Municipal Solid Waste Management
1. Municipal solid waste – definition; solid waste composition; and solid waste generated, collected, segregated and processed

2. Policy framework for Municipal Solid Waste Management (MSWM)
   1. Municipal Solid Waste Management Rules, 2016

3. Waste Characterisation

4. Components of Municipal Solid Waste Management in a ULB
   1. Collection
   2. Segregation
   3. Transportation
   4. Processing
   5. Reuse
1. Municipal Solid Waste
## Types of Municipal Solid Waste Treatment Technologies

### Composting / Bio-Methanation
- Biodegradable
- Recyclable
  - Paper, Plastic, Wood, Boards, Chips, Cardboards, Metal, Rubber, and Glass
- Refused Derived Fuel
  - Non Recyclables of Dry waste, Double coated plastic, Torn paper, Jute, Tetra packs, sanitary waste and Waste tyres
- Inert
  - Sand, Pebbles, Dirt and Gravel
  - C&D Waste

### Material Recovery Facilities
- Recyclables

### Waste to Energy Cement Factories
- Energy Recovery
- Refused Derived Fuel

### C&D Projects Sanitary Landfills
- Sand and other building materials

### Components of Municipal Solid Waste

<table>
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<tr>
<th>Biodegradable</th>
<th>Recyclable</th>
<th>Refused Derived Fuel</th>
<th>Inert</th>
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### Treatment Technologies

- Composting / Bio-Methanation
- Material Recovery Facilities
- Waste to Energy Cement Factories
- C&D Projects Sanitary Landfills

### Final Products

- Compost Bio gas / Bio-CNG
- Recyclables
- Energy Recovery
- Sand and other building materials
Solid Waste: “any material which has negligible value to the producer and has no direct consumption”. It is generated due to human activities
Municipal Solid Waste

- MSW consists of household waste, Construction & Demolition waste, sanitation residue and waste from the streets.
  - Municipal solid waste includes commercial / institutional and residential waste generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes (MSW Rules, 2016)
  - With rising urbanization and lifestyle changes the amount of MSW being generated is increasing and its composition is changing.
Municipal Solid Waste: Composition

India (2011)

- Biodegradable: 52%
- Inert: 23%
- Paper: 14%
- Rubber: 8%
- Glass: 1%
- Metal: 1%
- Rags: 1%

High potential for composting. Incentives are required for segregation at source and composting at source and or decentralized facilities at ward level.

India generates ~ 62000 MT of MSW per year

- Waste collected: 69%
- Uncollected waste: 31%
- Treated: 28%
- Dumped at Sanitary Landfill sites: 72%

India generates ~ 62000 MT of MSW per year

Solid Waste Management - Challenges

- Low level of segregation of waste at source
- Absence of incentives that encourage home composting
- Lack of space for creation of infrastructure for decentralized composting and waste treatment plants
- Waste transportation vehicles are poorly maintained
- Decomposing organic matter is leading to environmental pollution (land, water and air)
- Lack of dedicated staff and personnel with the required technical skills and capacities
- Limited uptake of innovative technological, financing and human resource / manpower related solutions
Waste generation and storage

Segregation, reuse, and recycling at the household level

Primary waste collection and transport to a transfer station or community bin

Street sweeping and cleaning of public places

Management of the transfer station or community bin

Secondary collection and transport to the waste treatment site

Waste disposal in landfills
2. Policy framework for MSWM
• It is the duty of the ULBs to take care of MSW generated from the point of generation to disposal due to the increased concerns of environment across the globe.
• However, Government of India framed MSW policy and rules in 2000 itself but neither the States were serious nor the ULBs were empowered to implement this.
• And now the movement has come after the new initiatives of the Government of India with increased stake of new CSS where it has become mandatory for the ULBs to reach the Service level benchmarks.
• With the new set of MSW rules revised after decade and half.
• Rise of a concept-MSW Management.
Solid Waste Management Rules: Evolution

1. Municipal Solid Waste (Management & Handling) Rules 2000

2. Municipal Solid Waste (Management & Handling) Rules 2016

Ancillary Rules:
- Plastic Waste Management (Amendment) Rules 2018
- Construction and Demolition Waste Management Rules 2016
- E-Waste Management Rules 2016 amended vide notification G.S.R. 261(E), dated March 22, 2018
- Bio Medical Waste Management Rules, 2016
MSWM Rules, 2016 – Key Provisions

- Segregation at source
- User fees for collection by ULBs
- Integration of informal sector (Rag pickers, waste pickers, and kabadiwalas)
- Zero tolerance for throwing, burning, or burying of solid waste
- Waste processing and treatment
- Promoting use of compost
- Promotion of waste to energy
- Revision of parameters and existing standards
- Constitution of a Central Monitoring Committee
• **Segregation at source**
Segregate and store the waste into three bins – green (biodegradable), blue (non biodegradable) and red (domestic hazardous waste)

User fee for garbage collection and spot fine for littering and non segregation
MSWM Rules, 2016 – Key Provisions

Integration of Informal sector
MSWM Rules, 2016 – Key Provisions

Zero tolerance for throwing, burning or burying of solid waste
Biodegradable waste to be processed through composting / bio methanation at premises

Left over waste to be handed over to waste collection agencies

All SEZs, Industrial estates / parks to earmark 5% of the area for recovery / recycling facility

All ULBs should set up waste processing facilities

**MSWM Rules, 2016 – Key Provisions**
Bio remediation dump sites

Promoting use of compost

Promoting Waste to Energy

MSWM Rules, 2016 – Key Provisions
MSWM Rules, 2016 – Key Provisions

Revisions of parameters and standards

- Standards for location of landfill site
- Emission standards amended
- Compost standards aligned to Fertiliser Control Order

Constitution of a Central Monitoring Committee

- Secretary, MoEF&CC as Chairman
- Stakeholders of the central & state governments as members
- Oversee and monitor the implementation of the SWM Rules, 2016
**MSWM Rules, 2016 – Duties (Generators & local bodies)**

<table>
<thead>
<tr>
<th>Duties of Generators</th>
<th>Duties of Local governments</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Segregation and storing waste generated and handover the same to authorized waste collectors</td>
<td>• Frame bye-laws incorporating the provisions of SWM Rules, 2016</td>
</tr>
<tr>
<td>• Refrain from throwing, burning or burying solid waste</td>
<td>• Collection system for segregated solid waste</td>
</tr>
<tr>
<td>• Pay user fee for SWM as specified in the bylaws</td>
<td>• Set up material recovery facility for recyclables</td>
</tr>
<tr>
<td>• All RWAs, gated communities/institutions (&gt;5000 Sqm area) and hotels / restaurants to segregate waste at source and hand over recyclables to authorised waste collector and process, treat and dispose off biodegradable waste</td>
<td>• Facilitate construction, O&amp;M of solid waste processing facilities and associated infrastructure</td>
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<tr>
<td></td>
<td>• Create awareness to the public</td>
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<td>• Submit reports as required by PCB</td>
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<tr>
<td>Ministry of Urban Development</td>
<td>Ministry of Fertilizers, Government of India</td>
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<tr>
<td>Formulate National Policy and Strategy on SWM (including policy on Waste to Energy)</td>
<td>Provide market development assistance on city compost and ensure promotion of co-marketing of compost with chemical fertilizers in the ratio of 3 to bags: 6 to 7 bags by the fertilizer companies to the extent compost is made available for marketing to the companies.</td>
</tr>
<tr>
<td>Review the measures taken by States and local bodies</td>
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<tr>
<td>Undertake training and capacity building of local bodies</td>
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<td>The National policy on SWM to be the guiding tool for States/local authorities</td>
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<tr>
<td>Providing technical guidelines and project finance to States, UTs and local bodies on SWM to facilitate meeting timelines and standards</td>
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### SWM Rules (2016): Duties of other government agencies

#### Ministry of Agriculture, GoI
- Provide flexibility in Fertilizer Control Order for manufacturing and sale of compost
- Propagate utilization of compost on farm land
- Set up laboratories to test quality of compost
- Issue guidelines for maintaining quality of compost & ratio of use of compost visa-a-vis chemical fertilizers

#### Ministry of Power, GoI
- Fix tariff / charges for the power generated from the WtE plants
- Ensure compulsory purchase of power generated from such plants by DISCOMs

#### Ministry of New & Renewable Energy, GoI
- Facilitate infrastructure creation for WtE plants and provide appropriate subsidy or incentives for such plants.
- Ensure that non recyclable waste (calorific value of 1500 K/cal/kg or more) shall not be disposed off in landfills and only be utilized for generating energy
• All manufacturers of disposable products such as tin, glass, plastics packaging etc. or brand owners who introduce such products in the market shall provide necessary financial assistance to local authorities for establishment of waste management system.

• All such brand owners who sale or market their products in such packaging material which are non-biodegradable shall put in place a system to collect back the packaging waste generated due to their production.

• Manufacturers or Brand Owners or marketing companies of sanitary napkins and diapers shall explore the possibility of using all recyclable materials in their products or they shall provide a pouch or wrapper for disposal of each napkin or diapers along with the packet of their sanitary products.

• All such manufacturers, brand owners or marketing companies shall educate the masses for wrapping and disposal of their products.

• All industrial units using fuel and located within 100 km from an solid waste based RDF plant shall make arrangements within six months from the date of notification of these rules to replace at least 5 % of their fuel requirement by RDF so produced.
• The local authorities and Panchayats shall prepare a solid waste management plan
• Door to door collection of segregated solid waste; integrate rag pickers / informal waste collectors
• Frame bye-laws incorporating the provisions of these rules
• Direct waste generators not to litter and to segregate the waste at source and hand over the segregated waste to authorized waste pickers
• Setup material recovery facilities or secondary storage facilities
• establish waste deposition centre/s for domestic hazardous waste
• direct street sweepers not to burn tree leaves collected from street sweeping
• provide training on solid waste management to waste-pickers and waste collectors
• promote setting up of decentralized compost plant or bio-methanation plant
• collect separately waste from sweeping of streets, lanes and by-lanes daily, or on alternate days
• collect horticulture, parks and garden waste separately and process in the parks and gardens
• transport segregated bio-degradable waste to the processing facilities like compost plant, bio-methanation plant or any such facility
• transport non-bio-degradable waste to the respective processing facility or material recovery facilities (MRF)
• transport construction and demolition waste as per the provisions of Construction and Demolition Waste management Rules, 2016
• involve communities in waste management and promotion of home composting, bio-gas generation, decentralized processing of waste at community level
• educate workers including contract workers and supervisors for door to door collection of segregated waste and transporting the unmixed waste during primary and secondary transportation to processing or disposal facility
• ensure that the operator of a facility provides personal protection equipment
• stop land filling or dumping of mixed waste; allow only the non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive inert waste and pre-processing rejects & residues from waste processing facilities to go to sanitary landfill
• investigate and analyse all old open dumpsites and existing operational dumpsites for their potential of bio-mining and bio-remediation
• ULBs in Andhra Pradesh generate ~6800 MTs of solid waste per day.
• Growing at 5% annually due to changing lifestyles.
• Absence of any uniform specifications / standards for micro level planning, route mapping, and workers’ distribution at a local level
• Instead of outsourcing complete work units for maintenance of sanitation, most ULBs engage workers from contractors on outsourcing basis. This arrangement suffers from the following issues:
  • Contractors do not pay minimum wages to the labour
  • A few bidders have been monopolizing the contracts
  • Contractors are not meeting service delivery requirements
  • Absence of any rationality in the number of workers engaged including permanent public health workers and workers engaged on temporary and contract basis.
  • Inefficient contractor management
  • Gaps in resource recovery including recyclables, compostable, combustibles.
Objectives

1.1. Guiding the ULBs for effective implementation of MSW rules, NGT directives and other regulations w.r.t. source segregation, collection, and transportation of solid waste

1.2. Guideline for micro planning of sanitation and SWM activities in residential, commercial areas and main roads.

3. Rationalizing the norms for manpower, transportation of vehicles, tools, implements and conservancy materials

4. Guidance on the methods of tendering and contract management
Operational Guidelines for Micro Planning, Work Rationalization & Outsourcing of Work Packages

- Residential Micro pocket management
- Main roads sweeping
- Litter collection and drains cleaning
- Commercial & Bulk solid waste handling
- Mechanical sweeping of main roads
Purpose of micro planning

- Demarcating residential, commercial and main road sweeping pockets for carrying out the sanitation and solid waste management activities
- Providing clear assignment of job responsibilities and defining key performance indicators for service providers
- Ensuring realistic estimates of resource requirements (manpower, transportation vehicles, tools, implements and conservancy materials)
- Developing clear resource inputs and results-outputs correlations to achieve standard service delivery results across the ULBs
- Identifying and developing clear work quantities, key performance indicators and performance monitoring mechanisms, in the event of outsourcing complete work packages to private agencies
3. Waste characterization
Waste characterization

Finding out how much paper, glass, food waste, etc. is discarded in your waste stream.

Helps in planning how to reduce waste, set up recycling programs, and conserve resources.
4. Municipal Solid Waste Management (MSWM) – Components
Municipal Solid Waste Management (MSWM)

Associated with control of generation, storage, collection, transport or transfer, processing and disposal of solid waste materials.

MSWM includes planning, administrative, financial, engineering and legal functions, in the process of solving problems arising from waste materials.

Aimed at reducing and eliminating adverse impacts of waste materials on human health and environment to support economic development and ensure a good quality of life.
DON’T WASTE

A FILM ON VALUE CHAIN OF WASTE MANAGEMENT
Municipal Solid Waste Management: Functional elements
Process flow and stakeholders: Current scenario

**Process flow**
- Door-to-door collection
- Segregation of recyclables from mixed waste
- Dumping of mixed waste
- Recovery and space management

**Stakeholders**
- Collection agents employed by external contractors do door-to-door collection of unsegregated household waste
- Informal traders pick up recyclables from the mixed waste (~10% recovery rate)
- Contractors dump into designated landfills; paid by tonnage dumped
- Wastepickers recover recyclables from trash; waste burnt in open air
Waste collection – door to door

Options

- Door to door collection
- Community based system
- Night collection (commercial areas)
- Dry waste purchase
- Dry waste sale
- Secondary storage (Central Bin)
Segregation is defined as “the sorting and separate storage of various components of solid waste” (MSW Rules, 2016)
Segregation of HH waste: Green and Blue Bin

**Green Bin**
A Green bin should be used for Wet waste.
- Food wastes of all kinds cooked and uncooked, including eggshells and bones
- flower, fruit and waste including juice
- vegetable peels
- household garden/plant wastes
- Soiled paper (used toilet paper, paper towel etc.)

**Blue Bin**
A Blue bin should be used for dry waste.
- Paper (Newspaper, notebooks etc.)
- Cardboard & cartons
- Containers & packaging of all kinds excluding those containing hazardous materials
- Compound packaging (Tetra pack etc.)
- Plastics
- Wood
- Rag
- Discarded Clothing
I KEEP TWO DUSTBINS
I HELP IN RECYCLING

By keeping separate dustbins for biodegradable and dry waste, I help my country in source segregation. This goes a long way in helping in recycling and reuse. Let us all join hands to create wealth out of waste.

GREEN FOR BIODEGRADABLE - BLUE FOR DRY WASTE

I KEEP TWO DUSTBINS
I HELP IN RE-USE OF WASTE

By keeping separate dustbins for biodegradable and dry waste, I help my country in source segregation. This goes a long way in recycling and reuse. Let us all join hands to create wealth out of waste.

GREEN FOR BIODEGRADABLE - BLUE FOR DRY WASTE

WHAT YOU THROW AWAY CAN THROW UP A NEW IDEA

KEEP TWO DUSTBINS TO HELP IN RECYCLE AND RE-USE

By expanding biodegradable and dry waste at source, you can actually help the country in conserving resources and environment, apart from achieving the vision of Swachh Bharat.

GREEN FOR BIODEGRADABLE - BLUE FOR DRY WASTE
Waste segregation and its potential uses

Source: CPCB Report on Management of Municipal Solid Waste
Waste Transportation

Schematic diagram of solid waste management in Tiruchirappalli city.
• Processing essentially include use of physical techniques to change the composition and character of waste.

• The biodegradable wastes can be processed by Composting, Vermi-composting, Anaerobic digestion or any other appropriate biological processing for stabilization of wastes.

• Waste to Energy (Incineration) & RDF (Refuse Derived Fuel) can also be used for processing wastes in specific cases.

• Mixed waste containing recoverable resources should be recycled.

• Municipal authorities should adopt suitable technologies to make use of wastes so as to minimize burden on landfill.
Waste Processing Methods

- Composting
- Vermi Composting
- Bio Methanization
- Incineration / Waste to Energy
- Refuse Derived Fuel (RDF)

BIODEGRADABLE WASTES
Composting

• Organic matter constitutes 25-4-% of the MSW in Urban India which can be processed through composting

• Natural process of decomposition of organic waste in which micro-organisms, mainly fungi and bacteria, convert degradable organic waste into humus like substance.

• This finished product is high in carbon and nitrogen and enhances the water holding capacity of the soil. It is an excellent medium for growing plants.

• The processing method is clean, cheap and safe.
Vermicomposting is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product.

Earthworms feed on organic waste materials and passes it through their digestive system and gives out in a granular form (cocoons) which is known as vermicompost.

Vermicompost can improve biological, chemical, and physical properties of the soil.

The chemical secretions in the earthworm’s digestive tract help break down soil and organic matter, so the castings contain more nutrients that are immediately available to plants.

The vermicompost contain higher percentage of both macro and micronutrients than the garden compost. Apart from other nutrients, it is rich in NPK which are in readily available form.

Vermicompost enhances plant growth, suppresses disease in plants, increases porosity and microbial activity in soil, and improves water retention and aeration.
Bio methanation / Methanogenesis

- A process by which organic material is microbiologically converted under anaerobic conditions to biogas.
- Three main physiological groups of microorganisms are involved:
  - fermenting bacteria,
  - organic acid oxidizing bacteria, and
  - methanogenic archaea
- Microorganisms degrade organic matter, via cascades of biochemical conversions, to methane and carbon dioxide
Bio methanation is an excellent urban waste management solution. **Advantages of Bio methanation**

- **Generation of Biogas** – energy and heat
- **No significant CAPEX**
- **Self sufficient system with no need for external power source**
- **System is sealed and enclosed** collecting every bit of gas for use
- **Eliminates foul odour**
- **No growth of pests and rodents**
- **No pollution or other social issues**
- **Leaves a waste product which can be used as manure**
Incineration

• A waste treatment process that involves combustion of organic substances contained in waste materials.

• **Incineration of waste materials** converts the waste into ash, flue gas and heat.
  • The ash is mostly formed by the inorganic constituents of the waste and may take the form of solid lumps or particulates carried by the flue gas.
  • The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere
  • In some cases, the heat that is generated by incineration can be used to generate electric power.

• Incinerators reduce the solid mass of the original waste by 80-85% and the volume by 95-96%, depending on the composition and degree of recovery of materials such as metals from the ash for recycling. Thus, while incineration does not completely replace landfilling, it significantly reduces the necessary volume for disposal.
Recycling and Reuse

Recycling

• Turning an item into raw materials which can be used again, usually for a completely new product. This is an energy consuming procedure
• Examples: fibre glass made from glass bottles, and insulation materials made from newspaper or plastic bottles

Reuse

• Reusing refers to using an object as it is without treatment. This reduces pollution and waste, thus making it a more sustainable process.
• Examples: Anything that was bought second hand, often furniture and clothing
Recycling

- Involves collection of used and discarded materials, processing them and making them into new products.
- It reduces the amount of waste that requires proper disposal.
- Only 7-15% of waste is currently recycled.
- Prior to recycling waste needs to be collected from various sites.
- Downside of recycling is the large amount of energy needed to transport, process and reassemble recyclable materials.
### Disposal

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<tr>
<th>Open dumps</th>
<th>Landfills</th>
<th>Sanitary Landfills</th>
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<tbody>
<tr>
<td>• Uncovered areas that are used to dump solid waste</td>
<td>• Located in urban areas where large amount of waste is generated</td>
<td>• These are landfills that are lined with materials such as plastic and clay and are built over impermeable soil so that the problem of leaching is addressed</td>
</tr>
<tr>
<td>• Untreated, not segregated and uncovered</td>
<td>• A pit is dug and garbage is dumped, covered</td>
<td>• Rate of decomposition in sanitary landfills is extremely variable</td>
</tr>
<tr>
<td>• Breeding ground for disease spreading vectors</td>
<td>• When water seeps through a landfill it contaminates surrounding land and water (leaching)</td>
<td>• Methane gas is produced during anaerobic decomposition</td>
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<tr>
<td>• Rain runoff pollutes land and water</td>
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**Bio Mining** method to process legacy waste using windrows technique and stabilisation of waste through screening so as to recover valuable resources aiming sustainable waste management

**Process**

1. **Excavate legacy waste and loosen it up through windrows.** The leachate formed dries through solar exposure facilitating methane removal from heap.
2. **Addition of composting bio-culture speeds up the decomposition process by creating biological heat.** There by ready for screening.
3. **Waste is then screened using different sized nets such as 150mm, 80-100mm, 24-50mm, 12-16mm and 4-6mm.**

**Output**

- The finest fraction obtained after screening is called bio-earth or good earth.
- The coarsest fraction contains bricks, stones, coconut shells, footwear, cloth and larger plastics.
- The lighter mid-fractions are mostly plastics and can use in bitumen hot-mix plants to make so-called plastic roads or as refuse derived fuel for co-processing in cement kilns.
- The heavier mid-fraction are mostly stony inert which can be used in the lowest layer of road making or plinth filling or in low laying areas.
- Less than 10% original waste remains as totally unusable residual reject, which can be land filled.
1. Geo-technical investigations (Contour Survey, Geotechnical Investigation, Physio-chemical analysis and baseline environmental monitoring).
2. Estimation of Legacy Waste Quantity
3. Execution plan, drawings of Scientific Reclamation Layout and required infrastructure
4. Site Assessment Report (SAR) including Environment Management Plan (EMP), Environment Monitoring Plan and its implementation Mechanism
5. Resource mobilization
6. Construction of processing facility and installation of weighbridge
7. Excavation, resource recovery, sale and disposal of the recovered material
8. Scientific disposal of the process rejects
9. Reclamation of land, leveling, grading and compaction
10. Storm water management system/ infrastructure
11. Leachate management system/ infrastructure
OVERVIEW OF DUMPSITE REMEDIATION

Detailed Screening of Legacy Waste

- >150 mm: Bricks, coconut and footwear
- 80-100 mm: Recyclables
- 30-50 mm: Shredding as per requirement
- <30 mm: RDF / Recycling/Roads
- <4-6 mm: Bio-Earth
- <30mm: Farmers / Landscaping
Additional Resources