.edmctracking.com).

• **Capturing the Methane Gas from the Existing Garbage at Gazipur**

At Ghazipur dumpsite EDMC with association with M/s GAIL (Gas Authority of India Ltd.) has setup a gas extraction facility, on pilot basis. Till date over 10 lac cum land fill gas has been extracted and flared and micro turbine has been installed to generate electricity.
Benefits for EDMC

- Fully automated and no manual intervenes
- All reports are being system generated.
- Real time monitoring of vehicles on Computer Screen
- Monitoring Garbage collection points status
- Optimized of vehicle usage
- Plan and execution become easier.
- Verification of contractor invoice become simple.
- Improved image in public due to quick action.
- History of transaction can be reviewed at any time.

Benefits for Public

Citizen can view and monitor of garbage collection online.

Garbage collection become systematic and simple.

Citizen can ensure the garbage collection vehicle visited their locality.
VEHICLE MONITORING SYSTEM

**Process Flow**

- **WARD BOUNDARY**
- **HOUSE/GARBAGE COLLECTION POINT**
- **AUTO TIPPER**
- **DHALLO GHAR/ BINS**

4 TO 5 TRIPS PER DAY IN A WARD

**Primary Vehicles**

- Auto Tipper

**Secondary Vehicles**

- Garbage Collection Point (Dhalao Ghar / Open Site /Bins)
Real-time monitoring of a selected vehicle
Reformation activities at Slice B and C
ENCLOSED FLARE SYSTEM
VISIBLE CHANGE OF LANDSCAPE

BEFORE

AFTER
## CONSOLIDATED OUTPUT

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Volume of LFG (m³/hr)</th>
<th>Average CH₄ (Vol %)</th>
<th>Cumulative LFG Captured &amp; Combusted (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May -2013-14</td>
<td>150.0</td>
<td>27.0</td>
<td>960000</td>
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<tr>
<td>May-2014-15</td>
<td>127.0</td>
<td>23.0</td>
<td>812800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.0</td>
<td>1772800</td>
</tr>
</tbody>
</table>

Amount of CH₄ Destroyed ~10,000MT of CO₂ equivalent

The Project was successfully validated & registered with UNFCCC for availing carbon credits
• Monitoring of Safai Karamcharis by Displaying Beat-wise Name & Photos on MCD website

• Web Based Citizen Grievance Management System

• Delhi Cleanliness & Sanitation Byelaws

• User Interface via Facebook

• User Interface via WhatsApp
Project is envisaged to treat 70 tons of Paunch waste and generate 5000 m$^3$ of bio gas per day.

Bio gas produced will be used for generation of electricity or as auto gas after refinement.
COMPOSITION OF MSW AT GAZIPUR
Soil: 68.6%, Plastic: 12.0%, Stone: 14.4%, Rubber/Stock Leather: 0.9%, Cloths: 3.2%, Glass: 0.2%, Metal: 0.7%

UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD EMBANKMENT
About 65-75% of segregated Municipal Solid wastes can be used for embankment construction
Leachate studies indicate that MSW is a non hazardous material as concentration of heavy metals is within the permissible limit.
Plastic waste will also be use in bearing coat of bituminous road
Recyclable will be sent to recyclable industry
Combustible part will be sent to WtE plants
CHALLENGES

• Mixed Waste/Segregation
• Densely populated and narrow lanes.
• Unplanned Development
• Multiple Agencies
• NIMBY Syndrome
• Saturated Land Fill Site.
• Land Scarcity
• Involvement of Informal Sector
12 MW Waste to Energy Project (Ghazipur, East Delhi)
Municipal Solid Waste (MSW) sent for dumping = more than 2000 TPD

Dumpsite operational since 1984, over 13mn tons of waste dumped

Dumpsite spread to an area: 29 hectares

Average Height of dumpsite = 50 metres

Current estimates of population around site: approximately 100,000

Waste to Energy: A SOLUTION!
ACTIVITIES PRIOR TO BID

- Transaction advisor was appointed
- All necessary NOCs/Clearances, including environmental clearance and Consent to Establish were obtained
- Extensive waste characterization studies to assess physical & chemical characteristics of waste delivered at landfill
- DPR & basic designs & engineering
- Detailed BOQ, costing and identification of potential vendors
- Power evacuation scheme finalized
- Environment Impact Assessment Study carried out
- PPA with the local DISCOMs were also concluded
- PIN & PDD prepared for Host Country Approval and Validation
International tariff based bidding was adopted

RFQ floated and after pre-bid potential bidders were shortlisted

RFP issued to only shortlisted bidders

No tipping fee was envisaged

After rounds of pre-bid meetings technical criteria was standardized and financial bids were invited in the form of tariff whereas year on year increment was given as fixed (3%). CDM benefits were accruable to the concessionaire

Bids were finalized based on lowest tariff offered – Rs 3.20 per KWh

COD was required to be achieved within 670 days from the date of issuance of LoI
CONTRACTUAL FRAMEWORK

- Concession period for Ghazipur WtE Project is 25 years
- Concession Agreement for supply of 1300 TPD (± 10%) MSW was signed between MCD and the project SPV
- Land License Agreement with Delhi Govt for 5.63 acres land at Ghazipur
- Sewage Supply Agreement for supply of 3.1 MLD treated sewage for condenser cooling executed with Delhi Jal Board
- Power Purchase Agreement (PPA) with BYPL, the local DISCOM for sale of 49% exportable power
- Remaining 51% exportable power available for sale to third party through open accessTotal project outlay is approximately INR 3160 Million
- 32:68 Equity/Debt ratioExpected IRR approximately 14%
- Expected IRR approximately 14%
**ENVIRONMENTAL BENEFITS**

**Air Pollution**
- Will reduce generation of toxic gases like Methane (CH\textsubscript{4}), Carbon dioxide (CO\textsubscript{2}), Carbon monoxide (CO), oxides of Sulphur and Nitrogen (SO\textsubscript{X}, NO\textsubscript{X})
- The levels of Solid Particulate Matter (spm, rspm) and odour will also be reduced
- Mitigation of GHG Emissions

**Water Pollution**
- Will reduce surface run off (leachate – a toxic liquid) due to the waste processing at WtE Ghazipur facility
- About 1.39 million litres per day of leachate was generated during peak monsoons months (reference to an IIT Delhi study)

*Will help Delhi meet its Renewable Power Obligation (RPO)*
**BENEFITS TO STAKEHOLDERS**

**Health**

- Due to avoidance of open dumping and processing of fresh MSW, there will be a **drastic reduction of the ill effects on the health** of the surrounding population,

- Reduction in respiratory related illnesses near dumpsite by 60% (of which 15% chronic)

- Will also reduce incidence of diseases of eye, skin, malaria, gastrointestinal, dengue, filariasis, etc.

**Land Savings**

- Land saved over a period of 20 years due to the installation of WtE facility = 208 acres

- Cost of land saved : Rs. 19000 million (300 million #)
ENVIRONMENT MANAGEMENT PLAN:

Environment Management Plan:

- RDF Plant
- Power Plant
- RDF
- Industry
- 2000 TPD MSW
- 12 MW Power
MSW CHARACTERISTICS

- Highly heterogeneous in composition and size
- Mixed with soil, road sweepings (dust), drain desilting, etc.
- High Moisture Content

- 70% of MSW is being collected and 12.45% is being processed or treated and rest quantities remain untouched (CPCB)
- 90% of the collected MSW is disposed of unscientifically in open dumpsites, creating problems to public health and environment

MSW without pre-processing poses following problems:
- Low combustion efficiency due to high Inert & Organic content
- Larger specific flue Gas volume - due to high moisture in MSW
- Larger Equipment & high cost of flue gas cleaning
- Larger Volume of Ash
- Extra supplementary Fuel (Oil) due to lower MSW CV
- Frequent breakdowns because of Corrosive
- Heavy load of dust in boilers
- Higher leachate generation in storage pit – more treatment cost

![MSW composition diagram]

- Organic, 41%
- Inerts, 25%
- Metals, 1%
- Glass, 1%
- Plastic, 9%
- Paper, 8%
- Others, 4%
RDF PLANT

• Seven Stage Elaborated pre-processing of mixed MSW to produce good quality fuel (RDF) and reduction in pollution. Steps are:
  • Manual Sorting - Segregation of PVC, Metals and oversized Combustible & Inert
  • Mechanical Sieving - Segregation of Combustible, Organic & Inert (2 stages)
  • Magnetic Separation - Separation of ferrous material
  • Shredding - Use of World’s best Shredders for sizing of RDF
  • Drying - Reduction in moisture content of RDF by Rotary Dryer
  • Air Classification - Final segregation of Combustible & Inert

• Integrated Approach for Sustainable Management of Combustible, Organic & Inert
• Proper Treatment of Dryer Flue gases after reduction of moisture
• Double stage Biological Treatment of Leachate with advance Kurare PVA Gel Technology of Japan
• Spray of Organic Culture on MSW and abetment measures for odor control by maintaining negative pressure and introducing the odorous air into the boiler
Elaborate pre-processing provides redundancy to accept garbage with silt, stones etc.
MSW PIT & GRAB OPERATIONS

PRE-PROCESSING SECTION
AIR-DENSITY SEPARATOR

DRYER & DGCS
RDF CHARACTERISTICS

- Low density material
- Moderate moisture content,
- High quantity of volatile matter (VM) and
- Low fixed carbon.

The pre-processing gives following advantage:
- Sustained and efficient combustion
- Recovery of thermal energy for direct heating or power generation offers an added advantage
- Relatively higher boiler efficiencies
- Comparatively low specific volume of flue gases
- Lesser volume of ashes
- Higher Boiler reliability
- reduces the quantity of dioxins emitted from MSW combustion facilities
- Occasional generation of Leachates - less cost of leachate treatment
- Good shelf life of RDF-May be transported to nearby power & cement plants as alternate mixed coal fuel
- Combustibility - can be mixed with other solid fuels for energy
- No foul smell & dust free fuel

RDF Specifications

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Avg. Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Heating Value</td>
<td>2800 ±100 kcal/kg</td>
</tr>
<tr>
<td>Net Heating Value</td>
<td>1880 kcal/kg</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>80 to 100 Kg/Cum</td>
</tr>
<tr>
<td>Size</td>
<td>All minus 100 mm</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>15% to 25 %</td>
</tr>
<tr>
<td>Volatiles</td>
<td>40% to 60%</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>10% to 15%</td>
</tr>
<tr>
<td>Ash Content</td>
<td>15% to 25%</td>
</tr>
</tbody>
</table>
- Boiler Technology & Basic Engineering from Keppel Seghers Belgium World Leader in Waste to Energy Plants with more than 100 operational plants worldwide

- Tailor-made moving, reciprocating & tumbling Grate especially designed for better combustion efficiency of RDF and low emission

- Triple pass boiler for complete combustion & progressive removal of Suspended Particulate Matter (SPM) to reduce toxic emissions

- Design Provision in Boiler for more than 2 sec retention of flue gases at plus 850 °C temperature to disintegrate Dioxin & Furans

- Selective Non Catalytic Reactor (SNCR) in the Boiler to reduce NO\textsubscript{X} emission

- **EURO Norms** Compliant Flue Gas Treatment System (FGTS) by Keppel Seghers Belgium. Most advanced FGTS technology for Emission control

- Detailed Scheme for FGTS to treat SPM, SO\textsubscript{X}, NO\textsubscript{X}, Heavy Metals, Toxic Gases & Dioxin & Furans
FLUE GAS TREATMENT SYSTEM

**Lime injection** for neutralization of acidic gases and precipitation of heavy metals.

**Activated Carbon** injection to adsorb mercury vapours, odorous constituents and complex organic compound like dioxins and furans.

**Flue Gases from Boiler**

**Semi-wet Reactor**

**Bag Filter** removes remaining SPM (fly ash) including Air Pollution Control (APC) residue.

**Clean air**

**ID Fan**

**Chimney**

**Other Measures**
- Manual Segregation of chlorinated plastic.
- Temperature control in furnace.
- SNCR (Ammonia / Urea injection in boiler) for NOx control.
- Multi pass boiler to capture maximum particulate matter in bottom / boiler ash.

**CEMS** for continuous emission monitoring for public display through website and boards.
FLUE GAS TREATMENT SYSTEM
LEACHATE TREATMENT PLANT

Leachate Collection/Equalization Tank

Homogenization of the variable characteristics of Leachate

Chemical Treatment

T/t of Total Suspended Solids, Colour removal and Heavy metals precipitation

Stripping Tower

Reduction of Ammonia

Two Stage Biological Treatment Process

Anaerobic Hybrid Reactor

Reduction of BOD and COD

Aeration Tank (KURA GEL Technology)

Filtration

Chemical Sludge

Ferrous

Lime

Polyelec

Ambient Air Contact

Biological Sludge

Treated Water for Horticulture use
LEACHATE TREATMENT PLANT
• **Bottom ash**: Use
  – Making hollow block for construction work
  – Raw material for cement production
  – Can be mixed with RMC
  – Can be used as filling material

• **Fly ash & APC residue**
  – Depending upon the characteristics, can be used for cement blocks and asphaltic mixtures
  – To be disposed at secured landfills after testing its leachability
GULMEHER (BLESSINGS OF FLOWER) : SOCIAL INCLUSION

- Registered as a producer company with **women as share holders**
- Waste picker women make handicrafts products with wounded flowers, recycled paper
- **Financial Inclusion** : Kiosk banking facility is being provided to the local community through Inde Pay and State Bank of India at Gulmeher :
  - 2075 accounts opened since July 2014
  - 1985 A/c holders have been issued passbooks
  - 1780 passbooks given to A/c holders till date
  - 250 persons from the waste picker community have an account at the centre
- **Panchhi** : Initiative to mainstream children of rag pickers [theatre/photography/filming]

Journey of rag-pickers to Artisans & Entrepreneurship!
THANK YOU