Toolkit

PREPARING CITY SOLID WASTE ACTION PLAN UNDER SBM 2.0

Managing non-biodegradable waste

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Managing non-biodegradable waste

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Contents

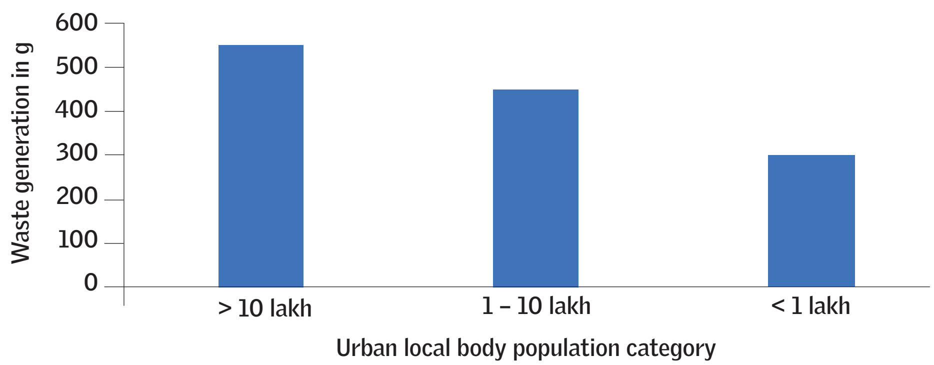
Introduction

Solid waste generated by domestic, commercial and other activities is frequently disposed of indiscriminately. Unscientific waste management causes serious environmental issues. Around the world, urban areas are already experiencing severe problems because waste disposal facilities are unable to keep up with the volume of waste generated. It is very common to find large, disorganized heaps of garbage in every nook and cranny of cities.

Urban India generates approximately 143,200 metric tonne (MT) of municipal solid waste daily, which comes to about 300–550 gram (g) per capita generation. Per capita waste generation varies from city to city depending on the level of urbanization, lifestyle and economic standard of the residents.

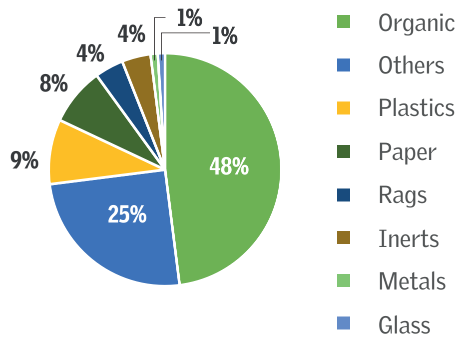
According to Swachh Bharat Mission (SBM) 2.0 data, 20–30 per cent of the waste generated in India is recyclable, whereas 10–20 per cent is non-recyclable. Both the recyclable and non-recyclable fractions of waste fall under the inorganic waste category, which means that put together, an average of 40 per cent waste generated in urban India is inorganic. This comes to about 57,280 MT of daily inorganic waste generation. Inorganic waste is constituted of paper, plastics, rags, glass, metals, etc. (see *Graph 2: Composition of municipal solid waste*). These materials can generate substantial revenue for urban local bodies (ULBs) if managed and processed correctly. However, improper management means these materials end up in dumpsites or landfills, where they cause severe environmental hazards. An integrated solid waste management system reduces waste disposal while

Graph 1: Per capita waste generation population category-wise



Source: SBM 2.0

Graph 2: Composition of municipal solid waste



Source: https://greensutra.in/

maximizing resource recovery. Non-biodegradable waste should be processed to recover valuable materials (e.g., plastic, paper, metal and glass), produce energy (e.g., through refused-derived fuel or RDF and co-processing of combustible non-biodegradable dry fraction of municipal solid waste in cement plants), and in other uses (road construction, etc.) before final disposal. Some advantages of recycling are:

(1) Revenue generation from the sale of recyclables
(2) Volume of waste to be managed is substantially reduced
(3) Creates livelihood opportunities for the informal sector, recyclers and the recycling industry on the whole
(4) The life span of landfills increases because they receive less waste and fill up slower

The best way to deal with non-biodegradable waste is by adopting the 3R principles—Reduce, Reuse and Recycle.

Inorganic waste should be segregated at source because mixing it with any other waste makes its pre-processing and processing much more complicated. The first step to deal with inorganic waste is to reduce its quantity at source. If less waste is generated, then there is less to recycle, reuse or manage. The second step is to reuse the material without disposing of it. Many things that might appear to be “waste” at a casual glance can in fact be reused without any problem.

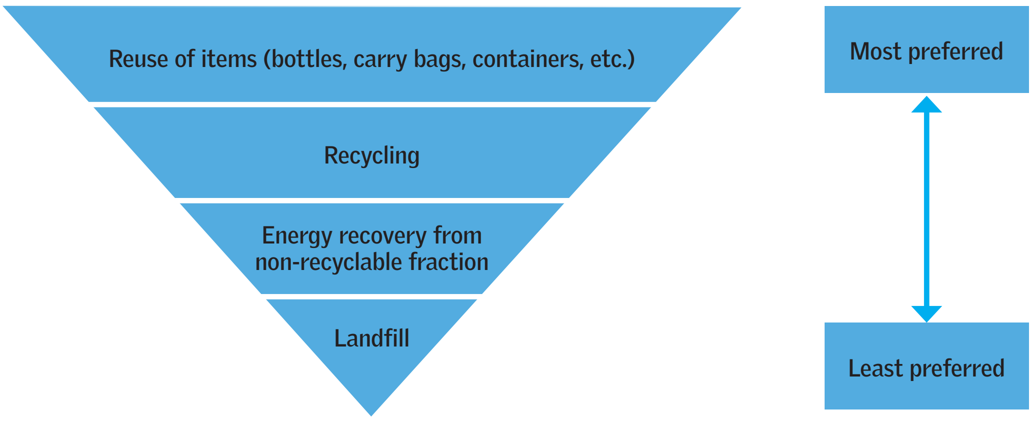
The third step is to recycle as much as possible. Recycling transforms waste into raw material for manufacturing a new item. There are very few materials on Earth that cannot be recycled; hence this option is very effective in waste management.

Under the Swachh Bharat Mission-Urban (SBM) 2.0, a total outlay of Rs 1,41,600 crore has been earmarked, which is nearly 2.5 times that of the total outlay of SBM–Urban 1.0. Of the total budgetary allocation under SBM 2.0, 39,837 crore have been assigned to proper and scientific solid waste management. Hence, cities must focus on establishing a more scientific and sustainable solid waste management system that concentrates on source segregation, treatment of various waste streams and resource recovery based on the principles of circular economy.

SBM 2.0 has mandated the formulation of City Solid Waste Action Plans by all urban local bodies to achieve 100 per cent scientific municipal solid waste processing. These action plans have to be submitted to respective state urban development departments. The plans must include details about processing plants, including capacity in tonne per day (TPD), estimated cost and date of commissioning.

State urban development departments consolidate all City Solid Waste Action Plans of the states and submit them to the Central Ministry of Housing and Urban Affairs (MoHUA). If the entry condition—identification and earmarking of land for setting up solid waste management facilities in all urban areas of a state—has been met, MoHUA will release the first instalment of 40 per cent from the budgetary allocation of SBM 2.0 to the state urban development department. The second instalment of 40 per cent will be released by MoHUA to the state urban development department on submission of a Utilization Certificate (UC) showing that at least 75 per cent of the money allocated in the first phase has been spent and at least 25 per cent physical progress in each subcomponent (processing plants, material

Figure 1: Hierarchy of inorganic waste management as per SBM 2.0



Source: SBM 2.0

recovery facilities or MRFs, scientific landfill and legacy dumpsite remediation) has been made. The third and final instalment of 20 per cent will be released to a state only after submission of a UC showing at least 75 per cent utilization of the money allocated in the second instalment and physical progress of at least 60 per cent in each subcomponent (processing plants, MRFs, scientific landfill and legacy dumpsite remediation).

Therefore, it is imperative that urban local bodies start planning immediately for setting up inorganic waste processing units for efficient and channelized waste management. This toolkit will, hopefully, help these bodies to choose the most suitable technologies for processing and treating inorganic waste.

Approach to planning

Unlike organic waste, inorganic waste is not processed by ULBs. The role of ULBs is limited to the collection, pre-processing and selling of inorganic waste to buyers/ recyclers. For inorganic waste, decentralized management is applicable only to bigger cities with 100,000 or more population. Such urban centres should set up decentralized dry waste collection centres where segregated organic waste can be collected and sorted into more specific categories through secondary segregation. Once segregated, the waste is transferred to centralized material recovery facilities where it is pre-processed to extract better value from it. Pre-processing involves removing dust, cleaning, washing, shredding, drying, bailing, etc.

Setting up decentralized material recovery facilities is not a feasible option as it involves higher investment. If a city creates a single point to dispose of various pre-processed materials, it becomes easier for potential buyers and recyclers to collect and transport them.

2. Management of non-biodegradable waste—key considerations for ULBs

- **Population:** One of the most critical factors that needs to be considered during a city's solid waste management planning. Most ULBs make use of data of the 2011 Census, but knowledge of a city's current population and floating population is required when planning the capacity of processing facilities. The formula to calculate the current population is given below:
  Formula: Pb = Pa (1+r) t
  Pb = Population of the year for which projection is to be made
  Pa = Population of the base year
  r = Rate of growth divided by 100 (generally considered as 0.02)
  t = The number of years between 'a' and 'b'
- **Waste quantification and characterization:** The composition of municipal solid waste changes with the location. Even samples taken from the same location on the same day but at different times can have considerably different properties.

  Waste generation rates are calculated by weighing collection vehicles at a municipal or private weighbridge in a city.

  At least 100 representative sample locations per 100,000 population, including low-income, middle-income, and high-income households; trading companies; institutional generators; hotels; function rooms; vegetable markets; sports complexes and facilities; and places of worship should be chosen. Waste can be collected daily for at least seven consecutive days and weighed on a sensitive scale immediately after collection. A record of the waste generated by different categories of waste generators should be kept. Waste collected from each type may be mixed category-wise and segregated component-wise. Therefore, each component needs to be weighed separately to arrive at the waste characterization for different categories of waste generators. When extrapolated to the entire urban local body and divided by the total population, this representative waste quantity will yield the per capita waste generation rates.

- **Land identification and requirement:** ULBs should identify land, ideally located near the source of waste generation and roads to minimize the transportation cost and for easy transportation of incoming and pre-processed waste. In the absence of processing facilities inside the city, material recovery facilities should preferably be in an industrial zone or close to a sanitary landfill to facilitate the efficient movement of waste from various generators and disposal of residual waste. Facilities should be sited keeping the local geography in consideration, and flood-prone areas must be avoided.

  Different land areas are required for different scale of processing units. ULBs must identify suitable land for setting up decentralized units during the planning phase. The space needed to set up different units is described in detail in the proposed material recovery facilities chapter. ULBs may end up searching multiple lands of various sizes, therefore, as per availability of land, the capacities of the decentralized processing units can be finalized, varying from between 2–5 tonne per day (TPD). However, a larger patch is required for a centralized unit as many different types of machinery need to be installed for pre-processing at such units.

- **Mapping:** Once all the aforementioned points have been taken care of, logistics need to be fine-tuned. At this stage, wards with decentralized treatment and processing facilities need to be mapped, vehicles with facilities need to be tagged, vehicle route charts need to be prepared, and facilities constructed.

  Every decentralized waste processing unit usually caters to a few wards. Making use of historical data on increase in waste generation, the likely growth curve of ward-wise waste generation can be estimated. The capacity of a decentralized waste processing unit and the number of wards it can cater to can be calculated using these estimates, so that the processing unit is reasonably future-proof (usually for 15 years or so).

  The width of roads and streets should be kept in mind in the selection and tagging of vehicles. Pushcarts and tricycles might work well in slums and under-planned low-income neighbourhoods, while as auto-tippers can be more effective in planned neighbourhoods. Similarly, vehicles with larger capacity can better serve areas with commercial and bulk waste generators.

- **Construction:** Once a ULB has obtained the land, construction work needs to be started because the other parameters will be in place by the time the construction is finished, thus streamlining the whole process. While planning the capacities of different units for a city, the ULB should design the units considering the projected waste generation for at least 15 years or more. If possible, the ULB should demarcate land for future use.

- **Linkages for sale of recyclables and by-products:** One of the most critical factors that every ULB should consider before installing such facilities is to create a proper channel to sell recyclable materials. This helps in avoiding the problems of storing these materials too. ULBs should create a linkage to dispose of non-recyclable and inert materials.

- **Necessary authorization:** Before construction of a material recovery facility, the ULB should seek necessary permissions from the relevant authority, i.e., State Pollution Control Board, if the facility's capacity is to exceed 5 TPD.

3. Treatment methods and technologies for the management of non-biodegradable waste

Municipal solid waste consists of organic, inorganic and inert fractions. The inorganic fraction of municipal solid waste is further categorized into recyclables and non-recyclables. Dry waste collection units act as a temporary storage point where secondary segregation of mixed inorganic waste is performed. However, it is at the materials recovery facilities that tertiary segregation and pre-processing takes place.

The Solid Waste Management Rules of 2016 define a material recovery facility as a place where the local body or any person or agency authorized by them can temporarily store non-biodegradable solid waste to maximize the quantity of recyclables processed while producing materials that will generate the highest possible revenues in the market and maximize the reuse of other segregated fractions in different processes or industries.

In some cities, the material recovery facilities receive mixed waste, which has to be segregated manually or mechanically to separate the organic, inorganic, and inert fractions. Mixing of waste makes the whole system more labour-intensive as mixed waste requires minute segregation, and it isn't easy to differentiate these materials mechanically. Hence, the practice of source segregation should be emphasized to make the pre-processing steps hassle-free. If a material recovery facility receives only dry waste, material contamination is reduced and more materials can be recycled than at a mixed-waste material recovery facility.

USE OF PLASTIC WASTE IN ROAD CONSTRUCTION

The Central government has been using plastic waste in road construction to utilize materials that otherwise are not recycled properly. A kilometre of road construction usually requires about 10 tonne of bitumen. However, 1 tonne of bitumen can be replaced with plastic waste, saving about Rs 30,000 per km. So far, more than one lakh kilometre of road has been constructed using plastic waste.

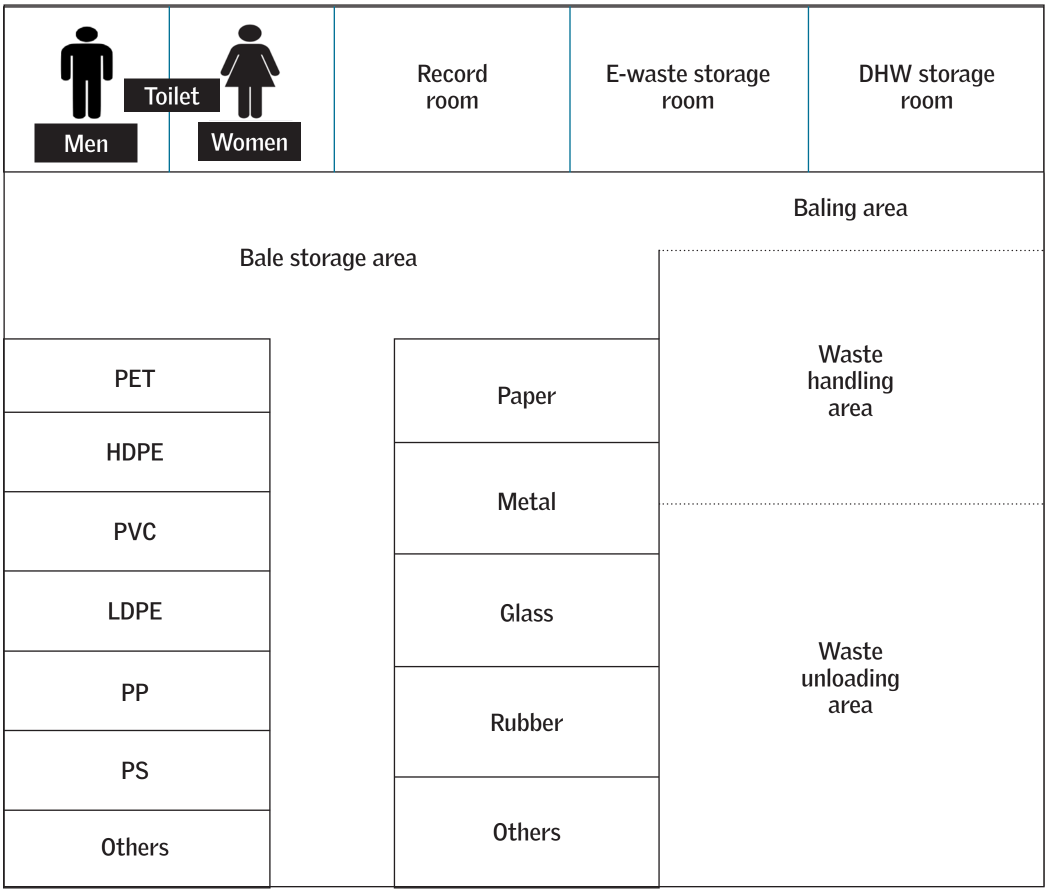
Depending on the level of mechanization and scale of operation, MRF facilities can be classified into three categories:

1. Manually operated
2. Semi-automatic
3. Fully automatic

Manually operated

In a manual material recovery facility, the process of sorting the materials is carried out manually, as the name suggests. Manual material recovery facilities are suitable for urban local bodies generating small quantities of municipal solid waste (varying from 5–10 TPD). These facilities sometimes receive waste in the mixed form so they can be integrated with a composting facility depending on land availability and location. Material recovery facilities employing manual labour for sorting have relatively lower operational costs. The main components of a manual-operated material recovery facility are a weighbridge and a sorting platform.

Figure 2: Design of a manual material recovery facility

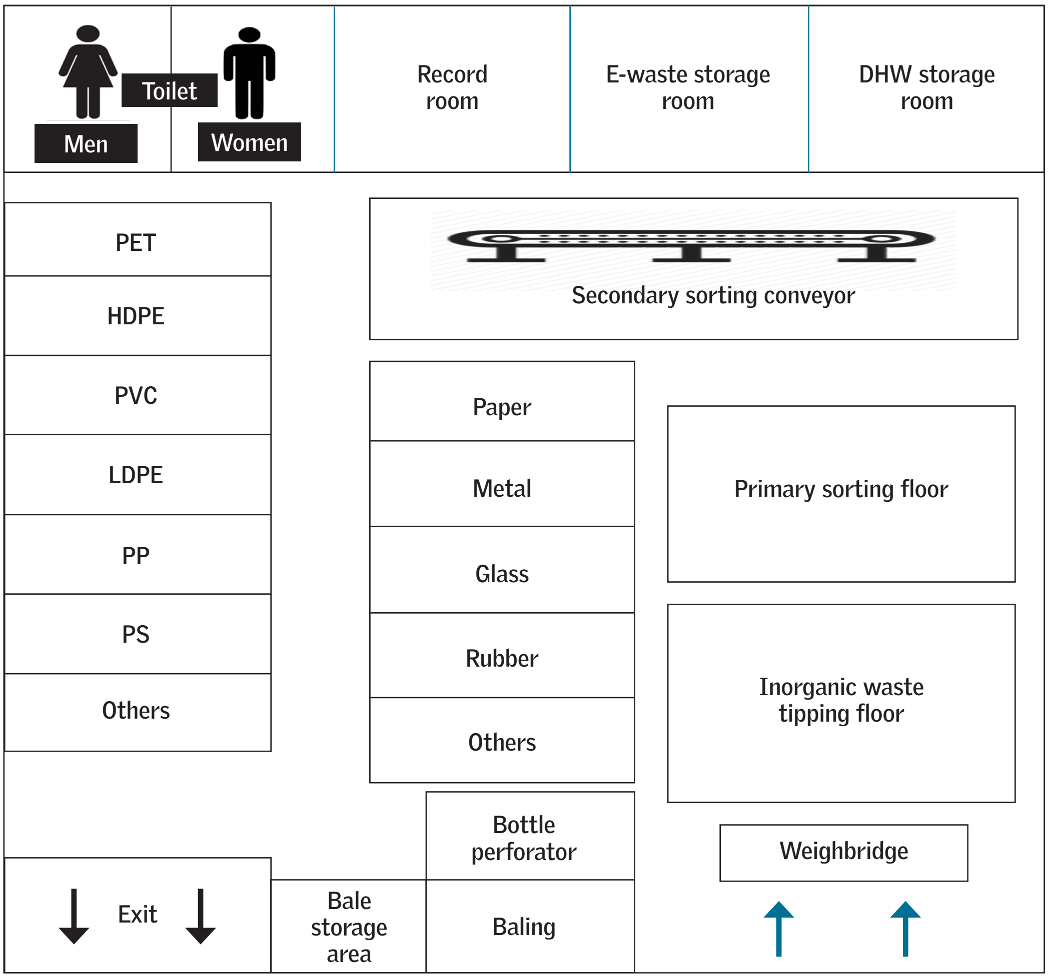


Source: Centre for Science and Environment

Semi-automatic

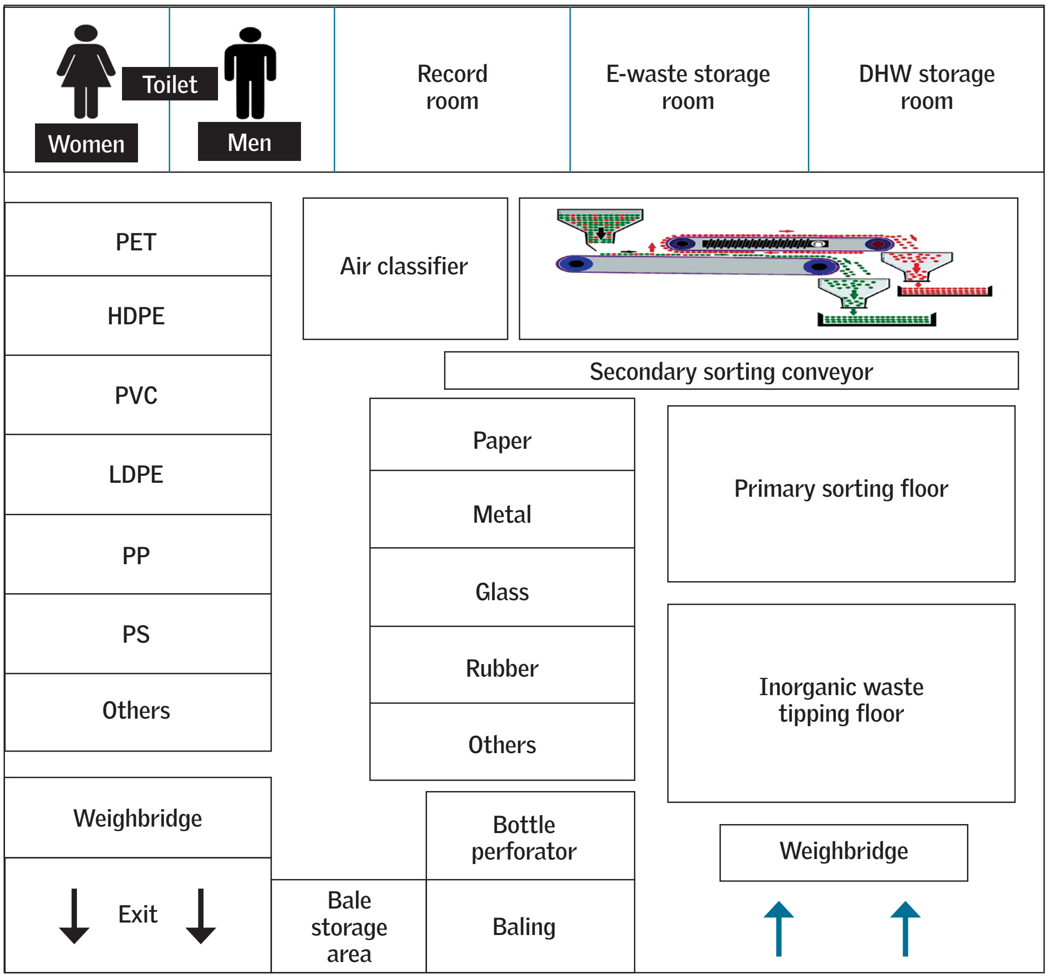
These material recovery facilities are operated both manually and mechanically. Semi-automatic material recovery facilities can have a capacity of 10–100 TPD or more, but only segregated dry waste should be brought to such facilities. Semi-automatic material recovery facilities can also work as a pre-processing unit depending on land availability and location, where segregated dry waste can be further cleaned to extract better value. These facilities can also work as intermediate storage points in those cities where centralized material facilities are not available, but ideally, these facilities should be decentralized. Various components of a semi-automatic material recovery facility are a weighbridge, sorting platform (primary sorting), conveyor belt (secondary sorting), bottle perforator, baling machine and forklift.

Figure 3: Design of a simple semi-automatic material recovery facility



Source: CSE

Figure 4: Design of an advanced semi-automatic material recovery facility

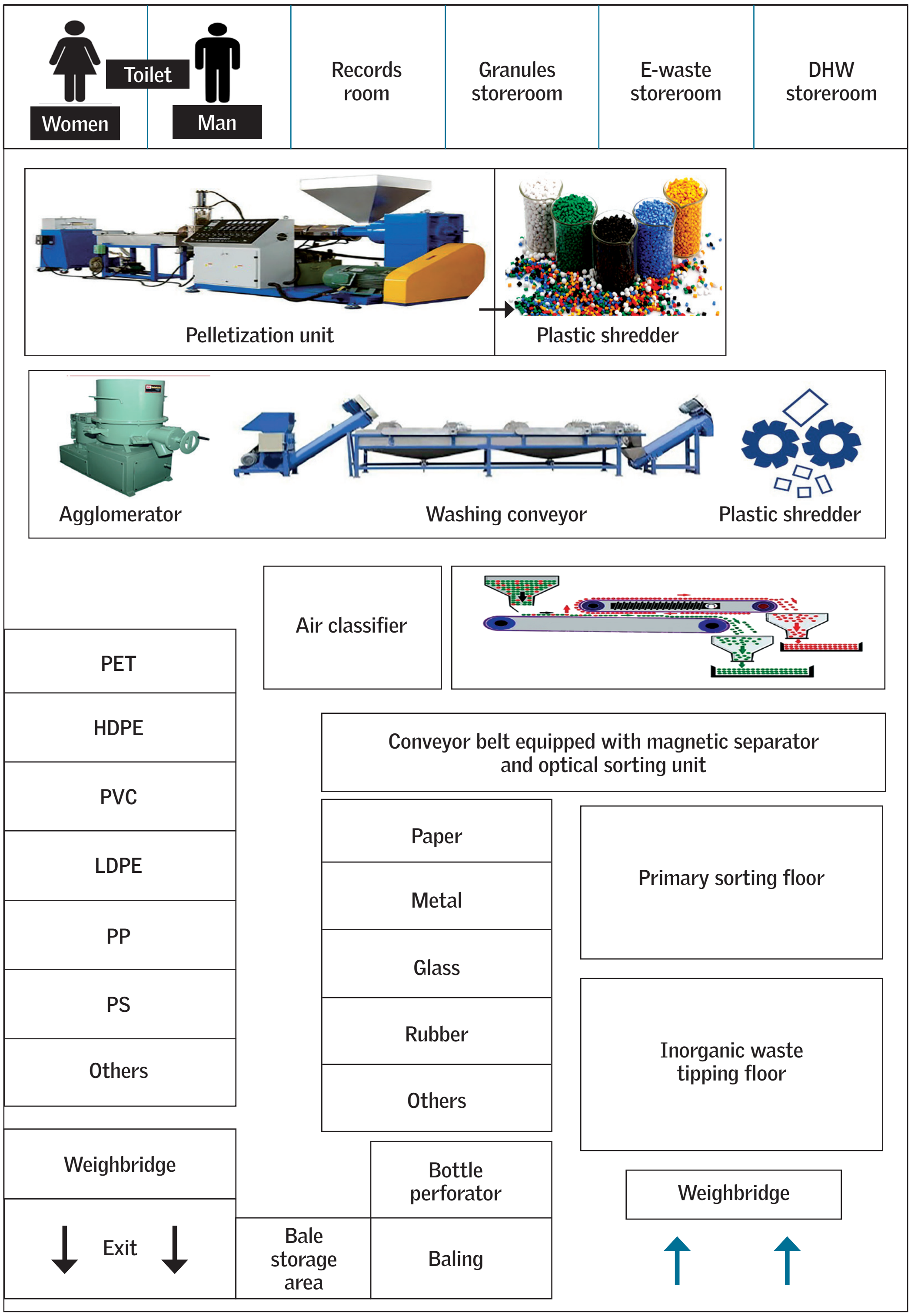


Source: CSE

Fully automatic

These material recovery facilities are fully mechanized. They deal with a large volume of source-segregated dry waste (> 100 TPD) with minimum human intervention. Such facilities work best for segregating recyclables, non-recyclables, refuse-derived fuel and inerts, etc. However, these facilities cannot function properly if mixed waste is more than 20 per cent of the total waste received at these facilities. A fully automatic material recovery facility comprises a weighbridge, mechanical loader, sorting platform, conveyor belt, trommel, air classifier, magnetic separator, optical sorting machine, shredding machine, bottle perforator, baling machine, forklift, agglomeration machine and granulation machine.

Figure 5: Design of a fully automatic material recovery facility



Source: CSE

Ideally, a material recovery facility should be set up above a concrete-floored warehouse-type building structure with a high ceiling, and the whole facility should be boundary-fenced. Along with the essential components of a standard material recovery facility, the following elements are also a must:

- Tipping area
- Vehicle movement area
- Sorting area
- Adequate storage area for different materials (for at least seven days worth of material)
- Record room
- Fire-extinguishing facilities
- Change or restrooms for both males and females
- Water and electricity connection

Operation of a material recovery facility

Depending on the scale of operation and mechanization, a material recovery facility can have different processing units, as follows:

1. **Weighbridge:** It is one of any processing facility's most essential components. This unit is used to determine the weight of both incoming and outgoing waste, which helps in record keeping. In the absence of a weighbridge at the facility, the waste must be weighed outside the facility, which is obviously not ideal.

Source: CSE

Door-to-door collection vehicles being weighed on a processing facility's weighbridge

Source: CSE

Commingled inorganic waste is being unloaded manually on the tipping floor

2. **Tipping floor**: Door-to-door collection vehicles unload source-segregated commingled inorganic waste on the tipping floor. During unloading, it should be kept in mind that the container carrying the organic waste has either been already emptied in the respective composting facility or the compartment is locked correctly to avoid mixing of the waste on the tipping floor. The tipping floor should be spacious enough for the convenient movement of vehicles. Waste from the tipping floor is taken to a sorting platform. The unloading operation can be carried out manually or mechanically depending on the scale of the operation and the level of mechanization.

3. **Sorting platform**: The sorting platform is used for secondary segregation of the commingled inorganic waste into various fractions. For a manually-operated material recovery facility, waste from the tipping floor is brought to the sorting floor, which must be covered from the top. In contrast, at a semi-automatic or fully automatic material recovery facility, waste from the tipping floor is unloaded over a slow-moving conveyor belt where secondary segregation takes place. Segregated secondary materials are kept in separate containers stored separately.

Source: CSE

Secondary segregation of inorganic waste on the conveyor belt

Source: CSE

Manual secondary segregation on the sorting floor

Source: CSE

Storage compartments for different types of segregated waste

4. **Storage area:** Segregated secondary waste is stored in separate waste stream-wise compartments. These compartments are separated by plywood or brick walls. The size of each compartment is decided on the basis of the capacity of the material recovery facility.

5. **Baling:** Once a substantial quantity of waste has been stored or the compartments are about to get full, the waste is taken and baled using the baling machine. Baling reduces the volume of the waste and makes it much easier to transport it. Different types of waste must be baled separately; otherwise the purpose of sorting materials from the commingled waste will not be served.

Source: CSE

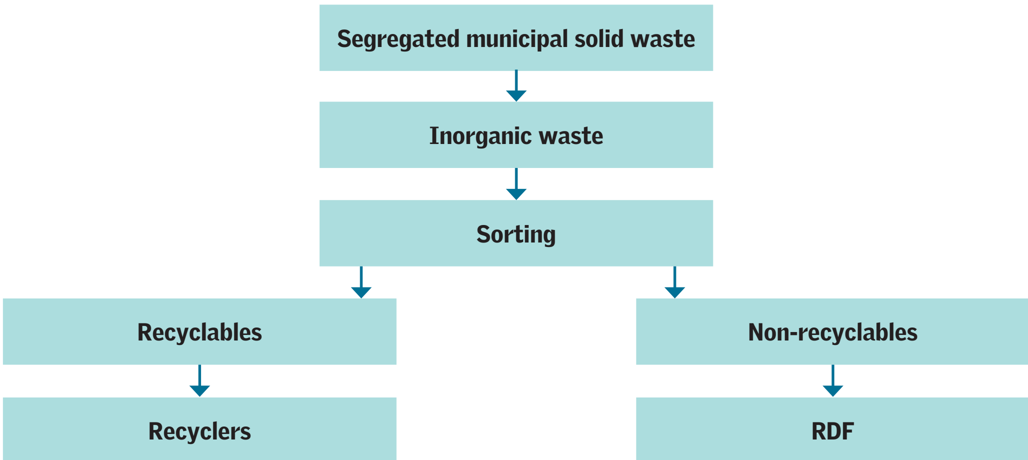
Baled waste at a MRF facility

Proposed material recovery facilities

The capacity of a material recovery facility depends on the quantum of waste generated from an urban local body. As discussed earlier, a manual material recovery facility can cater to waste from a small city; as the population increases, the level of mechanization also needs to increase for better performance. This section will discuss the details of a material recovery facility as per the population category.

- **Population ranges up to 50,000:** Cities under this category generate around 15–20 tonne of municipal solid waste daily. If we consider that 40 per cent of municipal solid waste is inorganic waste, a city with this population will yield produce 6–8 tonne of inorganic waste daily. For towns falling within this population category, a manual material facility is ideal. Such manual material recovery facilities can double up as a waste selling point.

Figure 6: Working principle of a small manual material recovery facility



Source: CSE

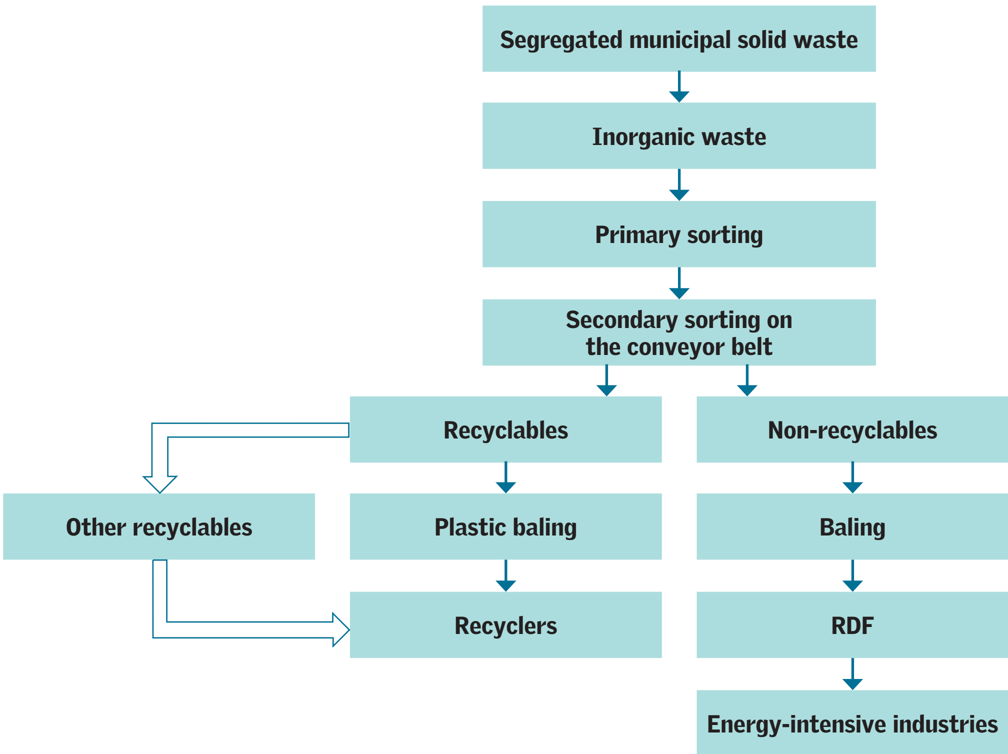
Table 1: Details of material recovery facilities for a town with a population of less than 50,000

Pointer	Details
Number of facilities	Two-three—decentralized
Capacity	Capacity can vary between 1–5 TPD per facility
Area	600 sq. m per facility, including the vehicle movement area, suitable for pushcarts, tricycles and auto-tippers only
Workforce	Eight-ten workers per facility
CAPEX	Rs 20–40 lakh per facility, excluding the cost of land
OPEX	Rs 2 lakh per facility per month

Source: CSE

- **Population range 50,000–100,000:** Cities under this population category generate around 35–40 tonne of municipal solid waste daily, of which 14–16 tonne is inorganic waste. According to their budget and space availability, cities under this population category can consider establishing a manual or semi-automatic material recovery facility. If the budgetary allocation is limited and land area is not large enough, a city can opt for two manual material recovery facilities, but if there are no budgetary or land area constraints, then one semi-automatic material recovery facility will be the more suitable option. In the case of a manual material recovery facility, the same facility can be utilized as a waste channelization point. As waste generation is not insubstantial, different categories of recyclable materials should be baled separately and then handed over to potential recyclers. The same process shall be followed for non-recyclable material, after which baled materials should be sent to energy-intensive industries such as cement or waste-to-energy plants.

Figure 7: Working principle of a mid-range semi-automatic material recovery facility



Source: CSE

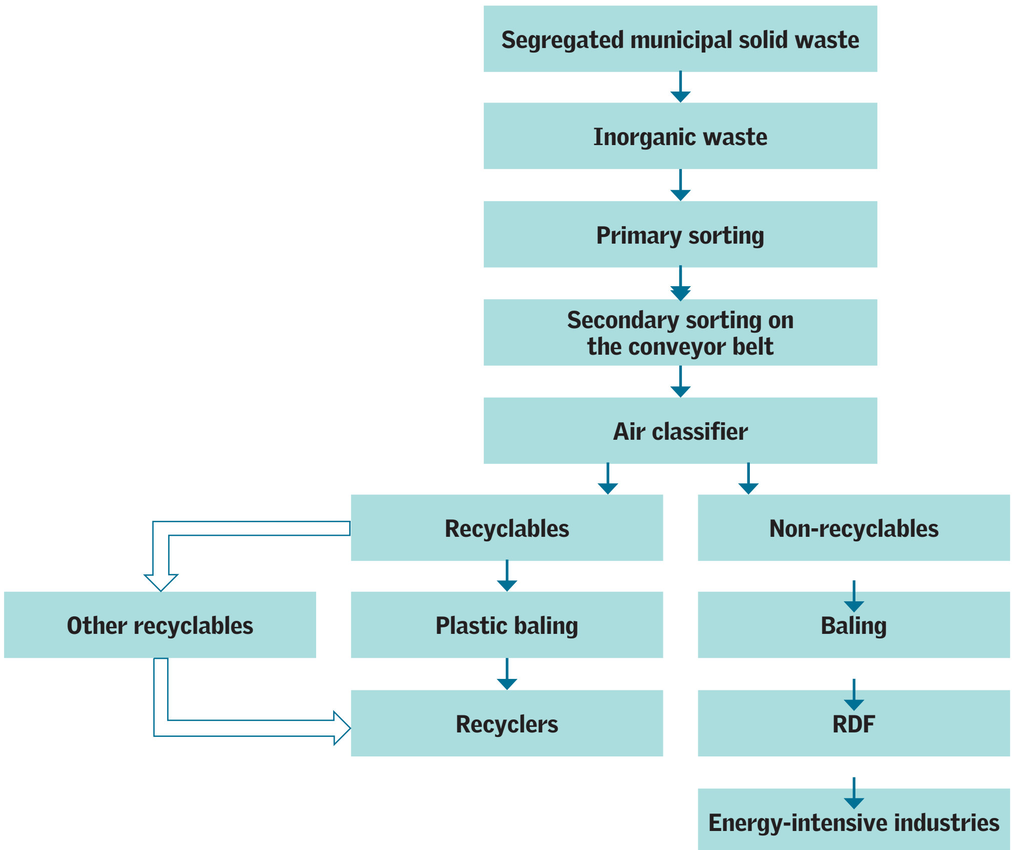
Table 2: Details of material recovery facilities for a town with a population of 50,000–100,000

Pointer	Details
Number of facilities	Three—decentralized
Capacity	Capacity of 5 TPD per facility
Area	2,000–3,000 sq. m per facility, including the vehicle movement area, suitable for tricycles, auto-tippers and tractors only
Workforce	Eight–ten workers per manual facility 18–20 workers per semi-automatic facility
CAPEX	Rs 50–60 lakh per facility, excluding the cost of land
OPEX	Rs 5–10 lakh per facility per month

Source: CSE

- **Population range 100,000–500,000:** Cities under this category generate up to 200 TPD of municipal solid waste and 80–100 TPD of inorganic waste daily. A manual material recovery facility is not a feasible option for cities like this as the volume of waste generated is high. For these cities, semi-automatic material

Figure 8: Working principle of a mid-range advanced semi-automatic material recovery facility



Source: CSE

Table 3: Details of material recovery facilities for a city with a population of 100,000–500,000

Pointer	Details
Number of facilities	Two–five
Capacity	Can vary from 50–100 TPD per facility
Area	6,000 sq. m per facility, including the vehicle movement area, that is suitable for all kinds of vehicles
Workforce	25–30 per facility
CAPEX	Rs 3–5 crore per facility, excluding the cost of land
OPEX	Rs 30–50 lakh per facility per month

Source: CSE

recovery facilities are the best option. If required, the machinery used can be suitably modified to increase efficiency and product ability. The additional machinery may include a magnetic separator to separate metals from the inorganic waste stream and air classifier units to separate light materials from heavier materials through a high-velocity air stream. These semi-automatic material recovery facilities can act as waste channelization units as each unit processes a substantial quantity of inorganic waste—transporting large quantities of inorganic waste to a centralized location is not feasible.

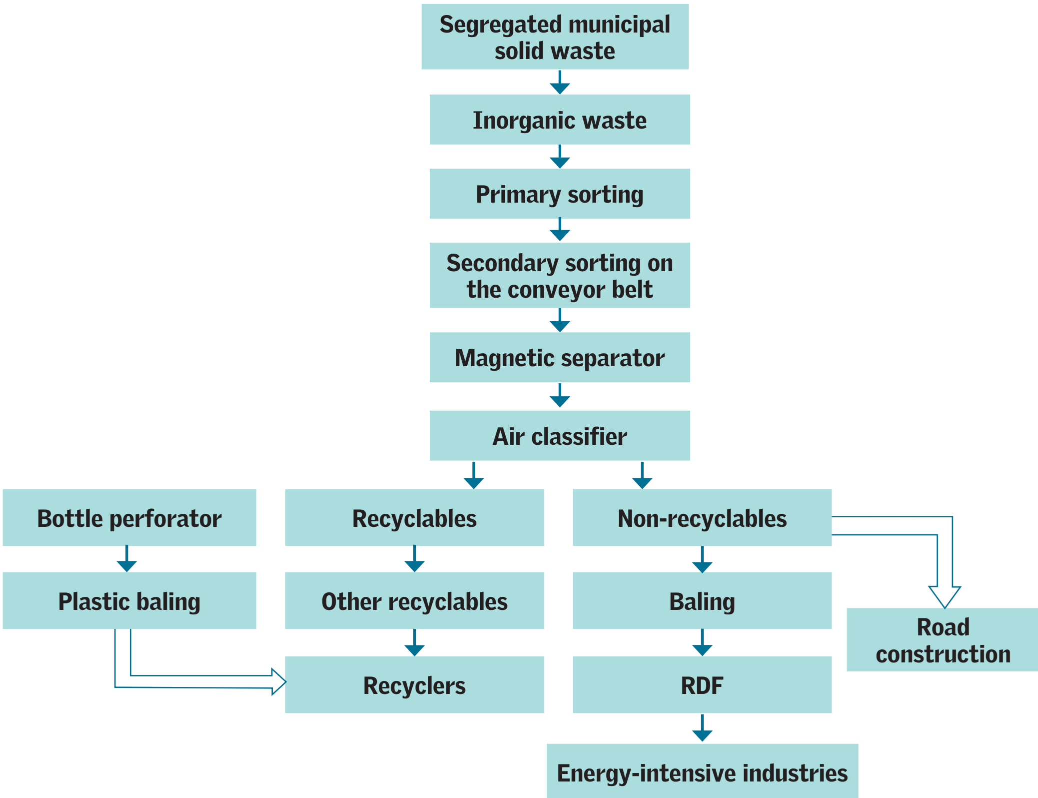
- **Population range 500,001–1,000,000:** Waste generation from the cities is around 500 TPD, of which inorganic waste generation is about 200 TPD. Cities like this should consider an upgraded semi-automatic material recovery facility of adequate capacity to manage inorganic waste. Setting up smaller facilities may not be feasible for waste management for cities like this; however, smaller facilities can act as transfer stations or primary collection centres from where waste can be transported to centralized facility. A bottle perforator machine that perforates holes in bottles, making it easier to bale and transport them, can also be a part of a semi-automatic material recovery facility.

Table 4: Details of material recovery facilities for a city with a population of 500,000–1,000,000

Pointer	Details
Number of facilities	One
Capacity	200 TPD
Area	8,000 sq. m, including the vehicle movement are, suitable for all type of vehicles
Workforce	25–30
CAPEX	Rs 5 crore, excluding the cost of land
OPEX	Rs 60–80 lakh per month

Source: CSE

Figure 9: Working principle of a large advanced semi-automatic material recovery facility

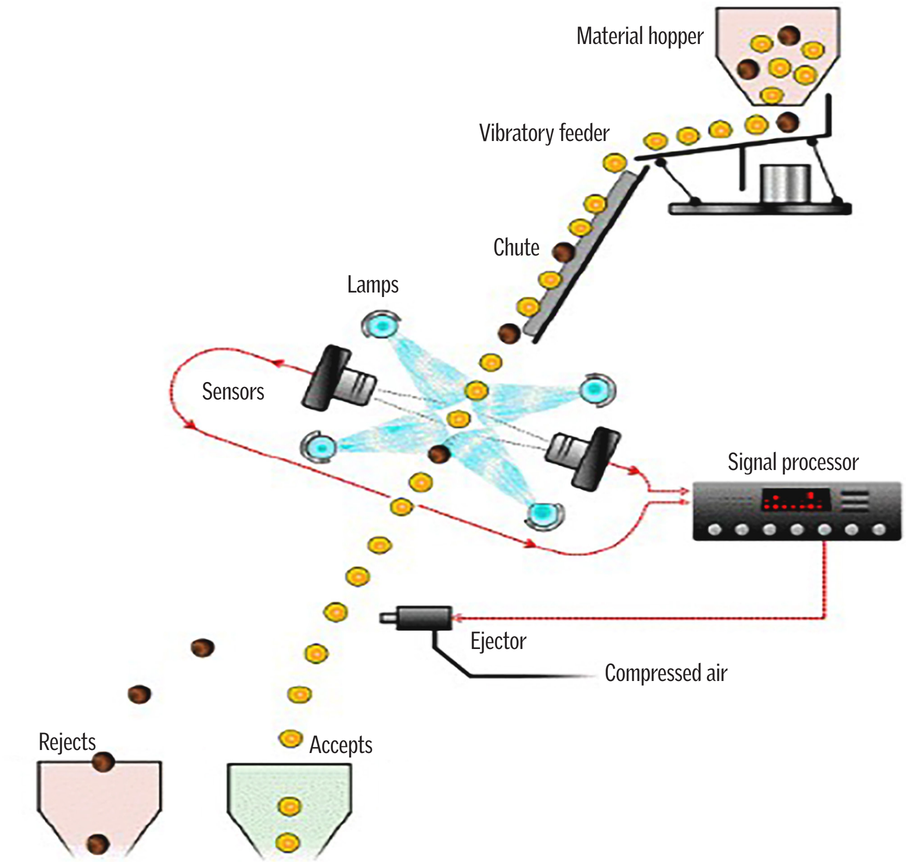


Source: CSE

- **Population range 1,000,000 plus:** Most metropolitan cities fall under this population category and generate more than 500 tonne of municipal solid waste daily. Because of the unique lifestyle of residents of big cities, inorganic waste generation is higher—i.e., more than 300 tonne per day. A fully automatic material recovery facility is best option for cities like this. The material recovery facility may be equipped with an optical AI (artificial intelligence) machine. The product is fed into a hopper and then onto a vibrating plate that carries the product to the feed chutes. The product free-flows down the chutes and is monitored by sensors on both sides. The sensor output is fed to a signal processor. If the processor detects a "reject image", it fires the appropriate ejector. The ejector diverts the impurity out of the product stream with a focused jet of compressed air.

  The facility can also be equipped with a plastic waste agglomeration and granulation unit to create a better market for processed plastic waste.

Figure 10: Working principle of an optical sorting unit



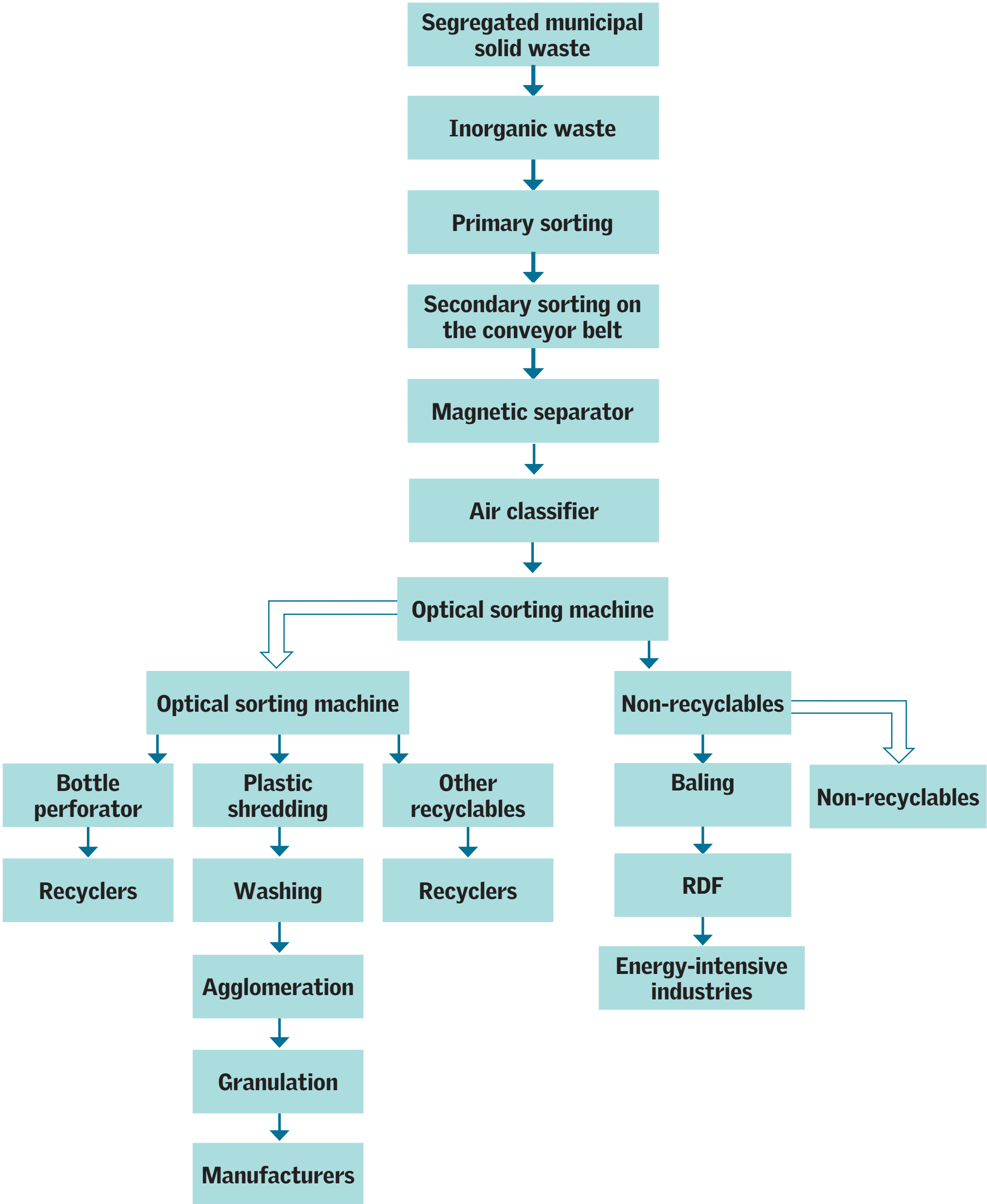
Source: https://www.satake-europe.com/optical-sorting/principles-of-optical-sorting

Table 5: Details of material recovery facilities for a city with a population of more than 1,000,000

Pointer	Details
Number of facilities	One
Capacity	More than 300 TPD
Area	15,000–20,000 sq. m, including the vehicle movement area for all type of vehicles
Workforce	35–50
CAPEX	Rs 30–50 crore, excluding the cost of land
OPEX	Rs 80–95 lakh per month

Source: CSE

Figure 11: Working principle of a fully automated material recovery facility



Source: CSE

Table 6: Do's and don'ts for material recovery facilities

Do's	Don'ts
Train the staff before the material recovery facility starts functioning	Hire children and pregnant women to work at the facility
Provide insurance to all working staff	Use of flammable objects inside the facility
Integrate the informal sector into the facility	Smoking or burning of waste inside or around the facility
Provide personnel protective equipment (PPE) to all staff	Attempt to repair machinery in the absence of experts
Solid and rigid flooring at the bottom	Not wearing PPE at work
Provide sufficient air ventilators	E-waste and domestic hazardous waste storage areas are close to the general waste storage area
Periodic maintenance of all machinery	E-waste and domestic hazardous waste are kept at the facility for long
Maintain records of both incoming and outgoing waste	Unnecessary usage of electricity
Equip the facility with adequate fire safety equipment	
Monitor indoor air quality	
The facility should have adequate space to store the commingled and processed waste	

Source: CSE

4. Key considerations for a sustainable system

- **Policy-level considerations:** The first and foremost thing to consider in the creation of a sustainable system of inorganic waste management is policy. Without good policy, the other elements cannot come together nor can processes be streamlined. Urban local bodies need to formulate bye-laws as per the Solid Waste Management Rules, 2016. These bye-laws can be tweaked to suit local conditions. They must be detailed and contain provisions on taxes, rebates and other extended benefits as well as the fines and penalties against defaulters to promote optimum inorganic waste management.

- **Information, Education, and Communication–Behaviour Change Communication (IEC–BCC):** Successful implementation of large-scale programmes requires public participation, which can only be ensured through sustained IEC–BCC programmes informing the public about the benefits of the programmes and their various stages and requirements. This can be achieved through mass education efforts. Source segregation should be a focus area.

- **Capacity building:** Capacity building is crucial with regard to inorganic waste management because the primary segregated materials collected from households and brought to the material recovery facility need to be further sorted and processed before channelizing them to recyclers. The existing workforce responsible for inorganic waste management must be trained on secondary and tertiary segregation and other management practices inside the material recovery facility. They should be trained on-site and taken to cities with best practices to experience first-hand efficient practices of waste management. This should not only be limited to ground-level workers but official must be trained too as they play a critical role in the funding, monitoring and implementation of programmes.

- **Monitoring:** In the absence of a proper monitoring system, it is difficult for ULBs to track day-to-day activities remotely. In the case of inorganic waste management, it is important for urban local bodies to set up a proper monitoring system using virtual technology such as Global Positioning System to track collection vehicles in the first place. As inorganic waste has excellent recycling potential, it needs to be monitored end-to-end to avoid misuse and diversion. Other than that, marking attendance of the sanitation staff;

maintaining records of incoming and processed, disposed of waste; and creating platforms (like mobile apps) to raise complaints related to sanitation can also be beneficial for the urban local body. However, to check the authenticity of data, urban local bodies should engage local self-help groups to monitor and institute surprise visits by officials.

- **Promote the PPP model for operation and maintenance of treatment facilities:** The public-private partnership (PPP) model is a suitable option for cases where funding is a constraint. The overall cost for setting up an inorganic waste processing facility is high compared to any organic waste processing facility. Hence, a PPP model can work because under it a significant portion of the overall funding requirement is taken care of by the private concessionaire thus reducing the burden on the ULB. The concessionaire shall set up processing facility(s) and manage it for an agreed period of time. However, it is the responsibility of the ULB to ensure source segregation of waste and that only segregated waste is being delivered at the facility. The concessionaire should be accountable for ensuring successful and sustainable management of the facility.

- **CSR fund for CAPEX:** Sometimes, ULBs should opt for corporate social responsibility (CSR) funding to set up material recovery facilities. A manually operated material recovery facility can be set up entirely on CSR funds as it does not require any machinery. However, only the construction of semi-automatic or fully automatic material recovery facilities can be taken care of with CSR funds, while other activities can be taken care of with funds from the ULB.

- **Integration of the informal sector and self-help groups:** Once all inorganic waste is successfully channelized into material recovery facilities, the informal waste sector, whose livelihoods entirely depends on processing inorganic waste, loses its source of income. ULBs should identify all informal workers within a city during the construction phase (of the material recovery facility) and formally offer them work at the material recovery facility. As informal waste workers are very good at secondary sorting of materials recovered from waste, ULBs should involve them in the processing activities inside the material recovery facility. Local self-help groups may also be roped in to manage the facility. The ULB can adopt the best approach to create a convergence between the informal sector and the self-help group to ensure synergy at the facility. In such cases, the ULB can take care of monitoring the facilities closely and help them financially when needed.

- **Marketing of materials:** A material recovery facility generates many products that have reusability and recycling potential, and replacement (e.g., of fuel, as refuse-derived fuel or RDF) value. The material should be channelized correctly for proper utilization. If channelized to potential recyclers, these recyclable materials can generate substantial revenue for ULBs. Similarly, non-recyclable materials with minimum calorific value exceeding 1,500 kcal/kg and excluding chlorinated materials like plastic and wood pulp can be used as RDF to replace coal in energy-intensive industries. Therefore, before setting up material recovery facilities, ULBs should make arrangements through an agreement with potential recyclers and nearest energy-intensive industries for a continuous supply of raw materials.

- **Quality monitoring:** Sometimes, recyclers or energy-intensive industries return the materials supplied by material recovery facilities of ULBs on account of poor quality. ULBs should ensure that these issues do not crop up. Periodic checking, verifying and certifying of products, by a certified third-party agency, to ensure that products are contamination-free will create a better market for them. Small ULBs, for whom funding is a concern, can opt for proper cleaning and drying of materials before disposing of them. The water used to clean the materials shall subsequently be diverted to a septage treatment plant or faecal sludge treatment plant for treatment.

Notes

Proper management of inorganic waste can generate substantial revenue for urban local bodies, besides vastly improving waste profile of cities. This toolkit will be helpful for all stakeholders in the planning, designing and choosing of optimum material recovery facilities for effective inorganic waste management.

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