



## STUDY ON MUNICIPAL SOLID WASTE MANAGEMENT IN INDIA

### A CASE STUDY ON MUNICIPAL SOLID WASTE MANAGEMENT IN VISAKHAPATNAM

<sup>1</sup>K.Aditya Sainath, <sup>2</sup>Sangeeta Das

<sup>1</sup>M.Arch(Sustainable Architecture),school of Architecture,

<sup>1</sup>Gitam deemed to be University, Visakhapatnam, India

**Abstract:** Municipal solid waste management is one of the major concern for environmental problems in India. Improper management and disposal of solid waste leads to health hazards to inhabitants, causes environmental pollution, accelerates natural resources degradation and causes climate change. Solid wastes represent a growing downside and also the quantity of solid waste generated in India is steady increasing and also the government is presently that specialize in strategies to approach the challenge.. In developing countries like India, there is a fast growth in municipal solid waste (MSW) due to urban sprawl and population growth. Economic condition of a country is declining due to pollution of air, water and land which results in long term reduction of productivity. The key component of sustainable development is to control pollution to reduce poor health risk, to protect the natural environment and to contribute to the quality of life. Owing to the significant change in lifestyle pattern and purchasing power of the urban population of India, the rate per capita waste generation increased from 0.44 kg/day (in 2001) to 0.50 kg/day (in 2011) to 0.62 kg/day (in 2019). Within a decade since 2001, urban population growth and increase in per capita waste generation have resulted in a 50% increase; in the waste generated by Indian cities. In this study, an attempt has been made to know the in depth review of the types of MSW, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India; and the Green Rating Standards that can be applied in urban area regarding MSW. This paper also carries a case study on municipal solid waste management in the city of Visakhapatnam, Andhra Pradesh, India.

**Index Terms - MSWM, collection, treatment, recycling, disposal of waste, legal framework**

#### 1. Introduction

Solid waste management is a term that's familiar to the method of collection and treating heterogeneous solid wastes. It additionally offers solutions for application on things that don't belong to garbage or trash. As long as the people are living in settlements and residential areas, garbage or solid waste has been a problem. Waste management is all about however solid waste is modified and used as a valuable resource. Solid waste management should be embraced by each and every family together with the business proprietors across the globe. Industrialization has brought tons of fine things and dangerous things in addition, One of the negative effects of industrial enterprise is that the creation of solid waste.

#### 1.1 Sources

Sources of Municipal Solid Waste (MSW) may be broadly classified as follows:

- A. **Domestic Origin:** Kitchen waste (left over/rejected food materials), human waste, paper, plastic, rags, metal, rubber, glass, cardboard, expired medicine, containers of medicine/disinfectants, etc.
- B. **Street/Kerb side Waste:** Street/ sweepings comprising dust, grit, dry leaves, papers, plastic, rubber, glass, cardboard, metal-pieces, etc. junk containers, carcass of animals and so on.
- C. **Market Origin:** Paper, plastics, cardboard, packaging materials, etc.
- D. **Industrial Solid waste:** Scrap metals, alloys, ores, glass, paper, plastic, chemicals and other industry specific items.
- E. **Hospitals/Medical solid waste:** Hospital wastes include used bandages, infected linen, Plaster of Paris, injection vials, medicine bottles and containers, disinfectants, diseased organs etc. apart from common solid waste items (Paper, plastic and food materials etc.)
- F. **Commercial Institutional Origin:** Paper, plastic, cardboard, packaging material etc. from shops and offices, leftover food from hotels/restaurants and miscellaneous items.
- G. **Agricultural and Animal Waste:** These also find their way into the urban area through the agricultural marketing complexes, dairy & poultry farms, Zoological & botanical gardens, etc.

## 1.2 Collection

### 1.2.1 Primary collection

Primary collection of segregated MSW from individual households and establishments (door-to-door collection) is accomplished through the use of containerized pushcarts, tricycles or small mechanized vehicles, compactors, or tipping vehicles depending on the terrain of the locality, width of streets, and building density. Spacious and well-lit safe neighborhoods allow collection systems with compactor vehicles and tipping equipment which are more efficient. Narrow streets do not allow for the use of conventional primary collection vehicles. In cramped neighborhoods, handcarts or pushcarts, or tricycles or small mechanized vehicles may be used for door-to-door collection of waste, which may then be transferred to a larger vehicle in the vicinity. Where access to individual houses or establishments is difficult, handcarts or rickshaws could be made to stand at designated spots.

### 1.2.2 Secondary collection

Secondary storage or collection and transportation is necessary for waste collected from households by smaller vehicles such as carts, tricycles, auto rickshaws, etc. Wherever possible, it is advisable to synchronize primary collection and secondary collection, thereby avoiding the need for secondary storage bins or depots. Segregated waste at the household level is collected by primary collection vehicles, which directly transports this waste to secondary collection vehicles. Secondary collection vehicles are parked daily at specific locations for the entire time during primary collection. Separate vehicles or chambers within a vehicle should be provided to ensure segregated transportation of waste.

Storage depots are required for secondary collection of waste in cities where the bin-less system is not adopted. In most cities, the following types of waste storage depots exist:

1. Cement-concrete bins
2. Masonry bins
3. Dhalaos
4. Metal bins or containers

Being unhygienic, cement concrete bins, masonry bins, and dhalaos are being replaced by metal containers. In general, waste storage containers should be covered and designed to facilitate mechanical lifting to avoid multiple handling and environmental harm. It is necessary to wash community bins at regular intervals to ensure a healthy and hygienic environment for users and workers. The design of waste storage containers or depots (secondary collection points) should be synchronous with the design of vehicles deployed for both primary and secondary waste collection.

## 1.3 Separation

### 1.3.1 Dry waste

Dry waste like paper, shampoo bottles, glass, note books, wires, safety pins, caps of

Mineral bottles, plastic utensils and toys, etc., can be handed over to rag pickers and kabaris, who will additionally carry the waste for utilization or utilize. Some items that can be recycled or reused are given below:

- a. Paper: Old copies, old books, paper bags, newspapers, old greeting cards, cardboard box.
- b. Plastic: Containers, bags, sheets.
- c. Glass and ceramics: Bottles, plates, cups, bowls.
- d. Miscellaneous: Old cans, utensils, clothes, furniture

### 1.3.2 Wet waste

Organic wastes left to them undergo a slow process of degradation. The activity is carried out by microorganisms of different kinds. Composting is a controlled process of decomposition of organic material by microorganisms into a helpful product. Waste Generators will create their own provide of compost in their own yard exploitation materials that would otherwise be thrown away. At the household and community level composting of kitchen and yard waste should be encouraged. Composting reduces the amount of waste material eventually going to municipal solid waste sanitary landfills. At the same time, finished compost can be used to improve soil texture, increase the ability of soil to absorb water and air, suppress weed growth, decrease erosion, and cut back the requirement for commercial soil additives/fertilizers.

## 1.4 Transportation and transfer station

Vehicles Typically Used for Transportation of Wastes

- Skip truck (dumper placer)
- Refuse collector without compactor
- Rear loading compactor truck (refuse compactor)
- Light commercial vehicle with tipping floor
- Hook loader or hook lifter



Figure 2 : Skip Truck (Dumper Placer Machines)



Figure 1: Medium Size Compactor Truck

## 1.5 Treatment

### 1.5.1 Composting

Composting is a natural micro-biological process where bacteria break down the organic fraction of the MSW under controlled condition to produce a pathogen-free material called “compost” that can be used for potting soil, Soil amendments (for example, to lighten and improve the soil structure of clay soils) and mulch. The microbes, fungi, and macro-organisms materials is placed into one or more piles (windrows) and the natural microbial action will cause the pile to heat up to 65-80°C, Killing most pathogens and weed seeds. A properly designed compost heap will reach 70°C within 6 to 10 days, and slowly cool off back to ambient temperatures as the biological decomposition is completed. Systematic turning of the material, which mixes the different components and aerates the mixture, generally accelerates the process of breaking down the organic fraction and a proper carbon/nitrogen balance maintained (carbon to nitrogen or C/N ratio of 20:1) in the feedstock insures complete and rapid composting. The composting process takes about 17 to 180 days.

There are two fundamental types of composting techniques i.e. open or windrow composting, this is done in outdoors with simple equipment and is a slower process. The other is closed system composting, where the composting is performed in an enclosure (e.g., a tank, a box, a container or a vessel).

### 1.5.2 Incineration

Mass-burn Systems are the predominant form of the MSW incineration. Mass-burn systems typically consists of either two or three incineration units move in capacity from 50 to 1,000 tons per day; therefore facility capacity ranges from concerning 100 to 3,000 tons per day. It involves combustion of unprocessed or minimally processed refuse. The major component of a mass burn facility include:

1. Reception of Refuse, handling and storage systems;
2. Combination and Steam generation System (a boiler);
3. Flue gas cleaning system;
4. Power generation equipment (steam turbine and generator);
5. Condenser cooling water system and
6. Residue hauling and Storage system

### 1.5.3 Recycling

Solid Waste Management (SWM) Rules, 2016 defines recycling as “the process of transforming segregated solid waste into a new product or a raw material for producing new products.” Further, it also states that “arrangement shall be made to provide separate recyclable material to the utilization business through waste pickers or the other agency engaged or licensed by the ULB for the purpose” According to the SWM hierarchy, recycling is a preferred waste management strategy after source reduction and reuse. Recycling systems should be adopted before planning for any waste processing or treatment facilities.

### 1.5.4 Windrow composting

Windrow composting is the production of compost in long rows (windrows) by piling organic matter or biodegradable waste, such as animal manure and crop residues. This technique is suited to producing large volumes of compost. These rows are generally turned to improve porosity and oxygen content, mix in or remove moisture, and redistribute cooler and hotter portions of the pile. Windrow composting is a commonly used farm scale composting technique. Composting technique control parameters include the initial ratios of carbon and nitrogen rich materials, the amount of bulking agent added to assure air porosity, the pile size, moisture content, and turning frequency.

### 1.5.5 Landfill

This is the most commonly used solid waste disposal method. Garbage is basically spread out in thin layers, compressed and covered with soil or plastic foam. Modern landfills are designed in such a way that the bottom of the landfill is covered with an impervious liner which is usually made of several layers of thick plastic and sand. This liner protects the ground water from being contaminated because of leaching or percolation. When the landfill is full, it is covered with layers of sand, clay, top soil and gravel to prevent seepage of water.

## 2. LEGAL FRAMEWORK AND NORMS

### 2.1 Green rating standards

A star rating framework in consultation with cities to ensure no visible garbage and enhanced waste processing in all cities/towns. The framework has been developed in consultation with states and cities. Third party certification at 3, 5 and 7 star stages.

#### Key Components of Star Rating Protocol

SEVEN STAR RATING devised to ensure holistic evaluation across entire SWM Chain, The rating is based on 12 key components:

1. Door-to-Door Collection
2. Segregation at source
3. Sweeping of public, commercial and residential areas (no visible eyesores on streets)
4. Waste Storage Bins, Litter Bins and material recovery facility
5. Bulk Waste Generators compliance
6. Scientific Waste Processing, Scientific Landfilling and C&D Waste Management
7. User Fees, Penalties, Spot Fines for littering and Enforcement of Ban on Plastic
8. Citizen grievance redressal and feedback system
9. Eradication of crude dumping of garbage and dump remediation
10. Cleaning of storm drains and surface of water bodies
11. Visible beautification in the city
12. Waste reduction

#### Criteria for GRIHA rating:

##### Criterion 22 Reduction in waste during construction

**Objective** - To ensure maximum resource recovery and safe disposal of wastes generated during construction, and to reduce the burden on the landfill.

##### Criterion 23 Efficient waste segregation

**Objective:** To promote the segregation of waste for efficient resource recovery.

##### Criterion 24 Storage and disposal of wastes

**Objective:** To prevent the mixing up of segregated waste before processing or disposal

##### Criterion 25 Resource recovery from waste

**Objective:** To maximize the recovery of resources from the recyclable and biodegradable waste and to reduce the burden on landfills.

### 2.2 Municipal Solid Waste Management Rules– 2016

#### a. Segregation at source:

The new rules have mandated the source segregation of waste in order to channelize the waste to wealth by recovery, reuse and recycle. Waste generators would now have to now segregate waste into three streams- Biodegradables, Dry (Plastic, Paper, metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellants, cleaning agents etc.) before handing it over to the collector.

#### b. Collection and disposal of sanitary waste

The manufacturers or brand owners of sanitary napkins are responsible for awareness for proper disposal of such waste by the generator and shall provide a pouch or wrapper for disposal of each napkin or diapers along with the packet of their sanitary products.

#### c. Collect Back scheme for packaging waste

As per the rules, brand owners who sale or market their products in packaging material which are non-biodegradable, should put in place a system to collect back the packaging waste generated due to their production.



d. **User fees for collection**

The new rules have given power to the local bodies across India to decide the user fees. Municipal authorities will levy user fees for collection, disposal and processing from bulk generators. As per the rules, the generator will have to pay “User Fee” to the waste collector and a “Spot Fine” for littering and non-segregation, the quantum of which will be decided by the local bodies.

e. **Waste processing and treatment**

As per the new rules, it has been advised that the bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority. The developers of Special Economic Zone, industrial estate, industrial park to earmark at least 5 per cent of the total area of the plot or minimum 5 plots/ sheds for recovery and recycling facility.

f. **Promotion of waste to energy**

In a not-so welcoming move, the SWM Rules, 2016 emphasize promotion of waste to energy plants. The rules mandate all industrial units using fuel and located within 100 km from a solid waste-based Refuse-Derived Fuel (RDF) plant to make arrangements within six months from the date of notification of these rules to replace at least 5 per cent of their fuel requirement by RDF so produced.

g. **Revision of parameters and existing standards**

As per the new rules, the landfill site shall be 100 meters away from a river, 200 meters from a pond, 500, 200 meters away from highways, habitations, public parks and water supply wells and 20 km away from airports/airbase. Emission standards are completely amended and include parameters for dioxins, furans, reduced limits for particulate matters from 150 to 100 and now 50. Also, the compost standards have been amended to align with Fertilizer Control Order.

h. **Management of waste in hilly areas**

As per the new rules, construction of landfills on hills shall be avoided. Land for construction of sanitary landfills in hilly areas will be identified in the plain areas, within 25 kilometres. However, transfer stations and processing facilities shall be operational in the hilly areas.

## 2.3 Governing bodies involved

A higher dependence on State Government for revenue income and the quantum of income which is uncertain poses financial management challenges to the local governments. The current urban financing framework relies significantly on the idea of resource transfers from the State Government to local Government Institutions by way of grants to fill the gap between the expenditure demand and the revenues demand. Government of Andhra Pradesh has taken a proactive interest in encouraging ULBs in the state to comply with the MSW rules 2000 and has spent entire allocation of 374 Crores under the 12th Finance Commission grants for development of the solid waste infrastructure and services.

### 2.3.1 Greater Visakhapatnam Municipal Corporation (GVMC)

For planning of processing & disposal facility, the MSW has been considered as 709,034 MT/day.

S. No	Year	Population	Waste Generation Rate (Kg/C/day)	Waste generated (MT)
1	Year 2020	2236649	0.49	400,025
2	Year 2030	2978974	0.53	576,283
3	Year 2040	3967670.5	0.58	839,956

Table 1 : Projected Quantities of MSW in Visakhapatnam

The Total project cost required for Visakhapatnam Integrated waste treatment plant is given below:

S. No	Item Description	Amount in Rs Lakhs
1	MSW Collection & Transportation	3807.00
2	MSW Treatment & Disposal (compost & RDF)	8333.00
3	Power Plant & Contingences	3967.00

Table 2 Total project cost required for Visakhapatnam Integrated waste treatment plant

The above includes vehicles required ie Autos at 70 Nos, Push carts at 1600 nos, Waste Bins at 1609 nos and Rear End Loaders at 12 nos.

### 2.3.2 Greater Visakhapatnam Smart City Corporation Limited (GVSCCL)

**Work on waste-to-energy plant commences at Kapuluppada. 17.5 acres handed over to Jindal Urban Waste Management.** With the delivering of land to a personal company, work on the waste-to-energy power plant is set to take off at the Kapuluppada dump yard on the outskirts of the city. The lease agreement has been signed recently and concerning seventeen.5 acres of land is handed over to Jindal Urban Waste Management (Visakhapatnam) and it has started construction work, Municipal Commissioner M.Hari Narayanan.

The company needs to complete the waste-to-energy plant incinerating municipal waste once segregating the non-combustibles to get 17 MW of power. It will construct web site workplace and compound wall first GVMC can offer solid waste once door-to-door assortment from concerning 4.5lakh households. GVMC signed AN agreement on 17.2.16 with the Jindal Urban Waste Management Limited on setting up a Waste to Energy plant at Gidijala in Anandapuram Mandal. GVMC would offer on lease twenty acres of land for the plant to get fifteen MW of electricity. GVMC has to supply 952 tonnes of solid waste to the plant to be set up with a cost of Rs.152 crore in 18 months.

### 2.3.3 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Release of Rs. 10,40,00,0001 (Rs. Ten Crore Forty Lakh only )as reform incentive to Government of Andhra Pradesh for issuance of Municipal Bonds of Rs. 80 crores by Greater Visakhapatnam Municipal Corporation under Atal Mission for Rejuvenation and Urban Transformation for the financial year 201 8-19. Release of Rs. 26,00,00,000/- (Rupees Twenty Six Crore only ) as reform incentive to Government of Andhra Pradesh for issuance of Municipal Bonds of Rs. 2000 crores by Andhra Pradesh Capital Region Development Authority (APCRDA), Amravati under Atal Mission for Rejuvenation and Urban Transformation for the Financial year 2018-19

### 2.3.4 Swachh Bharat Mission

Swachha Andhra Corporation was incorporated from 1st May 2015 with a goal to achieve the "Swachh Bharat Mission" campaign launched on 2nd October 2014 by Hon'ble Prime Minister of India. The Go.AP intends to institutionalize a holistic Integrated, sustainable environment and eco-friendly Municipal Solid waste Management System in the urban local bodies (ULBs) of the state. In view of this, Government has appointed APUFIDC a government entity and nodal agency for the development of projects in Urban Infrastructure. APUFIDC will be responsible for preparation of detailed project reports for 110 ULB's in the state of Andhra Pradesh. As part of the pro-cess, all the 110 ULB's have been divided in to 5 zones and APUFIDC invited Re-request for Proposal (RFP) from empaneled consultants to prepare Detailed Project Report for Municipal solid waste management, in compliance with MSW rules 2000 under the aegis of the Environment (Protection) Act 1986 and the guidelines issued there under from time to time.

## 3 VISAKHAPATNAM

### 3.1 Status and Challenges of MSWM in Visakhapatnam

Visakhapatnam district comprises of total area is 681.96 Sq.km and the population of as per census 2011 is 18, 83,000 this means a Density of 3533persons/Sq.km. GVMC (Greater Visakhapatnam Municipal Corporation) has been divided into six zones totally consisting of 72 wards. The need for proper MSW collection & transportation as well as processing & disposal has been realized by all the residents, shop keepers, service providers and the hospitality industry. As per the field survey, total quantity of solid waste of the district is 920 MT/day, out of which about 70% is generated by Domestic Household, Commercial Establishments, and Hotels & Restaurants and Institutional waste.

The average per capita waste generation of solid waste in Visakhapatnam was observed to be 0.45-0.47 kg/per capita/day. It is noticed that the waste generation from High-income groups was found to be 0.40 – 0.45 kg/day and from the low income groups between 0.25-0.30 kg/day. The commercial and the street sweepings also contribute for increase of the per capita waste generation for the city of Visakhapatnam. For planning of processing & disposal facility, the MSW has been considered as 709,034 MT/day.

#### Challenges:

The major deficiencies associated with the system are described in the following sections

- Fast Growing Areas to be attended and Quantity of Waste
- Inadequate Resources
- Inappropriate Technology
- Disproportionately High Cost of Manpower
- Societal and Management Apathy
- Low Efficiency of the System

### 3.2 Identification of MSW Processing Techniques

There are numerous MSW treating technologies which are being practiced in various parts of the world. Out of the various processing technologies, the technologies which in use/ considered for use in Indian conditions are classified into different technical groups:

- Composting
- Anaerobic digestion to recover bio- gas and electricity
- Refuse Derived Fuel

- Pyrolysis

Waste Processing Technology Group	Waste Processing Technology
<b>Biological Processing Technologies</b>	Aerobic Digestion (Composting ) Anaerobic Digestion (Biomethanization) Landfill as Bioreactor (Bioreactor Landfill)
<b>Thermal Processing Technologies</b>	Incineration (Mass burn) Pyrolysis / Gasification Plasma Arc Gasification
<b>Physical Processing Technologies</b>	Refuse-Derived Fuel (RDF) Densification/Palletization Mechanical Separation Size reduction

Table 3 : List of Identified MSW Processing Technologies

### Selection of the most suitable technology for GVMC

The composition of urban waste has rapidly undergone a radical change in the fast few years in the country in tune with the growth of the economy resulting in the increasing use of packaging material comprising of paper and plastics.

At Present about 957 TPD of waste is being generated only from Visakhapatnam which consists of huge quantities of compostable and combustible materials.

The typical composition of MSW characteristics of Visakhapatnam are shown as below:

Item	Item wise Generation %
<b>ORGANIC WASTE: Leaves , Fruits, Vegetables, Food Waste, Fine organic Matter, Hay and Straw etc</b>	52.0
<b>RECYCLABLES: Rubber and leather, Plastics, Rags, Pa-per, Wooden Matter, Coconuts, Bones, Straw, fibers</b>	23.0
<b>INERT MATTER: Ash, crockery, earthen ware (pots), Stones and Bricks, Metals, Glass, sand, silt from drains etc.</b>	25.0
<b>TOTAL</b>	100

Table 4 : Item wise Waste Generation

### 3.3 Waste Treatment

#### a. Landfill

The collected waste from Households will be deposited into the concrete/mild steel bins located in respective wards by sweeper. The sanitary workers of municipal corporation lifts waste from the bins, at a frequency of once in a day. The waste from the road side bins and street sweepings is collected regularly and transported to the disposal yard.

The waste generated from all the wards will be disposed at the dump site located near Kapuluppada. Currently, GVMC disposes the entire waste generated at Kapuluppada disposal site. This site is operating for the last 7-9 years with about 80 acres. JCBs and bulldozer are employed by GVMC for solid waste disposal management, including the operation of the waste disposal site.



Figure 3: Kapuluppada landfill area



Figure 4: Kapuluppada disposal site

The existing waste disposal site where crude open dumping is practiced with no leachate collection and treatment system and does not meet the current requirements of the MSW 2000 Rules. Open burning of waste, indiscriminate disposal, presence of stray animals & rag pickers at the disposal site and leachate migration into the subsurface are common occurrences.

The total quantity of waste generation and the quantity reaching the dump yard may not be same. The total waste dumped at Kapuluppada dump site is about 600-650 TPD, whereas the total waste generation is about 920 TPD.

#### b. Compost Plant

There is a small compost plant in the Visakhapatnam city which is located in ward no. 10 behind Eenadu office. It was established on pilot basis in the year 2001 with coordination of NGO Ex-nora. Total area of the compost plant is 1.5 acres and is receiving a total solid waste of 5 to 6 Tons per day. There are 27 members working for this compost plant to segregate the recyclables and biodegradable, and compost plant maintenance. There are 3 dumper bins provided in this compost plant to carry the inert material and disposes it in the Kapuluppada disposal site. Composting is done in the aerobic process which is in presence of oxygen.

#### Key Concerns in the Existing System

- Secondary storage points are in very poor condition
- Rag pickers who are taking out most of the recyclables which is having high calorific value.
- Drain silt and Municipal solid waste is getting mixed
- Transfer station maintenance is not good
- No scientific disposal, waste is being dumped at Kapulluppada without any treatment and No scientific landfill.

### 3.4 Waste to energy

The Refuse-derived fuel (RDF) to Power Project is approximate 8 MW Power Plant based on incineration of RDF, produced from MSW Processing Facility. The RDF can be fired in a specially designed boiler to produce steam which when passed through a steam turbine connected to an electrical generator will produce electricity through a conventional steam cycle.

An area of about 10 acres is available for setting up of the power plant in existing Kapuluppada dump yard site. Adequate area will be earmarked for the expansion while preparing the layout for the proposed power plant envisaged under this project. The Project Site is located at Kapuluppada, in Visakhapatnam the site is easily accessible by road, railway lines and by port. Major National highway is at NH-5 (at Madhurawada) which is about 2 kms from the Project Site and the nearest railway station is Visakhapatnam. The Power generated can be transmitted to the nearest Substation at Endada, which is about 19 km. from the Project Site.

#### RDF Production from MSW:



The parameters of RDF properties are directly dependent upon the properties of MSW which by the basic nature is not a single type of fuel, but is rather a mixture of various components. On a generalized basis the various components of MSW are as follows and its utilization is as follows.

S. No.	Component	Percentage	Used to Prepare
1	Organic Material	50 to 52 %	RDF/Composting
2	Recyclables	23 %	Plastics, rubbers etc.
3	Inert Material	25 %	Eco Bricks

Table 5: MSW Component

Process of MSW to RDF Conversion: As it seen it the Dry Organic matter which is converted into RDF. The generalized process is as follows.

- The solid municipal waste is unloaded in the premises of the plant, is stacked as heaps. A specific chemical is sprayed on the heaps to accelerate the bacteriological decomposition, to reduce the volume and to control odor nuisance.
- These chemicals also decompose plastics and polyethylene. The decomposed heap is sorted manually for removal of glass, stones and then allowed on to the sieves for separation of sand, dust and other inorganic substances. These screened materials are allowed on to the magnetic separators for segregation of iron pieces.
- MSW then is homogenized and taken to the rotary screen for separating different size articles. Bulk portions are passed through magnetic separators before taking into primary shredder for further size reduction.
- MSW in India contains high moisture percentage and requires to be dried up by hot air generated in a hot air generator. It is then screened to separate sand/ grit material. The heavy non-combustibles like stones or glass are separated by Air Density Separator.
- The light combustibles like paper/ textile/ biomass separated in the process are called RDF fluff. RDF fluffs are further processed in secondary shredder and densification unit to produce RDF cakes which have approximate size of about “6 x 6 x 12” inches.
- It is RDF which can be used for incineration to generate steam and subsequently. RDF can be used as an alternate fuel to conventional fuels such as coal. The heat content of RDF depends on the densification of the waste and its combustion characteristics. Hence, RDF yield and calorific value are inversely proportional to each other; higher calorific value requires higher densification which shall subsequently reduce the yield.

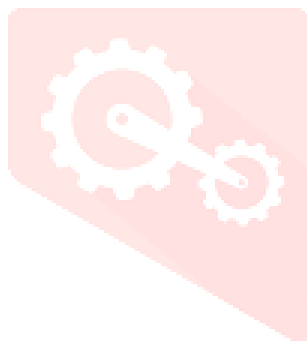


Figure 5: RDF Cake

RDF based Power Plant

Using RDF technology, the solid and liquid if any produced from the MSW which shall be used as fuel to generate power. The potential of Power Generation from MSW is as follows:

Period	MSW Generated (TPD)	Power Generation
2002	97174	1638
2007	148066	2550
2012	214865	3688
2017	303627	5192

Table 6: Potential of Power Generation from MSW

The average amount of waste required to generate 1MW of electricity is 58.5Tons.

### 3.5 Sanitary Landfill

Land filling shall be restricted to non-biodegradable, inert wastes and other wastes those are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land filling can be done following proper norms. Landfill sites shall meet the specifications as given in schedule III of the *Central Public Health and Environmental Engineering Organization (CPHEEO)* manual.

The basic steps essential for the landfill designs are:

- Landfill sizing
- Site layout
- Landfill layout
- Leachate management
- Landfill gas management

The landfill site is proposed at Tangudipalli village which is 40kms from city and 20 kms from kapuluppada dump site. Tangudupalli site is a fresh land with ap-proximate 200 acres area available to develop landfill facility.

#### As per MSW Rules'2016

Layer No.	Material Description	Thickness
Layer 1	Barrier soil layer comprising of clay or amended soil with permeability coefficient less than $1 \times 10^{-7}$ cm/sec	100 cms
Layer 2	High density polyethylene (HDPE) geo mem-brane	1.5 mm
Layer 3	Drainage layer	30 cm
	<b>Total Thickness</b>	<b>130 cms</b>

Table 7: Layer configuration is proposed for the bottom of the landfill

### 3.6 Information, Education and Communication (IEC)

IEC & Public Awareness on waste management is an extremely important component for any successful Solid Waste Management program, in addition to 'proper legislation, technical support and funding. This has also been a key strategy under the Swachh Bharath Mission of Govt of India. This targets the "Behavioral Change communication" to ensure that waste management is main-streamed with the general public at large. It also covers issues of proper management of municipal waste. The focus of the program is on the households, commercial establishments, etc. Sensitization of community towards efficient waste management and its related health and environmental consequences is the key because a clean community is a direct reflection of a clean city / town.

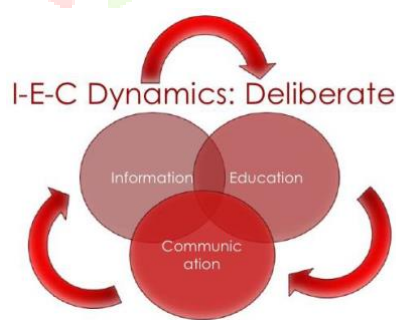


Figure 6: Goals of IEC Program

- a. To raise the awareness among the people about importance of cleanliness, solid waste management
- b. To Motivate people positive behavioral changes
- c. To propose source segregation
- d. To promote principle of 3 R's

#### 3 R's:

One of the goals behind IEC is to make principle of 3 R's as a part of life at every stage of waste management. The 3 – R's (Reduce, Re-use and Recycle) have produced demonstrative cost effective methods in handling of urban waste and also in conservation of resources.



Figure 7: 3 R's

#### Strategy of IEC Program:

Following steps needs to be followed for development of effective Strategy for IEC:

- a. Need Assessment
- b. Goal Setting
- c. Efficient framework of IEC
- d. Development of IEC activities
- e. Development of Distribution Plan
- f. Evaluation of Distribution plan

#### 4. CONCLUSIONS

Solid Waste management in Visakhapatnam seems to be not adequate and need some improvements. Segregation of waste at source is one of the recommendations of MoEF in Its guidelines on SWM, but it is not efficiently followed in Visakhapatnam. A well-organized strategy needs to be approved for optimizing the entire process of SWM including segregation at source, Timely and proper collection, transportation routes and types of vehicles and development and proper operation of sanitary landfill site. More extra importance should be given to scientific waste processing and disposal approaches for the city including efficient Utilization of the organic waste and recyclables and the development of landfill facility providing to the next 25-30 years period in line with the Municipal Solid Waste (Handling & Management) Rules 2016.

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