National Institute of Urban Affairs

सत्यमेव जयते
Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

SOLID WASTE MANAGEMENT PRACTICES IN URBAN INDIA

A COMPENDIUM

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FOREWORD

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Durga Shanker Mishra
Secretary

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Foreword

Swachh Bharat Mission was launched on 2nd October, 2014 to pay befitting tribute to Mahatma Gandhi on his 150th birth anniversary by making all urban areas open defecation free, scientifically process the solid waste and bring about behavioural change to make the country fully clean in five years.

National Institute of Urban Affairs (NIUA), an autonomous body under the Ministry has been assisting in capacity building efforts through workshops for Urban Local Bodies since 2016. This document is being brought out as a knowledge product that provides information on cities that have shown commendable efforts in solid waste management practices.

I would like to place on record my appreciation for the efforts made by NIUA in conducting 80 workshops across the country and documenting evidence based sustainable solid waste management practices that have worked on ground.

(Durga Shanker Mishra)

New Delhi
30 September, 2019

PREFACE

वी. के. जिन्दल
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MINISTRY OF HOUSING AND URBAN AFFAIRS
NIRMAN BHAWAN

नई दिल्ली-110011, तारीख 20
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PREFACE

Research and evidence suggest that with growing population, solid waste management has been an area of concern for the urban local bodies. Swachh Bharat Mission (SBM) is a flagship campaign by the Government of India, covering 4041 statutory towns, to address both elimination of open defecation and solid waste management in all the ULBs of the country by 2019. Capacity building of the state governments and local self-governments has been one of the key objectives of this mission. As part of the capacity building efforts under the SBM, Ministry also engaged NIUA for conducting Exposure Workshops on Solid Waste Management (SWM) for the Urban Local bodies (ULBs). These workshops have been spread over three years - from 224 participants of 108 in 2016 ULBs to 3439 ULB officials of 1789 ULBs in 2018-19.

This compendium is an effort to showcase various good and innovative approaches adopted across India in the solid waste management sector. The chosen 40 locations have been classified in four different categories: Cities with more than 10 lakh population, cities with population between 3 to 10 Lakhs, cities with population between 1 to 3 Lakhs, and cities with population less than 1 lakh. The categorization of cities is done to enhance the reading experience such that the cities with similar geographical context can easily relate, compare and contrast between the shared examples. Each case discussed under various cities contains essential project details such as the business model, the installed capacity of the facility, scale of the project, capital and operational expenditures and key highlights. In addition, some case studies showcasing innovation and sustainability in selected cities are also discussed. The compendium includes contact details of the concerned individuals and organizations of various projects to help the ULBs access any further information pertaining to the project.

I acknowledge the efforts of NIUA in bringing out this compendium, comprehensively covering all good and innovative approaches adopted across India. I hope this compendium serves as a guide for sustainable management of solid waste in cities.

V.K. Jindal

V.K. JINDAL
Joint Secretary and Mission Director, Swachh Bharat Mission (Urban)
Government of India

ACKNOWLEDGMENT

The document, “Solid Waste Management Initiatives in Urban India: A Compendium” is an outcome of the combined efforts of several organizations and individuals. Their contributions have been acknowledged to the best extent possible in the form of references.

We are thankful to the Ministry of Housing and Urban Affairs (MoHUA), Government of India for supporting us in making this project a success. We would like to extend a heartfelt gratitude to Shri. Durga Shankar Mishra, Secretary, MoHUA, Government of India for providing National Institute of Urban Affairs (NIUA) the opportunity to extensively contribute and be a part of the mission to clean India. We are greatly indebted to Shri. V. K. Jindal, Joint Secretary and Mission Director, Swachh Bharat Mission (Urban) for his continuous guidance and engagement. This document would not have seen the light of the day without his immeasurable support. We would also like to thank the team members of the PMU at MoHUA for their constant support.

We wish to acknowledge the efforts of our partner training organizations in different cities for delivering the programme under tight timelines. The site in-charges deserve a special mention for providing necessary logistics during visits and providing technical information that have contributed in shaping up the compendium.

We are grateful to the officials of the State Governments and Union Territories, and State Urban Development Authorities who have greatly helped in formulating this document. We are also thankful to the resource persons and participants for sharing their on-ground experiences and valuable feedback.

We hope that the best practices documented in this Compendium can help change the landscape of solid waste management in India.

Hitesh Vaidya
Director, NIUA

INTRODUCTION

Swachh Bharat Mission (Urban) 2014-19

Towards achieving A Clean India

India's urban population has been increasing rapidly over the last few decades. As per Census of India, in 1951, India had urban population of 17.29%, which increased up to 31.16% in 2011. Due to urbanization and change in lifestyle, India has had to deal with increased solid waste generation. Dealing with waste has now become a global issue, which poses a threat to public health, environment and economy.

SOLID WASTE SCENARIO IN URBAN INDIA

Solid Waste Management (SWM) is one of the 18 functions that comes under the purview of urban local bodies (ULBs) to implement in their cities and towns. To understand the importance of the linkages between MDGs, SDGs and Solid Waste Management in urban India, the approach and achievements of the Swachh Bharat (Clean India) Mission would be useful to study. This note delineates major initiatives of solid waste management in India, particularly that of SWM Rules 2016 and Swachh Bharat Mission (Urban) (SBM-U) 2014-19. Furthermore, SBM-U had various components and to implement one of its component i.e. capacity building on SWM, National Institute of Urban Affairs (NIUA), a think tank under the Ministry of Housing and Urban Affairs (MoHUA) conducted several SWM exposure cum training workshops for ULB officials on behalf of MoHUA since 2016. A detailed format of these workshops has been explained in this note while issues and challenges identified by participants from ULBs while addressing and solving some of the problems faced by community due to poor waste management, are also discussed.

SIGNIFICANCE OF SWM IN MDGS AND SDGS

It is significant that Solid waste management (SWM) is one of the important targets to be mentioned under Millennium Development Goals (MDG, 2000 to 2015) and Sustainable Development Goals (SDG, 2015 to 2030). Although not explicitly mentioned but the linkage between SWM and various global concerns stated in the MDGs, namely, eradication of extreme poverty and hunger (MDG 1), reducing child mortality (MDG 4), improving maternal health (MDG 5) and ensuring environmental

sustainability (MDG 7) is evident in the MDGs. However, Significance of proper treatment of solid waste is recognized in Sustainable Development Goals (SDGs-2015 to 2030) and it is embedded within the 17 goals of SDGs either explicitly or implicitly. SDG 11, "Make cities and human settlements inclusive, safe, resilient and sustainable", explicitly discusses about SWM. Target no. 11.6 of SDG 11, says, member states decided to "by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". Waste management has strong linkage to a range of global challenges, such as health (SDG 3), climate change (SDG 13), poverty reduction (SDG 1), clean water and sanitation (SDG 6), food and resources security (SDG 2) and sustainable production and consumption (SDG 12). It is also observed that, a significant proportion of the population of many large cities depends on solid waste management for their livelihood, whether employed by formal or informal organizations for street sweeping, waste collection, waste sorting, recycling and others.

SOLID WASTE MANAGEMENT INITIATIVES IN INDIA

MSWM RULES 2000 AND SWM RULES 2016

The first comprehensive solid waste management rules were promulgated in 2000 by the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India (GOI). The rules provided detailed mandates on various aspects of municipal solid waste management (MSWM) and identified the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) as nodal agencies to monitor its implementation directly in the union territories and the states respectively. Thereafter, amidst protests due to poor implementation (Hindustan Times 2016; Annepu 2014; The Hindu 2012; Times of India 2016) in several states of India, the rules were revised in 2016 by the Ministry of Environment, thus releasing the latest Solid Waste Management (SWM) Rules in 2016, to regulate effective collection, treatment and disposal of all solid waste in India. Under these rules, the responsibility of management of Solid Waste in cities has been entrusted with Urban Development Departments and Urban Local Bodies (ULBs) in the states. All Municipal Corporations and municipalities have to prepare a Solid Waste Management Plan. Besides that, to operationalize the SWM Rules 2016, the Ministry of Housing and Urban Affairs (MoHUA) through Central Public Health Environment Engineering Organization (CPHEEO), has published manuals in October 2016 which has incorporated the necessary specifications and actions for ULBs to implement them in their cities.

THE KEY FEATURES OF THE SOLID WASTE MANAGEMENT RULES, 2016 ARE:

i. A mandate for all waste generators to segregate waste, but with specific penalty on non-compliers to be announced through bye-laws
ii. A mandate for bulk generators (any institution with an area greater than 5,000 square meters) to manage their own waste, but with penalty mentioned for non-compliance of the same to be announced through bye-laws
iii. An extended producer responsibility on brand owners to set up a collect-back scheme for managing waste produced during packaging
iv. Promotion of options like Biomethanation, Waste to Fuel Oil, composting other than incineration are among the WTE (waste-to-energy) plants suggested for treating different streams of waste and inclusion of Market Development Mechanisms (MDMS) in addition to the directive to the Department of Fertilizers to market city compost along with chemical fertilizers
v. Provision for local bodies to levy waste collection fees on waste generators, with both fees and penalty for non-compliance to be announced through bye-laws.

SWACHH BHARAT MISSION (URBAN), 2014 - 2019

Swachh Bharat Mission (SBM) was launched on October 2nd 2014. The initiative has two thrust areas - SBM (U) and SBM (R). SBM (U) operates under the Ministry of Housing and Urban Affairs and SBM (R) operates under the Ministry of Drinking Water and Sanitation, now integrated into Ministry of Jal Shakti (Water Resources). The key objectives of SBM are to address both elimination of open defecation and achieving solid waste management in all cities and villages in India and that of SBM (U) in all ULBs of India by 2019. The mission has various components namely capacity building, construction of household toilets, community and public toilets & urinals, IEC & Public awareness, Solid Waste Management including faecal sludge management in the sanitation facilities. To address primarily Solid Waste Management issues, SBM (U) launched a multipronged approach to counter the cyclical effects of de-motivation and poor performance of ULBs by infusing enthusiasm, financial support, a feeling of accountability among ULB staff towards cleanliness through organization of massive awareness campaigns among citizens who are the primary generators of solid waste in the cities.

ACHIEVEMENTS OF SBM-U, MARCH 31ST 2019 (MINISTRY OF HOUSING AND URBAN AFFAIRS (MoHUA), GOI)

Urban areas of 31 states / UTs have become ODF. In all, 4,303 cities have declared themselves ODF. This has been achieved by the construction of nearly 58.98 lakh (hundred thousand) Individual Household Toilets and 5.05 lakh seats of community / public toilets under the Mission. MoHUA has launched the ODF+ and ODF++ protocols, with a focus on sustaining ODF outcomes and achieving holistic sanitation. While ODF+ protocol focuses on Operation & Maintenance of community toilet (CT) / public toilets (PT) by ensuring functionality and proper maintenance of CT/PTs for their continued

usage, ODF++ focuses on addressing safe management of faecal sludge from toilets, and ensuring that no untreated sludge is discharged into open drains, water bodies or in the open. Till date, 377 cities have been certified ODF+, and 167 cities have been certified ODF++

ACHIEVEMENT OF SBM PARTICULARLY ON SWM

At the time of launch of the Swachh Bharat Mission, 95,00,000 tonnes per annum (TPA) of waste was the treatment capacity across processes such as composting, bio-methanation, RDF and waste to energy plants (as per the erstwhile Planning Commission of India report). This has been enhanced substantially in the last 4 years, and presently, designed input capacity of functional waste to energy and waste to compost plants is approximately 238, 00,000 TPA including decentralized capacity;

- 76,851 wards out of 84,420 wards (91.03% wards) are practicing 100% door to door collection
- approximately 54% of the total waste generated is being processed and 64% of wards are practicing source segregation.
- India has 685 functional waste to compost plants (centralized) with capacity to process 188, 00,000 tonnes waste per annum, and another 232 plants are under construction, with approximate input capacity of 47,00,000 tonnes per annum. Current production of Compost is 43,87,000 metric tonnes
- India has 7 functional Waste to Electricity plants with Production Capacity of 88.4 MW, and another 56 plants under construction with Production Capacity of 415 MW.
- Additionally, 384 bio gas and bio-methanation plants with input capacity of 33, 00,000 TPA and another 21 plants under construction with potential input capacity of 25, 00,000 metric tonnes.

Protocol for garbage free cities was also launched during SBM 1. This protocol is based on 12 parameters, follows a SMART framework – Single metric, Measurable, Achievable, Rigorous verification mechanism and Targeted towards outcomes – and has been devised in a holistic manner including components such as cleanliness of drains and water bodies, plastic waste management, managing construction & demolition waste, etc. which are critical drivers for achieving garbage free cities. It is a single metric rating system, based on multiple parameters of SWM. It is envisioned that star rating initiative will also enable institutionalization of good practices such as source segregation, scientific processing of waste, dumpsite remediation, penalties and spot fines for littering, and compliance of bulk waste generators, amongst others. As on date, 3 cities (Indore, Ambikapur and Mysuru) have been rated as 5-star cities, and 53 cities have been rated as 3-star cities.

EXPOSURE CUM TRAINING PROGRAMME, PHASE I (2016), PHASE II (2017) AND PHASE III (2018-19)

As part of the capacity building programme under the SBM, NIUA has conducted Solid Waste Management (SWM) workshops for the Urban Local bodies (ULBs). These have been spread over three phases - Phase I (2016), Phase II (2017) and Phase III (2018-19). The purpose of the SWM Exposure Workshop was to get the participants recognize issues, challenges and constraints of SWM, understand the SWM Rules 2016, various approaches, technologies available to them and their financial implications while preparing an action plan to implement solutions in their cities.

In 2016, NIUA conducted twelve SBM-SWM workshops at United Service Institute of India, New Delhi. Each workshop had 40-45 senior officials from ULBs and covered 108 ULBs of 25 states and UTs and trained 224 municipal officials. A similar set of twelve workshops were conducted in 2017 at India Habitat Centre, New Delhi, covering 178 ULBs from 27 states and 5 UTs and trained 423 municipal officials. These workshops (Phase I – 2016 and Phase II - 2017) were conducted from May to October and duration of workshop were five days, wherein the first day was devoted to theoretical aspects while the next two days were site visit days. The ULB officials were taken to different locations in Delhi NCR and explained the details of different plants for treatment of different components of solid waste generated in a city. The fourth and fifth days were devoted to explanation of technologies, exercises and competitions to assess the action plans of the groups. These workshops were called SWM Exposure Workshops because they provided the required exposure to the participants regarding the SWM Rules 2016 and the ways and means for achieving compliance with it. Therefore, SBM SWM Exposure Workshop Phase III (2018-19), focused on capacity building of Class I (more than 1, 00,000 population), Class II (50,000 to 99,999 population) and Class III (20,000 to 49,999 population) cities, the major waste generators in India.

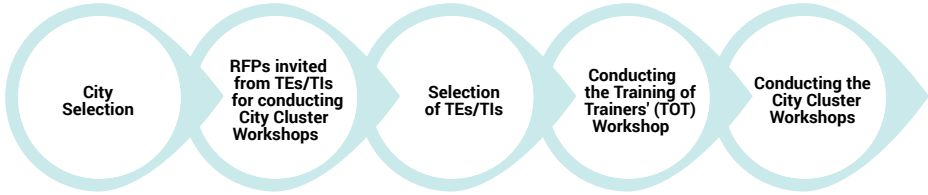


Figure 1 Project Sequence for Phase III (2018-19)

The third phase (2018-19) started with a five-day national master trainers' workshop in August, 2018 at the India Habitat Centre, New Delhi, wherein master trainers from thirteen Training Entities (TEs), selected through a competitive process, were trained. This was followed by the TEs conducting 80, three-day City Cluster Workshops, at 43

locations across India, from 17th September 2018 to 15th February, 2019. A total of 3439 officials from 1789 ULBs from 27 states and 4 UTs were trained.

At least one resource person from NIUA attended each of these workshops. In addition to monitoring the workshop, NIUA conducted sessions on Swachh Survekshan (Cleanliness Survey in 4203 cities in January 2019), Open Defecation Free (ODF), (Maintenance of Toilets (ODF+), Faecal Sludge Management (ODF++) protocols, Star Rating of Garbage Free Cities and mandatory requirements for accessing SBM funds for one's city from Central and State government exchequers.

Education and Training is a continuous process that helps in correcting and sustaining any system.

CONTENTS

Cities with population: More than 10 Lakh

		2 Indore	8 Ahmedabad	12 Bengaluru
18 Coimbatore	22 Madurai	28 Chennai	34 Nashik	40 Pimpri Chinchwad
44 Surat	46 Visakhapatnam	50 Nagpur	52 Varanasi	56 Jabalpur
58 Amritsar	62 Mumbai	68 Lucknow	70 Jaipur	72 Aurangabad

Cities with population: 3-10 Lakh

76 Chandigarh	82 Mysuru		
86 Salem	90 Gurugram	94 Jamshedpur	98 Bhubhaneshwar
102 Dehradun	106 Guwahati	110 Jhansi	114 Jammu
		116 Alwar	120 Aligarh

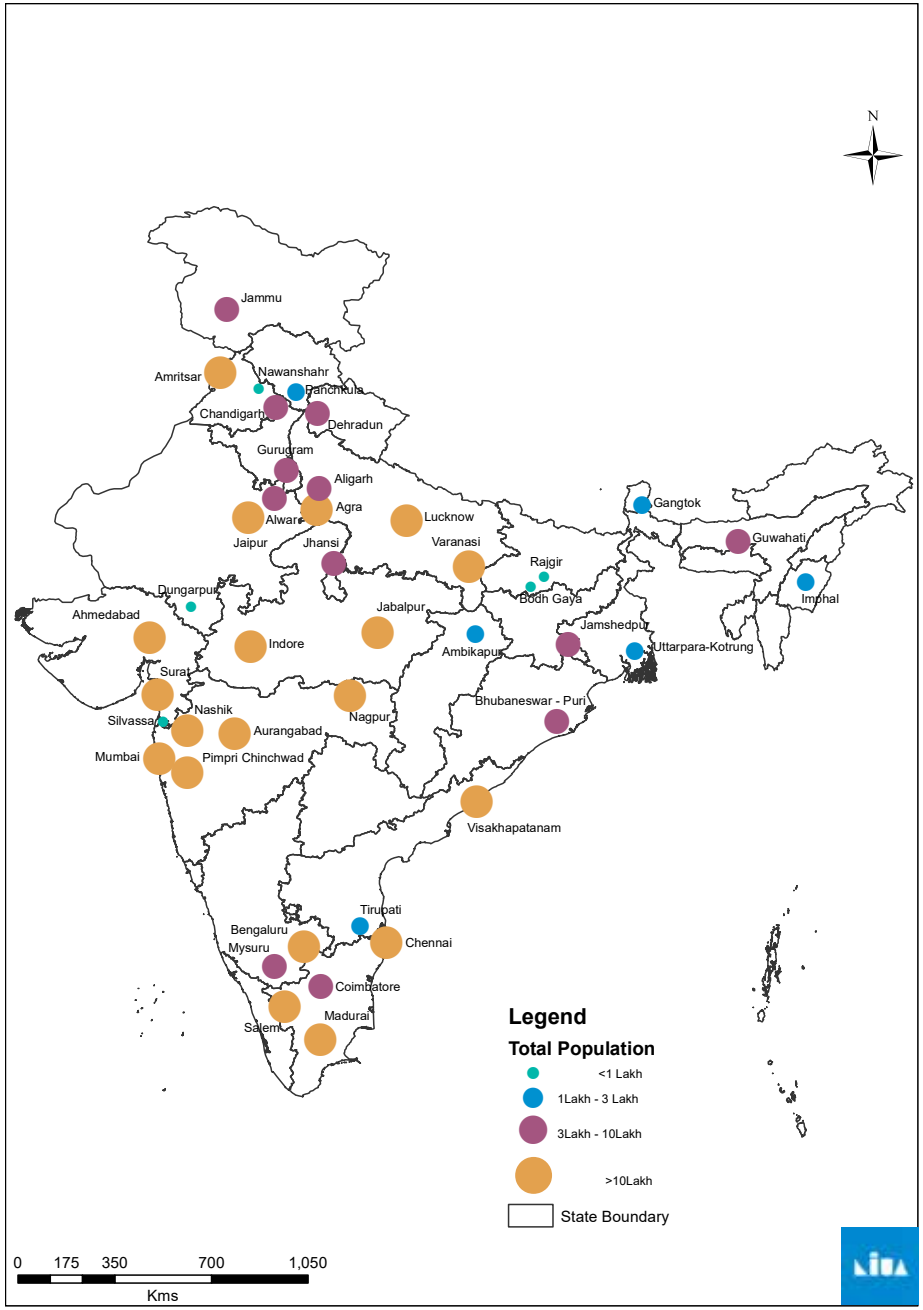
Cities with population: 1-3 Lakh

Cities with population: Less than 1 Lakh

LIST OF ABBREVIATIONS

ABR	Anaerobic Baffled Reactor
ASP	Aerated Static Pile
BGG	Bulk Garbage Generator
BOOT	Build Own Operate Transfer
CAPEX	Capital Expenditure
C&D	Construction and Demolition
CSR	Corporate Social Responsibility
CV	Calorific Value
DFBOOT	Design Finance Build Own Operate Transfer
DLB	Directorate of Local Bodies
DTD	Door to Door
FRH	Forest Rest House
FSSM	Faecal Sludge and Septage Management
GI	Galvanized Iron
GPS	Global Positing System
ICT	Information and Communication Technologies
HAG	Hot Air Generator
HD	High Density
HDPE	High Density Polyethylene
HH	Household
IEC	Information, Education, Communication
ISO	International Organization for Standardization
ISWM	Integrated Solid Waste Management
IUDM	Integrated Urban Development Mission
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KLD	Kilo Litre per Day
LD	Low Density
LEED	Leadership in Energy and Environmental Design
LPG	Liquefied Petroleum Gas
MLD	Million Litres Per Day
MoHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MT	Metric Tons
NGO	Non-Governmental Organization
NGT	National green Tribunal
NULM	National Urban Livelihoods Mission
O&M	Operation and Maintenance
OPEX	Operational Expenditure
OWC	Organic Waste Convertor
PET	Polyethylene Terephthalate
PPP	Public Private Partnership
RCC	Reinforced Cement Concrete
RDF	Refuse Derived Fuel
RFID	Radio Frequency Identification
RRC	Resource Recovery Centre
RTS	Refuse Transfer Station
RWAs	Resident Welfare Association
SBM	Swachh Bharat Mission
SCADA	Supervisory Control And Data Acquisition
SCF	Solid Combined Fuel
SHGs	Self Help Groups
SLF	Sanitary Landfill
SLRM	Solid and Liquid Resource Management
SORT	Segregation of Organic Waste for Recycling and Treatment
STP	Sewage Treatment Plant
SWM	Solid Waste Management
UDHD	Urban Development and Housing Department
ULB	Urban Local Body

WORKSHOP LOCATIONS, 2018-19



ABOUT THIS COMPENDIUM

WHAT IS THE NEED OF THIS COMPENDIUM?

Under the SBM SWM Exposure Workshops, field visits formed an important element. These visits included on-ground exposure to various aspects of solid waste management such as source segregation, collection and transportation, processing and treatment and scientific disposal. The visits benefitted the ULBs in understanding as well as resolving the various issues and challenges related to SWM. Thus, a need was felt to consolidate and share the experiences with a wider audience keen on working towards a sustainable SWM.

WHAT IS THIS COMPENDIUM ABOUT?

This compendium comprises a compilation of innovative approaches adopted across India in the solid waste management sector in forty locations. It highlights these initiatives along with their technical specifications and basic financial details. The chapterization is based on size of the cities (as per Census of India, 2011).

WHO CAN BENEFIT FROM THIS COMPENDIUM?

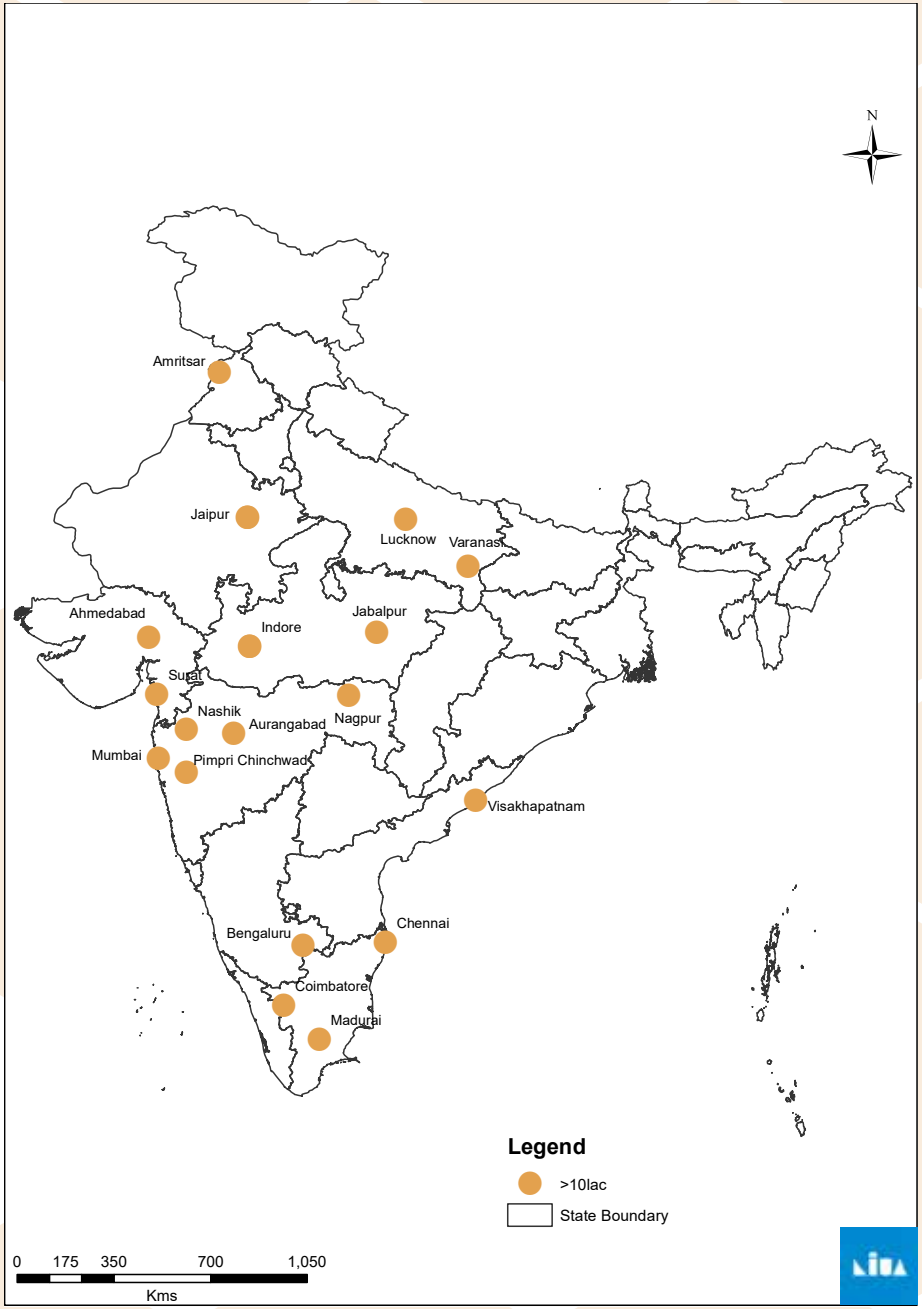
This compendium is intended as a reference to ULB officials to understand and implement an appropriate SWM plan. The compendium is therefore structured based on the population, demography, administrative set-up and financial status. This in turn will assist in peer learning. The contact details included in the chapters' will be a ready reckoner in accessing further information regarding the facilities. Glossary has been included at the end of the document for better understanding of terminologies related to SWM.

FROM WHERE IS THE INFORMATION ADOPTED IN THE COMPENDIUM?

The information regarding the facilities have been obtained from the interaction with site personnel during the field visits. Other sources include data derived from websites of city corporations, NGOs, facility operators and other credible sources like research papers, news articles and reports.

Cities with population:

More than 10 Lakh



Indore

Municipal Corporation

State: **Madhya Pradesh**

Area (in sq. km): **275**

Number of Wards: **85**

Population: **19,94,397**

Waste Generated in Metric Tons (MT) per day: **1,115**

Solid waste management in Indore comes under the purview of the Indore Municipal Corporation. Indore today generates over 1,115 MT of garbage a day and all of it is collected from the source-whether it is a household or a commercial establishment. The total wet waste generation is 650 MT per day and dry waste generation is 465 MT per day. The households are covered by the door to door collection system while the semi bulk and bulk generators are covered by the bulk collection system. IMC staff carries out sweeping, twice a day in all the commercial areas of the city and an activity log for sweeping is tracked by the Sanitary Inspectors and also through the 'Command and Control' centers established in the city for monitoring. The city has an integrated waste processing facility where the wet and dry waste is treated. The total manpower involved in the SWM of the city is 7500 persons.

The city was awarded the title of "India's Cleanest City - No. 1" in the Swachh Survekshan 2019.

Segregation, Collection and Transportation

Indore ensures 100% coverage of wards through its door to door collection system. 100% segregation at source is being practiced in the city. The city's door to door collection and segregation is implemented and monitored with the help of six NGOs (four for source segregation and to create public awareness and two for plastic waste management). All waste collecting vehicles have separate wet and dry waste collection partition in vehicles besides a separate container for domestic hazardous waste.

Waste Collection Vehicles having different compartments

A user charge of Rs 60 - Rs. 150 is collected per residential unit and Rs. 100 - Rs. 180 is collected per commercial unit on monthly basis. Aadhar linked biometric attendance for all waste cleaning workers is done in all the 85 wards.

Facility highlights of Collection and Transportation	
Area covered	250 sq. km.
Technology used	GPS, RFID
CAPEX	Rs. 160 Crore
OPEX	Rs. 150 Crore annually (Rs. 97 Crore for salaries and Rs. 53 Crore for rest of the operational cost)
Revenue Generated	Over Rs. 60 Crore

Source: Indore municipal corporation

Garbage Transfer Station (GTS): The collected waste is taken to the GTS built in the city. Capacity of each GTS ranges between 150-200MT of waste. The waste collecting vehicle which is bought to the garbage transfer station is weighed through the weigh bridges. The city has a total of 10 transfer stations, the capital cost of each transfer station being Rs. 6 Cr. The garbage transfer stations are known as 'Green Transfer stations' as each of the stations save approximately Rs. 20 Lakh per month on the fuel consumption and has its own biomethanation plant which uses 1.8MT of the waste to generate electricity which is used in the transfer stations itself.

Bin free city initiative: The initiative started in a phased manner from March 2016 to December 2016. Effective Door to Door (D2D) collection reduced the garbage on roads and open areas. On critical bin locations, 3 times movement of D2D garbage collecting vehicle is done.

Bin free initiative in Indore

The waste is collected through partitioned vehicles known as 'Tippers' and is transported to one of the ten transfer stations. The wet waste from semi bulk generators generating 25 to 100 kg of waste is collected through the Bulk Collection System. All vehicles used in the collection and transportation system are monitored by a GPS enabled tracking system. The GPS system is constantly monitored by the monitoring cell.

Key highlights

- 2000 open dump spots in the city have been eliminated.
- Removal of garbage bins from all the 1170 locations in the city
- Increase in attendance of Safai Mitr due to Biometric attendance and monitoring.

The supply, installation, implementation and maintenance of GPS based Vehicle Tracking Solution (VTS) for MSW, CCTV cameras at community and public toilets and integration of weighbridge at Devguradia landfill site all together had a total cost of 1.29 crore. Along with the GPS and RFID trackers, the city also has a 'Push to Talk System.'

Integrated Solid Waste Processing Facility (Centralized)

Indore city has a Centralized Processing Unit situated at Devguradia, Nemawar Road. The total area of Devguradia processing and disposal site is around 146 acres. The waste collected at the garbage transfer stations in city is weighed, compressed and further moved to Devguradia processing site / Trenching Ground for final processing. This centralized processing unit has the following facilities:

Facility 1: Centralized Organic Wet Waste Processing Unit	**Facility 2:** Material Recovery Facility 1 and 2	**Facility 3:** Bioremediation of old dumpsite	**Facility 4:** Plastic waste collection and processing unit and Plastic waste fuel convertor unit	**Facility 5:** C&D Waste Plant	**Facility 6:** Scientific Landfill Site

1. **Centralized Organic Wet Waste Processing Unit (Aerobic Composting Unit):** The wet waste is processed in two ways i.e. Central Processing Plant and at Decentralized Waste Processing Units. All the wet waste of the bulk generators (30 kg and above) is processed at their premises, so this waste is not processed at the central processing plant. The wet waste from the Garbage Transfer Station (D2D Collection) and semi bulk collection (those generating 15 to 30 kg/ per day) is transported to the central wet waste processing plant, where it is processed into compost.

   The wet waste after being bought to the processing unit, is kept in the open to decrease its moisture. Proper drainage lines are built near this area to discharge the fluid. This waste is treated properly from time to time and the compost so produced is of good quality.

2. **Material Recovery Facility 1 and 2:** In the processing facility, there are two Material Recovery Facilities constructed in which manual method of waste segregation is adopted. The capacity of each MRF is 270MT. At these facilities, the dry waste is segregated into different components as metal, rubber, plastic, etc. This segregation is done by the 343 wastepickers employed at the MRFs. Earlier the wastepickers were seen collecting scraps from the roads. But at present they are employed officially in the MRFs. Inert is recovered at both the MRFs. The inert is then transferred to the sanitary landfill at the same complex. An automated MRF

Centralized Organic Wet Waste Processing Unit

MRF facility at Indore

has been proposed, which is planned to be functional from April or May 2019.

3. **Plastic waste collection and processing unit:** Indore Municipal Corporation (IMC) has set up a Plastic Collection Centre (PCC) to reuse and recycle the city's plastic waste. Along with setting up a PCC, IMC has also installed a plastic cleansing machine known as a 'Phatka Machine.' Waste pickers segregate and sell the plastic waste that can be recycled. The remaining plastic waste is then taken to the PCC where it goes through the process of cleaning and shredding. Around 10 Tonnes of the shredded and purified plastic is sent to the plastic waste fuel converter unit while the rest of the plastic is sent to Madhya Pradesh Rural Road Development Authority for construction of roads.

Key highlights

- From being one of the biggest plastic waste generators in MP in 2013, to putting 50% of city's plastic waste to reuse, Indore is a shining example for the other big cities in India facing with waste management problems.

Plastic waste fuel convertor unit: IMC was facing difficulty in disposal of scrap plastic such as chocolate wrappers, tobacco and pan-masala pouches. So, IMC came up with a plastic waste fuel converter unit. This facility works on reverse polymerization process and is capable of producing at least 3000 litre of fuel per day with 10 tonnes of scrap plastic waste. The entire process takes at least 16 hours.

C&D Facility

Presently, the unit is producing around 2400 litre fuel including diesel, petrol as well as crude oil. The fuel produced is of good quality. This plastic waste fuel conversion unit has solved the problem of disposal of scrap plastic waste collected on daily basis from the city. The capital cost of the plant is approximately 3 Cr.

4 **Bio Remediation of old dumpsite:** During the previous year, by the process of Bio-mining 200,000 MT old garbage was treated by Indore Municipal Corporation at Devguradia dump site. 5 Acre land has been reclaimed and green belt has been developed. Recovered Soil, Compost and recyclables have been sold and rejects have been scientifically landfilled.

Facility highlights of Bio-remediation Site	
Area of the facility	4 acres
Processing Capacity	100 MT per day
Products obtained	40 mm and 20mm maximum size aggregate, sand and sludge which are converted into useful end products.
CAPEX	Rs. 2.5 Crore

The capacity of the plant is 254 MT per day and runs on 12 hour-basis which is managed by E-Tech Projects. The mode of contract followed is annual and on per cum term with extendable contract and is currently charging Rs.500 per cum. The treatment scheme involved the separation of material with the help of trommel (25mm) followed by accumulating plastics through baling machines.

Indore has transformed its garbage landfill site into a beautiful garden in a very small time frame.

5 **Construction and Demolition(C & D) waste plant:** Indore city generates 100 MT per day of C & D waste which is sent to four collection and segregation centers. For managing this amount of C & D waste, IMC has set up a construction and demolition debris waste processing facility which is constructed on a PPP model. Under the PPP model, the corporation provided 4 acres of land for setting up the plant for 15 years. The recovery period for the recovery of cost of construction is estimated to be 8 years.

The waste is subjected to a number of operations and processes through a number of units. The products obtained from the facility after treatment of the C & D waste are paver block with finished surface, rough paver block, rectangular paver bricks and masonry bricks.

6 **Scientific Landfill Site:** Two engineered landfills of 6.25 acre each have been constructed and are used as and when required. Only the inert is being transferred to this site which is approximately 5-6% of the total waste generated by the city.

Weigh bridges: Other than these waste processing facilities, the plant has also constructed two weigh bridges. The weighbridge facility at the processing plant is a computerized facility and is the first point of interaction for all vehicles incoming to the plant to offload their waste.

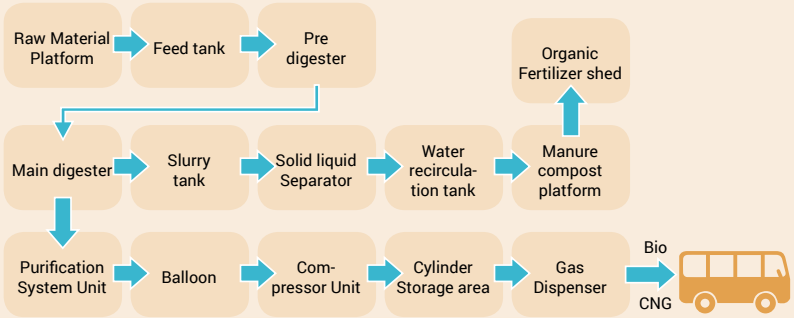
Facility highlights of Scientific Landfill Site	
Capacity of the facility	20 MT per day
Technology used	Bio-CNG
CAPEX	Rs. 15 Crore
Products obtained	Bio-CNG and compost
Quantity of Bio-CNG generated	800kg on daily basis

Source: Indore municipal corporation

Biomethanation Plant for Wholesale Vegetable and Fruit Market

Approximately 20-25 MT per day fruit and vegetable waste is generated in Choitram Mandi on daily basis. Earlier, the waste was collected and transported to the centralized waste processing and disposal site of IMC, which incurred heavy transportation and manpower cost. Hence, IMC under its policy of promoting decentralized treatment of organic waste established Bio-methanation plant (Bio-CNG Plant). Through a tendering process IMC appointed Mahindra & Mahindra Ltd. Mumbai to establish the plant, which was commissioned in December 2017. The concession period of the project is 15 years. Presently all the fruit and vegetable waste generated at Choithram Mandi is being collected and processed in the Bio CNG plant.

Approximately 800 kg of purified and compressed Bio CNG having 95% pure Methane gas is generated on a daily basis. The pressurized Bio-CNG gas is used as a fuel to operate approximately 15 city buses. Therefore, with the use of the Bio-CNG produced, there is a saving of Rs 4500 on the fuel expense of these buses which would amount to a saving of about Rs. 1.35 lakh every month. The digested slurry is passed through solid liquid separation unit. Filtered liquid is used in slurry making and the remaining solid are dried and converted into organic compost.



Flowchart of the process involved in the Biomethanation plant

Products manufactured at C&D facility

Biomethanation Plant

SBR based STP

Faecal sludge management: In India, 7 Cities have gone beyond the ODF Status to adopt Faecal Sludge Management, one of which is Indore. The city received ODF++ certification under Open Defecation Free protocol, indicating that IMC has succeeded in achieving sanitation sustainability by addressing complete sanitation value chain, including safe and complete faecal sludge management. Indore has achieved 100% treatment of the faecal matter generated in the city. Indore has three Sewage Treatment Plants (STPs) within the city for which proper log books are maintained. The three STPs are-

i. 245 MLD Sequencing Batch Reactors (SBR) based STP. This STP is the world's first largest 245 MLD STP with single stage SBR.
ii. 78 MLD and 12 MLD Upflow Anaerobic Sludge Blanket reactor (UASB) based STPs at Kabitkhedi. Along with the sewage treatment, electricity is also generated in these plants. The power generation capacity being around 18.5 KW to 22 KW.
iii. 122MLD STP

Some good initiatives taken by IMC with the help of decentralized STPs-

- Treatment and reuse of 50,000 litre per day sewage through decentralised STP at Zoo.
- Preservation of Khajarana lake water body by treating water through decentralised STP of capacity 2 lacs litre per day.

Recommendation

Indore city has effectively implemented 100% door to door collection and 100% source segregation along with proper processing, disposal and management of the entire waste generated in the city. Only 5-6% of the total waste is inert which is being sent to the sanitary landfill site. This model is the most recommendable model for the Class I cities and it can be achieved within a small time frame.

To Know More

Integrated solid waste processing facility
Name of the Organization: Indore Municipal Corporation
Website: http://www.imcindore.org/webindore/
Contact Number: 0731 253 5555

Segregation, collection and transportation
Name of the Organization: Eco Pro Environmental Services
Email: ecopro@rediffmail.com
Website: www.ecoproindore.com
Contact Number: 0731-4065172

Ahmedabad

Municipal Corporation

State: **Gujarat**

Area (in sq. km): **466**

Number of Wards: **48**

Population: **55,77,940**

Waste Generated in Metric Tons (MT) per day: **3,300**

Ahmedabad Municipal Corporation (AMC) has divided its activities into 6 Zones and 48 wards for smooth administration and effective service provision. The 3300 MT of waste generated per day in the city comprises 1100 MT of dry waste, 1200 MT of wet waste and around 1000 MT of Construction and Demolition (C&D) waste. As of 2018 data, the city has achieved almost 100% segregation at source.

Total waste collected	2300 MT per day
CAPEX	Rs. 2.82 crore
OPEX	Rs. 1.98 crore
Manpower	12500

AMC started the door to door waste collection system in 2009. The vehicles employed for the purpose comprise covered collection vehicles, container lifting vehicles and road sweeping machines that are monitored by GPS, RFID Readers and Tags. More than 600 Vehicles were deployed to start the collection process. The collection vehicles have separate compartments for collecting segregated waste. Nearly 50 percent of the entire waste, amounting to more than 1300 MT per day, is collected from municipal bins across 750 locations in the city and from street sweeping from the 6 zones. The collection is done with the help of 130 tractors, trucks, JCB and other equipment and machinery. Waste is collected from the residential units in the morning hours and from commercial units in the evening time by private contractor appointed by AMC. In order to remove nuisance spots, AMC has deployed around 1050 galvanized trolleys of 660/1100 liters capacity and around 60 Refuse Compactors. Animal waste amounting to 8.8 MT per day and food waste collected from nearly 1000 hotels and restaurants amounting to approximately 88 MT per day are delivered

Material Recovery Facility- NEPRA, Ahmedabad

to the centralized compost plant. After collection, the waste is transported to the Refuse Transfer Stations (RTS) from where it is sent to the processing plants. 7 Transfer Stations of about 400 MT capacity have been constructed in 6 zones of the city. All the stations are functional and 1 RTS is in under construction. Segregated waste collected from the RTS is transported to AMC's composting plants operated by Excel Industries Ltd. and Bharuch Enviro Engineers Ltd.

Material Recovery Facility by NEPRA

The Material Recovery Facility (MRF) at Ahmedabad runs on a public private partnership (PPP) model between Ahmedabad Municipal Corporation (AMC) and Nepra Resource Management Pvt. Ltd. Land for the facility is provided by AMC on a lease rent of Rs 2/Sq. m per year. The facility is designed, built, financed, owned and operated by Nepra Resource Management. The daily sorting capacity of dry waste of the plant is around 100 MT.

Facility highlights of Material Recovery Facility	
Area of the facility	130 sq.m.
Sorting Capacity of the facility	100 MT per day
Vehicles deployed	20-22
CAPEX	Rs. 13.5 crore

More than 20 vehicles are deployed for collection of waste from various locations in the city through a cloud-based technology to ensure transparency in scheduled pick up. Through this cloud-based technology, clients are informed about the quantity of waste collected, and the commodity and carbon emission mitigated by these.

Manual sorting of plastic waste

Key Highlights

- This PPP based model has helped to integrate nearly 1,800 waste-pickers into the formal economy.
- NEPRA foundation is also taking initiatives for creating awareness and education regarding climate change and sustainable waste management.

Dry Waste is collected with the help of waste pickers and through collection vehicles and brought to the material recovery facility (MRF) where it is manually segregated into various categories and passed through a stringent quality check to meet the requirement and standards of the recyclers. The segregated waste is then sold to the authorized recyclers. The employed waste pickers are also provided with personal protective equipment like-helmet, mask, safety shoes, dress etc. The best employees of the month are also presented with token of appreciation to keep up the motivation.

Construction and Demolition (C&D) Waste Management by Amdavad Enviro Projects Pvt. Ltd. (AEPPL)

The C&D waste management in Ahmedabad is based on Public Private Participation (PPP) model. The Design Build Operate Finance and Transfer (DBOFT) model is being followed in this project. Ahmedabad Municipal Corporation (AMC) is providing logistics support to AEP through differential tipping fees and is also working towards enhancing awareness among entrepreneurs for using the C&D recycled waste as a secondary raw material for generating market for the produced recycled waste. The processing capacity of the plant is 1000 MT per day. Out of the total 1000 MTD, 40-50% is soil and 50-60% is debris. The C&D waste from 16 designated dumping sites by AMC is collected by trucks owned by AEP and also through contracted tractors for which a tipping fee is charged to the corporation.

The trucks are enabled with GPS tracking system for better monitoring. Waste is also collected directly from the residents or individuals, provided the quantity of waste is more than 5 MT.

The collected waste is weighed at the receiving station of the processing facility and then processed into coarse and fine aggregates, which are further used for the manufacturing of secondary raw materials like paver blocks, kerb stones and other pre-cast structures, sold under the brand name of Nu-Earth materials. As per AMC's preferential procurement policy, 25% of the final products produced by the plant are purchased by AMC and utilized in development of different civil and infrastructure

projects of AMC after the approval of competent authority. The plant has also got local market available for the recycled products and hence further capacity expansion is under the process. The final debris which cannot be recycled further, accounting to 0.2-0.3% is then resold. The remaining non-usable waste is disposed either in the landfill or is used as a covering for the landfill.

Facility highlights of C&D Waste Management Plant	
Area of the facility	4050 sq. m.
Processing Capacity of the facility	1000 MT per day
CAPEX (Rs.)	7,00,00,000
OPEX (Rs.)	5,00,000 per month
Manpower	18

Composting of Flower Waste by "Brook and Blooms"

"Brook and Blooms", a partnership firm of Yash Bhatt & Arjun Thakkar, has been carrying out research in sustainable management of waste generated from religious premises since 2015.

Facility highlights of the flower waste processing facility	
Total flower waste processed	0.9 MT per day
Capacity of Plant	0.9 MT
CAPEX	12 lakhs
OPEX	45,000
Manpower	10
Selling price of Compost	Rs. 40 per 750 gm

AMC has provided 100 yards land to Brooks & Bloom on operational basis. However, no rent or lease needs to be paid to the corporation. The infrastructure with few initial equipment was set up by AMC. Other costs have been taken over by Brook and Blooms.

The flower waste is manually segregated and directed to the shredder in which it is shredded into particles of 2 cm size. Following this, the shredded matter is channelized into the mixing unit through a conveyor belt, where it is mixed with water and culture for around 10 minutes. The mixture is turned every 8 days for 20 days followed by intermittent drying. The dried mixture is then screened mechanically through 4mm screens and packed in packs of 750 g each.

Currently the facility has the capacity to process 100 kg of waste in an hour. The waste is collected from the "Kalash" (pot) placed by Ahmedabad Municipal Corporation (AMC) on

Key Highlights

- The duo is now planning to make rose water out of these discarded roses from the Jain temples of the city.
- Making herbal incense cones from flowers and coco-peat and coir pots from discarded coconuts are also a part of their plan.

Manual segregation and sorting of dry waste into different categories

C&D Waste Processing Facility, Ahmedabad

Loading bay at the MRF facility

Flower-composting unit

the 8 bridges of Sabarmati river and also from “Pipal Kalash” which is placed in around 50 temples of Ahmedabad.

Total quantity of waste collected amounts to 18 MT per day on an average. This waste is brought to the facility at Victoria Garden, Ellis Bridge. It is further segregated and only 0.9 MT is found suitable for making compost. The compost thus generated is partly sold to AMC (50%) and partly to the temples.

Recommendation

Ahmedabad has taken a lot of initiatives related to segregation, collection and processing of waste of different streams. However increasing the capacity of the processing units is required. Also, awareness programs emphasizing on utilization of C&D waste recycled products and the corresponding cost savings should be promoted at large scale amongst the citizens for generating better demand of the products. Emphasis should be laid on scientific disposal of waste and converting the existing dumpsite into sanitary landfill.

To Know More

Ahmedabad Municipal Corporation
Email: info@ahmedabadcity.gov.in
Contact Number: +91-79-25391811, 25391830
Website: http://ahmedabadcity.gov.in/portal/jsp/static_pages/about_amc.jsp

Brook and Blooms
Yash Bhatt
Contact Number: +91-7984196023

NEPRA: Let’s Recycle
Email: info@letsrecycle.in
Contact Number: 400-50-400/ 9924143113
Website: http://www.letsrecycle.in/

Amdavad Enviro Projects Pvt. Ltd.
Email: vinit_patel2000@yahoo.com
Contact: 8141611411
Website: www.amdavadenviro.com

Waste Collection Vehicles

Bengaluru

Bruhat Bengaluru Mahanagar Palike

State: **Karnataka**

Area (in sq. km): **713**

Number of Wards: **198**

Population: **84,43,675**

Waste Generated in Metric Tons (MT) per day: **5760**

Awareness at Compost Santhe

Bengaluru stands as the third most populous city in India. It has seen rapid urbanisation with its population doubling in a span of just 20 years. Though the city grew to embrace a successful and thriving IT economy, it led to urban chaos, pushing the waste system close to its breaking point. The closure of the Mavallipura landfill by the Karnataka State Pollution Control Board (KSPCB) in 2012, following the protest by the villagers of Mandur, the directives issued by the Hon'ble High Court of Karnataka and on the recommendations and guidance of the Expert Committee, a Sustainable Solid Waste Management Plan known as *Kasa Muktha programme* was set up by the BBMP. The city's generation of approximately 5760 MT includes 64% wet waste, 28% dry waste, 2% domestic hazardous waste and 6% inert waste.

Processing Facilities in Bengaluru

Processing Facilities	Number of units	Percentage of Waste Processed
Dry Waste Collection Centre (DWCC)	164	26%
Bio-Methanation Unit (BMU)	13	6%
Organic Waste Converter (OWC)	7	4%
Leaf Litter Processing Unit (LLPU)	4	2%
Coconut Waste Processing Plant (CWPU)	2	2%
Waste Processing Plant (WPP)	10	40%
Landfill	1	20%

The city has setup infrastructure facilities to process waste by stream at ward level. At the Zone level, Rs 440 crore have been invested to process over 80% waste per day. The BBMP has adopted six strategies to manage the waste:

1. Investing in stream wise processing of waste: Segregation at source, collection and transportation, infrastructure and technologies for processing.
2. Data Driven Approach for Estimation and Planning: Ensuring stream wise collection and transportation
3. Enabling Market Dynamics-Creating New Economic Opportunities: Polluter Pay Model for bulk generators, empanelment of authorized service providers
4. Awareness Creation and Enabling Behavioral Change: Training programs, large events, cleanup drives
5. Use of technology for data collection and monitoring: Creation of data repository, GIS mapping, control room and app usage
6. Creating Institutional Capacities and Enabling Legislative Reforms: Reforms in legislation and new notifications, extended producer responsibility, SWM Cell, expert committee, intensive training programs.

The city has 100% door to door collection. A three way source segregation (Two Bin and One Bag) is followed by domestic generators and two way source segregation is followed by commercial establishments around the city.

Bin requirement for non-bulk residential generators

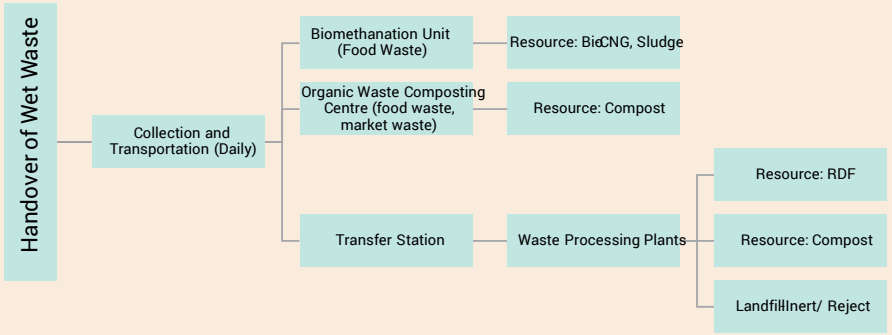
Generator	Bin System Specification
Independent Homes	2 BINS – 1 BAG Green Bin – Organic Waste Blue/White Bag – Dry Waste Red Bin – Domestic Hazardous Waste (Sanitary & Bio-medical Waste)
Multi Dwelling Units (< 50 flats)	3 BINS (for every 120 kgs generated) Green Bin – Organic Waste Blue Bin – Dry Waste Red Bin – Domestic Hazardous Waste (Sanitary & Bio-medical Waste)

Bin requirement for commercial establishments

Generator	Bin System Specification
Commercial (>10 kgs/day) Shops, Supermarkets, commercial establishment, Campuses, Institutions, Clinics, Nursing Homes, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste
Eateries (>10 kgs/day) Food vending carts, food stalls, canteens, Bakeries, Darshinis, small hotels, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste
Street Vendors Vending stalls, counters, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste

Bulk Waste Generator (BWG) Management – According to the BBMP guidelines, the BWG have setup insitu management of organic waste and handing over of the garden-horticulture waste, sanitary waste, dry waste and e-waste to the empaneled vendors. BBMP has an online portal (BG Net) where all information of BWGs is recorded.

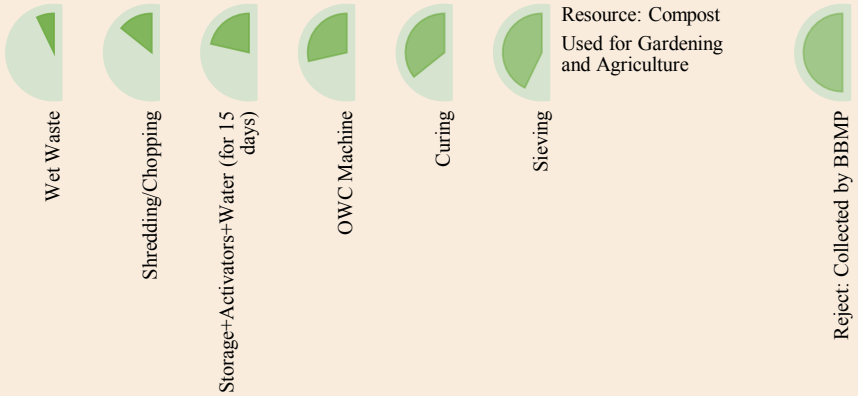
Wet Waste Flow Diagram of BBMP



Organic Waste Converter Centre

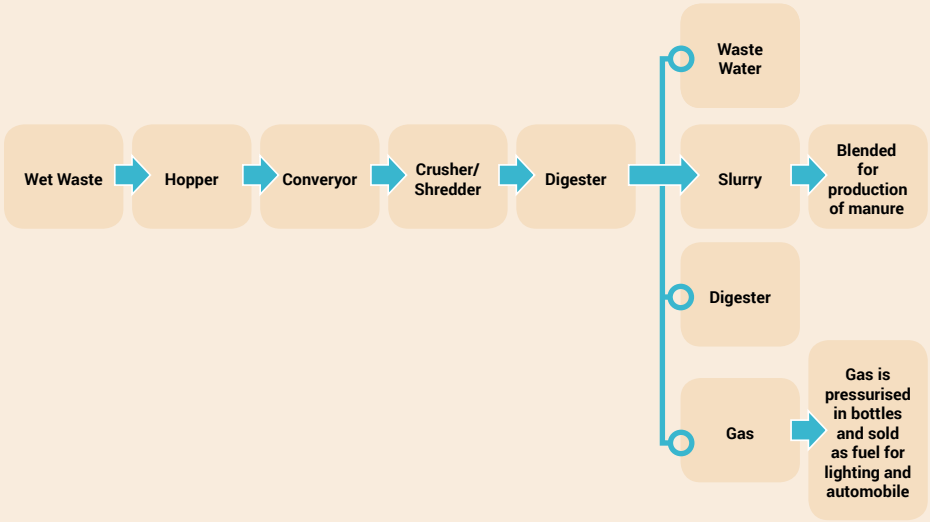
The Organic Waste Converter (OWC) plant works on the principle of Aerobic Microbial decomposition of solid waste into compost. This is a Bio Mechanical process which produces a homogeneous odour free output. The accountability for waste collection for the facility is on BBMP and the plants are operated and maintained by SHG or an agency. There are a total of seven such plants in Bengaluru with a capacity to manage 1 MT waste per day at the centre. The area of the plant is 220 sq. m.

Process Flow of Organic Waste Converter Centre



Bio Methanation Unit, Kuvempu Nagar

Process Flow Diagram of Biomethanation Plant



The BBMP has made it mandatory for citizens to segregate their waste. The agency involved in door to door collection aggregates the wet waste. The waste is taken to the plant to convert to energy (biogas powered engine). The plant was setup by Mailhem Engineers on Build, Own, Operate and Transfer (BOOT) basis in the year 2015. The plant processes 5 MT of waste per day. Biomethanation of organic wastes is accomplished by a series of biochemical transformations - hydrolysis, acidification and liquefaction followed by methane formation. The process generates biogas with high content of methane (55–70%) which after proper pre-treatment are directly used as fuel by employing gas engines to generate electricity. This technology has dual benefits. It gives biogas and manure as end product.

Facility highlights of Biomethanation Plant	
Capacity of the facility (MT) per day	5
Area of facility (in sq. m)	600
CAPEX	Rs 70 Lakhs
OPEX	Rs 67,000 per month
Products obtained	Manure and Biogas
Quantity of Manure obtained	250 (kg /day)
Quantity of biogas generated	500 (cu. m./day)
Manpower	7

Key highlights

- Decentralized Biomethanation Plants helps is reducing the cost of transportation of waste and managing the wet waste at the point of generation.

Leaf Litter Processing Unit (LLPU) Ward-151, Koramangala

The Koramangala 3rd Block community (RWA) has set up a LLPU, a unique initiative that processes leaf and garden waste generated in the community/ ward and converts it into usable compost. The unit is located at a public park in the area. The unit includes shredder and rotary sieves.

Facility highlights of Leaf Litter Processing Unit	
Capacity (MT) per day	1.5
Area of unit	600 sq. ft including (storage area)
CAPEX	Rs 4,00,000
OPEX	Rs 45,000 per month

Key highlights

- Since the alternative method in practice to leaf litter composting was the burning of leaves, leaf litter composting helps reduce the open burning of leaves. Leaf when composted can give high quality manure that can be used in agricultural practices. Coarser compost can be used for landscaping and horticultural practices.

Collection Process

Step 1: Roads in the neighbourhood/ ward are swept by sweepers/ Pourakarmikas

Shredding of Cocounut at Coconut Waste Processing Plant

Kalyani for Ganesh Immersion

Ganesh Idols for Immersion

(PKs)
Step 2: Each sweeper transfers the litter into the Jumbo bag, which is then left alongside the road
Step 3: The Jumbo bags are then picked up by an Autotipper, to be taken to the LLPU

Processing at LLPU

Step 1: Segregation of input material – recyclables (paper/ plastic kept in separate bin)
Step 2: Sieving of segregated material to remove smaller size material which need not be shredded
Step 3: Identified coarser size materials shredded and subjected to natural aerobic composting with the help of simple additives such as water and cow dung for about 15 days.
Step 4: After 15 days, material which now has started to become coarse compost, is turned again. The final compost is then sieved through the sieving machine to get coarse and fine compost.

The fine compost is used as manure for gardening and agriculture. This compost has been branded under the name of Kora3B Compost.

Coconut Waste Processing Unit, Freedom Park

Tender coconut shell is the toughest and heaviest single item among the biodegradable waste the BBMP collects every day. It takes long to decompose and poses a challenge to vehicles as well as pedestrians, if not collected from the streets or the sidewalks. Coconut Waste Processing Unit (CWPU) receives coconut and sugarcane waste. The agency (CIPL Resurge Private Limited) has independently geo-tagged coconut vendors and is currently collecting over 36 MT per day from major transportation hubs such as City Railway Station, Kempegowda Bus Station, and commercial areas such as City Market, Majestic, Chikpet, Binnypet, and Cottonpet. Under the arrangement, the BBMP has given on lease the land for three years behind

Facility highlights of Coconut Waste Processing Unit	
Area of the facility	750 (in sq. m.)
Processing Capacity of the facility	36 MT per day
Quantity of input	36 MT per day
Quantity of output	18 MT per day
Products obtained	Fibrous Material and Briquettes

CAPEX	Rs. 70,00,000
OPEX	Rs. 2,40,000 per month
Manpower	8

Key highlights

- Effective way of managing coconut waste and production of alternative fuel for energy generation at factories.

Freedom Park, where huge mounds of discarded shells can be seen around the plant shed.

If stuff is fed into the compactor which turns them into cylindrical briquettes of 90 millimeter (mm) diameter each. Shredding yields both fibrous material and sawdust. The fibrous material can be separated and sent to coir industries. The residual sawdust is fed into the briquetting machines which produces solid, black coloured briquettes.

Dry Waste Collection Centre at Ward No 168, Pattabiramana Nagar

The DWCC at Ward no 168 Pattabiraman Nagar is operated by Mansoor, a trained entrepreneur by Hasirudala for managing the dry waste in the ward. The built area of the DWCC is 320 sq. m and can manage waste upto 4 MT on daily basis. The estimated dry waste generation and collection in the ward is 1.5 MT per day but the DWCC receives around 300 – 350 kg of dry waste from the BBMP waste collection vehicles every day. Apart from the households, additional 150-200 kg of dry waste is received from bulk generators. Dry waste received is mixed with around 60-70% plastics (high+low value), 10% metals and glass, 10% paper and 10% is reject material. The DWCC does not take thermocol and e-waste. Through established contacts, the accumulated dry waste (plastic, metal, glass and paper) is sold to large aggregators in Jolly Mohalla and the tetra packs are sold to Samarthanam Trust. The kurkure covers and laminates of packaged food is sold off to KK Plastics. The centre is managed by 4 people for sorting and segregating. The workers in the plant are paid Rs 350 on daily basis for managing the DWCC.

On a similar model 164 DWCC are operational in the city to manage the dry waste in a decentralized manner.

Zero Waste Community, HSR Layout

The HSR Layout consists of 28,000 households and generates 65 MT of waste per day. The segregation level in the society is nearly 100% due to involvement of active members of the Resident Welfare Association who take firm steps for ensuring segregation in the neighborhood. The waste is segregated as wet (organic), dry (recyclables, low/ no value inert waste), sanitary waste. E-waste is collected separately. The

Key highlights

- Rental agreements with the tenants has a clause on waste segregation. If any new tenant is not segregating the waste, the landlord is immediately informed to act.

Dry Waste Collection Centre


Yelankha Group Awareness Campaign


Leaf Litter Processing Unit

Organic Waste Converter Plant


Leaf Litter Composting Tank


Coconut Waste Processing Unit

rental agreements with the tenants have a clause on waste segregation. If any new tenant is not segregating the waste, the landlord is immediately informed to persuade the tenant to do so.

The sanitation workers collect the wet and sanitary waste separately for 5 days a week, whereas dry waste is collected twice weekly. The wet waste is taken to transfer point, from there it is transferred to the compactor and sent to Karnataka Compost Development Corporation (KCDC). The dry waste is sent to the ward level Dry Waste Collection Centre (DWCC), where it is sorted, aggregated and sold off to the recycling industry.

The residents feel that their wet waste should not go out of the ward. Majority of the households in the neighbourhood practice home-composting or go for the lane composting. Each lane has 2 lane composters which take around 500 kg of kitchen waste. The sanitation workers collect wet waste from the households. They fill the lane composter with the given wet waste and waste management committees supervise the composters.

The e-waste is collected separately by 'Saahas'. The vehicle for e-waste collection comes once a month. The message of its arrival is sent to all residents via WhatsApp group. Whosoever has e-waste can give it at the e-waste collection vehicle.

Festival Waste Management, Yelahanka Zone

A group of volunteers in Yelahanka go around schools, colleges and households to spread awareness during the series of festival throughout the year and call themselves as Yelahanka Eco Group. The initiative of Yelahanka Eco Group in managing festival waste started in 2015. They have been advising and promoting that for the household Ganesha idol, immersion at the house is better so that lakes remain non-polluted. To ensure that lakes remain clean they advise the removal of all the garlands and decorations like flowers and puja material, which could later on be sent for composting at the OWC Centre or for recycling through the DWCC. Kalayanis, which are non-movable tanks have been constructed at the corner of the lakes, at the edge of major lakes such as Ulsoor Lake, Sankey Tank, Hebbal Lake, etc. so that the main lake is not disturbed and idols are immersed separately. If the idols are large, they are immersed in water tanks which are portable. For Bakri-Eid too, extensive awareness campaigns are conducted. Volunteers go around and talk to the concerned people. A tractor is placed at one point in the area (especially near mosques), where all the collected animal waste is dumped. A pit is dug and after the festival the tractor with animal waste is brought to the pit/s where the animal waste is buried in the pit.

There is no capital expenditure involved in volunteer activities carried out are for limited days only. Operating and Management expenditure is borne by the BBMP directly or indirectly. For Ganesha Festival, Karnataka State Pollution Control Board (KSPCB) also contributes in terms of deploying vehicles at specific wards.

Key highlights

- 164 Dry Waste Collection centres (DWCCs) to manage dry waste
- Ward Level Composting and Biomethanation, Leaf Shredder facilities with the goal of minimizing long distance secondary transportation
- Issue of ID cards to 7500 Waste Pickers and further integrating them into SWM by entering into a direct MOU with them for operation of the DWCCs
- To create a Ward Micro Plan and to have the Ward Committees prepare the ward level plan for SWM facilities

Recommendation

The city has moved forward on managing waste according to the waste streams. The city has even focused on managing the festival waste in an effective manner. As the population growth of the city is rising at rapid pace, more focus of the city should be towards defining a timeline and framework to achieve source segregation. The city should promote zero waste colonies and work towards replicating the model in other parts of the city. Home Composting should be promoted to reduce the cost of infrastructure development on Solid Waste Management by the municipal body.

To Know More

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Dry Waste Collection Centre
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Coimbatore

City Municipal Corporation

State: **Tamil Nadu**

Area (in sq. km): **246.80**

Number of Wards: **100**

Population: **10,50,721**

Waste Generated in Metric Tons (MT) per day: **990**

Vermicomposting plant at Vellalore

Solid Waste Management in Coimbatore City is a function of the Health Department of Coimbatore Municipal Corporation. The city is divided into five administrative zones – East, West, North, South and Central, each further subdivided into 20 wards. There is 100% source segregation of waste in the city. The total Municipal Solid waste (MSW) generated in the city is 990 MT per day of which 790 MT per day of waste is processed and the remaining 200 MT of waste is being disposed off at the sanitary landfill at Vellalore.

Door to door collection of segregated solid waste is done by 287 pushcarts. Road sweeping and mopping is carried out with 12 road sweeping flipper machines. There are about 100 containers each of 2 MT capacity, which are placed at important locations in the town. 36 private tractors are being used for collection of waste from the bins. About 288 MT of waste is being collected and disposed off at the secondary collection points by these tractors.

There are 4 Transfer Stations in the city at Peelaimedu, Ondipudur, Sathy Road, Ukkadam. Hook Loaders are used for secondary transportation of waste from transfer station to the compost yard or landfill site.

Vermicomposting plant at Vellalore

The vermicompost plant at Vellalore was established in 2016 by the Coimbatore City Municipal Corporation (CCMC) at an estimated cost of Rs. 50 lakhs. 100 MT of segregated waste is processed and converted into compost at this site. The incoming waste is shredded and transferred to the windrows' platform. The temperature and moisture levels of the windrows are maintained at 50 – 55°C and 40 - 45% respectively. The mass is aerated at least twice in the two week duration on these windrows.

The partly digested mass gradually turns greenish in colour after which it is transferred to the pre-constructed vermi beds. These beds contain 4 - 5% by weight of worms and the temperature of the beds is maintained around 25°C by sprinkling water regularly and using gunny bags for cooling. The completely digested compost reduces to 25% of its volume which is dark brown in colour. It is then tested in the lab and sent for packaging.

Facility highlights of Vermicomposting plant	
Area of the facility	80,000 sq.m.
Processing Capacity of the facility	100 MT per day
Quantity of input	100 MT per day
Products obtained	Compost
Quantity of Compost obtained	25 MT per day

Biogas Plant at Amma Unavagam premises, North Zone

Amma Unavagam is a food subsidization programme run by the Government of Tamil Nadu. Under the scheme, all Municipal Corporations of the state run canteens serving subsidized food at low prices. The Coimbatore City Municipal Corporation (CCMC) generates 50 MT of waste from large community kitchens, hotels and markets. Instead of disposal at Vellalore dumpsite, the CCMC generates biogas for cooking purpose, from this waste.

The CCMC has installed a biogas plant at Amma Unavagam premises at Chitra Nagar, Saravanampatty of the North Zone. Vegetable waste, cooked and uncooked food waste from the hotels and restaurants in and around Saravanampatty including the Amma Unavagam are used to generate biogas through anaerobic digestion. Initially, 21 kg of LPG gas was consumed per day which amounted to a daily expenditure of Rs.1500 resulting in a total expenditure of Rs.45,000 per month.

Facility highlights of Bio gas plant	
Capacity of the facility	25 cu.m. per day
Quantity of Input	50 MT per day
CAPEX	Rs. 10 lakhs
OPEX	NA
Product obtained	Biogas
Quantity of biogas generated	25 cu. m
Revenue Generated (if any)	Rs. 1500 per day in terms of savings
Manpower	2

About 27 LPG cylinders (each weighing 19 kg) were utilized for cooking purpose in a month. After installation of this bio-gas plant, the utilization of LPG cylinders has been reduced to 1 per three months. Waste is collected by the waste collectors of CCMC which is then fed into the mixer for slurry preparation. Water is mixed in the ratio 1:1 before putting it into the pre-digester tank. The slurry is stored in an elliptical digester tank. It takes about two to four weeks to digest the waste depending on the temperature. Thereafter gas is produced and sent out through the gas outlet at the top of the plant. This gas burns with a blue flame and is being used for cooking. The gas is routed through the smaller pipes to 2 stoves and 2 idli cookers.

Key highlights

- Amma Unavagams all over the city are currently estimated to feed about 20 % of the city's Below the Poverty (BPL) population on a daily basis.
- The outcome of the scheme is not only limited to mitigating food insecurity but also to creating livelihood security for destitute women thus enabling inclusion of marginalized slum dwellers into formal employment.

Gasifier Crematorium at Najundapuram Area

The Coimbatore City Municipal Corporation (CCMC) converted the then existing Biomass Gasifier Crematorium as LPG run gasifier crematorium in 2010 for cremation purposes. The Municipal Corporation Council evinced keen interest to Operate and Maintain (O&M) the above mentioned Gasifier Crematorium (Kayantha Sthanam Cremation Services) through PPP mode by entrusting the work to Isha Foundation, a Non-profit and spiritual organization located in Coimbatore.

Facility highlights of Gasifier Crematorium	
Capacity of the facility	5 MT per day
Quantity of Input	1.36 MT per day
CAPEX	Rs. 48 lakhs
OPEX	Rs. 30,000 per month
Product obtained	Biogas
Quantity of biogas generated	100 cu. m. per day
Revenue Generated (if any)	Rs. 62,000 per month on an average in terms of savings

Initially, the operator used to consume about 4 commercial LPG cylinders (19 kg each) for cremation of an average of 5 dead bodies a day. This amounted to a daily expenditure of Rs. 4,180. Thus, about 120 LPG cylinders was consumed on a monthly basis on an average. However, the operator collected only Rs.1750 for a single cremation from the public. In order to bring down the cost, the CCMC initiated an innovative project in 2015 by installing a kitchen waste based biogas plant of 100 cu. m capacity in the crematorium premises. Kitchen waste amounting to 1.36 MT per day is collected daily from the households, hotels and restaurants in and around the Nanjundapuram area and processed in this plant. The food waste collected from the households and hotels are pulverized and transferred into the feeding tank. Adequate water is mixed with this material. The pulverized food wastes are then fed into the digester by means of a feed pump where digestion takes place.

The gas produced is then passed through the scrubbers in which the hydrogen sulphide is removed. The biogas generated after purification is stored in a balloon made of polypropylene. The purified methane gas produced in the biogas plant is charged into the crematorium's burner as fuel along with the regular LPG cylinders and used for cremation.

Key highlights

- After installation of the Biogas plant, the usage of LPG cylinders has been reduced to 60 cylinders per month at the rate of 2 cylinders per day thereby reducing the cost to Rs.2,090/- per day.
- The plant does not release any foul odour and the water released from the plant is let out into the existing underground sewerage system.

(Top) the bio-gas plant at Amma Unavagam,
(Bottom) the gas produced being used in Kitchen

Biogas Plant at Najundapuram crematorium

Recommendation

Coimbatore is a class I city that has been successful in carrying out 100% collection and source segregation within the city. Innovative and context-specific initiatives such as using wet waste generated in the city as a source of generating biogas for Najundapuram crematorium and the Amma Unavagam scheme that takes into account livelihood generation of marginalized population, in addition from solid waste management are commendable steps taken by the Corporation. The Corporation has taken efforts towards handling waste in a decentralized manner under which it has set up zonal level waste collection and segregation centres and undertakes decentralised composting within the zone to minimise waste being transported outside the zone. It is popularly known as “Sunya Project” that has already been implemented in ward no. 23 of the city. Owing to the successful implementation of the project, it may be suggested that towns having similar population that are struggling to manage their waste may opt for such a decentralized initiatives in pilot form for specific wards or colonies.

To Know More

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Coimbatore - 641 005
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Madurai

City Municipal Corporation

State: **Tamil Nadu**

Area (in sq. km): **147.99**

Number of Wards: **100**

Population: **10,17,865**

Waste Generated in Metric Tons (MT) per day: **680**

Compost produced at the Compost yard

The Public Health department of the Madurai City Municipal Corporation (MCMC), headed by City Health Officer and Assistant Health Officer is responsible for the solid waste management in the city. For the efficient administration and for day-to-day operational purposes, the city is divided into 4 zones covering all the 100 municipal wards.

The primary collection of waste in Madurai corporation is done by sanitary workers, contractual labourers and SHG's. The collection of waste from bus stands and other commercial areas is privatized. Moreover, the corporation also engages contract workers for garbage loading on the transportation vehicles. The primary collection and transportation of waste to the collection points is done using tricycles (carrying capacity – 20 kg/Tricycle), hand carts (carrying capacity – 100 kg/hand cart) and auto minders. Transfer of garbage from collection points to corporation's compost yard at Vellakkal is done using open vehicles like lorries and tractors.

Solid Waste profile of the city	
Total quantity of solid waste generated per day(MT)	680 MT
Composting	380 MT
Recycling	60 MT
Total Quantity of waste scientifically processed (MT)	440 MT
Total Quantity of waste sent to the dump site	240 MT

The city has achieved 100% door to door collection in all wards. While the MCMC claims 100% source segregation in all 100 wards, unsegregated waste is still received at the corporation's solid waste management facility at Vellakkal. The facility comprising a composting facility, a sanitary landfill and a dump site is located at about 10 km from the city and spread across an area of 82 acres. The plant was set up in 2010 through a PPP model between Madurai Corporation and SPML Infra Ltd. The facility was sanctioned at a cost of Rs. 57 crores, under the JnNURM programme. Of the 680 MT of waste generated per day in the city, 420 MT is processed using processes like composting and recycling at the facility. The remaining 240 MT of waste is dumped into the dump site. Construction waste in the form of debris and wet silts from drains are used as covering material.

Waste Segregation at Composting facility

The unsegregated waste received at the facility is first segregated into wet and dry waste both manually and through trommels. The wet waste is processed to make compost while the dry waste is further segregated into reusables and inert items. The reusables are sold to the recyclers. The inert waste obtained through segregation and rejects after composting (higher size biodegradable wastes) is disposed in the sanitary landfill spread across an area of 24 acres within the facility.

Micro Composting Centre at Central Market

The Central vegetable market is situated in Ward 44 of Madurai City Municipal Corporation. 6-7 MT of bio degradable waste is collected on a daily basis from 1000-1200 shops in the market. Micro Composting Centre was set up by the corporation to facilitate decentralized processing of the organic waste collected from the market. The facility comprises waste receiving platform, secondary segregation arrangement with organic shredder, pits under steel trussed shed and storage room for manure packing.

Key Highlight

- So far approximately 2395 MT of manure has been produced in the facility, of which approximately 265 tons has been sold, generating a revenue of Rs. 9,14,849.

Facility highlight of Micro Composting Centre	
Area of facility (in acres)	2
CAPEX	Rs. 4 crore
OPEX	Rs. 2 lakhs per month
Manpower	8

The wet waste collected from the vegetable market is shredded and mixed with a mix of effective microbial solution, rice husk and rice bran. The mixture is then poured into the pits on a thin layer of cow dung or matured compost. Waste is filled in the various pits following a particular sequence. After 42 days, the matured manure is dried, sieved and packed for distribution from each pit one by one. The leachate collected during the process is utilized for adding moisture to the compost pit. The manure is distributed free of cost to the local farmers and general public. Regular monitoring is done to maintain high-quality operation.

Unsegregated waste is one of the prime challenges faced by the facility leading to inferior quality of compost. Management of odour is another challenge to be handled.

Also, the capacity of the shredder needs to be increased to handle the quantum of waste collected per day from the market.

Home Composting at Sathya Elite Apartments and housing society in Ellis Nagar

Decentralized composting is extensively promoted in Madurai to process the bio degradable waste at source and in return reduce the quantum of waste reaching the landfill. Similar approaches have been taken by various other housing societies and RWAs in Madurai. The manure obtained is used for gardening purposes.

Key Highlights

- The micro composting centre has not just reduced the quantum of waste sent to the central processing yard but has also helped in reducing the cost of transportation.

Waste Management at Meenakshi Temple

The world famous "Sree Meenakshi Sundareswarar" temple is located at the heart of the city. A floating population of over 10,000 to 25,000 (Pilgrims) visit the temple every day. The temple produces about 15 tonnes of waste during off seasons (May-July) which doubles during annual celebrations like Chithirai (April-May) and the Pongal festival (January). Temple authorities, Madurai Corporation and Exnora came together to discuss the best waste management techniques to process the waste generated in and around the temple area. The mission "Sunehra kal" was launched in 2017 in Madurai through which the biodegradable waste from the temple as well as the surrounding localities would be processed through composting. The project was funded by ITC Limited.

A composting unit was set up inside the public parking lot close to the temple across an area of 2000 square feet. The close proximity of the parking lot to the temple helped in eliminating the transportation cost.

The project initiated by training and motivating over 1000 households around the temple to practice waste segregation and kitchen waste composting, as an effective method to reduce waste at source. As a result, many households got into the practice of treating wet garbage at source while many others started giving segregated waste to the workers.

The bio degradable waste collected by the workers is brought to the composting unit at the public parking lot. The waste is then placed into the composting bins. Flower

Micro Composting Centre

Conveyer belt at the facility

Compost Pit

Organic Farming at the facility

Training conducted for the residents of the surrounding localities under Mission Sunehra Ka

Source: https://swachhindia.ndtv.com/waste-management-model-tamil-nadu-madurai-gives-organic-vegetables-23733/

Shredder at the Micro Composting Centre

Home Composting at housing society in Ellis Nagar

Composting Unit at the Public Parking lot

Source: https://swachhindia.ndtv.com/waste-management-model-tamil-nadu-madurai-gives-organic-vegetables-23733/

waste is placed in separate bins. Additives like microbes are added to hasten the composting process. The mixture is mixed at regular intervals using a shovel. It takes approximately 45 days to get fresh batches of manure. The newly produced manure is then layed out in a covered space for about two days to remove moisture. The mixture is then sifted and packed.

Approximately 600-700 kgs of wet waste including a variety of flowers, fruits and vegetables from the nearby households, restaurants and temple is collected and processed daily. About 200 kg of manure is obtained for every ton of waste. A trained team of eight people from Exnora handles the conversion process. The manure obtained is used in the temple gardens and also sold at Rs. 5/kg to the locals living around the temple.

While many hotels across the country have gone green and implemented various measures to conserve resources, Madurai has gone a step ahead. An Innovative Hotel Waste Recycling Project is being undertaken by Madurai Corporation and Madurai District Hotels Association. As many as 30 hotels have joined the initiative to utilize the waste generated by the hotels in manufacturing organic manure. The manure, in turn, is used to cultivate vegetables, organically, that are in turn used by the hotels.

Innovative recycling of waste by Hotel Temple City

An in situ 'Organic Enrichment Manure Factory with Organic Farming' has been set up by the corporation at Masthanpatti in 2016. Land for the facility is provided by the Madurai Corporation on lease. KT Greens India Private Limited, headed by K Thirupathi, is the company associated with the venture. Temple City Group of Hotels and Madurai Corporation split the costs and revenue 50-50.

Facility highlight of Waste recycling by Hotel Temple City	
Area of the facility	22258 sq. m (5.5 acres)
Processing Capacity	9.1 MT per day
CAPEX	Rs. 8.2 lakhs
Manpower	20
Products obtained	Manure, Organic Vegetables
Revenue Generated	Manure: Rs. 20 per Kg
	Organic seed packets: Rs. 20 per pack
	Organic Vegetables: Rs 60 per Kg

First the waste is collected from the hotels in a special fully closed van. As a part of the project, waste coconut water is also collected from hotels. Each hotel is charged approximately Rs 6000 per month for collection and transportation of waste. The collected waste is then further segregated to remove any plastic waste. After this, the waste is passed through the organic shredder. The shredded waste is then sent to a procession pit. A spray made from the coconut water is used to convert the shredded waste into organic manure.

This process takes nearly 20 to 22 days to convert waste into manure. The organic manure thus obtained is used to cultivate vegetables at the farm. The vegetables are grown using natural pesticides.

Currently the farm is growing various vegetables and fruits over an area of 2.50 acres. The produced organic vegetables are sold at discount rates to the partnering hotels. The organic vegetables are also sold to the public during all the seasons.

Key Highlights

- Potassium rich manure is obtained.
- The process is completely odourless.
- The dumpsite on which the composting facility is setup is currently being remediated by using compost produced from the biodegradable waste from hotels and organic farming is being carried out at the site.
- To ensure transparency, CCTV cameras have been fixed in the plant so that all the owners of the partnering hotels can witness the processes at the plant on their mobile phones.

Processing the organic waste at the composting unit

Source: https://swachhindia.ndtv.com/waste-management-model-tamil-nadu-madurai-gives-organic-vegetables-23733/

Bio-box technology at GRT Regency Hotel

Hotel GRT regency is a situated at Palankanatham area in Madurai. The hotel installed Bio Box facility in 2016, to handle the biodegradable waste such as kitchen waste, green plant waste, etc. generated at source.

Facility highlights of Bio-box technology at GRT Regency Hotel	
Processing Capacity	0.5 MT per day
Quantity of input	0.1 MT per day
Products obtained	Manure
Quantity of Manure obtained	10 kg per day
CAPEX	Rs. 7 lakhs
OPEX	Rs. 22,000/ month
Manpower	2

On adding organic waste to the Bio box, the humidity sensors turn on the heater and the composting tank gets heated. The water content in the organic waste gets vaporized and exits through the exhaust system, resulting in volume reduction and at the same time, the microorganisms decompose the organic waste into compost. The blades present in the system facilitates a uniform mixing of the waste. The organic

Key Highlights

- The Bio box machine is fully automated and noiseless during operation.
- No harmful emissions are produced during the operation of this machine.
- In case of overload, the machine automatically comes to a halt aiding in ease of operation.
- Due to its compact size, this plant can be setup in any part of the country even where the ambient temperatures dips low during the winter season.

Bio box Technology at GRT Regency Hotel

Gasifier Crematorium at Thathaneri

waste is converted into compost in just 24-36 hours. As the compost level reaches the mark inside the composting tank, the compost is removed up to the shaft level. It is necessary to maintain this level for future composting. The manure is then layed out in the adjoining covered shed for about two to three days and then packed. The compost is currently being used in the hotel garden.

The consumption of electricity during the process is pretty high leading to higher operational expenses.

Gasifier Crematorium at Thathaneri

The crematorium in Thathaneri is the largest in Madurai spread over in 17 acres. Wood was used in huge quantity for cremation, creating air pollution in the vicinity. MCMC came up with an initiative of gasifier crematorium in which, biogas generated from organic waste would be used for cremation. A biogas plant was established at Thathaneri in July 2018 on a PPP mode.

Facility highlights of Gasifier Crematorium at Thathaneri	
Area of the facility	144 sq. m
Capacity of the facility	600 cu.m
Waste Processed	1.8 MT per day
CAPEX	Rs. 50 lakhs
Products obtained	Biogas,Manure
Quantity of biogas generated	300 Cu.m per day

Vegetable waste is collected from nearby fish market and vegetable markets excluding the plastic and onion skin. Wet solid waste shredder is used to grind the waste from where it is routed to the agitator tank. In the agitator tank, the shredded solid waste is converted as slurry and fed to the digester. Inside the digester, the thermophilic microorganisms digest it and generate methane gas. The mix is fed to the anaerobic reactor to produce gas through an anaerobic digestion process. The gas produced is used for burning of corpses in the crematorium.

Key highlights

- The technology has helped reduce the consumption of wood for cremation and has also contributed in reducing the air pollution. Bio gas is an efficient alternative to wood.

Recommendation

Madurai city has achieved 100% door to door collection, but has managed to scientifically process only 64% (440 MT) of the waste generated per day in the city. Although the city claims to have achieved 100% source segregation, the huge quantity of unsegregated waste still received at the corporation's compost yard indicates that source segregation of waste is still a challenge. Due to unsegregated waste, the quality of compost and also the efficiency of plant is compromised. This results in huge quantities of unprocessed waste being sent to the dumpsite. It is thus recommended that the corporation should further focus on collecting segregated waste at source to further enhance the waste processing capacity and minimize the burden on the landfill.

To Know More

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Chennai

City Municipal Corporation

State: **Tamil Nadu**

Area (in sq. km): **426**

Number of Wards: **200**

Population: **46,46,732**

Waste Generated in Metric Tons (MT) per day: **5,400**

Khamba Composting

The Greater Chennai Corporation (GCC) is the civic body that governs the city of Chennai. The city is divided into 200 wards and 15 zones. Presently, the corporation is carrying out the solid waste management activities in 12 out of 15 zones and in the remaining 3 zones, the operations are privatized. Three different organizations namely the CoC, ONYX and CBOs such as Civic Exnora are involved. The estimated total waste generated per day in the city amounts to 5400 MT with 700 MT of construction and demolition waste. Of the 5400 MT, 68% waste comes from residential areas, 16% from the commercial, 14% from halls and 2% from the industrial areas.

Industrial Waste Management Association was formed on the directive of Tamil Nadu Pollution Control Board to establish facilities for the safe and scientific disposal of the solid wastes from industries as per the Hazardous Waste (Management and Handling) Rules and Environment Protection Act, 1986. IWMA was registered in 2002 and has facilitated the establishment and operation of a Common Hazardous Waste Treatment, Storage and Disposal Facility through a Service Provider for industries in Tamil Nadu.

The primary collection of solid waste is done using tricycles and roto-moulded wheeled bins by sanitary workers and contractual workers. The collected waste is deposited into compactor bins, placed at suitable intervals for easy access to the public as well as the waste collectors to transfer waste. The waste is then transported from these compactor bins to the Transfer stations. The GCC currently has 8 Transfer stations. From the transfer stations the waste is transported to the landfill sites for final disposal using fully covered heavy and light motor vehicles (HMV & LMV) and compactors. At present waste generated in the city is dumped at two land fill sites namely Kodungaiyur and Perungudi dump sites. Construction and demolition waste is being used for covering each layer of garbage in the two dump sites. For remediation of the existing Landfill or scientific closure and to have the integrated waste processing facilities with waste to energy plant as component at the existing Kodungaiyur and Perungudi dump sites. The Transaction Advisory Consultant have prepared DPR and sent for approval of the competent Authority and simultaneously the RFP documents are under preparation.

The Manali zone in the city comprising 19 wards has not only achieved 100% source segregation but is also processing 15 of the 55 ton of the solid waste generated in the zone into manure. The manure thus obtained is sold at a cost of Rs. 20/kg.

As per GCC, the city has achieved 100% door to door collection in all wards. This has been achieved only on introduction of tricycles which stands as a wonder tool for better collection of municipal solid waste at door steps. Now about 5400 tricycles are in use for reduction of dust bins on road side. Although the GCC has taken a lot of initiatives to promote segregation of waste through IEC activities and campaigns, source segregation is practiced in only 40 of the 200 wards.

Solid Waste Profile of The City			
Total Waste Generated in the city		5400 MT per day	
Total segregated waste collected		1050 MT per day	
Quantity of waste processed by Small Scale Waste Processing Units			
Processing Type	**No. of Plants**	**Waste processed per day in MT**	
Ordinary Composting	136	142.37	
Vermi-composting	2	3.20	
Biogas	23	8.94	
Bio-Electrical (BARC Technology)	5	11.50	
Dry Waste (Recyclables Sold)	-	38.3	
Total Waste Processed		204.31 MT/day	
Quantity of waste disposed at the dump site			
Dump Site	**Area**	**No. of years in use**	**Daily waste deposited**
Kodungaiyur Dump Site	269 acres	More than 35 years	2600-2800 MT
Perungudi Dump Site	200 acres	More than 30 years	2400-2600 MT

Decentralized small scale units such as waste to energy plants, composting yards and resource recovery centres are set up in all wards to promote waste processing at source and also reduce the quantum of waste sent to the dumpsite. The collected biodegradable waste is processed in the compost yard or vermi-composting centres, where it is converted into manure. For processing the bio-degradable waste and obtain manure through composting, various techniques are used in different divisions. For instance, Earth pit method of composting is adopted in division 20 at Mullai garden and well ring method of composting is adopted in division 15 at Eachankuzhi Burial ground. Similarly, vermi composting is also adopted in other wards. The compost thus obtained from these small scale units is utilized in the Greater Chennai Corporation parks. Small quantum of the compost is also sold to the public at nominal cost.

The non-biodegradable waste is brought to the resource recovery centres where it is further segregated into different categories and sold to the recyclers. The recyclables like thin plastics are shredded and made use of in plastic mixed bitumen road laying.

The rest of the waste is finally sent to landfills at Kodungaiyur and Perungudi. The composting facility and resource recovery centres in the various zones are managed by the sanitary workers.

In addition to the compost yards and resource recovery centres, Waste to energy plants are set up at locations where huge quantities of bio degradable waste are generated daily. The produced bio gas is then utilized at various Amma Unavagam centres.

Description	Kasturibai Gandhi Hospital (Division 114)	K.B. Dasan Road (Division 122)
Capacity of Plant	1MT	1 MT
Gas produced per day	10 Kg per day	16 Kg per day
Place of use	Amma Unavagam at KG Hospital	Amma Unavagam at K.B. Dasan road

The Koyambedu Market Biogas Project

The Bulk waste generators in the city are also taking responsibilities for segregating and managing their waste at source in partnership with local authorities and other organizations.

The Koyambedu Wholesale Market Complex, spread over an area of 60 acres generates approximately 90 MT of waste per day. A Bio-methanation Plant was established by Chennai Metropolitan Development Authority (CMDA) and the Ministry of Non-Conventional Energy Sources (MNES), Government of India in the market to utilize the organic waste for generating power. The plant was commissioned late in 2005. The plant makes use of 27 MT of bio-degradable waste from the market complex every day to generate an average 2000 units (8hrsx250kw) of electricity per day. After in house consumption, excess production is fed into the TNEB grid. Land of 1.16 acres was allocated by CMDA for this project.

Facility highlights of biogas plant at Koyambedu market	
Capacity of the Plant	27 MT per day
Quantity of Input	27 MT per day
CAPEX	Rs. 5 crore
Products obtained	Electricity, Manure
Power generated in kilowatt (kW) per hour	250 Kw per hour
Quantity of Manure obtained	9 MT per day
Manpower	10

Key highlights

- As much as Rs 13,00,000 to Rs.20,00,000 expenses per year have been saved which was otherwise wasted on fuel for transporting the waste to the Kodungaiyur dumping ground.

The total construction cost of this project was borne by the Ministry of Non-Conventional Energy Sources (MNES) of Government of India and by Market Management Committee.

Biocomposter at the Kapaleeswarar Temple

Fuel Briquette, Project Avthar

Manure obtained from Vermi composting, Project Avthar

Various Upcycled products, Project Avthar

The Upcycling Process, Project Avthar

The Upcycling Process, Project Avthar

Green Temple Initiative at Kapaleeswarar Temple, Mylapore

Facility highlights of Kapaleeswarar Temple	
Number of plants	2
Total quantity of input	400 kgper day
Total Quantity of biogas generated	12 cu. m. per day
CAPEX	Rs. 26.8 lakhs
Monthly Savings	Rs. 8,327

Exnora Green Pammal (EGP), a non-government organization along with ITC Limited started with the Green Temple initiative. The Green Temple initiative is a closed loop waste management model to process temple waste into usable products such as biogas and compost that can be consumed within the temple premises. In 2016-17, the first Green Temple programme was launched in Kapaleeswarar Temple in Mylapore.

The baseline assessment of the temple waste highlighted the presence of a cowshed generating 400 kg of cow dung daily, besides biodegradable waste (flowers, leaves, sweets, coconuts, garlands, millets etc.) generated as part of offerings by devotees amounting to 100 kg/day. The temple also has a kitchen and canteen where food is cooked and served to devotees daily.

Under the initiative, two biogas plants each with a capacity to generate 6 cubic metres of biogas per day was installed along with its accessory like Gas balloon chamber, pipe line to kitchen, complete set of booster to regulate gas flow, flame arrester, moisture trap and fire extinguisher.

Additionally, a bio-composter, with a capacity of 250 Kg/day, was installed adjacent to the temple wall to process other organic wastes like flowers, fruits, kitchen waste and dry leaves. The slurry from the biogas unit is mixed with the organic waste collected from the temple for composting. The compost generated is used as organic fertilizer for plants in the temple garden. Surplus compost is sold to devotees and the general public through the temple committee/association, thereby generating revenue.

Key highlights

- Before this initiative, all the temple waste was sent to landfills without any treatment. Post intervention, during 2017-18, more than 97% of the temple waste was scientifically and sustainably managed within the temple premises by converting it into resources like biogas and compost.
- With the significant positive outcomes of the Kapaleeswarar model, EGP has rolled out the Green Temple Model to Anantha Padmanabha Swamy temple with the assistance of ITC Limited. 97% temple waste is sustainably managed within the temple premise of Anantha Padmanabha Swamy temple.
- During the project period from April 2017 to March 2018, about 44 MT of cow dung has been utilized in the plants to generate approximately 3102 cu.m. of bio gas. Savings of Rs. 1,37,590 were made by utilizing biogas instead of LPG cylinders. In addition, about 23 MT of waste has been utilized to make approximately 5712 MT compost generating a revenue of Rs. 97,580.

Project Avthar by Exnora Green Pammal

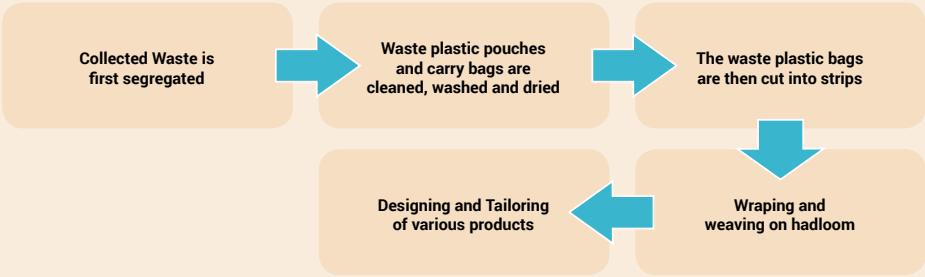
Besides the Green Temple Initiative, Exnora Green Pammal (EGP) has taken a lot of initiative to process waste at source and in turn reduce the quantum of waste reaching the landfill. The organization promotes feasible clean technology solutions like Bio-gas production for domestic applications and vermi-composting to process the wet organic waste. In addition, dry organic wastes, such as coconut leaves, which have a good calorific value and burn in a much cleaner fashion than other biomass wastes and could also be used in industrial boilers are being turned into fuel briquettes.

Key highlights

- No power is used to create these upcycled products.
- This initiative has helped provide employment opportunities to the underprivileged as well as has helped in reviving the handloom industry.

EGP strongly believes in finding a positive use for each waste stream, and works on resource recovery coupled with simple technology and innovations and gives back the society as recycled, upcycled and reusable products. Project Avthar, is one such initiative of the organization where the collected waste plastic pouches and carry bags are upcycled into a wide range of products for office, personal and household utilities. At first, the collected waste plastic pouches and carry bags are washed, cleaned and dried. Then the plastic pouches are cut into strips. The thin plastic strips are then woven on handlooms to make the upcycled products.

The Upcycling Process

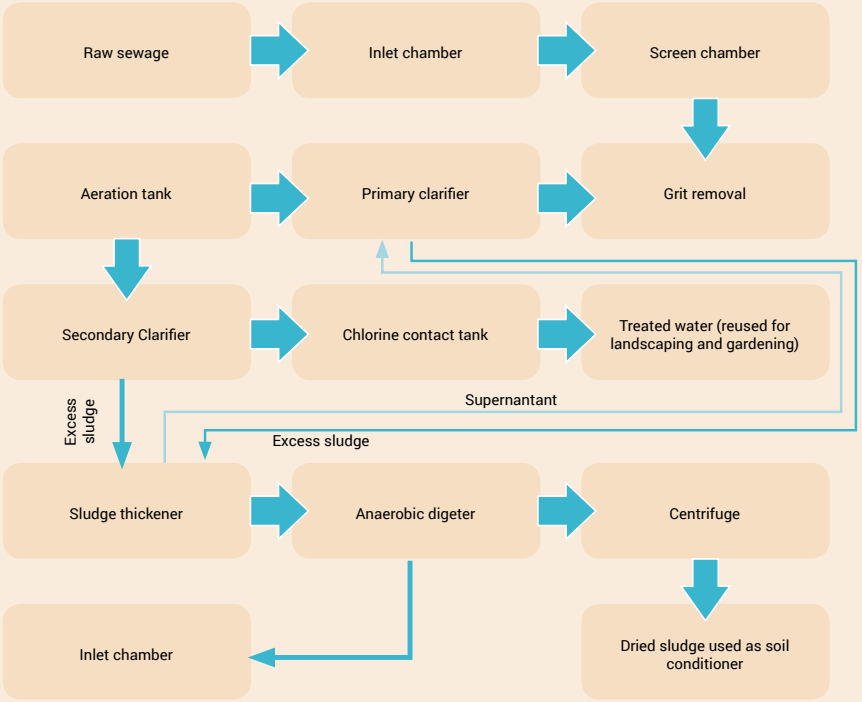


Sewage Treatment Plant at Nessapakkam

Facility highlight of Sewage Treatment Plant at Nessapakkam	
Area of the facility	45 acres
Capacity of the facility	95-100 MLD
STP Operational Since	1974
Co-Treatment Operational since	2006
CAPEX	Rs 2 crore
OPEX (O&M of the plant with Co-Treatment) (monthly)	Rs 41.60 lakhs

The wastewater system for the City has been divided into five drainage zones- Kodungaiyur (Zone I & II), Koyambedu(Zone III), Nesapakkam(Zone IV) and Perungudi (Zone V). These zones of macro systems covering the entire city have independent zonal collections, conveyance, treatment and disposal facilities. At present, there are a total 12 Sewage treatment plants functional in the city with the total treatment capacity of 727 MLD.

Four among these twelve STPs were constructed under the Chennai City River Conservation Project (C.C.R.C.P) during 2005 and 2006, at Kodungaiyur, Koyambedu, Nesapakkam and Perungudi. In these new STPs new technology for sludge treatment and generation of power using bio-gas were adopted which significantly reduced the electricity import from the state electricity grid. The main driver for initiating the co-treatment was to put an end to the practice of unauthorized dumping of septage into the city's waterways by private operators. At present, co-treatment is being undertaken at three locations namely, Nesapakkam, Perungudi and Kodungaiyur.



Schematic Treatment Process, Nesapakkam STP

At present the city has 5 decanting facilities, 3 co-located at STP (Kodungaiyur, Nesapakkam and Perungudi) and 2 are at Sewage Pumping Stations connected to Koyambedu STP.

The wastewater generated in Zone IV is conveyed to the treatment plant at Nesapakkam, located at Jafferkhanpet. The original technology installed in the system was Activated Sludge process. The treatment units for the process included inlet chamber, screening chamber, detritus tank for degriting, primary clarifiers, aeration tanks, secondary clarifiers, primary and secondary digesters, sludge drying beds and balancing tank.

Currently, the design capacity of the STP is 117 MLD and the sewage flow inflow is approximately 100 MLD. The STP started receiving Faecal sludge since 2006. A decanting station has also been added for the co-treatment process in the facility. The decanting station allows desludging trucks to discharge septage loads. This is in line with the recommendations of the "Operative Guidelines for Septage Management for Urban and Rural Local Bodies" issued by GoTN.

The decanting station comprises a covered receiving tank followed by grit removal chamber and screens. The receiving tank is covered and connected to an odour control air scrubbing unit. Septage from the receiving tank flows into the trunk sewer line passing outside the decanting facility and flows into the terminal sewage pumping station feeding into the STP.

Currently the number of trucks registered with the STP are 52, making approximately 200 trips per day. The private desludging trucks are charged a one-time registration fee of Rs. 2000 per truck. A tipping fee of Rs. 100 is charged per trip for disposal of septage at the STP. The trucks are allowed access to the STP only after showing the payment receipt.

Type of Charge	Frequency	Rate	Annual Collections (Approximate)
Registration	One-time payment	Rs. 2000	Rs. 1,04,000
User Fee	Per trip payment made in advance	Rs. 100 per trip	Rs. 60,00,000

Source: https://www.cseindia.org/nesapakkam-stp-chennai-8642

Domestic Biogas Plant, Project Avthar

The Upcycling Process, Project Avthar

The Upcycling Process, Project Avthar

Biogas engine for power generation, Nessapakkam STP

Receiving Tank- Decanting Station
Source: https://www.cseindia.org/nesapak-kam-stp-chennai-8642

Biomethanation Plant for Power Generation in Koyambedu Vegetable Market

As a sustainable solution to confront the ever rising energy costs and to combat the environmentally damaging Green House Gases, the Bio-Gas generated from the sewage sludge is being used as fuel for generation of electric power. All the four new STPs are generating power using Methane content of the Bio-Gas and are self-supporting without any need for additional power from the electricity grid. Bio-gas is a by-product of anaerobic digestion of sludge. Normally Bio-gas is composed of 60% to 65% Methane and 25 to 30% Carbon-dioxide with a trace amount of other gases. Methane has energy value but is also one of the greenhouse gases responsible for global warming. The bio-gas is a resource, converted to Non-Conventional Energy (Green Power), after the purification process.

The following table provides a comparative details of power production in the four STPs.

Non-Conventional Energy Production (Green Power) in 4 STPs

Location of STP	Capacity (MLD)	Capacity of Gas Engine (KW)	Power Production per month (KWh)	Cost Savings per month @ Rs. 350 per KWh
Kodungaiyur (Zone- I&II)	110	1064	4,50,000	Rs. 15.75 Lakhs
Koyambedu (Zone –III)	60	625	2,25,000	Rs. 7.90 Lakhs
Nesapakkam (Zone –IV)	40	469	1,50,000	Rs. 5.25 Lakhs
Perungudi (Zone- V)	54	1064	3,60,000	Rs. 12.60 Lakhs
Total	264	3222	11,85,000	Rs 41.50 Lakhs

Source: https://chennaimetrowater.tn.gov.in/pdf/stp.pdf

Recommendation

Although the city has achieved 100% door to door collection and is promoting decentralized waste processing practices, lack of source segregation is still a major challenge. Focus has to be laid on collecting segregated waste at source. If effective source segregation and recycling methods are followed at individual residential units, the garbage flow to the dump yards will go down drastically. Besides reducing the quantum of waste reaching the dumpsite, steps should be taken to upgrade the dump sites into sanitary landfills.

To Know More

Greater Chennai Corporation
Website: http://www.chennaicorporation.gov.in/index.htm
Contact: 25619501/502

Exnora Green Pammal
Website: http://www.greenpammal.in/
Contact: 044 2248 5955

Nashik
Municipal Corporation

State: **Maharashtra**

Area (in sq. km): **259**

Number of Wards: **108**

Population: **14,86,053**

Waste Generated in Metric Tons (MT) per day: **550**

Sewage Treatment Plant

Nashik is a holy city in the northwest region of India. Currently, the city generates 550 MT of waste per day from 108 wards. Door to door waste collection system in Nashik is operational since 1996 through 'Ghanta Gadi' concept. Six private agencies under PPP mode are carrying out collection and transportation of waste from all wards. In this management, approximately 206 Ghanta Gadi's, 50 other vehicles and 620 workers are deployed. All the vehicles are equipped with GPS for monitoring and tracking of routes. Also, separate vehicles for waste collection from hotels, gardens, and construction and demolition sites have been deployed. All the waste of the city is processed in the integrated solid management facility at Pathardi, Gaulane Road which is 15 km from the city. Waste segregation is absent in the city. NMC has conducted extensive IEC campaigns to create awareness among citizens on waste segregation and bulk generators are informed to manage their wet waste within premises.

Integrated Solid Waste Management Facility at Khat Prakalp

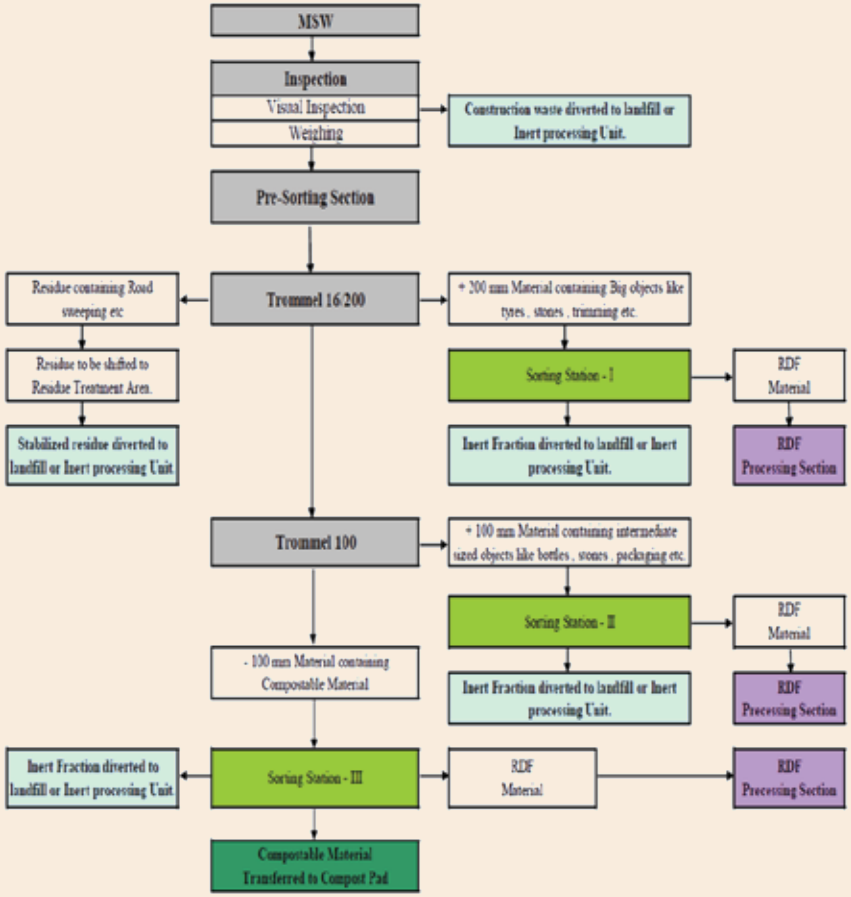
The total capacity of ISWM is 600 MT with an area of 82 acres. In order to have smooth operations and efficient management of waste at the facility, NMC signed a contract with Pune based agency, Mailhem Ikos Environment Pvt. Ltd. on Design, Finance, Build, Operate and Transfer (DFBOT) basis for 30 years in 2017. The company is registered as Nashik Waste Management Pvt. Ltd. and has got the contract for operating the ISWM facility. As per the contract terms and conditions the company is taking care of repair, upgradation and operation of compost and RDF plant, Leachate treatment plant, Plastic to fuel plant, Carcass incinerator, capping of dump site and setting up of new scientific landfill.

Online vehicle tracking system

Online monitoring of vehicle and weighing systems

The RFID and GPS tracking system helps in recording the weight of the vehicle with and without waste, which is captured digitally through SCADA system. There are two weighing bridges which are fully synchronized, and each has the capacity range of 25 MT. Every day the waste is coming from 7 am to 6.30 pm by 256 vehicles in 2 shifts. The total cost of equipment including 3 years O&M for two weighing bridges was Rs. 25 lakhs. The annual maintenance cost is approximately Rs. 50,000.

Process flow chart of Composting plant



Compost plant

The compost in this unit is prepared by Windrow method Aerobic composting. In this method there are three stages of treatment is involved – Presorting, Composting and Mechanical composting. After applying the necessary quantity of microbial inoculant slurry preparation along with sufficient moisture, windrows are formed to facilitate composting. The width at the bottom of the windrow is 3-4 meter and height is up to 2 meter. The moisture content of the windrows is maintained as 45-55%. Once in every week the windrows are turned and mixed thoroughly to homogenize the material using excavators.

After three turnings during a period of three weeks, the partially composted garbage is then subjected to mechanical processing. The mechanical processing system consists of different types of automated trommel screens with sieve sizes of 35 mm and 16 mm, in which majority of the inorganic and inert materials get removed and the sieved organic materials below 16 mm size is kept for curing process. Later the compost is refined through trommel screen followed by gravity separators. In these stages materials above 4 mm size, sand, silt etc. are removed. The remaining powdery compost is then stored in batches for quality check.

The plant prepares 50 MT of compost per day which is being sold in the market at Rs 3 per kg.

RDF plant

The incoming waste is put on a large primary crushing system to bring waste to a particle size (50-100 mm) in order to homogenize the mass for better handling as well for faster drying. Before putting the waste into the crushing system, manual sorting of large pieces of stones, tyres, etc. are done on a sorting belt conveyor. A magnetic separation unit is also attached to the sorting conveyor to remove ferrous particles. Waste coming out of the Primary Crushing System is spread over a paved yard. Then the waste is dried in a hot-air rotary drying system to reduce its moisture content to 15%. The hot air is generated in a fixed grate specially designed Hot Air Generator (HAG) where woody biomass extracted from waste is burnt. The heavy non-combustible fractions of waste like stones, glass etc. are separated by passing through the specially developed air classifier in which the light combustibles and heavy combustibles materials are separated like wood, cloth, etc. for firing in the hot air generator. The dried and segregated waste is further grounded to produce Fuel Fluff.

The fuel fluff is sent to the densification unit to make fuel pellets. Then both fuel fluff and pellets are directly sold in the market. This fuel fluff is prepared into different categories based on its calorific value (CV).

Conveyor belt of compost plant

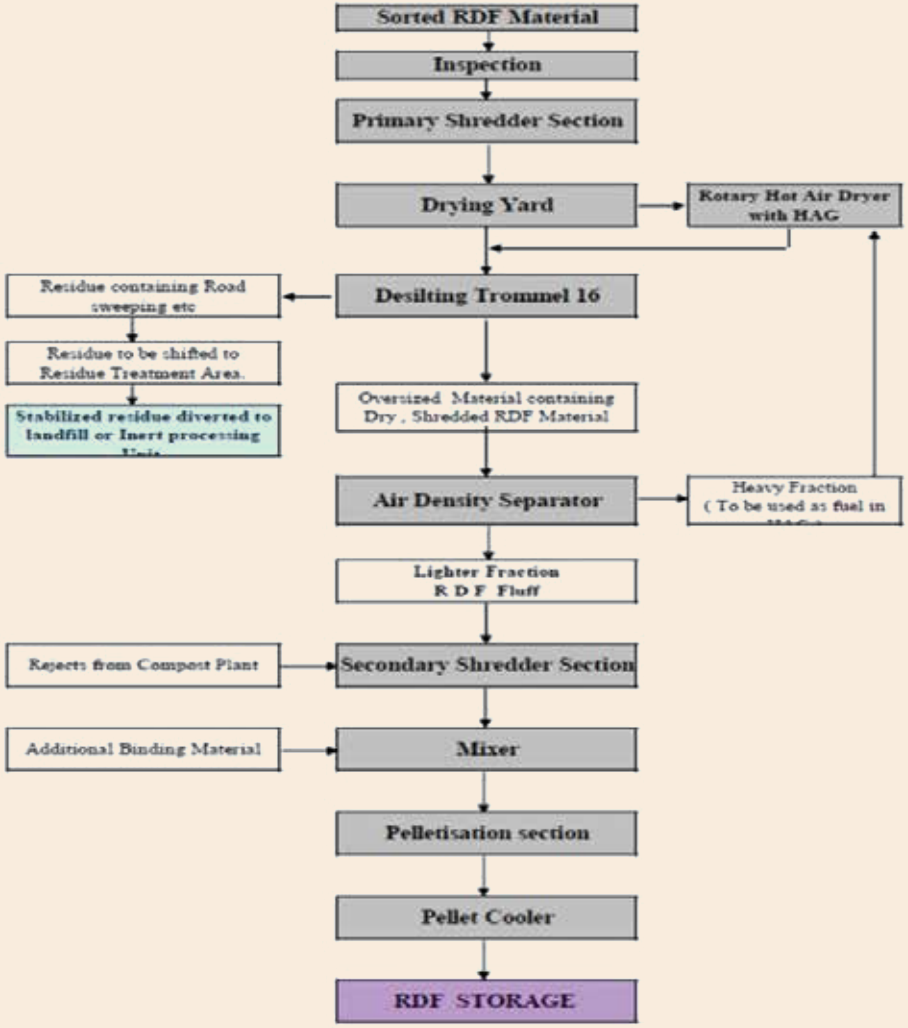
Animal Carcass Incineration

Leachate treatment plant

Testing of fuel from plastic to fuel plant

Plastic to fuel plant

Process flow chart of RDF plant



The plant produces 10-20 MT G1 grade, 20-30 MT G2 grade and remaining 100 MT is of G3 or SCF grade.

1. G1 grade has CV of 3500-4000 kcal and is sold at the rate of Rs. 1700 per MT
2. G2 grade has CV of 2500-3500 kcal and is sold at the rate of Rs. 1000 per MT,
3. G3 grade or the Solid combined fuel (SCF) has lower calorific value and is used in cement industries.

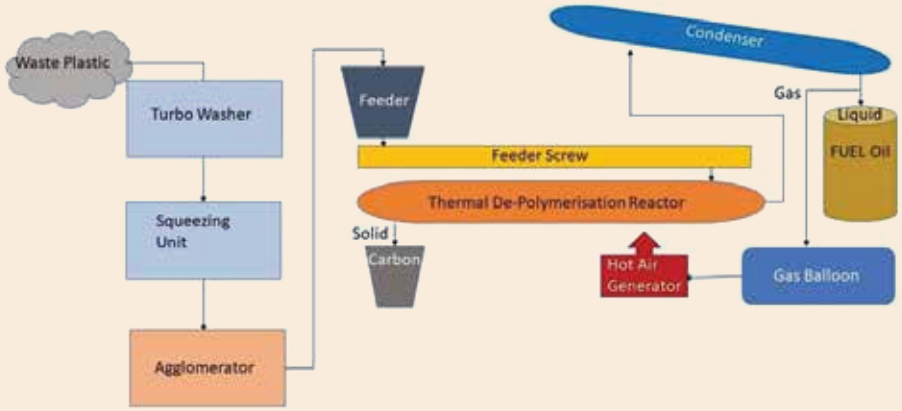
The SCF fraction is sent to Chandrapur (Ambuja Cement Factory). The remaining RDF fluff is sold to GVS at the rate of Rs. 800-1500 per MT. This plant produces 200 MT of RDF per day. Approximately the revenue generation is Rs. 4-5 lakh per month through sale of RDF.

Leachate treatment plant

60% of the leachate which comes to the treatment plant is from composting plant while 40% is obtained through underground drains from the landfill site. The plant has a capacity of 0.6 MLD. The leachate quality and quantity vary seasonally, in monsoon the quantity is 200 m^3 while in post monsoon 100m^3 per day. After the treatment leachate is used for production of biogas which is further used to generate electricity and the sludge is dried and used as manure. The water coming out of the plant is used for maintaining the moisture in windrow composting (50%) and for irrigation after dilution (50%). The O&M cost of this plant is Rs. 2 lakh annually and total requirement of electricity is 200kW to run the leachate treatment plant out of which 50 kW is self-generated.

Plastic to fuel plant

Process flow chart for plastic to fuel conversion



The plant has capacity to process 4 MT of plastic with an efficiency of loading of 400 kg per hour. In this plant, only good quality of plastic is processed for fuel production while the remaining is used as RDF. The entire process finishes in 10 hour. The output is FO grade oil which is used in small industrial furnaces. There is 40-45% oil recovery per day which is equivalent to 1500-1800 litre per day. The generated gas is used in

heating purpose, carbon black is sold as solid fuel which is used in making briquettes. The plant has electricity consumption of 250 kW which is reduced by 110 kW due to use of gas in heating. The O&M cost of this plant is Rs. 90,000 monthly. The high CV of FO grade has almost equivalent to diesel and is sold at the rate of Rs. 35-40 per litre.

Animal Carcass Incineration

The incinerator has burning capacity of around 300 kg. It takes around 4-5 hour to complete the process of incineration for 300 kg of animal carcass. The output of incineration is ashes and some parts of bones. These bones are disposed in the landfill and ash is used in compost. The O&M cost is Rs. 80,000 per month.

Steps followed in Animal Carcass Incineration plant	
Step One:	Loading of the animal waste (weight more than 200 kg) at the furnace bed by overhead crane.
Step Two:	Then cover the dead animal waste by mixture of RDF and biomass.
Step Three:	Now after closing the bed, start primary burner and immediately turn on the I.D.
Step Four:	After few minutes turn on the secondary burner, the secondary burner must be heated for 15 minutes
Step Five:	Charging the incinerator with small waste (Hydraulic gate)
Step Six:	Maintain two-hour average temperature of 500˚C-700˚C during waste combustion cycle until all waste is incinerated to ashes/bone-chips.
Step Seven:	All emissions must be vented through the single stack exhausting the incinerator.

Biomethanation Plant by Co-fermentation

The concept of co-fermentation in this plant incorporates co-generation of heat and electricity. The heat generated is used for pasteurization and for increasing the temperature of the digester for an enhanced digestion process. The plant has capacity of 27 MT and process daily 10 to 15 MT of organic waste from approximately 500 restaurants and 10 to 20 MT of septage from 400 community toilets is collected by trucks and delivered to the plant.

Facility highlight of Biomethanation Plant	
Area of facility (in Sq. m)	6000
Processing Capacity (in MT/day)	30
CAPEX	Rs 8.2 crore
OPEX	Rs 5 lakhs per year
Power Generation (in kWh/day)	3300

Approximately 2,500 m^3 biogas and 3,300 kWh of electricity is produced per day. This electricity is fed to the MSEB grid which is utilized by NMC to avail rebate on

Electricity Generator at Biomethanation Plant

Window composting

Trommels in composting plant

Compost buyers

monthly electricity bills. The additional power generated by the company is the source of revenue. The nutrient-rich effluent from the treated septage can be used as moisturizing agent in the composting process. The sludge produced can be utilized in the composting plant. There are 18 workers deployed in this plant. The capital cost was around Rs. 8.02 crore (Rs. 6.8 crore from GIZ and 1.2 crore from VWMSPL). This project is implemented in DFBOOT (Design Finance Build Own Operate Transfer) mode of contract between VWMSPL and NMC is for 10 years. During this period NMC would pay Rs. 4.94 lakh per year to the company for O&M cost.

Sanitary landfill

The scientific capping of old dumpsite with an area of 4.8 hectares is in under process and a new land area of 1.4 hectares has been selected for the development of sanitary landfill. Presently 30% closure has been done in Phase I covering the 20,000 m^3 portion of the total 400000 m^3 of area. The amount of garbage is estimated to be around 34,000 Tons. The second phase of closure would be completed by 2019 and the third phase leading to complete closure would be achieved by 2020. The total cost of closure of old dumpsite and the development of new Sanitary landfill is Rs 14 crore.

Recommendation

The city has come a long way on tackling solid waste generated in the city by adopting different technological interventions. It is also noteworthy that nearly 94-95% processing of waste is achieved. However due to lack of source segregation of waste, citizens' participation and lack of decentralized waste management, composting etc., transportation and the operational cost of composting plant etc are very high. Furthermore, reusable, recoverable non-biodegradables also reduce, thus reducing revenue for NMC. The lack of citizens' participation was also the reason for Nashik's low rank in SS 2019. It is recommended that more focus should be placed on defining a timeline and framework to achieve source segregation in the city.

To Know More

Nashik Municipal Corporation
Rajiv Gandhi Bhavan,
Sharanpur Road Nashik
Telephone(PBX) : 0253 - 2575631
Email: commissioner@nmc.gov.in

Pimpri Chinchwad

Municipal Corporation

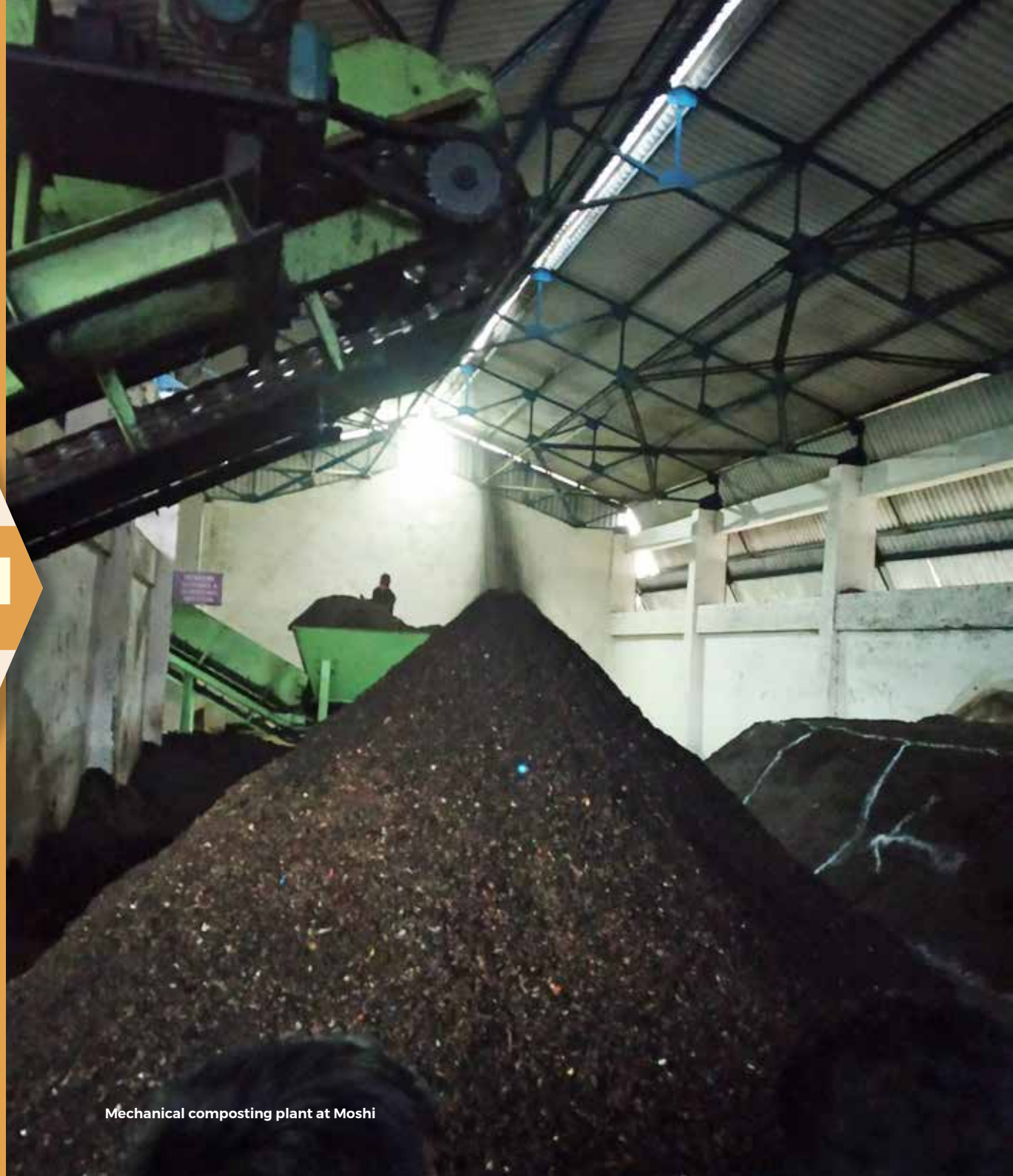
State: **Maharashtra**

Area (in sq. km): **181**

Number of Wards: **32**

Population: **17,27,692**

Waste Generated in Metric Tons (MT) per day: **820**



Mechanical composting plant at Moshi

Solid waste management in Pimpri Chinchwad comes under the purview of the Pimpri Chinchwad Municipal Corporation. Pimpri Chinchwad today generates around 820 MT of garbage a day out of which the total wet waste generation is 495 MT per day and dry waste generation is 325 MT per day. The total waste collected and processed is 525 MT per day and the waste dumped is 295 MT per day. The city so far has not been able to achieve complete compliance of SWM rules 2016, but have made efforts towards including sustainable technologies. The waste after collection is sent to the Moshi landfill site where initiatives of mechanical composting; landfilling and plastic to fuel have been implemented. The total number of staff involved in the solid waste management of the city is 2798.

Segregation, Collection and Transportation

Pimpri Chinchwad ensures the 100% coverage of wards through its door to door collection system. But only 25% segregation at source is being practiced in the city. The PCMC has introduced a “Ghanta-Gadi” (Belled Waste Carriage) to collect waste from households. The solid waste from each collection point is brought by dumper placers and other small collection vehicle, it is further transformed in compactors and then the waste is moved to Moshi landfill site. Roadside dustbins (size 4.5 cu.m.) have been placed in the city for primary collection of the waste.

The collection and disposal of the waste is managed mainly by the PCMC and only 15% is outsourced. Source segregation of waste, Vermi-composting, Mechanical composting & Bio-diesel are the main activities in practice by PCMC in the recent years in the city.

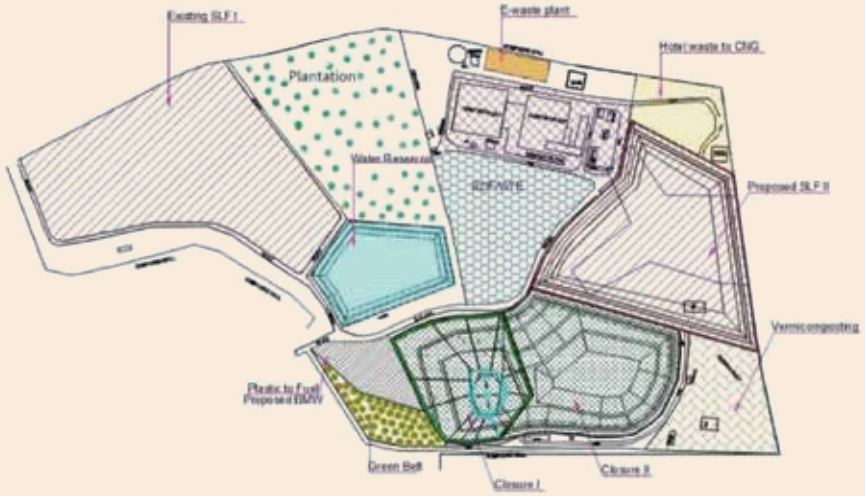
Mechanical composting plant at Moshi

Integrated Solid Waste Management

Pimpri Chinchwad city has a Centralized Processing unit situated at Moshi which is around 10km away from the city. The total area of site is around 81 acres.

After the collection of waste from the entire city, it is dumped at Moshi site for seven day to remove leachate and odour. Afterwards it is sent for segregation. The segregated waste is treated in various ways like land fill, composting, recycling and fuel generation. The plant has a capacity to process 475 MT of waste per day.

Moshi Site Plan



The site has a mechanical composting plant of a capacity of 450 MT per day, a vermicomposting plant of a capacity of 20 MT per day and a plastic-to-fuel plant with a capacity of 5 MT per day. This centralized processing unit has the following facilities:

FACILITY 1:	FACILITY 2:	FACILITY 3:
Mechanical Composting	Landfilling	Plastic to fuel facility

1. Mechanical Composting

Much of the total 820MT of solid waste generated every day in Pimpri Chinchwad is not segregated. The waste after collection is bought to this centralized processing site. The Moshi site has a mechanical composting facility of 450 MT per day capacity. The

facility is treating about 392 MT per day waste presently. At the sorting facility, trommel machines are used to separate the waste. The biodegradable waste is mechanically converted into compost for agricultural use.

Facility highlights of the mechanical composting plant	
Processing Capacity of the facility	450 MT
Quantity of input	392 MT
Products obtained	Manure
Capex for Mechanical composting and scientific land filling	Rs. 35 Crore
Tipping rate per MT	Rs. 398.94

2. Landfilling

This landfill site for the municipal solid waste is run by the Pimpri-Chinchwad Municipal Corporation (PCMC). The site is spread over an area of 7.4 acre and has two capped landfills, one active landfill and one newly constructed landfill. The active landfill is 90% full and is to be closed soon. The new landfill is constructed with modern landfill engineered methods including impermeable linings, a drainage system and a leachate collection system.

Facility highlights of the landfills	
Area of the facility	7.4 Acres
No. of landfills	4
Capex for Mechanical composting and scientific land filling	Rs. 35 Crore
Transportation rate from composting plant to landfill (per MT)	Rs. 169.33

Approximately 295 MT per day of waste generated by the city is brought to the landfill site. The Mechanical composting and scientific land filling is a joint project, managed by BVG India Pvt. Ltd.

3. Plastic to Fuel Plant

The centralized processing unit has a plant to convert plastic to fuel. All the plastic waste generated by the city is sent to this plant for fuel generation. The plant operates on a lease, PCMC provides land to a private agency namely, BVG India which operates and maintains the plant. The agency provides Re.1 per litre as a royalty to PCMC. The entire project cost is incurred by the BVG India.

Facility highlights of Plastic to Fuel Plant	
Processing Capacity of the facility	5 MT per day
Current operational capacity	1.5-2 MT per day
Product obtained	Fuel

The capacity of the plant is 5 MT per day, but currently it is operating at a capacity of 1.5-2 MT per day. Plastic from the waste is being converted to fuel and used in industrial areas.

Compost produced

Mechanical composting plant at Moshi

Plastic to fuel plant

Scientific landfill at Moshi

Compost produced at Roseland Apartments

Decentralised Waste Management at Roseland Society

Roseland Residency, which is located in Pimple Saudagar area of Pimpri Chinchwad. The society has bagged the National Swachh Bharat Award for 2017. The society practices various innovative techniques in plastic collection, e- waste management, wet and dry garbage segregation, leaf composting, awareness campaigns, composting at source as well as sewage treatment plant (STP) for recycling drainage water. There are 1,000 families, 3,500 people of all ages living in 35 buildings of this society and each one of them is a contributor to, and believer in, the eco-friendly lifestyle. The society generates around 1.5 MT of waste per day.

Facility highlights of decentralized composting plant at Roseland Society	
Processing Capacity of the facility	1 MT
Quantity of input	0.9 MT
Quantity of output	90 kg
Products obtained	Manure
Capex	Rs. 2.5 lakh
Opex	Rs. 18,000 per month

The society practices the composting of wet waste within their premises. All the wet waste generated in the society is taken to the composting plant and the compost so generated is used in the gardens of the society.

Spreading awareness: Roseland Residency provided a solid waste segregation handbook to each resident which gives detailed guidelines about three-way waste segregation, plastic waste and e-waste disposal systems. Periodic trainings are conducted for the residents and housekeeping staff. E-waste awareness and collection drive was conducted by Cummins India.

Segregated waste collection area

Composting plant at Roseland Society, Pimpri

Other initiatives taken by the society:

- The society has setup a plastic waste collection area, where a bin is kept to collect plastic waste for recycling. More than 300 kg plastic waste is collected annually for recycling. Reusable shopping bags are distributed to every resident.
- The society has setup an e-waste collection area, where a bin is kept to recover e-waste for recycling by handing over to an industrial unit. Nearly 500 kg of e-waste is collected annually.
- Leaf waste is collected and composted in-house and the compost is used in the seven gardens within the society.

The recognition to the society provided by the National Swachh Bharat Award 2017 motivated many other resident welfare associations to feel that this initiative can be practised in their societies to make them eco-friendly and enjoyable.

Recommendation

Though PCMC has taken good initiatives in treating the waste generated by the city, but PCMC needs to focus more on improving the status of segregation of waste at source. Presently source segregation is only 25% in the city, according to the SWM Rules 2016, there should be 100% source segregation being practiced in the city. Furthermore, the city needs to promote decentralized processing and treatment of the waste.

To Know More

Pimpri Chinchwad Municipal Corporation
Email: egov@pcmcindia.gov.in and sarathi@pcmcindia.gov.in
Website: https://www.pcmcindia.gov.in/index.php
Contact Number: 91-020-2742-5511/12/13/14

Surat

Municipal Corporation

State: **Gujarat**

Area (in sq. km): **326.5**

Number of Wards: **101**

Population: **44,67,797**

Waste Generated in Metric Tons (MT) per day: **1575**

Sewage Treatment Plant at Bamroli, Surat

The average quantity of Municipal Solid Waste (MSW) collection is 1575 MT per day[1]. Out of this, 1499 MT per day of waste gets collected. The door to door waste collection is outsourced to different agencies. Collected waste is transferred to closed body transfer stations. Surat Municipal Corporation (SMC) has 8 transfer stations located in 7 different zones, viz., Bhatar, Katargam, Varachha, Anjana, Pal and Bhestan, having varying capacities.

Apart from door to door collection, about 1100 large storage bins which are placed at fixed locations in the city for waste collection are lifted by trucks and emptied on a periodic basis. The trucks dispose off the waste at the transfer stations. The activity of container lifting is carried out by SMC using its own vehicles and is also outsourced. The compacted waste from the transfer stations are transported to the centralized compost and Refuse Derived Fuel (RDF) facility at Khajod. Plastic waste collected from the 7 zones of Surat is transported to the plastic processing facility at Bhatar that is run by Eco-Vision Environmental Resources. Though Surat has achieved almost 95% door to door collection of waste, segregation of waste at source is yet to be achieved. Source segregation of waste would help to make the city compost better in quality and will thus be easily marketable, which is currently a challenge.

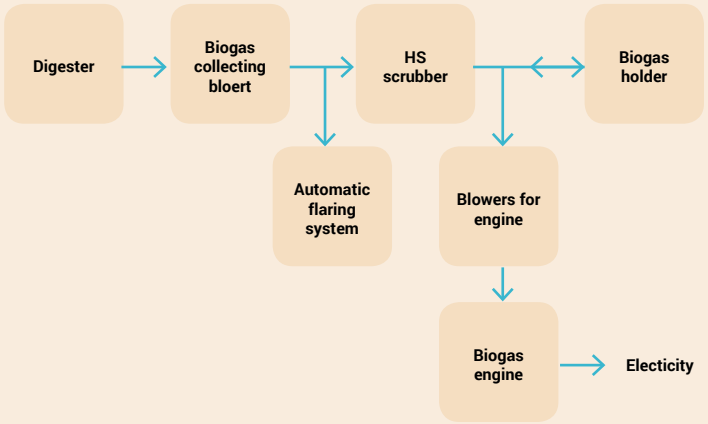
SMC workers carry out sweeping on designated locations during day time in two shifts. Commercial areas and areas having heavy daytime traffic are covered under night scrapping and brushing activity. The scrap and waste collected is transferred to primary transfer station by a contractor's vehicle. Separate vehicles are assigned to collect hotel waste from various hotels across Surat.

Sewage Gas based Power Generation at Bamroli

Bamroli Sewage Treatment Plant (STP) in Surat has a secondary treatment system with a capacity of 100 MLD. Out of which 40 MLD sewage, after tertiary treatment is supplied to the Pandesara Industrial estate that majorly houses textile processing industries. Initially, the entire treated sewage was being discharged into Koyali Khadi. The project involves a tertiary sewage treatment plant of 42 MLD capacity to treat sewage and generate industrial grade water in Surat. The technology for treatment of wastewater involves Sand Filtration, Ultra-filtration (UF), Reverse Osmosis (RO) and Activated Carbon Filter (ACF). Sand filtration removes suspended matter as well as floating and sinkable particles when the wastewater flows vertically through a fine bed of sand or gravel. Ultrafiltration removes colloidal particles (0.01 to 1.0 microns) from water and reverse osmosis helps in removing a large majority of contaminants from the water. The facility converts the sludge into biogas, this in turn is used to generate electricity for the operation of Sewage Treatment Plant (STP).

[1] Surat Municipal Corporation

Flowchart showing electricity generation by the biogas plant, Bamroli



(Source: Akshay Urja, December 2011 Volume 5, Issue 3)

Key Highlights

- This project has helped SMC to reduce pressure on water resources in the city and minimizing dependency of Pandesara Industrial Units on bore-wells and private tanker operators.
- The project is expected to save 1180 lacs litre per day of potable water by 2019, which would serve a population of more than 8,00,000.30 timely desludging of septic tanks and single pit done

Facility highlights of Bamroli Sewage Treatment Plant	
Technology used	Sequential Batch Reactors (SBR)
Products obtained	Biogas
Quantity of biogas generated	42,000 cu.m.
Electricity generated	72, 240 kWh per day
CAPEX	Rs. 62 crore
OPEX	N.A.
Revenue Generated	Rs. 3 lakhs per month in terms of savings on electricity

To Know More

Enviro Control Associates (I) Pvt. Ltd.
Patar 4 Road, Surat
9998970688

Visakhapatnam

Greater Visakhapatnam Municipal Corporation

State: **Andhra Pradesh**

Area (in sq. km): **681.96**

Number of Wards: **72**

Population: **17,28,128**

Waste Generated in Metric Tons (MT) per day: **920**

Windrow Composting at Gajuwaka Transfer Station

Visakhapatnam is a port city and industrial center in the Indian state of Andhra Pradesh, on the Bay of Bengal. The Public Health and Sanitation Department of Great Visakhapatnam Municipal Corporation (GVMC) is responsible for collection, transportation and disposal of solid waste generated in Visakhapatnam City. For operational purposes the entire area of the corporation is divided into 6 zones comprising 72 wards. Sanitary Supervisors heads each of the zones and the sanitary inspector heads each of the wards.

The collection and transportation of waste is practiced in 100% households on all the days of the year including the public holidays by GVMC. In GVMC, waste stored in open spaces is either loaded manually or with the help of loaders (in case of huge accumulations) in trucks. GVMC has selected one of the least expensive and less capital intensive, but approved method of windrows composting. The windrows composting is decentralized in five locations covering the entire city at Gajuwaka, K.R.M. Colony, Kapuluppada, Mudasarlova and Bhimunipatnam with the one Gajuwaka accounting for a major quantity.

Gajuwaka Solid Waste Transfer Unit

Gajuwaka Solid Waste Transfer Unit established under the thrust of the programme Visakha Integrated Solid Waste Management. The transfer unit is composting the waste in four ways. The transfer station has been allocated 14 acres of land to manage the wet waste. Using pulverisers, the wet waste is utilised for windrow composting, organic composting unit. The main objective of this transfer unit is to reduce the waste being dump to Kapulapada Landfill site. Currently, the compost produced by GVMC is being used by the horticulture department of GVMC.

Facility highlights of Gajuwaka Solid Waste Transfer Unit

Area of facility (in acre)	14
Quantity of Input (in MT/day)	70
Quantity of Output Generated	35

Organic waste composting unit

Windrow Composting Unit

The Windrow Composting unit processes 30 MT wet waste per day. The segregated wet waste, is laid on open beds for about four to five days. Later, it is transferred to composting yard and laid on big beds known as windrows. This is rotated once in a week so that waste on the lower side is also exposed to the air for aerobic composting. In this way, it is rotated for 45 days, till the final product is obtained. The final product is again segregated and sieved.

Organic Waste Composting

Gajuwaka Organic Waste Composting Unit is processing the food waste that are being generated from the hotels. The wet compostable waste from hotels is about 1 MT per day which is converted to compost. A composter is used for size reduction and mixing of wet waste with inoculum. This is followed by composting in trays kept racks, humified and daily for about 2 – 3 weeks yielding about one fourth of its weight as compost. The compost is cured, sieved and finally it is packaged for sale.

Smart Covered Composting Technology

Smart Cover Composting technology has been implemented under Greater Visakhapatnam Smart City Corporation Limited for processing decentralized organic waste by using smart covered composting technology. The facility is conceived as a part of Smart City initiative and it is being managed by Smart Enviro Systems Private Limited, Pune. The facility capacity is 20 MT/day.

The technology is cost effective, efficient solutions and it is processing organic waste by applying Covered Aerated Static Pile (ASP) composting systems utilizing compost cover. Compost Cover System leads the way in no smell, no noise, no negative visual appearance and no air/water quality issues. An enclosed heap composting with membrane covered, pressure-aerated, oxygen-controlled decomposition technology is maintained at 40oC under enclosed cover through air blower.

Vermicomposting Unit

The facility has vermicomposting unit and processing 20 MT/day. The composting technology uses following materials: breeder worms, a wooden bed and organic wastes. The process involves sieving and shredding of the wet waste into small pieces. This followed by blending process using the cow dung slurry. The raw materials are then kept into piles and the temperature is allowed to reach 50-550 C. The piles are kept at this temperature for 7 to 10 days. The compost is ready after a month.

Key highlights

- It is one of the least expensive and less capital intensive. The transfer unit is composting the waste in four ways.
- Smart Cover Composting Technology generates no foul odour, no negative visual appearance and no issues no regarding air and water quality.

Composting at Simhachalam Temple

Simhachalam temple is a heritage and pilgrim place in South India. On a daily basis 3000-5000 pilgrims avail free lunch under Nityannadanam scheme. The temple generates around 200-300 kg of organic waste per day consisting of waste food, tulsi and flowers etc. To tackle the quantum of waste in the temple RINL - Vizag Steel Plant, installed a Compost Machine under at Simhachalam Devasthanam Temple premises under its Corporate Social Responsibility (CSR) in the year 2018. The fully automatic and highly compact machine of 250 Kg capacity is capable of processing all kinds of organic waste into compost. The compost thus generated is proposed to be used for nurturing the temple gardens.

Facility highlights of Composting at Simhachalam Temple	
CAPEX	Rs 9, 39,000
OPEX	Rs 40,000 per month
Manpower	4 persons

Key highlights

- The composting machine is helping in improving the insanitary conditions which could arise due to the waste generated at temple..

Anakapalle Dry Waste Recycling Centre

Anakapalle dry waste recycling centre is a decentralized recycling centre. The facility is started in the year 2014 and processes 1.5 MT of dry waste in a day. The centre is spread across in two floor building at Zonal Office area. The facility employs 10 waste pickers for waste segregation and recycling. The dry waste coming to the centre generally contains plastic bottles, tissue papers, soft drink

Composting Unit at Gajuwaka

Gajuwaka Windrow Composting Unit

WTE Plant under construction

Biomining process being carried out at Kapuluppada Landfill Site

cans, alcohol bottles, carton box, newspapers etc. Due to improved techniques and innovative ideas, the centre is able to withdraw items from mixed waste such as paper, glass, PVC, improved recyclable items. The sorted dry waste is then passed into various waste buyers and recycling centres for recycling. The income generated from the centre is distributed among the waste pickers as incentive.

Kapuluppada Landfill

The Kapuluppada landfill site is spread over an area of 100 acres and has been in operation from the last 10 years. The landfill receives waste from all eight zones of the city. Three JCBs, two bulldozer and one EX-80 lift are employed by GVMC solid waste disposal management. Currently, 2.5 Lakh of Metric Tonnes of waste is accumulated at the dumping site. However, Kapuluppada landfill site has 60 – 70 % of the biodegradable waste.

To utilize the potential landfill waste GVMC has started the work for Waste to Energy (WtE) and Sanitary Landfill at Kapuluppada landfill along with Jindal Urban Waste Management Limited. Out of the 100 acres of land, 17.08 acres is being used for WtE facilities and about 39.85 acres for scientific landfill site. The land has been allotted for a period of 25 years to handle and manage waste from GVMC including other ULBs and the residual inert matter generated from the Waste to Energy plant operations of JUWMVL.

Recommendation

It is recommended to ensure source segregation at household level. Decentralized waste processing techniques like community composting, Solid Waste Transfer Unit, etc. being practiced by GVMC needs to be promoted in other parts of the city. Such centers reduces the amount of waste being transported to the dumpsite and thus savings in transportation cost and land.

To Know More

Greater Visakhapatnam Municipal Corporation
10-3-19/1, Tenneti Bhavanam , Asilmetta , Vizag - 530002
Phone Number: 180042500009, 2568545

Nagpur
Municipal Corporation

State: **Maharashtra**

Area (in sq. km): **227.38**

Number of Wards: **136**

Population: **24,05,665**

Waste Generated in Metric Tons (MT) per day: **1200**

The city of Nagpur also known as the "Orange City" is the third largest city (population-wise) in the state of Maharashtra. Currently, the city is generating 1200 MT of waste per day from 136 wards out of which 200 MT is processed. The rest is being dumped at Bhandewadi dumping site which is 10 km away from city. There is 100% door to door collection but segregation at source is not practiced in the city. Kanak Resources Management Ltd., are carrying out the door to door collection in all wards and transportation to dumpsite. This is being done on a PPP mode Approximately 255 vehicles, 670 cycle rickshaws and around 1500 workers are deployed in SWM. Every vehicle is equipped with the RFID and GPS tracking system and helps in recording the weight of the vehicle with and without waste, which is captured digitally through SCADA system. In 2008, Hanjer Biotech Energies got the contract for processing and disposal of solid waste on BOOT basis. The contract is for 12 years out of which first 2 years were for construction and development activity and 10 years for operation and maintenance (up to 2021). The contract included setting up of processing plant, SLF and closure of the dump site. The contract amounted to a total of Rs 26.78 crore.

In 2018, the city has been awarded with the Innovation and Best practices award among big cities with more than 10 lakh population for the project "Soft Asset Geo-Fencing and tracking for NMC employees".

Centralized Composting Plant at Bhandewadi

In this plant, Hanjer Biotech Energies is treating 200 MT per day of waste to produce 35-50 MT per day compost by Windrow composting method. NMC has provided 11 acre of land area at Bhandewadi for this plant. This site has four windrows of size 70mX12mX2.5m each. The watering is done by showers mounted on crane. About 50 kg Inoculum is added in a windrow to accelerate microbial activities. Windrows are turned four times in a week with the help of crane for aeration. The moisture content and aeration are monitored to maintain the thermophilic temperature within the windrows. After 30 days the waste is kept at maturation yard for a week. It is then segregated through 18 mm and 13 mm trommel. Finally, compost & inert material are separated through 4 mm and

Facility highlights of Centralized Composting Plant	
CAPEX	Rs. 26.78 crore (under the cost of ISWM)
Manpower	10
Compost produced	35-50 MT per day

3 mm trommel. The compost is collected and packaged in 50 kg bags and the inert matter is sent to the landfill. The production of manure is about 1000 bags per day (50 MT) which is sold to local farmers directly and also sold as Rashtriya Chemicals and Fertilizers Limited (RCF) and Sampada brands.

Centralized Vermi-composting plant at Bhandewadi

Facility highlights of Centralized Vermi-composting plant	
CAPEX	Rs. 20 lakh
OPEX	Rs. 10000 per month
Manpower	4
Compost produced	5 MT per month

Nagpur's vegetable market, fruit market waste and food waste from hotels, restaurants is processed in a vermi-composting plant at Bhandewadi. This plant is operational since 2008 and is being operated and maintained by the health department of NMC. The total capacity of this plant is 2 MT but presently runs at its 50% operational capacity. Around 5 MT compost is produced on a monthly basis. The total plant cost is Rs. 20 lakh and the recurring cost of earthworms is around Rs. 800 per kg. The plant produces fine quality compost which is used in the gardens of NMC.

In the vermi-composting plant, preparation of appropriate bed is done in the tank by using straw, husk and earthworms. The food waste and fruits are mixed with cow dung reconstituted water (1:1 ratio), approximately 10 liters of this reconstituted mixture is required for the waste of 2 to 3 kg. The layering of organic waste is done daily and is mixed with the reconstituted water by sprinkling it over the layer. The tank is left undisturbed for around 45-60 days and then transferred to another empty tank. The compost is passed through the machine where fine and coarse compost is separated from the worms. The worms are reused, and the compost is sent for use to NMC. NMC uses the vermicompost for enriching the garden soil.

Decentralized composting at Tata Reality Infrastructures, Rambagh

Facility highlights of Decentralized composting	
CAPEX	Rs. 05 lakh
OPEX	Self-operated
Manpower	2
Compost produced	450 kg per month

This society has 352 flats spread over an area of 3.5 hectares. In this society, segregated waste is collected by 8 workers from all occupied flats. The wet waste is processed in OWC and dry waste is collected by NMC from the common area within the society. The total capacity of the OWC machine is 200kg but at present the operational capacity is 50% because around 150 flats are vacant. The waste from garden and 100-110 kg wet waste is subjected to shredding and then loaded in the OWC. After processing the waste, it is kept in the baskets for curing for around 28 days. During the curing process, moisture content is maintained to optimum level through sprinklers. A deodorizer with the microbial culture (Sani treat and Bioculum respectively) is added and the carbon balance is maintained by adding saw dust and dry leaves from garden.

Composting Pits

Recommendation

In Nagpur, most of the best practices are at local level. At present, a huge number of workers and vehicles are deployed only for collection and transportation of waste. The NMC needs to enforce segregation at source and promote onsite waste management. NMC should plan for MRF, decentralized composting, bio-methanation plant, etc. to reduce the waste landing directly onto the dumping site. This will result in cost savings in terms of fuel used for transporting waste and land required for the dumping site.

To Know More

Nagpur Municipal Corporation
Mahanagar Palika Marg, Civil Lines,
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0712 2567035, nmcegov@gmail.com

Varanasi
Municipal Corporation

State: **Uttar Pradesh**

Area (in sq. km): **82.1**

Number of Wards: **90**

Population: **11,98,491**

Waste Generated in Metric Tons (MT) per day: **583**

Segregation of the MSW at Karsada Plant

Varanasi, also regarded as one of the oldest cities in the world and lies in the state of Uttar Pradesh along the banks of the river Ganga. The solid waste management system of Varanasi city is being managed by Varanasi Municipal Corporation (VMC). The city is divided into five zones and ninety administrative wards for management of basic services to citizens. The average waste generation of Varanasi is 0.50 kg per capita per day amounting to 583 MT of waste per day. [1]

The door to door waste collection is functional in all 90 wards of Varanasi. Waste collected from the households is transferred to the roadside bins or nearby secondary storage points. Waste from roadside bins is collected by refuse compacters and from secondary points by dumper placers and transported to the processing facility.

Door-to-door collection and transportation of waste for thirteen wards is carried out by VMC. The collection and transportation of waste for the rest of the wards is outsourced to different firms namely Kiyana Solutions and Services Pvt. Ltd. (30 wards), Ecopal Facility Management Services (32 wards) and IL&FS Environmental Infrastructure & Services Ltd (IEISL) (15 wards). 2 Presently in Varanasi both centralized and decentralized systems are functional for solid waste processing. The details of the processing facilities functional in the city are discussed in the table below:

Details of the Waste Processing Facilities

1198491	Plant Location	Process/Technology	Waste Processed per day
Mixed MSW	Karsada	Windrows Composting	544.3 MT
Organic MSW	Bhawaniya Pokhari	Biomethanization	4.5 MT
Organic MSW	Pahariya Mandi	Biomethanization	4.5 MT
Organic MSW	Near IDH Hospital	Biomethanization	4.5 MT
Flower Waste	Ram Ghat	Composting	0.9 MT

Of the total 583 MT of municipal waste generated per day, the city processes about 559 MT per day. The remaining 24 MT of waste is either left in open at garbage vulnerable point or is taken to the dump site. The city is making efforts to reduce the quantum of waste reaching the dumpsite. Some of the noteworthy initiatives towards solid waste management in the city are discussed as below:

Composting Plant at Karsada

The solid waste management plant at Karsada is the main centralized composting plant for the management of the MSW generated by the city. Until May of 2012, the plant was operated by a private company, A2Z Infrastructure Private Limited. However, due to disagreement between the company and VMC, A2Z withdrew from the agreement. As of September 2016, the plant is operated and maintained by a private firm IL&FS.

Facility Highlight of Composting Plant at Karsada	
Processing Capacity (in MT per day)	544
Technology Used	Windrow Composting
Quantity of Manure obtained (in MT per day)	72.5
Cost of compost for Marketing firm	Rs. 2268 per MT
Cost of compost for Local Farmers	Rs. 907 per MT

The plant receives mixed waste of 600 tons per day on an average. The mixed waste is first sorted into organic and inorganic waste. The organic waste is processed using windrows for composting wet waste. Around 72.5 MT of compost is obtained per day after treatment. The Varanasi Municipal Corporation (VMC) along with IL&FS entered into a memorandum of understanding with the Indo-Gulf Fertilizers Ltd to market the organic fertilizer processed at Karsada Plant. The compost is sold to farmers as well as the horticulture department of VMC

After the windrow composting the rejects from the compost are dumped in the sanitary landfill present at the treatment plant. Also, the RDF produced in the process is further supplied to local factories for incineration. The plant also has an operational scientific landfill within its premises that has an area of 10,000 square meters and a leachate treatment plant of 50-kiloliters per day.

Waste to Energy Plant near I.D.H Hospital

A decentralized waste to energy plant of 4.5 MT per day capacity was jointly commissioned in near I.D.H hospital by VMC and Indian Oil Corporation Ltd, (IOCL) in February 2018. The project was executed under the Corporate Social Responsibility scheme of IOCL. Approximately 400 sq.m. of land was allotted by the Corporation for the installation of plant. The total cost of the plant including the operational & maintenance cost was provided by IOCL through their CSR fund.

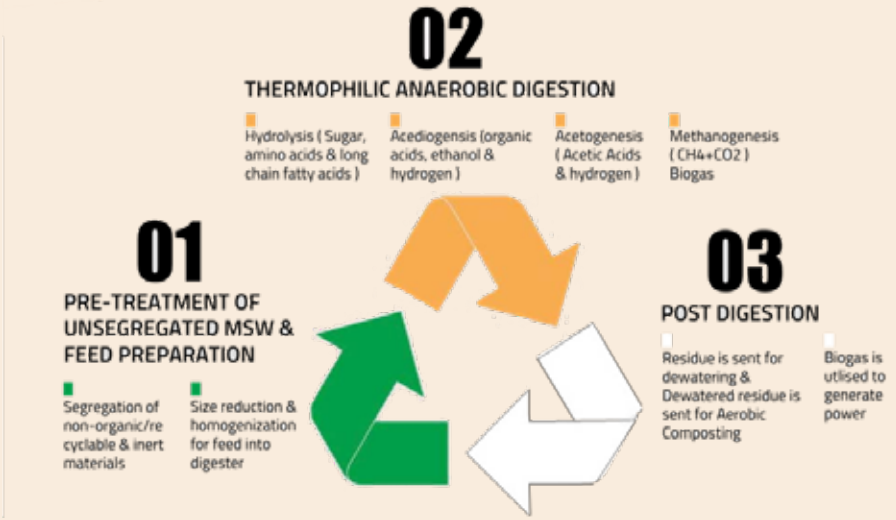
IOCL has engaged M/s Organic Recycling Systems Pvt. Ltd (ORSPL) for designing, commissioning and operations of the plant.

Facility Highlight of Waste to Energy Plant	
Area (in sq. m.)	400
Technology Used	Thermophilic anaerobic digestion technology DRYADTM
CAPEX	Rs. 2 crores
OPEX (monthly)	Rs 2.15 lakhs
Quantity of input (in MT per day)	4.5
Electricity produced (per day)	800 Kwh
Manure obtained (per day)	35 kg

[1] Varanasi Municipal Corporation, —Varanasi city development plan, Varanasi, 2015.

The plant comprises a small-scaled containerized unit called 'Yasasu Green' designed by ORSPL. The unit is designed to process the organic waste to obtain biogas and manure. It is based on continuous high solid thermophilic anaerobic digestion technology (DRYADTM), producing zero effluent and leachate in the process. The biogas produced on digestion is combusted through the gas engines to produce electricity which is used for captive use as well as lighting of the surrounding areas. The manure generated is of high quality and is being used by the horticulture department of VMC in city parks. The process involved is depicted in the figure below:

Process adopted in Yasasu Green



Source: http://yasasu.in/tech.html

The digestion and composting period ranges from 14 to 21 days. The quality of compost obtained is better than the conventional product as all the inerts are removed during pre-treatment stage and the pathogens are completely absent as the digestion takes place at a high temperature. This plant produces nearly 800

Key Highlights

- The initiative showcases the success of public private partnerships in the sector and demonstrates how CSR funds could be used at decentralized level to address the challenges at city level.
- Installing these plants at ward level also helps in reducing the waste transportation costs by the ULB.
- It is a 'plug and play' model and is a zero-charged plant with minimal requirement of water for cleaning.

Composting Plant at Karsada

Compost obtained through Windrow composting at the Plant

Feeding the segregated waste into the digester

Generation of Power from Biogas

Upcycled products at Scrapshala

Kwh (units) of energy per day from feed of 4.5 MT of organic waste. After captive consumption, the unit is designed to ensure 400 units of energy per day to electrify the city's water treatment plant. This plant also produces 35 kg of manure per day in the process.

Scrapshala, Ravindrapuri

Scrapshala, founded by Shikha Shah in 2016, is a unique initiative that works towards creating decorative products from waste materials and discarded items. It is a service and product based social venture for managing non-biodegradable dry trash/scrap in the city. Scrapshala provides customized products to customers out of urban trash by the process of upcycling. The company also operates as service provider for green decor themed parties, sustainable home décor and also creates livelihood options through up cycling and waste management.

The company is currently dealing in two types of features – Product based (using trash and converting it into useful decorative pieces) and service based (fixing non-working items). Waste or scrap is collected from people on door-to-door basis. A lot of people or industries also happily donate scrap on weekly basis. People from different cities even courier the scrap. The quantity of waste collected per day varies depending upon the waste obtained from the donors and the municipal office. The donated scrap is further segregated, cleaned and stored at the workshop. The workforce at Scrapshala comprises a team of fifteen local artisans and women belonging to the disadvantaged groups. So far, the company has recycled more than 12-13 MT of non-biodegradable waste into creative products of décor and utility.

One can buy ScrapShala products online on more than 15 portals such as Kraftly, Flipkart, Amazon, Craftsvilla, WAC, Engrave, lovethistsuff, Culture truck, Soulescence, etc. The products are reasonable enough for people to buy and range between Rs 100 to 5000 depending upon time and skill required to finish a product. It takes usually 2-3 days to transform trash into a product of utility.

In addition to upcycling dry waste, the foundation along with the municipal corporation of Varanasi conducts community drives towards waste management. The foundation also works with a few NGOs for providing skill training to the less-privileged girls in Varanasi. However, besides these initiatives, changing the perspective towards waste and selling products made out of waste was one of the few initial challenges faced by the foundation. Other limitation faced by the company for making these type of products is that it can only use uncrushed and unbroken items. Scrapshala presently deals with plastic, glass, Styrofoam, paper and e-waste [2].

[2] http://www.thealternative.in/lifestyle/scrapshala-upcycling-space-instead-landfilling-waste/

Key Highlights

- Scrapshala has managed to bring about a behavioral change at consumer level by promoting a fresh perspective on managing waste and has also contributed significantly in pushing the market for green and energy-efficient products in Varanasi. This initiative has helped generate livelihood for local artisans which is also helping in improving their socio economic status.
- With support from government and educational institutes, Scrapshala has also played a significant role in motivating youth to take charge of cleanliness situation.
- Products of Scrapshala are sold online on about fifteen e-commerce websites.

Recommendation

Although the city has achieved 100% door to door collection and is promoting decentralized waste processing practices, lack of source segregation is still a major challenge. Focus has to be laid on collecting segregated waste at source. If effective source segregation and recycling methods are followed at individual residential units, the garbage flow to the dump yards will go down drastically. Besides reducing the quantum of waste reaching the dumpsite, steps should be taken to upgrade the dump sites into sanitary landfills.

To Know More

Varanasi Municipal Corporation
Website: http://nnvns.org/contact-us.html
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YASASU environment Management Services
Website: http://yasasu.in/index.html
Email: info@yasasu.in
Contact: 022-41702222Treating waste at source

SCRAPSHALA
Website: https://scrapshala.com/
Email: scrapshala@gmail.com
Contact: 8400029536/ 07200364536

Jabalpur

Municipal Corporation

State: **Madhya Pradesh**

Area (in sq. km): **367**

Number of Wards: **79**

Population: **10,55,525**

Waste Generated in Metric Tons (MT) per day: **670**

Solid waste management in Jabalpur comes under the purview of the Jabalpur Municipal Corporation (JMC) which is responsible for providing municipal and civic services, which includes collection, segregation, transportation, treatment and disposal of solid waste generated in the city. Jabalpur today generates approximately 670 MT per day of garbage a day and all of it is collected from the source whether it is a household or commercial establishment. The total wet waste generation is approximately 410 MT per day and the dry waste generation is 260 MT per day. Jabalpur ensures 100% coverage of wards through its door to door collection system. JMC claims that 100% segregation at source is being practiced in the city (Source: Smart cities data, MOHUA website).

The city was awarded the title of "Best Big City in Innovation & Best Practices" in the Swachh Survekshan 2019.

Most of the waste is sent to the waste to energy plant set up in the city, rest of the waste goes to the two landfill sites that the city presently has at Ranital and Kathonda. Jabalpur has setup a waste to energy plant at Kathonda for disposal of the solid waste collected from the 79 wards of Jabalpur Municipal Corporation. Essel Infra projects Ltd. has set up a 600 TPD processing plant for converting solid waste to energy at Jabalpur on BOT basis with concession for 20 years for electricity generation of 11.5 MW as of May 2016. The noteworthy initiative taken by the city is discussed as below:

Integration of Technology in Collection and Transportation, Jabalpur, Madhya Pradesh

JMC needed a way for refining the solid waste management services in Jabalpur city. For meeting this objective, JMC established a collection and transportation system in the year 2016 through private sector participation. To manage, maintain and monitor the door to door collection of waste

Collection of waste in Jabalpur

and holistic view of waste from source to end was one of the major challenges faced by the city. The city required a system which can track, help to locate and monitor the door to door collection with RFID tags, semi underground bin management with BLS and the jobs carried out by the department such as Vehicle Tracking and Monitoring System (VTMS) using GPS and dashboards was an important requirement.

In Jabalpur, about 670MT of solid waste is generated from both household and commercial sources. The waste generation rate in the municipality is expected to increase by 15% by the year 2020. The total number of vehicles available in the city are 240 tippers, 20 hopper trucks, 14 waste compactors, 4 cranes mounted waste transfer vehicles and 6 static compacters.

The collection and transportation of the waste in Jabalpur is undertaken through the following steps:

STEP 1	STEP 2	STEP 3	STEP 4
RFID tags for door-to-door and community bins, to improve the customer experience	Bin Level Sensors (BLS) to increase the productivity	Weight collected waste at W2E plant to reduce the maintenance cost	Integration for VTMS, Weight monitoring and GIS

After the implementation of daily door to door garbage collection system in the morning hours, it has now become the practice of every citizen to store the household waste temporarily in dustbin till the door to door garbage collection vehicle arrives. This has made a good improvement in the overall scenario. A sense of good hygiene and awareness towards environment are visible. Door to door collection is adopted in the entire city, which has resulted in efficient collection of waste, reduction of littering, foul odour and unaesthetic appearance of bins. The innovative characteristics of the project:

1. Smart Application for SWM Resource Plan
2. GPS enabled vehicles
3. Sensor Enabled Smart Bins
4. RFID tags on each household
5. Smart Grievance Portal for citizens
6. Analytics
7. Integrated command and operations centre

Tech Mahindra has been given the responsibility to integrate the information technology for improving the collection and transportation in the city at an estimated cost of Rs. 6.94 crore. This has also helped in the monitoring of the system and rectifies the processes to reduce the operational cost.

Key highlights

- Implementation of "Door to Door Collection Monitoring System" by supply and installation RFID tags and readers.
- The designing and integration of the tracking system and the monitoring system for waste collection in the city.

GPS has been deployed on vehicles that are involved in collection and transportation of waste and the real time movement is monitored through a centralized control room. Such GPS enabled mapping tracks the vehicular movement as per the designated hours of operation. Furthermore, these GPS systems enable the identification of vehicles that have broken down during operations and hence enable the routing of stand-by vehicles or closest collection vehicles.

RFID readers are installed at every household which gives information as to whether solid waste has been collected on time or not. 250 RFID readers have been deployed at various locations in the city. The monitoring system is being used in conjunction with Vehicle Tracking and Monitoring System (VTMS) solutions; this has resulted in ensuring complete coverage of door-to-door and community collection, management of refuse picking routes for SWM and monitoring and tracking the refuse weight by the refuse vehicle along the route; integration of refuse transfer station facilities with the centralized monitoring facility etc.

Recommendation

While the door to door collection and transportation system in the city is using RFID, BLS, etc. giving an impression of cleanliness in the city, but burning of mixed waste using waste incineration technology is against the SWM Rules 2016 compliance expectations. The SWM Rules 2016 clearly states that the wet waste should be segregated at source and composted, recyclables should be recycled and only non-compostable, non-recyclable waste should be made into RDF and taken to RDF based incineration plants or cement kilns. The city needs to improve its waste management and treatment facilities.

To Know More

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Amritsar

Municipal Corporation

State: **Punjab**

Area (in sq. km): **136**

Number of Wards: **88**

Population: **11,32,383**

Waste Generated in Metric Tons (MT) per day: **600**

Amritsar, one of the biggest city in Punjab. This city is home to the Harmandir Sahib, popularly known as "the Golden Temple," one of Sikhism's most spiritually significant and most-visited Gurudwara. As per state tourism department, daily tourist influx is 50000-60000. Currently city generates 600 MT of waste per day from 88 wards. Essel Infra Pvt ltd. under PPP mode are carrying out the collection and transportation of waste from all wards. In this management approximately 320 vehicles and 2410 workers (1710 AMC and 700 outsourced) are deployed. Entire waste is dumped at 21 acres Bhagtanwala dumpsite, which is around 10 km from the centre of the city.

Solid and Liquid Resource Management (SLRM) Centre at Amritsar Cantonment Board

The SLRM Centre is spread over an area of 2.4 hectares in Cantonment board. The implementation of the project is taken up by Swachh Mission co-operative society limited in 2016 with the technical support of India Green Service agency. This centre is efficiently managing the entire collection, transportation system and managing them with suitable techniques, such as composting, manually segregating the RDF fraction and converting the recyclable waste in to value-added products. Centre is preparing value-added products from

Facility highlights of SLRM Centre	
CAPEX	Rs. 38.5 lakh
OPEX	Rs. 4 lakh per month
Manpower	119 (96 female workers)
Waste being managed	3 MT per day

Collection vehicle

recyclable products, such as cardboards, clothes, certain plastic materials etc. For instance, cotton towels are converted into beautiful flower pots. These products are displayed during certain occasions and sold to the public to earn funds for the SLRM centre.

For this unique and inspiring initiative, SLRM, Amritsar Cantt has been awarded with the coveted "Raksha Mantri's Award for Excellence" in the Swachh Chhavni Swasth Chhavni Category. Also, the centre has been conferred with "Certificate of Excellence in 3Rs" by the National Productivity Council.

This SLRM Centre has been developed at a place, where there was slaughter house operating earlier. Army authorities were requested to allot the condemned building to cantonment board for SLRM centre. For this centre the agency have identified and integrated female waste pickers from all over the city and engaged them as key resource after imparting initial training on the SLRM. Currently 3 MT of waste per day is collected from 7 wards covering about 3400 households. It includes about 283 hectares of defence establishment as well. For this purpose, the centre has deployed 7 e-rickshaws and 18 hand carts. Collection of waste is done twice daily. Each e-rickshaw covers about 200 households within an area spanning over a radius of 2.5 km. User fees is being collected by the centre, broadly depending upon the waste generation. Residential households pay Rs. 70 per month, while commercial establishment pay Rs. 140 and Rs. 170 depending upon the generation. While bulk generators (including hotels, restaurants, schools etc.) pay Rs. 2100 per month. Waste comes segregated at the source, which is collected in partitioned vehicles. The dry waste undergoes washing treatment, is segregated further, packed and sold as RDF materials. The organic fraction, which is edible by animals is sent to the dairies or piggeries. After segregation for dairy and piggery usage, the remaining organic fraction is used for making compost. SLRM has achieved great success in segregating the waste in to fractions.

SLRM Centre at Cantonment Board, Amritsar

Organic Waste Converter (OWC) at Trillium Mall

Trillium mall is located at the centre of the city and is one of the few Indian malls that is compliance with LEED guidelines. This mall is owned and operated by TATA Reality and Infrastructure Limited. Spread over 2.2 hectares with 700,000 sq. ft of shopping area, it is the largest mall of Punjab. The Mall management has adopted a culture of paper-less working and works on generating minimum waste where ever it is possible. Mall is having 15 eateries, which generate about 20 kg of organic waste on daily basis. To manage this waste, an Organic Waste Converter (OWC) has been installed in the mall since 2013. The OWC converts all organic waste in to manure, helping the mall administration deal with such waste in-situ.

Facility highlights of OWC machine	
CAPEX	Rs. 9 lakh
OPEX	Rs. 40,000 per month
Manpower	1
Waste generation	20 kg per day
Waste processing capacity	25 kg per batch
Specification of Excel OWC-60	Size: 3 x 3 meter Mixer Size: 60 Litres Batch Size: 25 Kg

Remediation of dumpsite at Chabhal Road

The remediation site located at Chabhal Road was a designated dumping ground of AMC for decades. Dumping of waste has started since 1965 and up till 2005. The dump yard spreads over an area of 3.4 hectares. Remediation of the dumpsite started in June 2018 and the project has been taken up in PPP mode with Essel Infra Pvt ltd Group in collaboration with Hitachi. This legacy waste is segregated with the use of a ballistic separator. After separation manure, RDF, C&D waste is obtained. The garbage is then turned into manure with the bio-treatment. The RDF material is sold to recyclers.

The separator performs effective separation of waste according to different physical characteristics

Facility hightlights of Bioremediation dumpsite	
Total area	3.4 hectares
CAPEX	Rs. 1 Crore
OPEX	Rs. 10 Lakh per month
Method	Gravimetric Separation
Manpower	12
Processing capacity	300 MT per day

Secondary segregation

Secondary Segregation Unit

Tertiary segregation

Composting

Recycled Flower pots

Glass Bottles

Hard Can, Aluminium Foil

Steel, Zinc, Copper items

Dry leaves

Paper cup, Board

Processing of making flower pots

Ballistic separator

of the constituents, known as gravimetric separation. Heavier fractions settle down at the base and lighter ones automatically come up. This method is ideal for separating various organic and inorganic fractions such as, paper/cardboard, metals, polythene, plastic containers and construction and demolition (C&D) waste etc. from biodegradable matter.

The ballistic separator classifies the flow of material into three fractions

1. Heavy and Rolling Fraction (known as 3D) - This includes plastic bottles (PET and polyethylene HD), cans, wood, bricks, stones, etc.
2. Flat and Light Fraction (known as 2D) - This includes envelopes, trays and plastic film (polyethylene LD), textiles, paper, cardboard, etc.
3. Sieved Fraction (known as under-screen fine fraction) - This includes soil, sand, organic waste and small pieces of recyclables.

Recommendation

City needs to reduce the amount of waste which is dumped at dumping site. For this, it is recommended to ensure source segregation at household level. Decentralized waste processing techniques like community composting, SLRM, etc. being practiced by the cantonment board needs to be promoted in other parts of the city. Such centers reduces the amount of waste being transported to the dumpsite and thus savings in transportation cost and land.

To Know More

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Mumbai

Municipal Corporation of Greater Mumbai

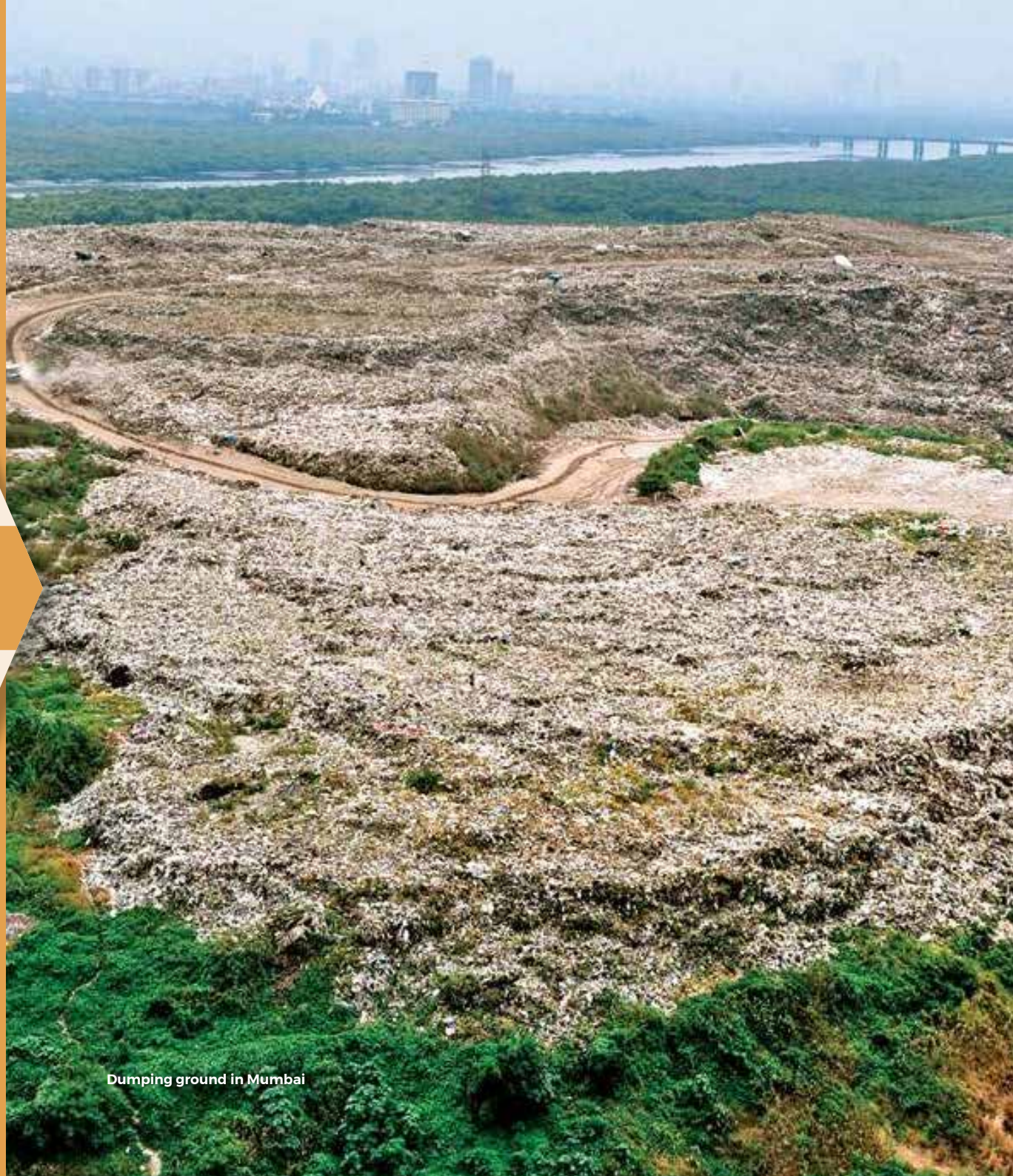
State: **Maharashtra**

Area (in sq. km): **437**

Number of Wards: **227**

Population: **1,24,42,373**

Waste Generated in Metric Tons (MT) per day: **6364**



Dumping ground in Mumbai

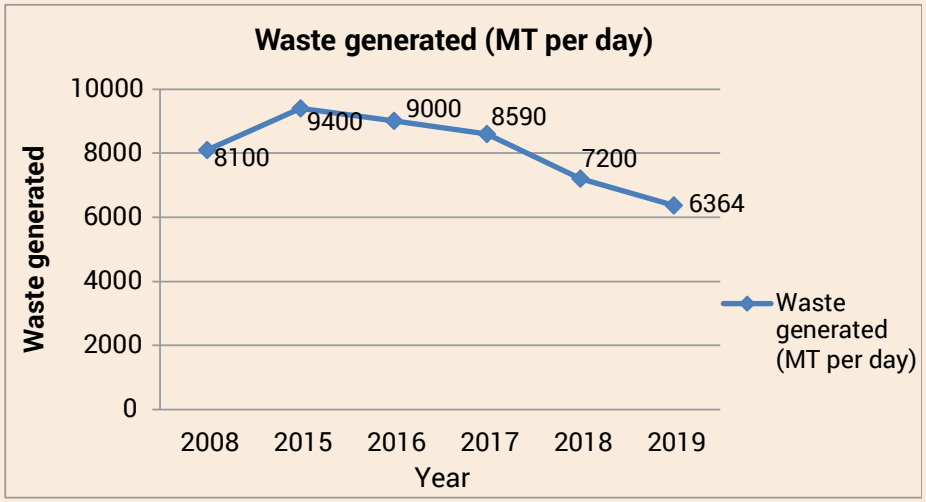
Solid waste management in Mumbai comes under the purview of the Municipal Corporation of Greater Mumbai, also known as Brihanmumbai Municipal Corporation (BMC). It is responsible for providing municipal and civic services, which includes collection, segregation, transportation, treatment and disposal of MSW generated in the city. Mumbai today generates approximately 6364 MT per day of garbage, of which the total wet waste generation is approximately 4450 MT per day and the dry waste generation is 1914 MT per day. In Mumbai the coverage of SWM services through door to door collection is 100%. Waste segregation has gone up to 82% and in next 6 months BMC is targeted to achieve 100% source segregation. The city has approximately 950 garbage collection centers and 37 permanent dry waste segregation centres. Around 325 MT of plastic waste has been collected since the ban has come into effect. Under EPR, companies like Bisleri & Coca Cola are setting up plastic processing units across the city.

The city was awarded the title of "Best State capital/ UT in Innovation and Best practices" in the Swachh Survekshan 2019.

Two bins placed in a commercial area

BMC is spending about Rs 2 crore on awareness campaign and cleanliness activities all over the city. The total SWM budget of BMC is 2366.87 Cr for the financial year 2018-19. The total number of manpower deployed for sanitation is 54885 (which includes the BMC staff and the NGO labourers). Garbage Collection and Transportation costs have come down by around 5 % year on year.

It has been observed that the waste generation in the city has been reduced from the year 2016 by approximately 30%. The graph below depicts the same:



Source: Author

A significant drop has been witnessed in the waste generation of the city since 2016, especially after the development of waste recycling systems, action on bulk generators, waste segregation centres, proper planning and processing of waste. With door-to-door collection, segregation and processing at source, only a small fraction of green waste is going to the dumping ground. 200-250 MT garbage is processed at local level or by housing societies and commercial units. In addition, 1624 bulk generators are processing their waste. As of November 2018, the civic body has collected Rs 27 lakh in fines from bulk generators who are not segregating and composting their waste as per the SWM rules, 2016.

Key highlights

- Over the years, the generation of waste has been reduced in the city.

Monitoring System

Vehicle Tracking and Management System (VTMS)- All the waste collection vehicles are being monitored through real-time VTMS. The system is controlled through a modern "Control Room" which monitors activities round the clock. The VTMS system helps in checking the malpractices and maintains transparency.

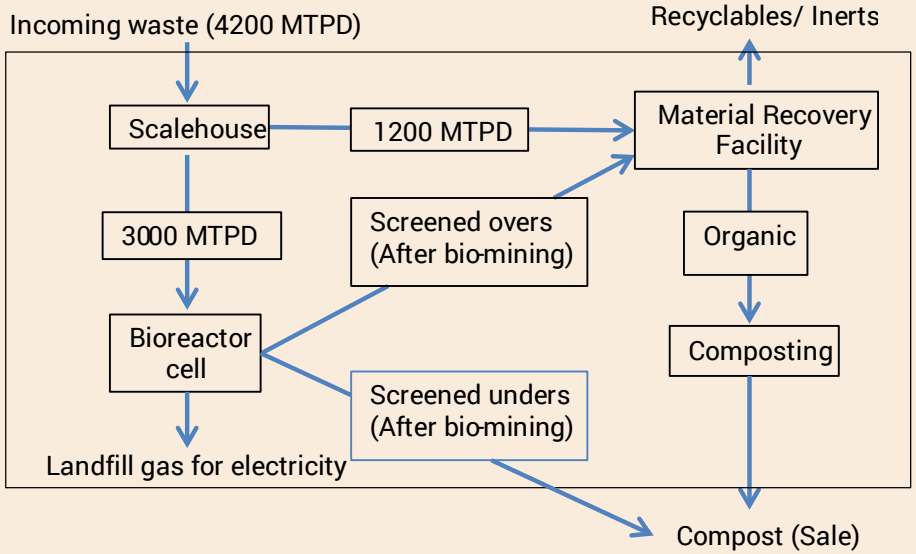
VTMS in Mumbai

Weigh Bridge Management System- The integration of weigh bridges at disposal sites with the capturing of number plate of refuse vehicle is in effect.

Integrated Solid Waste Management Facility

An Integrated SWM facility is located at Kanjur Village (adjacent to Kanjurmarg east), Mumbai. The work of design, construction, operation and maintenance of the ISWM facilities on Design, Build, Own, Operate and Transfer (DBOOT) basis is entrusted to M/s Antony Lara Enviro Solutions Pvt. Ltd.

All the treatment at ISWM facility in Mumbai is done using biological treatment and no chemical is used in the processing, also there are no emissions which affect human health.



Layout of the ISWM facility

The site has a combination of technologies. This centralized processing unit has the following facilities:

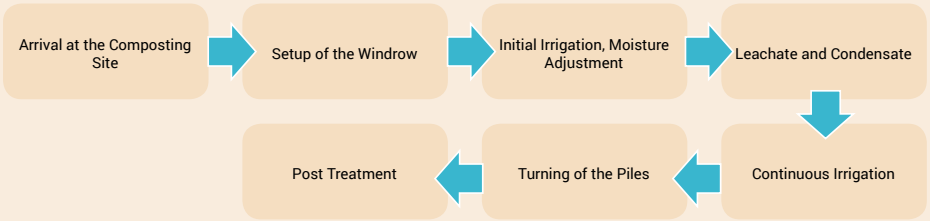
FACILITY 1:	FACILITY 2:	FACILITY 3:	FACILITY 4:
Material Recovery Facility (MRF)	Composting	Bioreactor cell	Sanitary Landfill Facility

In the first phase, 3,000 TPD waste is treated by way of Bio-reactor Landfill technology and 1000 TPD waste is treated by way of aerobic composting technology. In March 2019, the Kanjurmarg MSW Processing Facility's overall intake capacity enhanced to 6000 MT per day.

Material Recovery Facility (MRF) - MSW is collected and delivered to the facility by Mumbai Municipal Corporation. Processing capacity of the facility is approximately 100-300 TPD.

Refuse transfer station- There are four Refuse Transfer Stations viz. Mahalaxmi Refuse Transfer Station, Kurla Refuse Transfer Station, Versova Lagoon Transfer Station and Gorai Refuse Transfer Station. Waste with a capacity of approx. 2000 MT is being handled daily in these refuse transfer stations.

Composting technology – In this technology the mixed solid waste is mechanically and manually segregated into organic component, recyclables and refused derived fuel (RDF). The organic constituent is aerobically composted to generate city compost. 1000 TPD waste is treated by way of aerobic composting technology. Methodology followed for composting:



Bioreactor Landfill (BLF) - In this technology the mixed waste is landfilled and covered for a specific period so that the organic matter present is degraded naturally. The degradation process is controlled through leachate collection and landfill gas extraction. After complete degradation of the material the landfill is mined to recover the degraded organic matter (compost), inert (soil, rock) and refuse derived fuel (RDF). After mining the space is recovered and again used for processing next batch of mixed solid waste. The compost that is produced by the process is used for agricultural purposes and the landfill gas is used for Waste to Energy/Flare.

6,500 TPD waste is treated by way of Bio-reactor Landfill technology. The city has a total of 3 bioreactors. At the Kanjurmarg bioreactor approximately 3200 MT waste is processed.

Sanitary landfill (SLF) site - A Sanitary Landfill (SLF) as per SWM Rules 2016 is used for inert waste material. First action for SLF construction is a compacted base of C and D approximately 3 meters deep and 3.5 meters above High Flood Line. Once the base is prepared, inert waste is then placed inside the SLF. A cover of soil or soil like material is used on all exposed areas of SLF with special attention given to the area worked that day. In addition, the facility has an on-site Leachate Treatment Facility.

Dry Waste Segregation Centre (DWSC)

The DWSC are operated by associations of Ragpickers. They are provided 94 numbers of dedicated dry waste collection vehicles by MCGM for door to door collection and transportation of dry waste. Total number of existing DWSC is 37. The new compactors having separate provision for collection of Dry Waste unload the segregated dry waste at centres. Daily 140 MT of dry waste is received at DWSC. The revenue generated from the activity is kept by the ragpickers. EOI has been floated for 5 numbers of dry waste centre having capacity of 100 MT per day expandable up to 250 metric tons per day.

Garden Waste Management

Key highlights

- 50TPD of garden waste is being treated onsite and is not being sent to the landfill.

Garden waste generated from Municipal Garden is composited on site. The waste is treated and converted into pellets. One site is at Sikova compound Ghatkopar and another site is at Jogeshwari are being operated by Godrej Industries. The project is run on PPP basis without any tipping fee and land lease. Every day around 50 TPD of Green Waste is treated at the above site. No chemical fertilizers are used in any of the municipal gardens.

Dumping Grounds in Mumbai

Key highlights

- 2 dumpsites have been closed and the waste is treated by bioremediation

There were 3 dumping grounds in the city (at Kanjurmarg, Deonar and Mulund) but at present the city has only 2 dumping grounds (at Kanjurmarg and Deonar) as the Mulund dumping ground has been recently closed. There was another dumping ground in Mumbai at Gorai which was scientifically closed way back in 2009.

PARAMETERS	LANDFILLS		
	Deonar	Mulund	Kanjurmarg
Area	120 Ha	32.77 Ha	66 Ha
Type of waste received	Municipal solid waste	Municipal solid waste and Construction and Demolition waste	Municipal solid waste and Construction and Demolition waste
Capacity	2500- 3000 T	Municipal solid waste- 1500-2000 T Construction and Demolition waste- 600- 800 T	Municipal solid waste- 3000 T Construction and Demolition waste- 600 T

Source: BMC's Environment Status Report

Public Participation and IEC

As a part of I-E-C activity, MCGM has organised city level Exhibition for promoting segregation and processing of solid waste at source. Similar exhibitions have been arranged at ward level for creating awareness about segregation, decentralised

processing of waste techniques and options in market. MCGM conducts public awareness and participation programs by staging “Street Plays” and involving dignitaries.

Key highlights

- Major focus was laid on awareness generation and capacity building of the people.

Public Participation through Advanced Locality Management (ALM)- Partnership between Citizens and MCGM for better waste management & other civic issues. Objective is to strengthen and empower citizen groups for participation in the enforcement of the SWM Rules 2016. These groups form the ALM and coordinate with the respective Ward Officer. 719 such ALM groups have been formed. The focus in these ALMs is on segregation/composting of waste at source and trying to achieve zero waste.

Capacity building of staff - Awareness has been created amongst sweepers to ensure that no garbage is being burnt and that different types of waste collected after sweeping are stored separately before handing over to the collection vehicle. Monthly training sessions regarding segregation of waste and storage, processing techniques of domestic treatment of wet waste and attending complaints of citizens are conducted at chowky level.

Awareness programme for plastic waste management- Use of media for spreading awareness about active public participation in minimizing use of banned plastic is being done. 3 day program for creating awareness amongst citizens regarding various alternatives to banned plastic and adopting eco-friendly materials was conducted at NSCI, Worli.

Other Noteworthy Initiatives

1. BMC has proposed that by the end of the year 2019, waste to energy plant and construction and demolition plant would come up in the city. The revised tender for the waste-to-energy plant at the Deonar dumping ground with a capacity of 600 TPD is under process. A budget of 100 crore has been proposed for the same. BMC has also made a provision for 4.5 crores for setting up the construction and demolition waste processing facility for which, the work order is to be issued soon.
2. Clearing of Mulund dumping ground - Bio-remediation of existing landfill site at Mulund Dumping ground & reclamation of land of 20Ha is underway. 70 lakh MT of waste is going to be cleared using Rs. 558.6 crores for 6 years.
3. It is proposed to set up an In-Situ Compost facility at few markets. The tenders for same are invited.
4. Beach Cleaning initiative- Total Length covered is 33.5 Kms. Comprehensive cleanliness of beaches at Girgaon, Dadar- Mahim, Juhu, Versova, Madh- Marve-

Dryer Machine used for composting

Briquetting Machine used for composting

Gorai dumping ground which was scientifically closed

Waste being dumped at the landfill

Public participation & IEC activities

Awareness generation on plastic waste

Beach cleaning of Versova beach

Tourist spot cleaning

Underground bin installed

Gorai has been initiated. For cleaning the Versova beach, Versova Resident Volunteers (VRV) group was formed and they updated their progress regularly on social media. In July 2016, VRV's efforts were recognized internationally as the United Nations Environment Programme (UNEP) called it the "world's largest beach clean-up in history". By March, VRV had cleared 5,000 MT of trash from Versova beach alone.

5. Tourist Spot Cleaning initiative- 35 Tourist Spots identified for cleaning which included Gateway of India, gardens, zoo, etc. which are maintained clean, round the clock.
6. Underground Bins - Underground bins have been installed for first time at 4 locations in the Business District of Mumbai. Compactor compatible standard size bins of 1.1 Cu mtr capacities each, for collection and storage of waste underground have been deployed.

Key highlights

- Beach cleaning initiative- Versova beach cleaning is the 'World's largest beach clean-up".

Recommendation

BMC needs to focus more on improving the status of segregation of waste at source. Presently source segregation is 82% in the city, but according to the SWM Rules 2016, there should be 100% source segregation being practiced in the city. Furthermore, the city needs to initiate effective processing and treatment of the waste especially Construction and Demolition waste generated. Only inert waste should be allowed to be sent to the landfills, for which decentralized waste management can be further promoted.

To Know More

Municipal Corporation of Greater Mumbai
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Lucknow

Municipal Corporation

State: **Uttar Pradesh**

Area (in sq. km): **349**

Number of Wards: **110**

Population: **28,17,105**

Waste Generated in Metric Tons (MT) per day: **1350**

Drying of flower waste

Slum Women in process of making incense sticks

Sale of incense stick

Composting unit at Kanha Upvan

Lucknow has been divided into 6 zones consisting 110 administrative wards. The governing authority for the management of MSW in the city is Lucknow Municipal Cooperation (LMC). The total waste generated in the city is approximately 1350 MT per day.

LMC handed over the task of door to door collection of waste to a leading waste management company named Ecogreen in 2017. Primary collection of waste is done through rickshaw trolleys, hand carts & other carrier vehicles. The collected waste is transferred to the nearest collection points (depots or community bins). From the collection points, waste is transported to the disposal site. About 1100-1200 MT of waste is collected per day from the city.

Currently, the status of door-to-door collection and segregation of waste at source in the city is weak. The practice of segregation of waste into organic and inorganic waste is still not followed in many wards. The existing MSWM system of Lucknow does not have an engineered landfill site for disposal of waste and at present the waste collected from the city is disposed-off at the landfill site at Shivri, located 25km from the city and spread across 46 acres. The site is operational since 2010.

Although the city is still paving its way to improve its solid waste management system, one of the noteworthy initiative taken is discussed as below:

Floral waste to Incense Sticks, Mango Foundation

The Lucknow Municipal Corporation (LMC) has moved into collaboration with a city-based social enterprise "The Mango Foundation" for converting the numerous amount of floral waste generated from the temples and shrines into organic incense sticks and vermi-compost. The Mango Foundation has been involved in improving the living standards of people in the slums of Lucknow from the past 3 years. The Central Institute for Medicinal and Aromatic Plants (CSIR-CIMAP) has also been roped in the project by LMC for scientific expertise.

LMC also approached the management of the major temples and shrines to help in the project. The space for processing of waste is allotted by LMC and a sum of Rs. 10,000 was invested by the enterprise to initiate the project.

Besides handling the waste generated from the temples, the initiative also provides employment opportunities to the people living in slums. Women from the slum area of Nirala Nagar were trained about the process of making incense sticks from the flower waste by scientists from the Central Institute of Medicinal an Aromatic Plants (CIMAP), a prestigious CSIR laboratory. Currently a team comprising 8 women handle the processing work while 4 other members are involved in the marketing of the product. The earnings from the sale of the incense sticks are utilized in providing the salaries to the workers. The compost produced is sold to the farmers at a nominal price.

Key highlights

- Besides handling the waste generated from the temples and shrines, this initiative has helped in empowering the women from the slums by providing them employment opportunities.
- Packaged as 'Happiness Incense Stick', the Incense sticks promises to be 100% natural, toxic chemicals free and lasts for over 50 minutes each.

At first, flower waste is collected from the special designated dustbins from the temples and shrines. Small carrier vehicles are used to transfer the collected flower waste to Kanha Upvan where the flowers are segregated. Fresh flowers are used for making incense sticks while the rest are used for making compost.

After segregation, the flowers are dried under the sun and then crushed to obtain a paste. A little quantity of wood powder is mixed with the paste. Coal powder is used as a coating on the sticks and fragrant oil is also used. As per experts, 30-35 kg of incense can be obtained from a quintal of fresh flowers. So far, the project has converted over 150 Kgs of floral waste into 1.2 lakh incense sticks.

The enterprise plans to expand the project in various phases. It aims to eliminate the all floral waste and convert them into other useful products and provide employment to around 100 people and majorly the women and create market of our products in the nearby cities of Lucknow.

Recommendation

A lot of efforts are required to improve the solid waste management system in the city. Besides improving the efficiency of waste collection, focusing on waste segregation at source would help LMC in handling the waste generated in the city more efficiently and in turn reducing the amount of waste sent to the landfills. Micro-management of waste at housing societies, schools and hospitals, and other such establishments should be promoted.

To Know More

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Jaipur

Municipal Corporation

State: **Rajasthan**

Area (in sq. km): **467**

Number of Wards: **91**

Population: **30,46,163**

Waste Generated in Metric Tons (MT) per day: **1150**

Jaipur generates around 1150 MT of solid waste per day. Door to door collection system is practiced only in a few housing societies of the city which amounts to about 900 MT per day. Segregation of waste is not practiced in the city. Street sweeping is done in core areas and major business districts of the city. In other areas it is done twice a week. About 6400 streets sweepers are engaged for this purpose. Transportation of the collected waste is done majorly through 3-wheelers, tractors and trucks. The vehicles are loaded manually and these are used for 2-3 shifts in a day. There are three disposal sites in the city, viz. Mathura Das Pura, Langariyawas and Sewapura. One of the good approaches followed in the city related to manage urban sanitation issues is the application of SAHAY Single Window Interventions coupled with community engagaement.

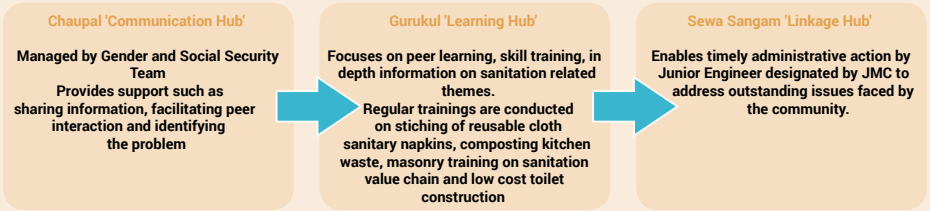
SAHAY Single Window Intervention

The SAHAY Single Window was set up in Ward No. 62, Jaipur city, in August 2017 to strengthen community engagement and administrative convergence to regulate unsafe sanitation practices. The one-stop community-led sanitation node aims to ensure well co-ordinated service delivery, and enables the community to secure timely intervention for services. This intervention was conceived, anchored and facilitated by Centre for Advocacy and Research (CFAR). It was set up by CFAR in collaboration with Jaipur Municipal Corporation (JMC). The idea of a Single Window found support in the community, as well as with JMC, Department of Health, and Directorate of Local Bodies (DLB), given the poor access to sanitation services in the area.

A Single Window is a physical space or facility, which serves as a focal point for all operations associated with improving delivery of services. Activities such as reaching out to communities, building their capacity and subsequently supporting them in applying or demanding appropriate and essential services and providing support to ensure that services and programmes are duly delivered. The Single Window is sustained until the needs of the local communities are realized or fulfilled.

The Single Window is managed by community representatives, many of who are volunteers, and also includes frontline workers appointed by the government for various programmes. As frontline workers are tasked with reaching out to the entire community, including collaborating with grassroots bodies, they find a physical space such as the Single Window effective in mobilizing the community, especially those who are difficult to reach. Having a space close to the local community helps to win trust and reinforce vital messages. More importantly, a Single Window brings together key persons and influencers who can drive change, open up opportunities, and help facilitate scale up and replication. This includes influencers from both the government and private sector. To facilitate this level of support to the Single Window, the primary focus is on collective visioning between all stakeholders to develop a shared perspective and shared framework of principles, thrust, approach and objectives so that all key processes get taken

forward in a well-coordinated and purposeful manner.



Institutionalising of the Single Window Intervention

In March 2018, in response to the findings of a survey conducted on Faecal Sludge Management (FSM) in Ward 62 of Moti Dungri Zone, the JMC issued a Government Order deputing a Junior Engineer (J. E) to be present at the Single Window thrice a month.

The Single Window Forum members interact with the J. E and other ULB functionaries and service providers like Assistant Engineer (A. E), Chief Sanitary Inspector (CSI), Sanitary Inspector (SI), desludging operators and Supervisor-SWM and submit resolutions passed by their respective Community Management Committee (CMCs) demanding specific improvements and redress. They also facilitate visits of service providers to the concerned areas so they can see for themselves the nature and extent of the problem. The convergence of services establishes a meaningful communication between the affected community and their representatives and the ULB officials and service providers.

Scaling of Single Window Intervention

The Single Window had scaled up its interventions across seven Wards within a 10 km radius covering two Zones of JMC1, reaching out to 17,013 households across 46 settlements by April 2018. Of these, 6,800 households have been linked to Sanitation Services directly and 10,200 households have benefited indirectly through increased information and understanding on Faecal Sludge Management (FSM) and Solid Waste Management (SWM). The Single Window connected with communities of these settlements through various processes. These include Rapid Participatory Appraisals (RPAs); joint micro-planning by ULB officials and CMC and Daksha Samooh; meetings of CMC and Single Window Forum members; through orientation and knowledge camps on FSM and SWM. In addition, in collaboration with concerned departments enrolment camps on social security schemes were held in the different Wards. The Single Window Forum remodeled itself to accommodate active members from the new Wards in two Zones of JMC. At present there are 61 Single Window Forum members drawn from CMCs across the 7 Wards from 20 settlements. In April 2018, JMC Hawa Mahal Zone nominated 18 Point Persons or Lead Representatives across three Wards and 18 settlements to represent JMC across the seven wards of the Single Window. These Point Persons lead all joint assessments and site inspection visits across the 46 settlements. They bring concerns of the people to the J. E for on the-spot resolution. The Single Window is working closely with NUHM in building capacity of Mahila Aarogya members on the Sanitation Value Chain.

Key Highlights

The SAHAY Single Window is now functioning like a one-stop equity centre. It has become a mechanism of convergence between the community and ULB officials and allied departments and stakeholders like Resident Welfare Association (RWA) representatives, local service providers, youth and adolescents. Single Window has enabled representatives of women's forums and community facilitators who are well versed with the schemes and programme to assist all departments in ensuring a systematic last mile delivery.

- Four Government Orders, One Inter-Departmental Directive have been released by the Jaipur Municipal Corporation mandating presence of Junior Engineer nomination of point persons and release of toilet subsidy
- 6800 households linked to Sanitation services directly
- Out of 153 Cases registered, 118 have been resolved benefiting 11,800 households directly
- Timely desludging rate has increased from 1% in 2016 to 3.2% in May 2018
- 30 timely desludging of septic tanks and single pit done

To Know More

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Aurangabad
Municipal Corporation

State: **Maharashtra**

Area (in sq. km): **139**

Number of Wards: **122**

Population: **11,75,116**

Waste Generated in Metric Tons (MT) per day: **400**

Aurangabad Municipal Corporation (AMC) is divided into 9 zones each given around 9 to 13 wards. It currently generates about 400 Metric ton (MT) of municipal solid waste from about 0.25 to 0.3 million housing units. There is 100% door to door collection of waste in the city. Waste is collected three times a day. Around about 145 vehicles that includes tippers, trucks, tractors, JCB and loaders are used for the waste collection transportation and handling of solid waste. Around 1545 sanitary workers and 48 supervising members are engaged in solid waste management of the city. Waste is being segregated post collection near Central Naka area of Aurangabad city. Overall 10% of disposed waste is being recycled currently and the remaining is being disposed of at the dumpsite at Naregaon. The AMC along with Civic Response Team (CRT) is playing an import role of reducing the amount of waste going to landfill by applying waste segregation at various wards. AMC has been working on various latest methods to reduce waste reduction at source level which include encouragement by public awareness campaign and penalties on citizens for unmindfully spreading solid waste.

"Mazhi City Taka Tak" Campaign

The AMC initiated the *Mazhi City Taka Tak* (MCTT) campaign, with residents, NGOs, corporate sectors and elected representatives thereby joining hands with the civic bodies focusing on a long

Volunteers of the "Mazhi City Taka Tak" Campaign

term policy on garbage collection system. The MCTT was launched on January 2016 by the civic body in collaboration with Bajaj Private Limited, Confederation of Indian Industry (CII) and Civic Response Team (CRT). 12 wards in 6 zones of Aurangabad were selected for this campaign.

Volunteers of the "Mazhi City Taka Tak" Campaign

The Civic Response Team (CRT) designed and conducted a comprehensive capacity building program on Solid Waste Management (SWM) for the Sanitation Department of Aurangabad Municipal Corporation (AMC). A total 18 wards, 2 from each zone, were selected based on the deliberation with the team. While selecting the wards equal importance was given to the amount of work carried out in that ward and the results obtained. Survey was conducted for households, Sanitary Inspectors, Jawans and Safai Karmacharis from each of these wards. Training not only covered the technical knowledge but also focused on the soft skills such as team work and effective communication.

Awareness programs were organized for the residents, to inform them regarding the new system and the segregation process. In the course of the campaign, AMC propagated the practice of door-to-door collection of segregated wet, dry and biomedical waste. Around 5580 gunny bags and over 10,000 Personal Protective Equipment (PPE) were distributed to the Safai Karmacharis to facilitate segregated collection. Efforts were made to compost and generate biogas out of the wet waste and recycle the dry waste. Instead of limiting the efforts to training residents on source segregation, residents are encouraged to become active participants by monitoring the work in their areas, participating in/ organizing awareness drives/ events etc. The main forms of resident awareness and involvement included the following:

- Rallies with school children
- Events to reclaim old dumping points
- Awareness programs with "Mahila Mandals", society members, youth groups etc.
- Events led by local corporators to generate awareness
- Caller tunes with information regarding waste segregation
- Engagement of local artists and performers
- Presentation on home composting/ biogas by experts
- Events for appreciation of sanitation staff
- Print, audio and visual media.
- Development of audio materials to play on primary collection vehicles

AMC has also banned the use of plastic bags under 50 microns and started a cloth bag campaign where bags made of recycled cloth are being encouraged.

The campaign has helped to get rid of over 740 dumping points from around 34 wards, catering to over 70,000 households. In a bid to avoid more burden on Naregaon dumping ward, the citizens cooperated with the civic body in the *Voluntary Garbage Disposal Scheme* (VGDS). Efforts were made to stop littering on streets and burning of dry leaves. This has enabled the civic body in curbing transportation expenses to the dumpsite and saving Rs. 1.5 crore per month. Currently, 89.7% citizen store their household waste in segregated manner.

Citizen engagement under the "Mazhi City Taka Tak" Campaign

Recommendation

The IEC activity carried out has created a positive response about the management of solid waste in the city. The civic bodies along with the NGOs should try to replicate it in a phased out manner at different wards to achieve Zero Waste Status.

To Know More

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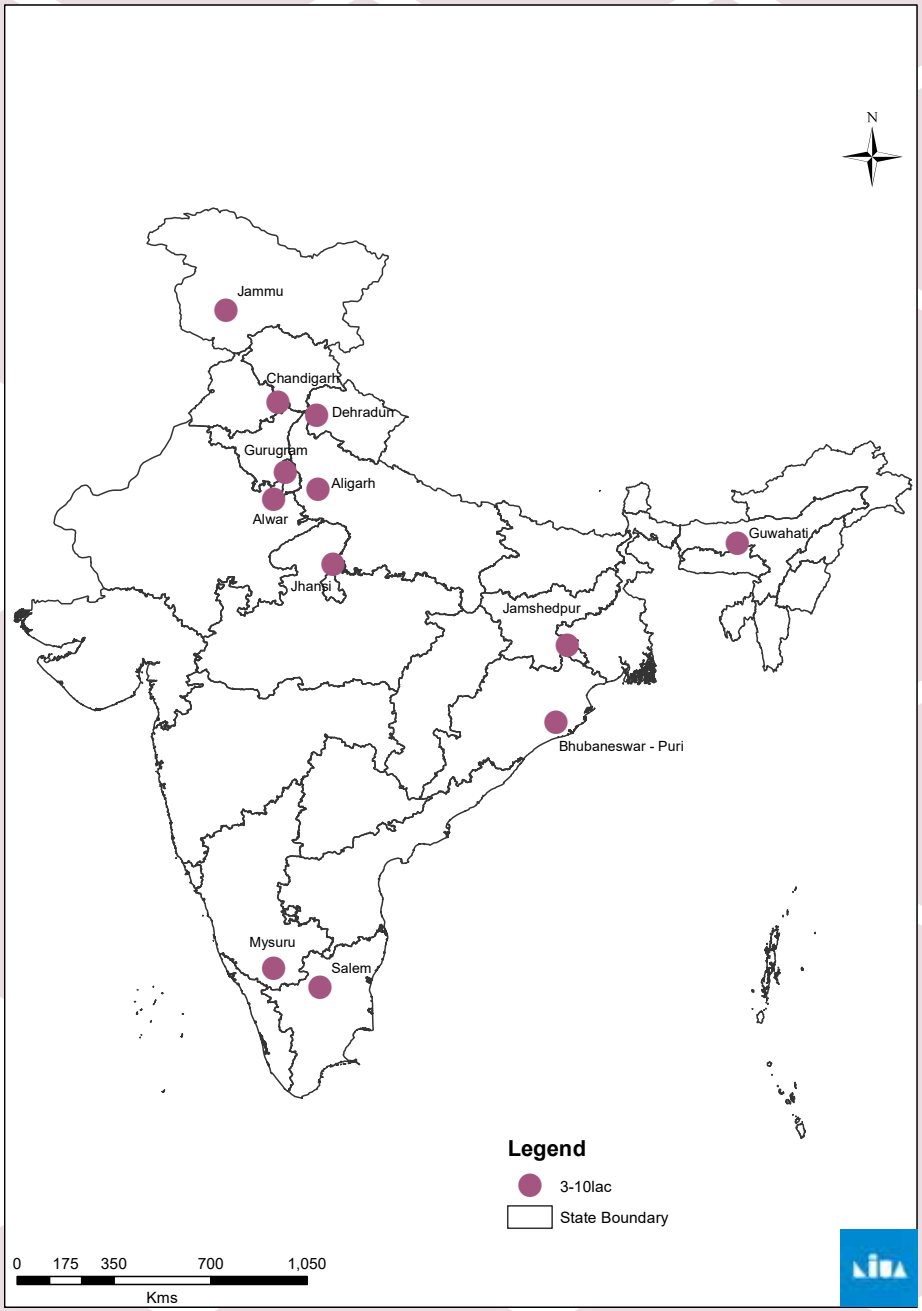
Aurangabad, Maharashtra-431001
Email: contact@aurangabadmahapalika.org
Contact No. 02402333536

Cities with population:

3-10 Lakh



Chandigarh

Municipal Corporation

Union Territory: **Chandigarh**

Area (in sq. km): **114**

Number of Wards: **26**

Population: **9,61,587**

Waste Generated in Metric Tons (MT) per day: **425**

MSW Processing Plant

Solid waste management in Chandigarh comes under the purview of the Chandigarh Municipal Corporation. Chandigarh today generates 425 MT per day of garbage a day and has an effective door to door waste collection system to address this waste. Out of the total waste generated 50-55% comprises mainly compostable organics, 15-20% inorganic waste and 25-35% of the waste consists of inert waste.

The city was awarded the title of "Best State Capital/UT in Solid Waste Management" in the Swachh Survekshan 2019.

Roads and community spaces of all the residential as well as commercial areas are clean as they are swept twice a day. The city has its own mechanism in place to manage construction and demolition(C&D) waste as per C&D Waste Management Rules, 2016. A cradle-to-grave approach has been adopted by the ULB for proper management of C&D waste.

Nearly 100% of the operational cost of sanitation and SWM is covered by property tax, user charges and advertisement rights on Community toilets/Public toilets and litter bins. The city has an integrated waste processing facility where the wet and dry waste are treated.

Segregation, Collection and Transportation

Chandigarh city ensures 100% door to door garbage collection from all the households. The city has achieved approximately 95% segregation of waste at source from both residential and commercial areas. Primary collection of the waste is done directly from households, institutions and other commercial establishments by tricycles and mechanized small vehicles. In Chandigarh, the Corporation has constructed buildings called Sehaj Safai Kendras (SSKs) as primary collection centers.

Sehaj Safai Kendra

Facility highlights of waste segregation and collection	
Wards covered	26
Total number of SSKs	38
Waste received	1.8-2.7 MT per day per SSK
Manpower	114 for all 38 SSKs
CAPEX	Rs. 1,90,00,000 for all 38 SSKs
OPEX	Rs. 1,90,000-2,00,000 per month for all 38 SSKs

Key highlights

- The SSKs help in managing the waste within the community under a hygienic condition.
- It also gives the administration an opportunity to integrate the waste pickers into the system and make them part of the formal economy.

At present, there are 38 SSKs operational at various places in the city. Small, compact sized waste collection bins are placed inside the SSKs, where the Safai Karmis manually segregate the waste which is not segregated at source or which is to be further segregated. The SSKs are basic, low cost units that do not require any heavy equipment or machinery for their functioning.

The waste from various dustbins and SSKs is transported to either the waste processing plant or the landfill site by vehicles owned by the Municipal Corporation or hired from private bodies. A total of 133 conservancy vehicles are deployed for collecting and transporting the solid waste generated by the city.

Processing and Disposal

Part of the solid waste in Chandigarh is processed at the Green Tech Fuel Processing Plant (A unit of Jaiprakash Associates Ltd.) located near the designated landfill site at Dadu Majra village. The organic, bio- degradable waste is processed to manufacture compost, while inorganic, combustible waste with high calorific value is segregated as Refused Derived Fuel (RDF). Part of the solid waste is treated in their Bio-methanation plant. However, the fraction of such waste being processed at the Bio-methanation plant is negligible compared to the total waste generated in the city.

In Chandigarh, as processing is limited to the recorded amount of 250 MT per day, most of the MSW collected is directly dumped at the landfill site at Dadu Majra.

Integrated Solid Waste Management Facility

The Integrated SWM facility is located near the landfill site at Dadu Majra. The facility is spread over 11 acres out of which 5.5 acres is for the RDF plant and the other 5.5 acres for the composting facility. The facility was built on a PPP model between Chandigarh Municipal Corporation and Green Tech Fuel Processing Plant. Green Tech is responsible for the complete processing of the waste sourced from the corporation, manufacturing compost and deriving the refuse derived fuel from it. The Total Capital expenditure of the facility is approximately 7.5 crore and the total operational expenditure is 3.5 lakh per month.

The Refuse-Derived Fuel (RDF) obtained from the plant has a calorific value of 3100 Kcal/Kg, while the moisture content is less than 15%. The plant has installed state-of-the-art European technology, which is customized keeping in view the characteristics of Indian solid waste and its composition. The various processes involved at the RDF facility are depicted in the diagram below:

Uploading and Manual Separation: The tipper trucks are weighed at the weighbridge and then are loaded on the tipping floor.

Homogenization: The particle size of waste varies widely and is difficult to process unless particle size is homogenized.

Size Reduction: A primary shredder is used to cut down the waste to less than 150 mm. After size reduction, the output proceeds towards further processing

Drying: The waste is fed into a Rotary Dryer by conveyer. The wet waste is dried by injecting hot air into it. This reduces its moisture content to 15%.

Segregation: The matter coming out of the Rotary Dryer is fed into the Rotary Trommel. Fine particles below 10 mm particle size are separated.

Densification: RDF-pellets are produced by densifying the fluff in the "Special Purpose Densification Unit". The bulk density of RDF-Fluff is reduced by minimum of 5 times.

Process Flow Involved in the RDF Facility

Apart from RDF, the facility also produces good quality compost through the process of aerobic composting. After maturation, waste is processed in 35 mm trommel followed by the 16 mm trommel. The rejected inorganic waste from both the trommels is transferred to the Secured Landfill (SLF) while organic waste is again transferred to windrows for further decomposition.

Key highlights

- The efficiency in collection and transportation of waste to the facility becomes a major challenge.

MSW Processing Plant

The Concrete tiles are put in pond for curing

Concrete mix is poured into the frames and left to set

After the final quality testing, the produced compost is packaged into bags and sold at approximately Rs.150 per ton

Construction & Demolition Waste Processing Facility

Chandigarh city is reusing the C & D waste which is collected from 23 designated sites for disposal. A C&D waste processing facility has been set up over 2.5 acres of land. The site is located in the Industrial area phase-1, which was earlier used for waste disposal in the year 2016-17. Besides the processing unit, the plant also has a manufacturing unit producing Plain Concrete Cement (PCC) products to be used for pavements, road work, fencing work, etc.

The plant has a processing capacity of 45-55 MT per day, however the corporation is currently in the process of further enhancing the plant and its processing capacity.

The process followed at the C &D facility is depicted in the diagram below:

Facility highlights of the C&D processing plant	
Capacity of the facility	45-55 MT per day
Area of the facility	2.5 Acres
CAPEX	Rs. 3 Crore
OPEX	Rs. 200 TPD for processing the waste and Rs 200 TPD for collection of waste
Products obtained	Plain Concrete Cement (PCC) products
Manpower	25

Key highlights

- The corporation is currently in the process of further enhancing the plant and its processing capacity.
- Besides manufacturing many value added products like concrete blocks, such as kerb channels, PCC tiles etc., the project has also helped generate employment opportunities for many.

C&D waste Recycling Process

Bio-Methanation-cum Electricity Generation Plant

The Bio-Methanation-Cum Electricity Generation Plant located in Industrial area, Phase-1 of Chandigarh. The plant was established by Chandigarh Municipal Corporation

whereas designing and execution was done by Avi Plast Garbage Treatment Projects, Mumbai. The project was commissioned in November, 2015 and inaugurated in November, 2016. The total area of this facility is 150x150 feet and processing area is 450sq.ft. The plant has a daily intake capacity of 4.5MT per day of organic municipal garbage that comprises of kitchen waste, paper, grass, gobar (cow dung), dry leaves etc.

Facility highlights of the biomethanation plant	
Capacity of the facility	4.5 MT per day
Current processing capacity of the facility	3.2 MT per day
Technology used	NISARGRUNA' Technology developed by Bhabha Atomic Research Centre (BARC)
CAPEX	Rs. 96 Lakh (16 lakh Rs for 0.9 MT per day capacity)
OPEX	Approx. Rs. 1.6 Lakhs per month
Products obtained	Biogas and weed free good quality manure
Manpower	5

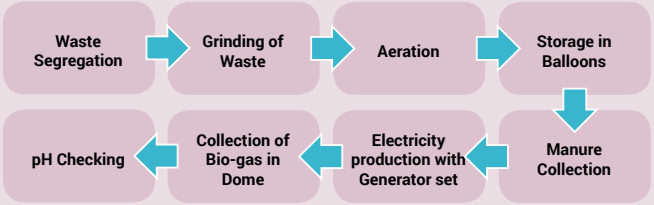
NISARGRUNA technology offers a "Zero garbage, Zero effluent" method for waste management. Unlike conventional bio-gas plants that can handle only cow dung and/or human waste, BARC's NISARGRUNA technology has the capability to process almost any biodegradable waste, such as kitchen waste, paper, grass, cow dung, dry leaves etc. This makes, such bio-gas plants a good potential for energy generation in this biphasic-bio- methanation plant.

Key highlights

- Generation of good amount of high-calorie fuel gas
- Generation of high-quality, weed-less manure, which is an excellent soil conditioner.

The gas is used to generate electricity with the help of a generator set. The electricity so obtained is used to light the street lamps. Proper record of the materials taken in to the plant from all the sources is maintained through a register.

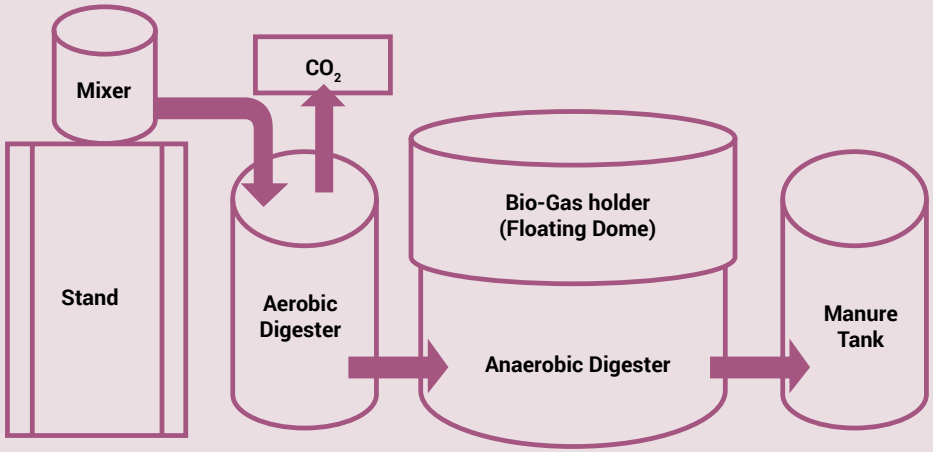
The process followed at the Bio-Methanation-Cum Electricity Generation Plant is depicted in the diagram below:



Source: Chandigarh Municipal Corporation

Bio-Methanation-Cum Electricity Generation Plant

Compost produced and packed for sale



Schematic Bio-Methanation Plant Layout

Decentralised Onsite Composting in gardens

Decentralised Onsite Composting

Onsite composting is an initiative taken by Chandigarh Municipal Corporation to deal primarily with the large volumes of garden waste that is generated at various parks, residential colonies, schools, institutions and similar places. The idea is to minimize dumping of such waste to the landfill and utilising the same for producing compost at the place of generation. For this, a standard structure is built as composting pit with a steel wire mesh surrounding it. All the garden waste is put inside the pit layer upon layer and some water is sprinkled to help decomposition. Once the pit is filled, it is left for composting. It takes about 60 days for this system to prepare compost.

Recommendation

Chandigarh has effectively implemented 100% door to door collection and claims to have achieved 95% source segregation. The city needs to achieve 100% segregation of waste at source in the true sense. More than half of the city's waste is left unprocessed and is going to the dumpsite, the city needs to improve the amount of waste being processed. Furthermore, the city needs to reduce the amount of waste going to the landfill and it should ensure proper processing of the waste generated in the city.

To Know More

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Website: http://mcchandigarh.gov.in/
Contact Number: +91-172-2541002

Mysuru
Municipal Corporation

State: **Karnataka**

Area (in sq. km): **128**

Number of Wards: **65**

Population: **8,93,062**

Waste Generated in Metric Tons (MT) per day: **420**

Segregation of dry waste at Kumbarakoppal, Mysuru

The municipal solid waste management in Mysuru Municipal Corporation (MCC) includes door to door collection, street sweeping activity and secondary collection and transportation. There is 100% door to door collection of waste in the city. Among the 65 wards, collection of waste in 62 wards is handled by 620 outsourced labourers. The collection in the remaining 3 wards are managed by the Federation of Mysore City Wards Parliament (FMCWP) by engaging 30 workers. About 168 auto tippers and 396 pushcarts have been deployed by MCC for the door to door waste collection.[1] The daily movement of all the garbage collection vehicles is monitored by Global Positioning System (GPS) and Radio Frequency Identification (RFID).[2]

Street sweeping and drain cleaning activity in Mysuru takes place during the daytime from 6.30 A.M to 2.30 P.M. It is partly handled by the "Pourakarmikas" of MCC (17 wards), and partly by outsourced labourers (47 wards). Only in ward 28, it is managed by the Federation of Mysore City Wards Parliament. Truck mounted street sweeping machines are used for night sweeping of core area and main roads. Among the 420 MT per day of waste that is collected, about 181 MT of waste per day is sent to centralized compost plant at Vidyaranyapuram. Around 23 MT per day is sent to 5 Zero Waste Management (ZWM) plants located at 5 different zones of Mysuru city. These ZWM plants each have a capacity of 4.5 MT. About 4.5 MT of fresh market waste is sent to Pinjrapole Society where the waste is fed to the stray cattle. The remaining waste comprising of the rejects from the compost plant and zero waste management plants are sent to the sanitary landfill site at Vidyaranyapuram .

Solid waste profile of the city	
Total Quantity of Waste collected	420 MT
Waste sent to centralized compost plant	181 MT
Total Waste sent to the 5 ZWM Plants	23 MT
Waste sent for feeding cattle	4.5 MT
Rejects from compost Plant and ZWM Plant that is sent to the sanitary landfill	208.5 MT

Zero Waste Management (ZWM) Plant at Kumbarakoppal

The "Zero Waste System" at Kumbarakoppal was started in 2005 and covers 5 wards of Mysuru Municipal Corporation. The population served is 20,000 and waste collected per day amounts to an average of 9 MT. The FMCWP operates the solid waste management system in this area. It is entrusted with the work of collection, segregation and selling of waste. The system occupies an area of 0.6 ha of land and accommodates a segregation area, compost beds, shed for storage of segregated waste and vehicle parking area. Two people are assigned for door to door collection of waste from the wards from 7 AM to 10 AM. Residents have been provided with two plastic bins for separation of wet and dry waste. About 75% of the waste gets segregated at this stage.[3] Transportation of wet and dry waste is done in vehicles but with two different compartments. Each vehicle has an average capacity of 400 kg. Collected dry waste is transported to the segregation plant. The wet waste is directly supplied to the composting beds.

Facility highlight of ZWM Plant	
Area of the facility	0.6 ha
Processing Capacity	4.5 MT per day
Quantity of compost produced	2.5 – 3.5 MT per month
Manpower	30
OPEX	Rs. 2.68 lakh per month
Revenue Generated	Rs. 11,000 per month

Key highlights

- A 'Stree Shakti' group is formed by local women which works for social awareness, daily report of waste collection and cooperation between workers and public at Kumbarakoppal.
- The net profit from the solid waste management system is utilized for providing medical and educational facilities to workers. .

Segregation of dry waste is done in two stages. In the first stage, segregation of plastic, glass, and soft plastic is done. The second stage involves segregation of the sub parts of each material for marketing i.e. plastic with different colors and thickness. Segregation of dry waste is done in 17 categories, viz. (i) Milk covers (ii) Plastic bags (iii) Tablet (iv) Bulb (v) Oil packets (vi)Glass pieces (vii) Shoes (viii) Black Plastic (ix) White Plastic (x) Colored Plastic (xi) Tooth paste (xii) Cardboard (xiii) Waste Paper (xiv) Tins (xv) Road waste (xvi) Beer bottles (xvii) Plastic Bottles. Segregation of all material is done manually. Segregated bio degradable waste is directly dumped in composting beds. Each bed has a dimension of 3m x 3m x 1.8m.Usually two months are required to completely fill one composting bed. The compost is sold to local farmers.

Vermicomposting and Biogas plant at Mysore Zoo

Sri Chamarajendra Zoological Gardens, popularly known as the Mysore zoo, has a daily garbage generation of around 1000 kg per day and comprises majorly of animal dung and some amount of food and horticulture waste. In Mysore zoo, bed vermicomposting method is adopted to process the organic waste. The dung from the enclosure is transported to the vermicomposting yard and heaped. Usually 8 to 10 days is sufficient to prepare one bed. The partially decomposed green material is placed over the heaped dung and mixed thoroughly and made into a bed. The zoo uses the Eudrilus eugenae species of earthworm, as they are prolific breeders with high multiplication rate. The bed

[1] http://www.mysorecity.mrc.gov.in
[2] Swachh Survekshan Report, 2019
[3] Zero Waste Management System: Case Study- Kumbarakoppal, Mysore, International Journal of Engineering Research & Technology (IJERT) Vol. 6 Issue 05, May - 2017

site should be free from all debris. In the case of hard ground, flooring is generally not required. Otherwise, flooring with locally available stones is prepared for the purpose of sieving and packing. Regular watering is carried out twice a day for about 10 days, then once a day for another 10 days and then on alternate days until vermicomposting is complete. This process helps to soften the raw material and maintain the required moisture in the bed. The earthworms are released into the bed thus prepared. The population slowly builds up, with an initial contribution of approximately 10 kg of earthworms.

Facility highlight of Vermicompost Plant	
Area of the facility	298 sq. m.
Quantity of input	0.9 MT per day
Quantity of compost produced	1 – 1.5 MT per day
Price of compost	Rs. 2800-5000 per ton
Manpower	5

Facility highlight of Biogas Plant	
Quantity of input	1.3 MT per day
Quantity of biogas generated	120-130 cu. m. per day (Equivalent to 2-3 commercial LPG cylinders per day)
CAPEX	Rs. 2.5 crore
Manpower	3

After one month, black, granular, lightweight and humus-rich compost gets ready. To facilitate the separation of the worms from the compost, watering should be stopped 2 to 3 days before emptying of the beds. This forces about 80% of the worms to the bottom of the bed and the remaining worms can be removed by hand. The harvested vermicompost is then sieved to remove any debris and other waste before weighing and packing.[4]

In order to reduce the dependency on LPG cylinders, the Zoo Authorities has set up a biogas plant within the zoo premises adjoining the vermicomposting unit. The dung from the elephants forms 70% of the total waste produced in the zoo. It is rich in fibre content, which helps in the production of biogas. The byproduct, slurry, can then be used to produce manure. The biogas plant works on the principle of biomethanation/ anaerobic digestion of waste to generate biogas. The anaerobic digestion occurs in three phases, hydrolysis of organic solids, acetic acid formation and biogas production. The biogas plant is of floating drum type having a capacity to process 1.3 MT of organic waste per day.

Key highlights

- To boost the sales of vermicompost, the zoo authorities have started the process of registration of the brand with the Weights and Balance Department, Government of India. The compost is available for purchase at the zoo precincts for visitors, farmers and horticulture department.

[4] B., D. P. (2019, January 28). Sustainable use of vermicomposting in Mysore zoo, India. Retrieved from www.academia.edu.

Segregation of dry waste at Kumbarakoppal, Mysuru

Biogas facility at Infosys Campus, Mysore

Scrapyard for segregation of waste into various categories at Mysore campus, Infosys

"Zero Waste Campus" of Infosys

Facility highlight of Biogas Plant	
Quantity of input	1.5 MT per day
Quantity of biogas generated	140 cu. m. per day (Equivalent to 3 commercial LPG cylinders per day)
Manpower	2-3

The Infosys Mysore campus is a mini city spread over 350 acres that hosts more than 15,000 trainees residing on campus, more than 8,000 employees and several thousand contract workers. Segregation and composting holds an important position in the company's food waste management agenda. From 2012, Infosys adopted 100% segregation and on- site food waste treatment policy. Today, the campus has standardized the color, size and visual communication materials for food waste collection at food courts resulting in 100% segregation. Hazardous waste and e-waste are disposed to authorized recyclers, who possess the required clearances from the Pollution Control Boards. Paper waste is sent for recycling to authorized vendors who in turn provide recycled paper products in return.

The biogas plant at the campus uses segregated food waste from the food courts on a daily basis for gas generation. The food waste is anaerobically digested in the biogas digester from which it is directed to the storage unit. The plant provides gas on demand basis as per the needs of the food courts.

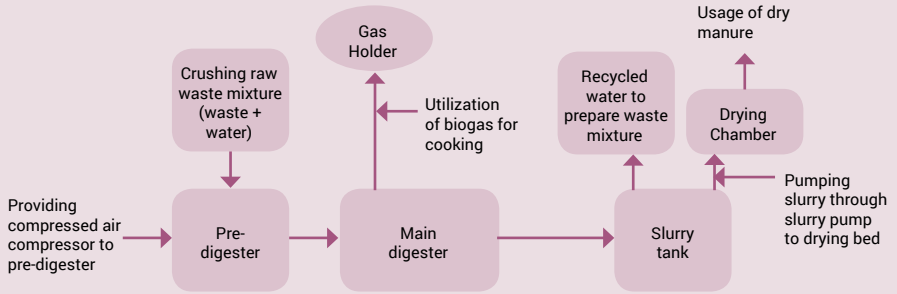
he plant is fully-automated and integrated with the building management system (BMS) to facilitate online monitoring on a continuous basis thereby minimizing manual intervention. The plant is estimated to generate about 140 cu.m. of gas per MT of food waste.

Bio-methanation at National Institute of Engineering Campus

Facility highlight of Bio-methanation Plant	
Area of the facility	50 sq. m.
Quantity of input	60 kg per day
Capacity of plant	100 kg per day
Quantity of biogas generated	6 cu. m. per day
Quantity of manure generated	6 kg per day
CAPEX	Rs. 5.5 lakhs
Manpower	2
Savings	Rs. 182 per day through biogas and Rs. 21 per day through manure

NIE-CREST has come up with kitchen waste-based biogas plants (KWBP) to manage wet waste generated from their canteen. This plant digests rice starch, used rice water, used tea and coffee powder, leftover rice and sambhar, waste flour, over-ripened fruits, used edible oil, vegetable waste and other cooked waste from the kitchen. The plant produces biogas that is used for cooking purposes in the canteen itself. The slurry is used as manure for the kitchen garden. The plant is designed, established and maintained by NIE-CREST.[5]

[5] https://issuu.com/ragpickervendors/docs/60kg_biogas_plant___ptc_mysore



Flowchart of the process involved in the Biomethanation plant

Recommendation

Solid Waste Management (SWM) initiatives in the city of Mysuru largely focuses on decentralised action. The ZWM at Kumbarakoppal promotes local community to participate in SWM. Reuse of non-biodegradable waste and minimization in quantity of waste generation makes this system environment friendly. Not only is the dry waste recycled, but also the system generates revenue from its sale. Similar models of ZWM should be followed in more wards of the city. The impetus of institutional Campuses like Infosys and NIE-CREST towards sustainable practices are sure to go a long way in instilling responsible citizen behaviour among the residents of big campuses.

Key highlights

- The biogas plant at NIE-CREST has an annual savings of Rs. 66,576 due to the replacement of LPG and Rs. 10,950 from the manure production. Thus, the total returns from the facility amounts to around Rs. 77,525 per year.

To Know More

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Salem
Municipal Corporation

State: **Tamil Nadu**

Area (in sq. km): **91.4**

Number of Wards: **60**

Population: **8,29, 267**

Waste Generated in Metric Tons (MT) per day: **400**

Salem City is the district headquarters of Salem district. Solid waste management in the city comes under the purview of the Health and Sanitation department of Salem City Municipal Corporation (SCMC). The city is divided into 60 wards and categorized under four zonal offices namely Suramangalam, Hasthampatty, Ammapet and Kondalampatty. Out of the 60 wards, the solid waste management in 21 wards is privatized, while in the remaining 39 wards, the city municipal corporation is carrying out the SWM activities. A team of 28 sanitary inspectors, 38 sanitary supervisors and 1464 sanitary workers are engaged in SWM activities.

Push carts (242) and battery operated vehicles (29) are used for the primary collection of solid waste. Street sweeping is carried out at regular intervals in all wards and 180 workers are entrusted with the task. Through IEC (Information, Education, Communication) people are sensitized to keep the biodegradable and

Solid Waste Profile of The City	
Total quantity of solid waste generated per day(MT)	400 MT
Quantity of Waste Processed per day (MT)	
Bio-methanation	7.5 MT
Recycling	15 MT
Composting	38.5 MT
Total Quantity of waste scientifically processed (MT)	61 MT (15.25%)

Source: Retrieved from http://salemcorporation.gov.in/download/rf.6%20-%207.scientific%20disposal.pdf

Waste collection near Kanchi Nagar Park

non-biodegradable waste in two separate bags. At collection point itself separate containers are used for segregated collection of waste at source. The collected waste is then transferred to either dumper placer bins or compactor bins located at different places at suitable intervals. Tipper autos, tipper lorries and tractors transport the collected waste to the waste processing facilities.

As per SCMC, the city has achieved 100 % door to door collection and 100% source segregation in all wards. However, the centralized processing facility still receives huge quantities of unsegregated waste, which in turn is dumped in the open at Chettichavadi dumping yard spread across 100 acres, due to unavailability of secure land fill facility in the city. The corporation is under the process of revamping the Erumapalayam dumpyard by camouflaging the waste dumped with several tiers of green cover. The stabilization of the waste has been carried out and screening work has to be carried out. The corporation has also taken various initiatives to limit the amount of waste going to the landfill. By adopting processes like bio-methanation, composting and recycling, the corporation is able to scientifically process 61 MT i.e. 15.25 % of the 400 MT of waste generated.[1]

In order to treat the biodegradable waste such as food waste, vegetables and fruits

[1] (2018). Retrieved from http://salemcorporation.gov.in/download/rf.6%20-%207.scientific%20disposal.pdf

Compost Pit at Kanchi Nagar Park

waste and waste from the slaughter house, two Bio Digesters with capacities of 5MT and 2.5MT are functional in the city. The corporation has also proposed to set up micro composting centres in 16 locations within the city limits for the production of organic manure under the smart city programme. The organic manure would be marketed and the sale proceeds would be utilized for giving salary to the workers employed in these centres. To recover the dry waste such as plastic, paper, glass, metals and other materials, the corporation has established Resource Recovery Centres (RRC) at several points across all four zones of the city. The centres are operated and managed by "Kuppaikaaran", a company engaged in waste management. In addition to this, the corporation is also processing the garden waste and other horticulture waste at several parks through composting.

Garden waste and domestic horticulture waste processing at Kanchi Nagar Park

The corporation has constructed one compost pit in Kanchi Nagar Park, in ward no. 60, to process the garden waste. One battery operated vehicle with two workers are appointed to collect the garden waste from nearly 100 households surrounding the park. Cow dung is added and mixed properly with the garden waste once every two days to ensure better aeration and even decomposition. Holes have been provided in the pit to facilitate aeration. After 15-20 days, a single batch of compost gets ready. Most of this compost is distributed free of cost to the farmers in the nearby areas and some amount is utilized for horticultural purposes within the park itself.

Facility Highlight of waste processing at Kanchi Nagar Park	
Pit size	7' x 4' x 4' (1 pit)
Processing Capacity	2 MT
Quantity of input	27 Kg per day
Quantity of Manure obtained	0.5 MT per month
CAPEX	Rs. 1,80,000
OPEX	Rs. 15,000/month
Manpower	3

Dry Waste Collection Centre and Material Recovery Facility (MRF) at Thongum Poonga

The resource recovery centre is located within the city near Windsor Palace Hotel. The facility has proper sheds, bins and partitions for the segregated waste. The land for the facility is provided by Salem Municipal

Facility Highlight of Material Recovery Facility (MRF) at Thongum Poonga	
Area of the facility	279 sq. m. (3000 sq. ft)
Quantity of waste collected per month	7-8 MT per month
Quantity of waste recovered	5-6 MT per month
Manpower	30-35 Sanitary Workers; 5 Kuppaikaran Team members
OPEX	Rs. 65000-70,000 per month

Corporation on lease to the company for handling the dry waste collection. The centre was established in July 2015 and caters to two zones namely Kondalampatty and Hasthampatty of Salem Municipal Corporation.

No capital expenditure was incurred to initiate this project, since the available assets of the corporation were brought into use.

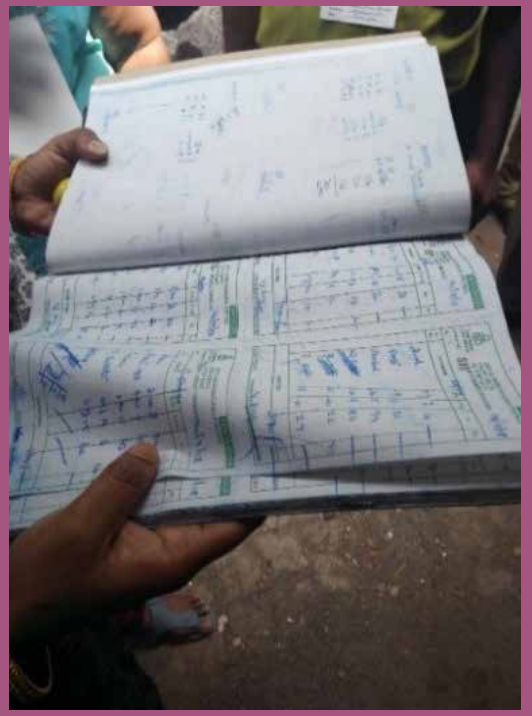
Sanitary workers of the corporation collect the dry waste every day from the two zones of the corporation. Besides, the public in the nearby areas also hand over the waste at the centre and avail the benefit of sale. In addition, the Kuppaikaran team also sends a vehicle every Saturday to collect the waste from specified locations. The collected waste is weighed and sanitary workers are paid as per the amount fixed per unit of the type of waste collected. The collected segregated waste is then further sorted and stored separately.

Amount per unit of waste collected

Type of Waste	Amount Per Unit (RS.)	Type of Waste	Amount Per Unit (RS.)
Newspaper	8/Kg	BB Cardboard	4/Kg
White Paper	10/Kg	Stainless steels	35/Kg
Plastic Bottles	18/Kg	Steel	17/Kg
Plastic	16/Kg	Tin	15/Kg
Black Plastic	3/Kg	Aluminium	30-80/Kg
Beer Bottles	1.5/pc	E-waste	Depends on product
Quarter Bottles	0.5/pc	Copper	50-100/Kg
Coconut shells	4/Kg	Flex Board	3-10/Kg
Cigarette buds	100/Kg	Twine	2/Kg
Cardboard	7/Kg	Glass	2/Kg

The sanitary workers are also given report cards and bills to encourage them to segregate and recover more dry waste. Besides this, monthly review meetings are held with respective sanitary officers and inspectors to discuss ways and means to capture more waste.

The operational cost includes the staff salaries and transportation cost of segregated waste to the authorized recyclers. The segregated waste is transported to the authorized recyclers every fifteen days.



Keeping records for the waste collected by the sanitary workers and the amount paid

Waste collection with the help of sanitary workers

Waste collection centre

Key highlights

- Through "The Bhogi Bucket Challenge!" jointly organized Salem Corporation and Kuppaikaran team, 20 tons of old clothes were collected and segregated into reusables and recyclables. The reusable items were given to the needy and the recyclables were sent for recycling.
- Kuppaikaran with the help of Code enterprise, a company based in Noida (near Delhi) have found an environmentally safe way of disposing the cigarette butts. Code enterprise converts the tobacco and paper in the cigarette butts into manure. Even the filter is turned into reusable plastic through chemical treatment. Kuppaikaran buys these cigarette butts from the shopkeepers of tea-stalls at a cost of Rs. 100/kg and further segregates, packs and transports them to Noida bearing a cost of Rs. 450/ kg. Code enterprise buys these collected cigarette butts for a cost of Rs. 600/ kg. Thus, besides resolving the issue of managing the waste of cigarette butts, the company also earns a profit of Rs. 150/kg.77,525 per year.

Bio-Methanation Plant at Veeranam

The bio-methanation plant at Veeranam compost yard was setup in 2013-2014 under the Integrated Urban Development Mission (IUDM) to handle the biodegradable solid waste collected from vegetable markets and hotels in all the 60 wards of the city. Two other plants were also proposed under this mission.

Biomethanation Plant, Veeranam, Salem

Facility Highlight of Bio-Methanation Plant at Veeranam	
Capacity of the Plant	5 MT per day
Quantity of Input	3 MT per day
CAPEX	Rs. 90 lakhs
Products obtained	Biogas, Manure, Electricity
Quantity of biogas generated	300 cu. m. per day
Quantity of Organic Fertilizer obtained	159 MT per annum
Power generated per day in kilowatt (kW)	400 kW

A Pune-based company, Mailhem Engineers Private Limited, has been vested with the responsibility of operating and maintaining the plant for seven years before handing it over to the corporation. Of the 400 kW power generated daily in the plant, 150 kW is consumed by the plant and the remaining is utilized in public toilets and also for street lighting purpose.

Recommendation

Salem city has achieved 100% door to door collection and has managed to scientifically process 15.25 % of the waste generated per day in the city. While SCMC claims that the segregation at source is 100% in all wards, huge quantities of unsegregated waste is still received at the centralized processing facility. Moreover, no secure land fill facility is available in the city due to which waste is dumped in open in the dumping yard, resulting in groundwater pollution leading to various health hazards. It is thus recommended that corporation focuses more on collecting segregated waste at source to reduce the amount of waste sent to the landfill and also ensure proper scientific disposal of waste.

To Know More

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Gurugram

Municipal Corporation

State: **Haryana**

Area (in sq. km): **232**

Number of Wards: **35**

Population: **8,76,969**

Waste Generated in Metric Tons (MT) per day: **907**

The Solid Waste Management (SWM) operations in Gurugram are managed collectively by Municipal Corporation of Gurugram (MCG), Haryana Urban Development Authority (HUDA), Haryana State Industrial and Infrastructure Development Corporation (HSIIDC) and private developers such as DLF and Unitech. Gurugram generates around 900 MT of solid waste per day. About 400 MT of municipal waste is collected every day by the civic authorities. As per official estimates, about 55% of the waste that is collected by MCG comes under Old Gurugram areas and 25% comes from the HUDA areas. The rest comes from the private colonies such as DLF and HSIIDC area. In addition to this, the city also produces about 700 TPD of construction and demolition waste; 1.5 TPD of bio medical waste and 30TPD of e-waste.[1] The MCG follows a centralized approach and currently the solid waste service is outsourced to Eco-Green, a private agency. The agency's scope of work includes door-to-door collection, processing and disposal. It is estimated that about 90 percent of the Municipal Solid Waste (MSW) goes to the landfill in Bandhwari. The city has about 3,648 sanitary workers which includes both permanent and contractual workforce. Given the amount of waste generation in the city and the limited availability of land and serious concerns on the air quality, MCG is working towards improving the waste management process by encouraging decentralized systems for bulk generators and at the same time improving the centralized system.

Decentralized solutions have worked well for many housing societies in Gurgaon where Resident Welfare Associations (RWAs) have taken the lead themselves or have roped in local or national Non-Governmental Organizations (NGOs) to assist them for the same. The "Alag Karo – Har Din Teen Bin" Program is one such initiative that was launched on Sep 6th, 2017 with the objective to inspire, handhold and implement source segregation of waste in residential complexes, educational and commercial establishments and also to develop capacities of waste workers to improve waste recycling. The project has already connected to 32 RWAs, 19 schools and has reached out to 499 waste workers. Among these 32 societies, 14 are also successful in managing their wet waste on-site. Alag Karo' is a collaborative initiative involving Government, private sector and civil society members. The initiative is being supported by Coca-Cola India Pvt Ltd, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Tetra Pak India. The implementation partner Saahas, is working in close coordination with the Municipal Corporation of Gurugram (MCG). One of these decentralized SWM projects is described below.

[1] Implementing Source Segregation of Waste in Apartment Complexes -an initiative under the Alag Karo program in Gurugram

Cowshed at Nandi Dham, Gurugram

Decentralized Solid Waste Management at Heritage City, Sector 25

Facility highlights of Decentralized Solid Waste Management at Heritage City	
Households covered	850
Total waste generated	1.45 MT per day
Total dry waste recycled	420 kg
In-Situ Composting (Y/N)	Yes
Total Diversion Rate	69.27 %
E-Waste collection (Y/N)	yes

Heritage City is one of the largest residential apartment complexes covered under "Alag Karo" Program. Due to the size of this society, this program was executed in a phased manner. The complex had chute system of waste collection. Since door to door collection would be major shift for residents and housekeeping, the RWA decided to do a pilot launch in 2 towers out of 49. Alag Karo team conducted a total of 18 training sessions for the residents, volunteers, housekeeping and maids, to ensure full understanding of process by every member of the complex. Door to door campaign ensured that the information about the program was shared to all the residents of the RWA. It took approximately 3 months to complete Alag Karo program in the whole society with the help of two volunteers and support from the RWA. Since this society had only two volunteers, the Alag Karo team pooled in to support trainings and door-to-door campaigns. The awareness campaigns were so effective that from day one

Key highlights

- Regular monitoring and follow up were carried out by the Alag Karo team and a dedicated team of housekeeping staff was actively conducted regular monitoring and undertook grievance redressal of the residents.
- The program enabled elimination of almost 80% plastic bin liners.

around 95 percent of waste segregation at source segregation was achieved.

Implementing the program took about 3 months. Trainings for maids, residents and the new house keeping staff by the Alag Karo team helped in bringing discipline among the residents and achieve the milestone of no bin liners from the very first day. In addition to this, the RWA has set up an on-site composting plant for disposal of their wet waste keeping in line with the SWM Rules 2016 and the MCG notifications

Composting at Nandi Dham Cowshed

Municipal Corporation Gurugram (MCG) along has partnered with Harit Recycler Association, a private operator in order to initiate decentralized composting at Nandi Dham goshala (cowshed) at Ashok Vihar, Phase III, Gurugram. The project was started in October, 2015. The area of Nandi Dham Goshala has been assigned by the MCG Wet waste collected from sectors 22 and 23 of Gurugram is used to produce organic manure.

Facility highlights of Composting at Nandi Dham Cowshed	
Pit size	1.5m x 1.5m x 0.9m
Quantity of wet waste processed	2.5 – 3.5 MT per day
Total dry waste recycled	420 kg
CAPEX	Rs, 5 lakhs
OPEX	Rs. 1.6 lakhs
Manpower	7-8

There are 55 aerobic composting pits at the goshala that are made of bricks. However, the base of the pits are devoid of bricks to maintain natural water flow. On an average 3 - 4 T of organic waste is received at the composting site daily. 7 - 8 pits are filled every day with organic waste. After 4 - 5 days, cow dung is added on the waste. It is then filled with another layer of fresh waste from top. During a one-month period, this cycle is repeated 4 - 5 times for the same pits.

Key highlights

- It is very low cost method, provided there is availability of adequate land. The manure produced is of good quality and has a high NPK value.

The mixture is then allowed to decompose for 40-50 days. After decomposition is complete the manure thus produced is dried and sieved and used by the Nagar Nigam. Apart from the aerobic composting pits, there are 3 deep anaerobic composting pits at the goshala of 10 feet X 10 feet size each. Each pit has the capacity of holding 20 T of wet waste. This process takes 3 - 4 months' time to completely decompose the waste.

Decentralized Composting at Silver Oak, DLF Phase IV

The Silver Oak Condominium Complex (SOCA) undertook the project of introducing waste segregation at source and processing of solid waste in their premises. The project is funded by the DLF Foundation and is maintained by Green Bandhu, a city-based startup. The program initiated by spreading awareness among the residents and waste handling staff through distribution of pamphlets and explaining them the concept and benefits of waste segregation at source.

At first, the waste collecting staff and maids were introduced to the steps of the solid waste management program management and source segregation was shared through pamphlets and talks. After providing training to the staff, the security personnel were told to keep a look-out for new inductees and train them on SWM. Personnel, like Housekeeping and Security, who are integral to the successful implementation of any process, were also trained. Space was allocated within the premises for the collecting and processing of wet and dry waste were identified and the equipment were installed.

The efforts made by the committee in communicating to and training residents and staff, paid off and resulted in total compliance within a few days. Waste segregation by residents is almost 100% and processing of wet waste yields 800-1000 kg of organic compost every month. The dry waste is being collected separately for recycling purposes. The solid waste is segregated in two different categories. Dry waste is disposed in blue polybags and wet waste is collected in green bags. Both are segregated at source. These are not collected if the waste is not segregated properly at source.

Saurav Bardhan from greenbandhu demonstrating the steps for community composting at Silver Oak, Gurugram

While green bag is send to the Composting shed the blue bag is sent to Dry waste shed to the other end of the campus. The wet waste is mixed with garden waste and crushed using Chipy Chopy Organic Waste Crusher or Shredder, which are available in different capacities such as 1HP, 2HP, 3HP etc. Further, rinsing and dehydration of excess water, liquid or moisture from the waste is done through Easy Squeezy De-hydrator. The wet waste is mixed with dry leaf litter from their gardens and put in various canvas container Bins or Bags. The compost for use is ready in 20-30 days. The dry waste is taken by a waste collector/ recycler at a specified time once a day.

Key highlights

- The segregation is done at two different levels. Dry waste goes into Blue bags and then to the blue bins and wet waste goes into green bags and then to the green bins.
- The hybrid-Rapid Composting system is installed inside campus composting.

The quarterly maintenance charges paid by each house hold for several services including Solid Waste Management Rs.5000 and the waste pickers and workers in the shed are paid their monthly remuneration from the collected maintenance charges only. The technology for composting plant was installed by Mr. Saurav Bardhan of Green Bandhu, a small start-up. Their technology is fully functional in the campus and is taken care of by the staff.

Space allocated for collection and processing of segregated waste at Silver Oak

Recommendation

The city of Gurugram has so far followed a centralized approach to waste management. Currently, a major part of the waste in mixed form goes to the landfill at Bandhwari. Since treatment plant at Bandhwari has been dysfunctional, the waste pile has become a health and management hazard. It has been found that the centralized waste management suffers from several drawbacks. Firstly, they do not distinguish between different needs of the neighborhoods within each city and between cities. Secondly, the centralized arrangements are often capital and land intensive owing to the scarcity of land. Thirdly, centralized arrangements have minimal scope for community-based participation, social entrepreneurship, livelihood generation, and fostering innovation. Certain modes of centralized systems (such as incineration plants) may not permit access to the recyclable material, make available space to segregate waste and add value to it locally. The livelihoods of a large number of persons (such as rag-pickers and scavengers) currently involved in India in waste management in the informal sector may be adversely affected by these modes.

Thus, the shift of attention from centralized to decentralized model of waste management by RWAs and NGOs as seen in case of Gurugram is a welcome move. It not only eliminates the above mentioned drawbacks, but also encourages civic responsibility and innovation. Gurugram has taken lessons from cities such as Pune and Bangalore where several residential condominiums have embraced a decentralized system of waste management involving processing of organic waste into compost for meeting neighborhood gardens' needs and the excess being sold to private companies.

However, there is a need to accord sufficient incentives to make these arrangements viable and enable the communities to expand their reach. Large commercial ventures such as hotels, hospitals, educational institutions and corporate canteens should institute their own waste management system on the premises. Stringent regulations need to be put in place for ensuring the separation of solid waste into organic and inorganic components. Furthermore, greater efforts need to be channelized in the direction of crafting innovative communication campaigns educating the public about the benefits of a decentralized system which will go a long way in inducing a behavioral change among them and eliciting their cooperation for making Gurugram a clean and sustainable city.

To Know More

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Jamshedpur

Notified Area Committee

State: **Jharkhand**

Area (in sq. km): **99.75**

Number of Wards: **240**

Population: **6,31,364**

Waste Generated in Metric Tons (MT) per day: **349**

Tricycle for Waste Collection at DWCC

Jamshedpur is one of the oldest and is considered as the largest existing industrial town in India. Tata Steel's town division, now under Jamshedpur Utility & Services Company (JUSCO), a subsidiary of the steel major, provides municipal and civic facilities to the city.

Jamshedpur has an organized 100% door to door waste collection and transportation controlled by JUSCO through its own team of conservancy workers. Currently, 86% of the households segregate waste into wet and dry. About 349 MT is generated every day and to manage the waste generation JUSCO has roped in 257 waste pickers for doorstep waste collection and segregation in the project named 2 Bin 1 Bag.

In the early phase of the project an enumeration drive was taken up by JUSCO to identify the number of waste pickers living in the city which gave an overview of social and economic status of waste pickers. JUSCO then developed a system for issuance of Occupational identity cards to waste pickers which provided them access to all social security benefits granted by Government of India (GOI).

Each waste-picker has a cart or a van with a green bin to collect kitchen and garden wastes; a red bin for collecting used sanitary napkins, bandages, rejected razors and blades, used syringes and injection vials; and a white bag for dry items plastic, paper, glass, rubber, cosmetics and e-waste.

Each team comprises of seven waste pickers, one represented as team leader with whom work order is placed for rendering services of door to door collection. The remaining waste picker are team members. A pilot study was done at ECC flat complex of 1500 households, Farm area colony - 500 household and Kadma market consisting of 400 establishments to assess the facts for scaling up to entire Jamshedpur city. Based on the pilot study a total of 257 social entrepreneurs are engaged to cover 44,191 house holds for door to door collection of source segregated waste from this project.

Sporting uniforms that come with safety masks and gloves, waste-pickers steer vans or carts to collect garbage at ECC Flats in Kadma, Jamshedpur.

The household waste contents of the green bin are taken to the JUSCO compost plant near Jubilee Park. The red bin trash goes to the Bara landfill. The white bag items go to the dry waste collection centre at Kadma from where they reach recycling units. The dry waste are further segregated at dry waste collection centre (DWCC) and the revenue which is generated through sale of recyclables is completely an incentive for waste picker. This is for motivation and retention.

Composting Plant, Jubilee Park

The compost plant near Jubilee Park handles this segregated wet waste and has a capacity of handling 50 MT of waste. Fresh garbage is stacked on the windrow platform. This is followed by mixing of inoculum and water with the garbage heap. This is done in order to fasten the process of decomposition of organic matter. The moisture content of the waste is maintained at 40-45%, as less than this level would result in the killing of helpful microbes while more moisture would lead to anaerobic kind of decomposition. Water is sprinkled on the heap on a daily basis and it is turned at least once every week, so all the parts of wet waste get in contact with air. By the end of fourth week the heap is decomposed completely, except items that take longer time to decompose (molasses, coconut fibre and shell etc.). These items are separated from the ready compost by a set of screening. First screening is of 35mm where larger objects are removed, and then the second screening is of 16mm where stones and other smaller undesirable particle are removed. After this the product is again left for about 15 day for further decomposition then again the same is passed through 8mm screen and then the compost gets ready.

Facility highlights of composting plant at Jubilee park	
Area of facility (in acres)	2
CAPEX	Rs. 4 crore
OPEX	Rs. 2 lakhs per month
Manpower	8

Key highlights

- Increment in the income of waste picker and formalization of informal economy.

Dry Waste Collection Centre, Bistupur

The dry waste collected through door to door collection are brought to the DWCC centre. The DWCC has a storeroom and a change room. The entrance gate is wide enough to allow easy entry to the vehicles that bring in the collected waste. Once the waste

is brought to the DWCC, the dry waste is divided into fifteen categories. Periodically when the resource grows into a substantial volume, it is sold off through a transparent process to the recyclers. The revenue which is generated through sale of recyclables is completely an incentive for the waste pickers.

Before the commencement of the project the income of each waste picker was approximately Rs.3000 per month. After the project the income of each waste picker increased up to Rs. 14000 which includes a basic pay of Rs.7202 per month and incentive up to 3000 per month plus provident fund and Employee State Insurance benefits.

Biogas Plant at Xavier School of Management (XLRI), Sakchi

Xavier's Labour Research Institute (XLRI) is the oldest management institute in the country. Under the campus sustainability initiative, XLRI converts about 400 kg of food waste to energy as part of its programme to reduce carbon emissions. The food waste from the college's five cafeterias goes into a giant biogas digester that generates gas equivalent to two LPG cylinders per day, or about a fifth of the kitchen fuel needed to feed 1,100 students on campus.

Facility highlights of biogas plant at Xavier school of management	
Plant Capacity (MT/day)	1
Area required for the plant (m^2)	45
Bio Gas Generation (m3/day)	40 – 45
CAPEX	Rs 3,00,000
OPEX	Rs 12,000 per month

In similar manner the biogas plants have been set up at - Chemmury Guesthouse in Northern Town, three graduate trainees' hostels in Kadma, residential flats near Kadma police station, Tata Football Academy in Bistupur and Tata Main Hospital. Three more are on the anvil at Tayo Rolls, JRD Tata Sports Complex and the centralised kitchen for midday meals at Ramdas Bhatta community centre.

Key highlights

- The installation of biogas plant is helping in managing the food waste at source and saving the cost of LPG to cook food at canteens.

Recycling Plastic Waste to Construct Road

The disposed plastic ranging from polybags to biscuit packets are used for constructing roads in the city using bitumen technology. JUSCO has constructed 12-15 km roads in the

Process Flow Diagram of Compost Plant

Biogas Plant at XLRI

Recyclable Paper at DWCC

Road from Plastic Waste

Compost Plant near Jubilee Park

steel city, as well as widened 22 roads using the environmentally-friendly technology. Bitumen, also commonly known as Asphalt, is a sticky, black and highly viscous liquid or semi-solid form of petroleum. The primary use of bitumen is in road construction where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete. The initiative is helping in reducing the use of bitumen by 7% in construction. For every stretch of such one km long and four metre wide road, one ton of bitumen costing Rs 50,000 is saved. The quality and longevity of roads made of waste plastic-aggregate-bitumen is two times better than bitumen road.

Key highlights

- The use of plastic waste for road construction is helping in tackling the plastic waste problem and improving the quality of road.

Recycling Plastic Waste to Construct Road

The city has been able to reach 100% door to door collection but the major focus should be towards creating awareness for source segregation. Community Composting should be promoted in the city to manage waste as the town has parks and open spaces. This could also help in reducing the cost of transportation for waste management.

Key highlights

- Gainful employment of waste pickers and appropriate solid waste management.
- JUSCO has helped waste pickers to become social entrepreneurs and led them towards better living conditions.
- City Reducing 90% of waste going to landfill site.

To Know More

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Bhubaneswar

Municipal Corporation

State: **Odisha**

Area (in sq. km): **135**

Number of Wards: **67**

Population: **8,43,402**

Waste Generated in Metric Tons (MT) per day: **520**

Biogas pLant at Kalinga Institute of Social Sciences (KISS) Campus

Solid waste management in Bhubaneswar comes under the purview of the Health and Sanitation department. There is 100% door to door collection in Bhubaneswar. Out of the 67 wards in Bhubaneswar Municipal Corporation (BMC), 57 wards are grouped into four packages for the purpose of the solid waste management activities. Three private agencies under Public Private Partnership (PPP) mode are carrying out the entire SWM (Solid Waste Management) activities in the privatized 57 wards on daily basis, which includes door-to- door garbage collection, street sweeping, MSW (Municipal Solid Waste) transportation, drain cleaning, drain de-silting, conservancy cleaning and bush cutting. In the remaining 10 wards, BMC is carrying out the SWM activities. Tricycles are used for door-to-door garbage collection. About 3290 staff members are involved in the door-to-door waste collection. Segregation of waste at source is absent in the city.

Tipper, trucks, dumper placers or compactors transport the MSW collected from various parts of the city to Temporary Transfer Station (TTS). An area of 10.45 ha near Sainik School is being used as the TTS where the collected wastes are weighed and recorded. The payment to the private agencies is done on monthly basis based on quantity of waste collected and transported. All MSW collected at the TTS is transported by the private agency through tippers and heavy vehicles to the dump site located at Bhuasuni.

Vermicomposting at Nandankanan Zoological Gardens

The waste so collected at land fill site are dumped and levelled in layers by BMC on a daily basis. There are no operational solid waste treatment plants in Bhubaneswar.

Implementation of online monitoring and tracking of MSW Management activities in BMC area under a PPP mode was taken up under Bhubaneswar Smart City Plan. Currently the BMC is tracking 65 vehicles as part of the project.[1] In the following section, certain good approaches and case studies in Bhubaneswar related to SWM are discussed.

Biomethanation at Kalinga Institute of Social Sciences (KISS) Campus

Kalinga Institute of Industrial Technology (KIIT) University constitutes 21 campuses with 23 canteens and 4 cafeterias. Kalinga Institute of Social Sciences (KISS), located at Chandaka Industrial Estate is a sister concern of KIIT University. It has setup a biogas plant within its premises in order to sustainably manage the food waste from the canteen.

Facility highlights of Biomethanation Plant	
Area of the facility	140 sq. m.
Processing Capacity of the facility	1 MT per day
Quantity of input	700 – 750 kg per day
Products obtained	Manure and Biogas
Quantity of biogas generated	70 – 75 cu. m. per day

CAPEX	Rs. 10 lakhs
OPEX	Rs. 35,000
Savings	Rs. 78,000 per month
Manpower	5

The canteen provides food to 25,000 students and generates food waste generated in the canteen is approximately 4 MT per day. The plant uses segregated food waste that are sorted and fed to the crusher/shredder along with a suitable quantity of water to form a slurry. The homogenized slurry from the inlet chamber is then fed into the anaerobic digester. The anaerobic digester is designed with baffles which trap the suspended solids and allow degradation of the waste. The digester has slow revolving scum breaking mechanisms that breakdown the scum. The liquid overflowing from the digester collected in the recycle chamber is partly used for slurry preparation at the sorting table and the remaining is discharged to the drains after

Key highlights

- The Institute has a daily saving of Rs. 4000 after installation of the biogas plant.
- The institute won the Energy Globe World Award 2017 for its green initiatives.

1 City Sanitation Plan for Bhubaneswar, CDD Society

suitable dilution. The sludge is periodically removed from the bottom of the digester and can be used as manure for horticultural purposes. The biogas generated from the anaerobic digester is collected in the bio-gas holder, pressurized and is used as a cooking fuel for the canteen.

Vermicomposting at Nandankanan Zoological Gardens

Facility highlights of Vermicomposting Unit	
CAPEX	Rs. 5 lakhs
OPEX	Rs. 6500 per month
Manpower	30 -35
Compost produced	1 MT per batch

Nandankanan Zoological Park is a 400-hectare zoo at Bhubaneswar that has established a vermicompost facility in the Fodder Farm area, around 2 km away from the park. The compost unit contains 6 pits of 10 T capacity each. The dimension of each pit is 8ft x 3ft. The waste that is fed to these pits comprises 2-3 T of dry leaves from park, straw and animal dung. At first animal dung, dry leaves and grass are collected and dumped into the pit. Water is sprinkled on the waste for a period of 15 days. Partially decomposed wet waste is then transferred to the pits and forms a 2-3 inch deep layer. A layer of cow dung is then spread over the mixture. This process is repeated until a desired height of accumulated waste is achieved. After this, earthworms are introduced into the waste pits to facilitate its further decomposition . The compost takes about 2 months to fully decompose and be ready for use. It is then screened and packed to be used in nurseries and botanical gardens. A total of 30 to 35 people are required for the 2-month duration for operation and supervision.

Faecal Sludge and Septage Management (FSSM) Plant at Basuaghai

Facility highlights of FSSM Plant	
CAPEX	Rs. 35.4 crore
OPEX	Rs. 19.3 lakhs

The state government has taken steps to implement Faecal Sludge and Septage Management (FSSM) at Basuaghai in the outskirts of Bhubaneswar in order to treat and thereafter safely dispose or reuse the faecal waste. This is being covered under the AMRUT scheme. The treatment plant has a current capacity of 75 KLD and is designed such that it has capacity to handle faecal waste generated for next 7 years. The plant involves a series of treatment steps to first separate the liquids from the solids, and then treat both the liquid and solid streams while recovering as much of the energy or nutritive value as possible.

The plant has an elevated unloading platform for trucks and tankers. Faecal sludge is emptied into a sludge receiving box of 1.5 m x 1.5 m x 3m. It goes into an inlet channel of

Faecal Sludge and Septage Management (FSSM) Plant at Basuaghai

Lily plantation at Basuaghai premises

3m length. Screen bar is placed in the channel at an angle of 45°. From the screens, influent goes to Settling-Thickening tanks of size 14.5 m x 2.5 m x 2.55 m. Thickened sludge is taken out of tanks after a period of 10 days and the supernatant goes into Anaerobic Baffled Reactor (ABR) chambers. The Thickened Sludge is taken to sludge drying beds where they are kept till they are fully dried under direct sunlight. The supernatant is then kept in ABR for 2-3 days for anaerobic treatment. Effluent from ABR is then sent to the horizontal planted or unplanted gravel filter. Water from gravel filters is then taken to polishing pond and finally the treated water is used within the plant premises for landscaping.

Key highlights

- A population of 2,20,000 has been covered by the project.
- Effluent is used within the plant premises for landscaping and growing lilies.
- The present capacity of 75 KLD is proposed to be expandable upto 150 KLD.

Recommendation

While Bhubaneswar has been able to achieve 100% door to door collection and transportation to a common dumpsite, it has unfortunately not been able to achieve source segregation of waste or processing of different waste streams as envisaged in the Solid Waste Management Rules 2016. Some of the bulk generators like a college campus, zoological park have implemented biomethanation and vermi-composting projects while fecal sludge management has been achieved in a suburb of Bhubaneswar. It is recommended that Bhubaneswar Municipal Corporation should endeavour to achieve 100% source segregation of different waste streams in all the 67 wards and establish processing plants so that the least amount of waste (6-8%) of waste goes to the secured landfill site.

To Know More

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Kalinga Institute of Social Sciences
Bhubaneswar, Odisha, PIN: 751024
Phone: +91 674 6010001
E-mail ID: info@kiss.ac.in

Dehradun
Municipal Corporation

State: **Uttarakhand**

Area (in sq. km): **196**

Number of Wards: **100**

Population: **5,69,578**

Waste Generated in Metric Tons (MT) per day: **350**

Presorting Unit

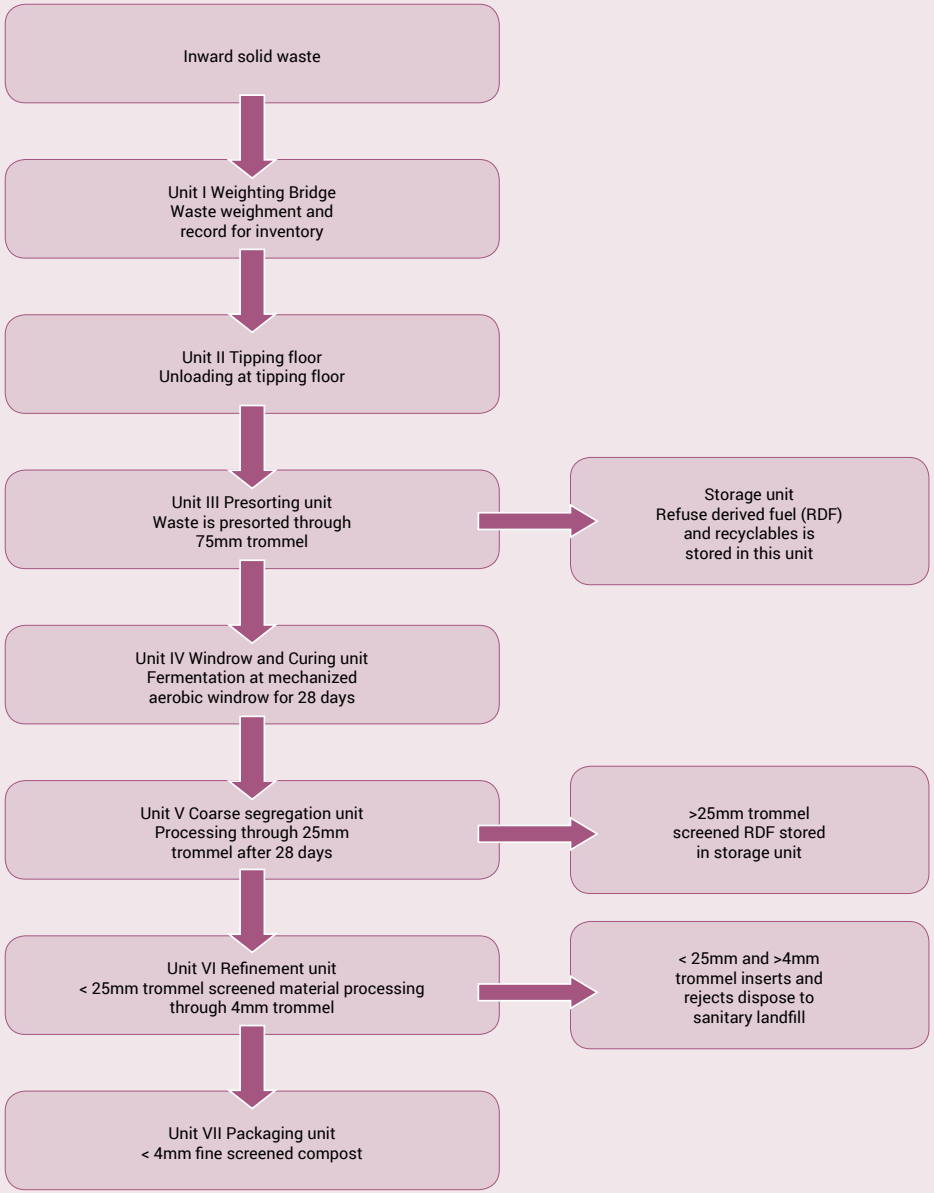
Dehradun is the capital city of Uttarakhand and is the largest corporation in the state. City is generating 350 MT from 100 wards. Dehradun Nagar Nigam (DNN) is carrying out the Solid Waste Management activities in all wards, which includes door to door collection, street sweeping, transportation of waste and drain cleaning. Segregation of waste at source is lacking in the city, DNN has deployed vehicles around 75 tippers, 81 rickshaws and 4 compacters in door to door collection. Entire waste is processed in Integrated Solid Waste Management facility at Shishambara 18 km away from the city. In this entire SWM 310 workers are involved and around 1 crore per month is spent on collection transportation

Integrated Solid Waste Management Facility at Shishambara

The Integrated Solid Waste Management (ISWM) facility at Shishambara in Dehradun is currently operated by Ramky Enviro Engineers Ltd. DNN has developed a centralized processing plant and sanitary landfill for the entire city through an agreement with M/S Deshwal Waste Management Pvt. Ltd. (DWMPL) on 26th August 2016. The total project cost is Rs 36 crore and the plant is spread over an area of 8.32 hectares including the composting plant and Sanitary Landfill Site (SLF). The capital grant from DNN is Rs. 21.97 crore. The plant of capacity 600 MT per day, is operating in two shifts (8 hours each) with 55 manpower. At present, the plant is processing 350 MT of waste per day. This plant is operational from December 2017. This facility is India's first fully covered mechanized aerobic windrow system technology based plant, covering an area of 1.40 hectares.

Facility highlights of ISWM facility at Shishambara	
Total plant capacity	600 MT per day
CAPEX	Rs. 36 crore
OPEX	Rs. 3500-4000 per MT
Current operational capacity	350 MT per day
Total area of ISWM facility	8.32 hectares
Total area of composting plant	3.40 hectares
Total area of sanitary landfill	1.40 hectares
Processing area	1.20 hectares
Manpower	50-55

Stages followed in Integrated Solid Waste Management facility, Shishambara



Refuse derived fuel (RDF) Plant

The collected waste is passed through the pre-sorting section with 75 mm trommel. The 75 mm above recyclable material is segregated and stored.

Composting Plant

The compost plant comprises of waste receiving area, aeration bays chamber (windrows), where the sorted waste (less than 75mm) is dried through aeration system for preparation of compost, trommel and RDF processing unit, leachate management system through Solar Evaporation Pond (SEP) and Leachate Treatment Plant (LTP)

In this plant almost 18 MT of compost is produced. The compost prepared in the plant is tested as per FCO 1985 Schedule IV specifications. Other than that this plant has its own laboratory where testing is done on all the parameters such as NPK content, pH, moisture, all heavy metals etc.

Sanitary Landfill

The Sanitary Landfill (SLF) site covers an area of 1.4 hectares and has a capacity of 50 MT. It has been designed and constructed for the safe disposal of inert and final disposal of rejects from the treatment plant. The SLF comprises a geo-membrane (layer of Geo-Synthetic Clay Liner, HDPE Liner, Filter Media, and Geotextile) which prevents contamination of leachate in to the ground water.

Initiatives taken by Local NGO: Waste Warriors - Composting at Gandhi Park

Facility highlights of composting plant at Gandhi Park	
CAPEX	Rs. 2200 per mesh pit
OPEX	Rs. 2000 per month
Manpower	2
Compost produced	600 – 650 kg

Waste Warriors was founded by Jodie Underhill and Tashi Pareek in the year 2011. It is non-profit organization and is registered under society, committed to tackling India's garbage problem. They started the campaign from their native place Dehradun through a community clean-up drives, education programs and creation of affordable and sustainable waste management system. Waste Warriors have prepared several composting enclosures across the city parks, where dry leaves are being used to make compost. Horticulture waste collected from all the parks of Dehradun is brought to Gandhi Park where 10 pits have been constructed to carry out composting. The total garden waste from all these parks (including Gandhi Park) amounts to 3200 kg per month. About 600 - 650 kg of compost is generated from

Compost yard

Leachate Treatment Plant

Inhouse Laboratory

Solar Evaporation Pond

Trommel

these pits every month. One batch of compost takes around 45 days to get ready which is then sieved and packed for sale. One supervisor personnel is required for monitoring and supervision of these pits once they are constructed. The capital expenditure includes cost of wooden poles, wire mesh, bamboo and paints for construction of the pits which amounts to around Rs. 2200 per mesh pit. The operational expenditure is around Rs. 2000 per month that includes maintenance of the civil structures as well as payment of salaries to the supervisors. The compost thus produced is sold at Rs. 15 per kg to the residents, schools and other institutions. This compost is also available online

Key highlights

- Economical model because the capital, operational and maintenance cost is too low.
- This organic compost is sold at Rs 15 per kg

Decentralized composting at Madhuban Hotel, Rajpur road

Madhuban Hotel in Dehradun is one of the best luxury hotels in the city with an area of 4.4 hectares. This hotel is having 107 guest rooms, four conference rooms and board rooms amongst large stretches of lush green vegetation that includes gardens and lawn areas. The hotel has adopted decentralized composting from food waste within its premises. For this, they use the Quick Compost Machine from Alfa Therm Ltd. It is capable of converting food waste into compost in just 24 hours. The machine has a capacity to process 200 kg of wet waste per day and there is no necessity for a separate curing system in this composting method. The area occupied by the facility is around 24 sq. m.

The food waste is mixed with dry organic waste like garden waste in the ratio of 70:30 (70% food waste and 30% dry garden waste) and certain decomposing agents. Finally, the mix is put into the composter. The composter converts the matter into compost in 24 hours. The most important aspect of this composter is that it is automatic and runs on 24x7 mode. The compost generated in this process is used in their gardens of the hotel itself. This has helped the hotel authorities in completely cutting down the expenses that were earlier made on the purchase of fertilizers.

The hotel generates 125 to 130 kg of food waste on a daily basis that amounts to 18 to 20 kg of compost, which is more than sufficient to meet the compost requirement in the gardens and lawns present in the hotel premises. The capital expenditure of the facility is Rs. 9, 75,000. Only one person has been employed from amongst the existing employees of the hotel for the supervision of the machine. The operational expenses include the electricity charges incurred for the running of the facility. Hence there are no operational expenditures incurred in this project. The compost thus produced is being used for horticultural purposes of the hotel itself.

Recommendation

DNN needs to strengthen its solid waste management strategy. Currently, segregation at source is absent in the city and entire mixed waste reaches to the ISWM plant. The city needs to ensure segregation at source through provision of two bins for wet and dry and separate collection of domestic hazardous waste. DNN needs to engage local citizens, NGO's, RWA's, private players for awareness programmes. It is also recommended, to achieve effective management, solid waste management committee needs to monitor the SWM system.

To Know More

Nagar Nigam Dehradun
Patel Road Near Doon Hospital,
New Road, Dehradun,
Uttarakhand -248001

Guwahati
Municipal Corporation

State: **Assam**

Area (in sq. km): **216.79**

Number of Wards: **31**

Population: **9,57,352**

Waste Generated in Metric Tons (MT) per day: **550**

Waste collection vehicle

The solid waste management of Guwahati comes under the purview of Health and Sanitation Department of the municipal corporation. There is 100% door to door collection in the city. The Guwahati Municipal Corporation (GMC) is divided into 31 wards and there is one NGO each assigned for the job of Primary Collection and Street Sweeping within the respective ward and for depositing the waste so collected at the nearby secondary collection bin/s. The work of Primary Collection is being monitored by the Sanitary Supervisors of the ward. The NGOs are also mandated with the collection of monthly User Charges from the households and commercial establishments. The NGOs have a total manpower of 450 workers who operate a total of 480 Tricycles and 64 Auto Tippers all around the city.

The Secondary Collection and Transportation (C&T) is being handled by a fleet of modern compactors and tippers by GMC. This is looked after by Zonal engineers and Supervisors assisted by a fleet of hand carters and sweepers. There are two functional Transfer Stations in Guwahati at RGB Road near Nursery, Ganeshguri and Bhangagarh. Approximately, 85-90 % waste is being transported daily to Boragaon landfill site which is spread over 48 acres of land.

Garbage Compactor	18
Dumper	22
Mini Auto Tipper	78
Excavator cum Loader	10
Auto Van	11

Integrated Compost Plant

The Windrow composting plant has all required machinery to produce compost with the capacity of 200 MT per day. Presently this plant is not functional as the required raw material of biodegradable waste are mixed with the plastic waste which cannot be segregated efficiently and produces low quality compost contaminated with plastics and heavy metals. The cost incurred for developing the facility was around Rs 5 crore.

Community Waste Assimilator at IAS Colony

Decentralized Waste Management at IAS Colony, Khanapara

The IAS Colony has recently taken up an initiative of zero waste campus with Environ a local NGO from Guwahati. The IAS colony has 60 households and produces 70 kg of wet waste per day. The waste is segregated in the colony and is being used to make compost.

Facility highlights of Waste Management at IAS Colony	
Area of the facility	50 (in sq. m.)
Pit size	3.6 m x 4. 5 m x 1.5 m (2 pits)
Processing Capacity of the facility	100 kg per day
Quantity of input	50 kg per day
Products obtained	Compost and Leachate

CAPEX	Rs. 1,00,000
OPEX	Rs. 27,000 per month
Manpower	4

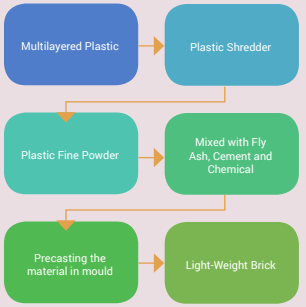
Apart from this dry organic waste consisting of dried leaves, flowers and twigs are also used in the composting pile which is collected from the lawns and gardens of the campus.

The project was setup with an aim of promoting community based composting in Guwahati. The compost and leachate obtained is being used in the horticulture purposes within the premises itself.

After the success of the project similar initiatives have been started in different colonies of Guwahati to manage waste at source.

Non-Recyclable Multilayered Plastic Waste Recycling

Guwahati generates 37 MT of plastic waste every day - about 12.37 percent of the entire state's production. Taking the seriousness of the situation, three engineers Rupam Choudhury, David Pratim Gogoi, Mousum Talukdar from Assam Engineering College have setup Zerund Bricks Manufacturing Pvt. Ltd. at an initial capital expenditure of Rs 50 lakhs. The enterprise makes patented Plastic Embedded Light Weight Brick using the multilayered plastic waste derived from plastic carry bags, biscuits & chips packs and different wrappers from chocolate which create a lot of



Steps of Brick Making process

environmental problems. The enterprise helps in managing 600 kg per day of plastic waste by utilizing them to create the bricks.

Table: Comparison with red clay brick

Parameters	Zerund Brick	Red Clay Brick
Size of Brick (in mm)	500 X 200 X 100	225 X 100 X 75
Compressive Strength (kg/cm2)	38-45	30-35
Fire Resistance (in hours)	6-7	2-3
Water Absorption (in %)	7	30

CAPEX	Rs. 50 lakhs
OPEX	Rs. 10 lakhs per month
Revenue	Rs. 15 lakhs per month
Manpower	4

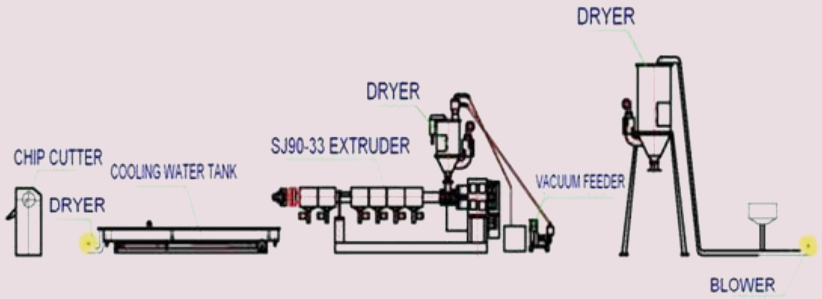
As the brick is light-weight, total dead load of the structure reduces up to 40% in comparison to the red clay bricks, hence the cost of the whole structure decreases. The brick has been developed in larger size. The larger size reduces the total number of mortar joints in the walls which leads to the less consumption of cement and sand in the joints and hence cost of infrastructure development decreases.

Key Highlights

- The enterprise is helping in tackling the plastic waste by converting it into light weighted bricks with commercial value.
- Solving the problem of shortage of brick issues in the city.

Plastic Bottle recycling by "Green Recycling Industry"

"Green Recycling Industry" at Bongshar, Kamrup is the only Plastic Bottle recycling unit of Assam where 3MT waste Polyethylene terephthalate (PET) bottles are recycled for producing 'Hot Washed PET Flakes'. Mr. Ranendra Baishya is the proprietor of the unit. The Flakes and PET powders acts as the ingredient of different polyester garments and second grade PET bottles.



Process flow of Plastic Bottle recycling

Zerund Bricks

Casting Area for Zerund Brick

Guwahati- Covered MS Bin

Door to door collection

The waste plastic bottles are collected by the waste collectors and compressed into bales. The bales are then dispatched to the plant. After reaching the plant, sorting process is done and pet bottles are separated from other materials. It is recycled into a new form which is named as PET flakes. Later these flakes are transported to different facilities where it is transformed into different finished products.

Key Highlights

- The enterprise is helping in tackling the plastic waste by converting it into PET Flakes
- It is helping in providing livelihood to 50 people

Recommendation

Guwahati has been able to achieve 100% door to door collection through convergence with local NGO, the next step for the city should be towards source segregation and treatment of different waste streams in a scientific manner. The municipal corporation should try to revive the ISWM plant and promote household and community based initiatives.

To Know More

Guwahati Municipal Corporation (BMC)
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IAS Officers Colony, Khanapara
Guwahati-781022
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Email ID: environne1@gmail.com

Zerund Bricks
Azara, Opposite Don Bosco University
Guwahati-781017, Contact: 7002218935
Email ID: ask@zerund.com

Green Recycling Industry
Bongshar, Kamrup
Assam-781103, Contact: 9864630439
Email ID: ranendra3089@gmail.com

Jhansi
Nagar Nigam

State: **Uttar Pradesh**

Area (in sq. km): **150**

Number of Wards: **60**

Population: **5,05,693**

Waste Generated in Metric Tons (MT) per day: **285**

Jhansi Jhansi is a historic town located in the Bundelkhand region of Uttar Pradesh. About 285 MT of solid waste is generated every day in the city from 60 wards. The Health Department is involved in planning and management of the SWM activities and in providing sanitary facilities to the residents of Jhansi. For the purpose of solid waste management, the city is divided into 5 sanitary wards/circles. Each sanitary ward/circle comprises 12 wards and is managed by a Sanitary Inspector.[1]

In the city of Jhansi, NGOs and organizations like Muskaan Jyoti Samiti, Arva Associate Jhansi, S.R. Techno Gwalior, Om Motors and Construction Jhansi, Society for Education and Welfare for All Jhansi and J.R.M. Group Jhansi play a significant role in collection of waste from households. Jhansi Nagar Nigam has contracted these six agencies to collect waste from each household daily at the rate of Rs. 40 per month. All 60 wards are served by waste collecting vans of private agencies having separate sections for wet and dry waste.

The city has achieved 85% efficiency in collection of municipal solid waste and the extent of segregation is about 91.4%.[2] The segregation of dry and wet waste in twelve of the sixty wards is done by an NGO called Muskaan Jyoti. The segregated dry waste collected is transported to the waste disposal centres where the dry waste is further segregated and sold to the recyclers. The wet waste is transported to the composting facilities of the NGO. In the remaining wards, the municipal solid waste collected from the households and other establishments is transported to the dumper placerP containers or open dumps, which are the secondary collection points. From the secondary collection points waste is then transported to the designated dumpsite by Nagar Nigam. The existing SWM system for Jhansi does not have a designated engineered sanitary landfill for disposal of solid waste.

Behavioural change and awareness raising campaigns are being carried out by the Nagar Nigam to uphold the spirit of waste segregation and treatment. Many projects have been proposed to increase the waste processing capacity of the city in order to reduce the quantum of waste going to the dumpsite. Some of the noteworthy initiatives taken by the city are discussed as below:

Plastic Waste Management Plant at Rajgarh

As per the study conducted by the R.R. Collective (Project Management Consultant) in 2015, the municipal solid waste generated in Jhansi has approximately 11% plastic. To tackle the plastic waste generated in the city, Jhansi Nagar Nigam installed the Plastic Waste Management facility in the year 2016 at Rajgarh, Babina road. A land of

Facility Highlights of Plastic Waste Management Plant at Rajgarh	
Processing Capacity (in MT per day)	4.5
Area(in sq.m.)	20234.28
CAPEX	Rs. 15 crores

[1] http://jnnjhansi.com/docs/CSP_Jhansi_reviewed_fin%20july14.pdf
[2] SLB Data (2018-19), Nagar Nigam Jhansi

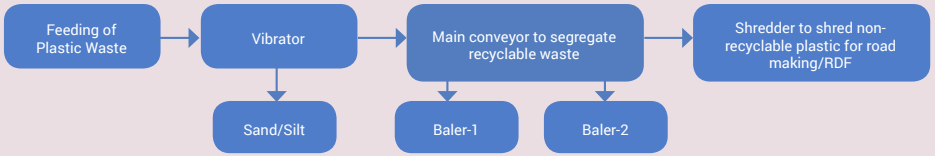
approximately 5 acres was earmarked for the plant by Jhansi Nagar Nigam. Jhansi Nagar Nigam invested 20% of the capital expenditure and the remaining 80% was bought under Viability Gap Funding (VGF), Extended Producer Responsibility (EPR) and Corporate Social Responsibility (CSR). The plant is operated by M/S Jain Hydraulic Pvt. Ltd.

Key Highlights

- The current Plastic Waste Management facility in Jhansi and use of plastic waste in construction of the road has helped in handling the plastic waste generated in the city. The main success of the whole process has been reduction of plastic waste reaching to the dumpsite from 11 percent to 2 percent.
- Convergence with the informal sector on procuring of plastic waste.
- Construction of road using the plastic waste in PMGSY.

Once the segregated dry waste reaches the plant, it is fed through an input conveyor to the vibrator machine which removes all the dust material from the lot. From the vibrator machine the waste is then passed on through the output conveyer to the sorting conveyor. Sorting Conveyor is a horizontal conveyor of 25 metre length and has compartments on its both sides for different categories of dry waste like plastic, paper and metals etc. Once the sorting is completed, the recyclable waste is sent to the baling press to increase the density of the waste transported in one trip and in turn reduce the transportation cost. The non-recyclable waste is fed into the shredding machine. Shredding machine shreds all non-recyclable and non-commercial plastics into sizes that are suitable to be used in road construction.

Plastic Waste Management Plant at Rajgarh, Jhansi



Process Flow Diagram

Use of plastic waste in road construction: The city is using the shredded plastic waste to make roads. A plastic road of 1.20 Km was first built in Veerangana Nagar in ward no- 39 following which, a road of length of 3.25 KM was built in district Fatehpur under Pradhan Mantri Gramin Sadak Yojana.[3] Details of road made using plastic waste in Jhansi Nagar Nigam are shown in below Table:

Details of road made using plastic waste in Jhansi Nagar Nigam

Name of the road	Name of Agency	Road Laid year	Type of Plastics
Shivaji Nagar	Jhansi Nagar Nigam	Feb-17	PE and PP Mix
Firojabad	PMGSY Firojabad	Nov-17	PP mix
Bharda Gaon, Mauranipur	PMGSY Jhansi	Mar-18	PE and PP Mix
Pathar wale Hanuman ji, Jhansi	Jhansi Nagar Nigam	Feb-18	PE and PP Mix
Hardoi	PMGSY	Apr-18	PE and PP Mix
Galla Mandi	Jhansi Nagar Nigam	Apr-18	PE and PP Mix
Srinagar, Hansari	Jhansi Nagar Nigam	Jun-18	PE and PP Mix

Source: http://smartcities.gov.in/upload/uploadfiles/files/4_%20Jhansi%20SCP.pdf

Faecal sludge management plant at Bijoli

In the absence of any comprehensive sewerage network, Jhansi Nagar Nigam has installed a faecal sludge management plant in the Year 2017 at Bijoli industrial area, for the treatment and disposal of faecal sludge generated from the city. The plant is installed and operated by M/S Purna Pro Enviro Engineers Pvt. Ltd.

The FSM plant makes use of gravity-based biological treatment to process the sludge received at the plant. The process involves two treatment stages:

1. **Sludge Stabilization/ Dewatering:** Planted Drying Beds
2. **Liquid Wastewater Treatment:** Integrated Settler and anaerobic filter; Horizontal planted gravel filter.

[3] The Pradhan Mantri Gram Sadak Yojana is a nationwide plan in India to provide good all-weather road connectivity to unconnected villages

Facility Highlights of FSTP at Bijoli	
Capacity	6KLD per day
Technology	Root zone biological Treatment
Area (in sq.m.)	1000
CAPEX	Rs. 2 crores
OPEX (monthly)	Rs. 2 lakhs

Planted drying beds (PDBs) are beds of porous media (eg. sand and gravel) that are planted with emergent macrophytes. The liquid sludge is first conveyed to PDBs to undergo liquid-solid separation. The percolated effluent waste water is treated separately in two stages. The volume on the sludge on the PDB reduces continuously (through moisture loss and degradation) and the plants maintain porosity in the sludge layer thereby significantly reducing the need for sludge removal compared to the unplanted drying beds (which requires sludge removal every 2-3 weeks). The dried sludge from the planted drying beds are removed once in 1-2 years depending on the rate of feeding.

The percolate from the PDB is further subjected to treatment in the Integrated Settler and Anaerobic Filter (AF). Although most of the solids are retained on the top of the planted drying beds, a small percentage of the solids may still infiltrate the percolate. The settler is a primary treatment technology for wastewater that helps in removing the suspended solids by anaerobic digestion. From the settler, the waste water is passed to the Anaerobic Filter (AF). The AF consists of 3 chambers in series in which the wastewater flows through down take pipes enabling water to reach the bottom of tank. Here, the suspended and dissolved solids present in the wastewater undergo anaerobic degradation. As wastewater flows through the filter media, particles are trapped and organic matter is degraded by the biomass that is attached to the filter material.

The planted Gravel Filter (area 52 sq.m.) is used as an aerobic tertiary treatment unit where the pollutants (mostly nutrients) present in the waste water are degraded aerobically. In order to remove the odour and colour and to enrich the wastewater with oxygen it is necessary to allow the wastewater to pass through the aerobic treatment. Horizontal planted gravel filter (HPGF) is made of planted fibre materials consisting of graded gravel bed. The bottom slope is 1% and the flow direction is horizontal. The main plants used in this filter bed are Canna indica, Reed juncus, Papyrus and Phragmites. The plant selection is mainly based on their ability to grow in wastewater and have their roots spread wide. The horizontal planted drying beds also aid in reducing the nutrients such as N, P and K present in waste water.

The treated water then flows into the polishing tank (area 22 sq.m.) by gravity where it further gets treated with ultra-violet rays of the sun. The polishing pond is emptied

Use of Plastic Waste in road making

Sludge being fed into the Planted drying beds

FSTP at Bijoli, Jhansi

Planted drying bed, FSTP

The Polishing Tank, FSTP

every 2-3 days and the treated water is used for gardening. JMC plans to use the dried sludge as manure.

Recommendation

Although the city has achieved 100% door to door collection and has taken various initiatives to handle the solid waste generated in the city, more focus is required towards collecting segregated waste at source and processing it. In addition, efforts taken by municipal authorities regarding solid waste handling and treatment need to improve. However, the initiatives of Jhansi Municipal Corporation towards plastic waste management for road construction while reducing its dumping in landfills and the excellent FSM initiative for fecal sludge management needs special mention. Both these good practices should be emulated by other ULBs especially of similar population and geographic challenges.

Key Highlights

- According to JMC, they have now become the 3rd city in India and 1st city in Uttar Pradesh to have FSM plant in fully operational stage.
- The plant utilizes gravity to transport the effluent from one module to the next, making it an energy efficient model. Also, no freshwater is used in the process.
- 6KL of Faecal Sludge treated per day.
- 60 MT of nutrient rich bio-solids generated per year.

To Know More

Jhansi Nagar Nigam
Website: https://jnnjhansi.com/contactus.php
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R.R Collective
Email: r.r.collectivepma@gmail.com
Website: http://rrcollective.com
Contact Number: 708-0430865

Purna Pro Enviro Engineers Private Limited
Website: https://www.indiamart.com/purna-pro-enviro/
Contact Number: 09696969696

Jammu
Municipal Corporation

State: **Jammu and Kashmir**

Area (in sq. km): **240**

Number of Wards: **75**

Population: **5,02,197**

Waste Generated in Metric Tons (MT) per day: **368**

Jammu is situated on the banks of the Tawi River and the foothills of Himalayas. At present, 368MT waste is generated per day in the city from 75 wards. Entire 368 MT untreated waste is dumped at the 8 hectares Kot Bhalwal dumping site. This dumpsite is around 15km from Jammu city, every day about 70-80 vehicles are used in collection and transportation to dumpsite. Due to direct dumping the entire area has become a nuisance and a source of health hazards.

The city has so far not been able to achieve complete compliance of SWM rules 2016, but have made efforts towards including sustainable technologies and citizen awareness as part of the mission. These efforts are worth evaluating and emulating. For citizens' engagement JMC organized several sanitation drives and awareness campaigns under Swachh Bharat Mission. The programmes were organized with the participation of elected representatives, social workers, Mohalla Committees and large number of school children.

Mule Dung Biogas Plant at Jammu (Katra)

Katra-Vaishno Devi is located at an altitude of 5200 ft in the foothills of Trikuta Mountains where the holy shrine of Vaishno Devi is located. Katra serves as the base camp for pilgrims who visit Vaishno Devi. Shri Mata Vaishno Devi Shrine Board (SMVDSB) is responsible for management, administration and governance of the Shri Mata Vaishno Devi Shrine and its endowments, including land and buildings attached to the Shrine. More than 10 million pilgrims visit the Vaishno Devi Temple every year. To reach the Vaishno Devi Temple, these pilgrims have to trek a total length of 20.5 km. Upto 15 km, horses or mules carry pilgrims from Katra. Managing the dung of more than 4600 horses and mules that ply on this 15 km trek is one of the major challenges for the Shrine Board. In the absence of proper disposal facility, the dung was either thrown into Banganga river or burnt or destroyed, causing water and air pollution. For appropriate disposal of waste, the

Mule dung biogas plant at Banganga

Shrine Board has now set up a 24x7 mule dung based biogas plant for scientific processing of the waste.

Facility highlights of Biogas plant	
Capacity of the facility	4 MT per day
Technology used	Anaerobic digestion
CAPEX	Rs. 53 lakh
OPEX	operated by shrine itself
Products obtained	Manure and Biogas
Quantity of biogas generated	200 cu. m
Revenue Generated (if any)	Gas is used in community Kitchen
Manpower	5

For scientific disposal, a mule dung based biogas plant of 4 TPD capacity was commissioned in Banganga, Katra by the Shrine Board in April 2012 and the plant was first of its kind to run purely on mule dung. The project cost is approximately 53 lakh. The plant was installed and commissioned by M/s. Mailhem Engineers Pvt. Ltd., Pune. The company also carried out operation and maintenance of the plant for the next 5 years from 2012 to 2017. The plant is based on the principle of anaerobic digestion of cow dung. The biogas generated by this plant contains 65% methane which is suitable for cooking, it is being used in langar to meet cooking energy requirements. The daily bio gas generation is 170-200 m3. The bio-manure being generated is used as soil conditioner in various greening project. The total manpower for this plant is 5 persons.

The mule dung is collected from the adjoining cattle shed from the treks. It is then fed into the digester for anaerobic digestion process. It is further heated to approximately 38-40 °C for fermentation. The substrate is decomposed by the micro-organisms under exclusion of light and oxygen. The final product of this fermentation process is biogas and methane acts as the main ingredient. Afterwards, the bio gas gets collected in the balloon, which holds the gas until the time of consumption. The gas pipeline carries the gas to the community kitchen. The remaining sludge is collected in sludge drying bed. In the first few hours, the liquid drains off after which drying occurs due to natural evaporation. The sludge completely dries within almost three weeks. The drying period may vary depending upon sunshine, rainfall, wind velocity, and relative humidity, apart from sludge characteristics.

Key highlights

- The problem of odour and mule dung on the trek have now been resolved after the installation of this plant.

Decentralized Composting Facility at Satwari Jammu Army Cantonment

Satwari Jammu Army Cantonment is a good example of decentralized aerobic composting system where segregated wet waste is composted. The site is at Fringe Range, Satwari that is around 3 to 4 km from the Army Cantonment area.

The composing facility uses the wet waste from 1500 households of the cantonment area. A total number of 12 composting pits of 6 ft x 3 ft x 3 ft size, each of capacity 1 MT are present at the composting site. Wet waste from 1500 households that amounts to 500 to 600 kg daily is transported to the site. The waste is placed in layers within the pits. The waste is rotated daily and covered with jute bags. Water is then sprinkled over these bags. Jaggery solution is used for enhancing the microbial activity for decomposition of organic waste. 12 to 15 people are engaged in the cantonment area who are involved in collection, segregation, transportation of waste and also for the supervision of the composting facility.

Key highlights

- Almost 80- 90% of organic waste from households of Cantonment area, Jammu was collected, segregated under
- Inclusion of waste pickers in the process of collection and segregation

Facility highlights of Decentralized composting	
CAPEX	Rs 10 lakh
OPEX	Rs 1.20 lakh
Manpower	10

An approximate amount of Rs. 10 lakhs was required for the purchase of vehicles for transportation and construction of these pits. The compost is utilized within the Cantonment Area for horticultural purposes and also in individual home

Recommendation

City needs to reduce the amount of waste which is dumped at dumping site. JMC should start waste segregation at source of wet, dry and DHW, adopt decentralized methods of recycling and treatment. The aim should be that only inert and rejects goes to sanitary landfill. Thus this would result in saving in transportation and dumping site land cost. This effective management can make the city self-sustaining in terms of environment and SWM cost.

To Know More

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Alwar
Municipal Council

State: **Rajasthan**

Area (in sq. km): **48**

Number of Wards: **50**

Population: **3,20,000**

Waste Generated in Metric Tons (MT) per day: **129**

Collection of waste through auto-tippers

Total geographical area of Alwar Municipal Council is 48 sq.km. There are 50 wards in the city. The city has achieved about 90% door to door collection however, source segregation is still a challenge. A company named ENSOL is assigned for door to door collection of waste in 50 wards of the city. Waste is collected from the households through auto tippers comprising separate compartments for wet and dry waste for source segregation. The collected waste is then transferred into big containers or refuse collectors from where it is transported to the landfill site. For processing the wet waste collected from the vegetable market at source, Alwar Municipal Corporation has installed two composting machines near the market of capacity 200 kg each.

The city does not have a secured landfill facility yet. The landfill site is located at Bagad Ka Tiraha and spread across an area of 2.47 acres. Untreated municipal solid waste is dumped here on a daily basis. Approximately 120 MT of waste is dumped daily in the landfill.

Landfill site at Bagad Ka Tiraha

Sewage Treatment Plant at Bagad Ka Tiraha, Alwar

In the absence of any comprehensive sewerage network, the municipal council of Alwar under the Rajasthan Urban Sector Development Investment Program, proposed the Sewage Treatment Plant at Bagad Ka Tiraha. The operation contract of the sewage treatment plant was given to M/s BHOORATNAM CONSTRUCTION CO. PVT., LTD., a private company in Alwar. The plant with 20 MLD capacity is spread across an area of 80,937 sq.m.

Facility Highlights of STP at Bagad Ka Tiraha	
Capacity	20 MLD
Sewerage received per day in litres	5-6 MLD per day
Technology	Anaerobic Pond Stabilization
Area (in sq.m.)	80,937
CAPEX	Rs. 11 crores
OPEX (monthly)	Rs. 1,60,000
Manpower	10-12

At first, the sewerage from the nallas is collected in the storage tank from where the coarse screens extract 40 mm size materials. After coarse filtration, the sewerage is transferred to sump well. In the sump well, 7 pumps have been installed to pull water from the well in to a channel. Total capacity of 1 pump is 21 kWh. Fine screens have been installed in the channel area where waste water is collected and 5 mm size materials/particles are extracted.

Once the coarse material filtration is completed, waste water from the channel area is collected in a grid chamber. Sand present in the sewage water is settled here and extracted through conveyer belt. Once the sand is extracted from the waste water in the grid chamber, it is transferred into the anaerobic pond for a few days.

The anaerobic pond is the primary treatment stage to reduce the organic load in the wastewater. Anaerobic ponds (42m x 159m x 65m) contain anaerobic bacteria that converts the organic carbon into methane and through this process, removes up to 60% of the BOD. After a week of retention, the sludge gets settled at the bottom and the water is then transferred to the facultative ponds (129m x 283m x 3m). The facility comprises two anaerobic ponds and three facultative ponds.

The top layer of the facultative pond receives oxygen from natural diffusion, wind mixing and algae-driven photosynthesis. The lower layer is deprived of oxygen and becomes anaerobic. Settleable solids accumulate and are digested at the bottom of the pond. The aerobic and anaerobic organisms work together to achieve BOD reductions of up to 75%. After a retention time of about three to four weeks, the water is finally transferred to an aerobic pond (also commonly referred to as a maturation, polishing,

or finishing pond) for two to three weeks for pathogen removal from where it is then used in the nearby farm areas.

Electronic Waste Recycling Facility, Matasya Nagar Industrial Area

Key Highlights

- The company has not only integrated the rag pickers at local level in this initiative but has also focused on their capacity building through training programs.

The e-waste recycling facility located in Matasya Nagar industrial area is spread across an area of 20 acres and is run by a private firm *Green Scape Eco Management Pvt. Ltd*. Green Scape Eco Management Pvt. Ltd. is an electronic waste management company focusing on end of life IT asset disposition and providing best solutions including re-use, de-manufacturing, brand security and e-waste recycling.

The facility is fully compliant to the local and global norms and operates to the highest EHS standards. Green Scape ensures brand security and has 24×7 video surveillance at all operational units. The facility is equipped with all fire and safety equipment, where regular air quality and noise testing takes place.

Recycling of e-waste requires a series of steps. Protecting personal rights is integral to e-waste recycling services, thus, once the collected waste is brought to the facility, the first step involves data recovery ensuring compliance with data protection. The safety of client's confidential data is of highest importance. Data security can be ensured through various procedures like overwriting, degaussing and physical destruction. Green Scape Eco Management continuously works towards improving the data security measures to protect the client's brand. The second step is de-manufacturing and component harvesting wherein, the whole unit is broken down into components or parts for reuse and resale. After de-manufacturing, the e-waste recycling and material recovery process starts. This step involves processing of residual e-waste into segregated material streams for reuse in manufacturing or downstream refining. The last and final step involves the re-configuration and re-deployment of working assets, site clearance, valuation or appraisal of disposal options, etc.

Although the capacity of e-waste processing at Green Scape is 60,000 MT per year, however, only 1200 MT per year is currently being processed. A total of five machines are used for destruction of big components. The extraction of metals from e-waste is mostly done by workers manually. Almost ninety people work in this facility, where

Screening

Screening

Pumping after screening

Sand extracted from the grid chamber

The Storage Tank

Waste water transferred to the Anaerobic and Facultative ponds

Aerobic Pond

forty are managers and supervisors and fifty are workers. All of them are provided with personal protective equipment.

Thus by extending the life cycle of obsolete electronics, the company not only ascertains its commitment towards running a socially responsible business, but also extends an opportunity to its clients for doing the same. However, one of major challenges highlighted by the facility is the difficulty in getting registered recyclers for different commodities extracted from E-waste. Also, the registered recyclers pay very less to the company due to the existing scrap dealers who illegally de-construct the e-waste and provide commodities to the recyclers at very low price.

Recommendation

Alwar Municipal Council needs to adopt measures to improve the extent of door to door collection and segregation of waste at source. If effective source segregation and recycling methods are followed at individual residential units, the garbage flow to the dumping site will go down drastically. It is also alarming to note that the city lacks scientific disposal site especially when there is an e-waste facility, which will definitely be generating some amount of hazardous waste, which would require disposal at a secured landfill site. Besides reducing the quantum of waste reaching the dumpsite, steps should be taken to upgrade the existing dumpsite into a secured sanitary landfill.

To Know More

Alwar Municipal Council
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Ensure Consortium
Website:
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Contact Number: 08049673095

Green Scape Eco Management Pvt. Ltd.
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Email: info@greenscape-eco.com
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Aligarh
Nagar Nigam

State: **Uttar Pradesh**

Area (in sq. km): **40**

Number of Wards: **70**

Population: **8,74,408**

Waste Generated in Metric Tons (MT) per day: **390**

Compost Plant

Aligarh is the ninth largest city (population-wise) in the state of Uttar Pradesh and famous for Aligarh Muslim University. Currently, the city is generating 390 MT of waste per day and collects about 360 MT from 58 wards. There is 93% door to door collection but segregation at source is not practiced in the city.

For the production and local use of Magic Bricks, in 2018 Swachh Survekshan Aligarh Nagar Nigam got India's Best Medium City award in 'Innovation & Best Practices' in the National Level category (Above 3-10 Lakh Population).

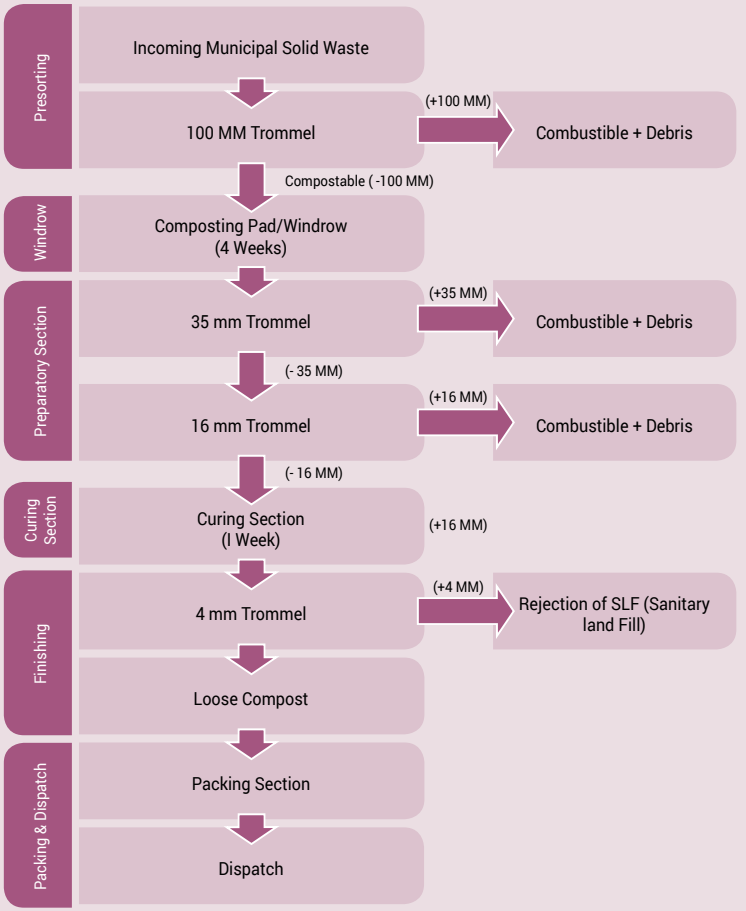
A2Z Green Waste Management Limited operates under Design-Build-Own-Operate-Transfer (DBOOT), Public Private Partnership mode to carry out the door to door collection in all wards and transportation to dumpsite. In 2016, Aligarh Nagar Nigam (ANN) installed an integrated solid waste management facility at Jamalpur with the capacity of 300 MT. This plant is managed by A2Z GWML and prepares compost via windrow composting method and RDF blocks which is being further used to make Magic bricks.

This plant is spread over an area of 10 hectare with 2 hectare allocated to sanitary landfill and another 2 hectare to temporary dumping ground. The initial investment to setup the plant was about Rs. 32 crores.

Transfer Station for collecting waste

Facility highlights of ISWM	
Total plant capacity	300 MT per day
CAPEX	Rs. 32 crore
OPEX	NA
Current operational capacity	300 MT per day
Total area of ISWM facility	10.11 hectares
Total area of composting plant	3.40 hectares
Total area of sanitary landfill (proposed)	2 hectares
Manpower	20-25

Process Flow Diagram of Integrated Solid Waste Management Facility



Dry Waste Compressed to make RDF Block






The Integrated solid waste management is helping the ANN successfully turning waste into a bricks through its innovative method of waste management. The plant operates for 12 hours in a day and processes 290 MT and generates about 40 MT of compost and 18 MT of RDF. The RDF is compressed to form blocks which are encased in RCC to make bricks using RDF and cement concrete of size 12inch x 9inch x 6inch. These bricks are sold at a price of Rs 35 per piece. This ISWM facility charges a tipping fee of about Rs 714 per MT of waste collected and processed in the facility and sells compost at a price of Rs 2500 per MT.

The bricks are developed with a casing of concrete by filling shredded dry waste that includes plastics.The dry waste is first segregated from the waste and then put through a multi-stage compression process which creates the filling for the brick. This filling is then placed into a mould and concrete is filled around all sides of it. The brick is lighter in weight, equal to six regular bricks in size and extremely strong.

ANN is using this brick in lining footpath kerbs, or linings for flyovers, after getting the bricks tested for their strength and durability. This idea certainly can find its way into more local governments and defines a new horizon for waste management.

Recommendation

Though the city is able to use innovative method in making the magic bricks and managing the solid waste but for a long term sustainability efforts should be made towards source segregation. This would help in increasing the efficiency of the ISWM facility and improve the quality of compost prepared in the plant.

To Know More

Aligarh Nagar Nigam
Sewa Bhawan, Near Ghanta Ghar,
Church Compound, Civil Lines, Aligarh,
Uttar Pradesh 202001
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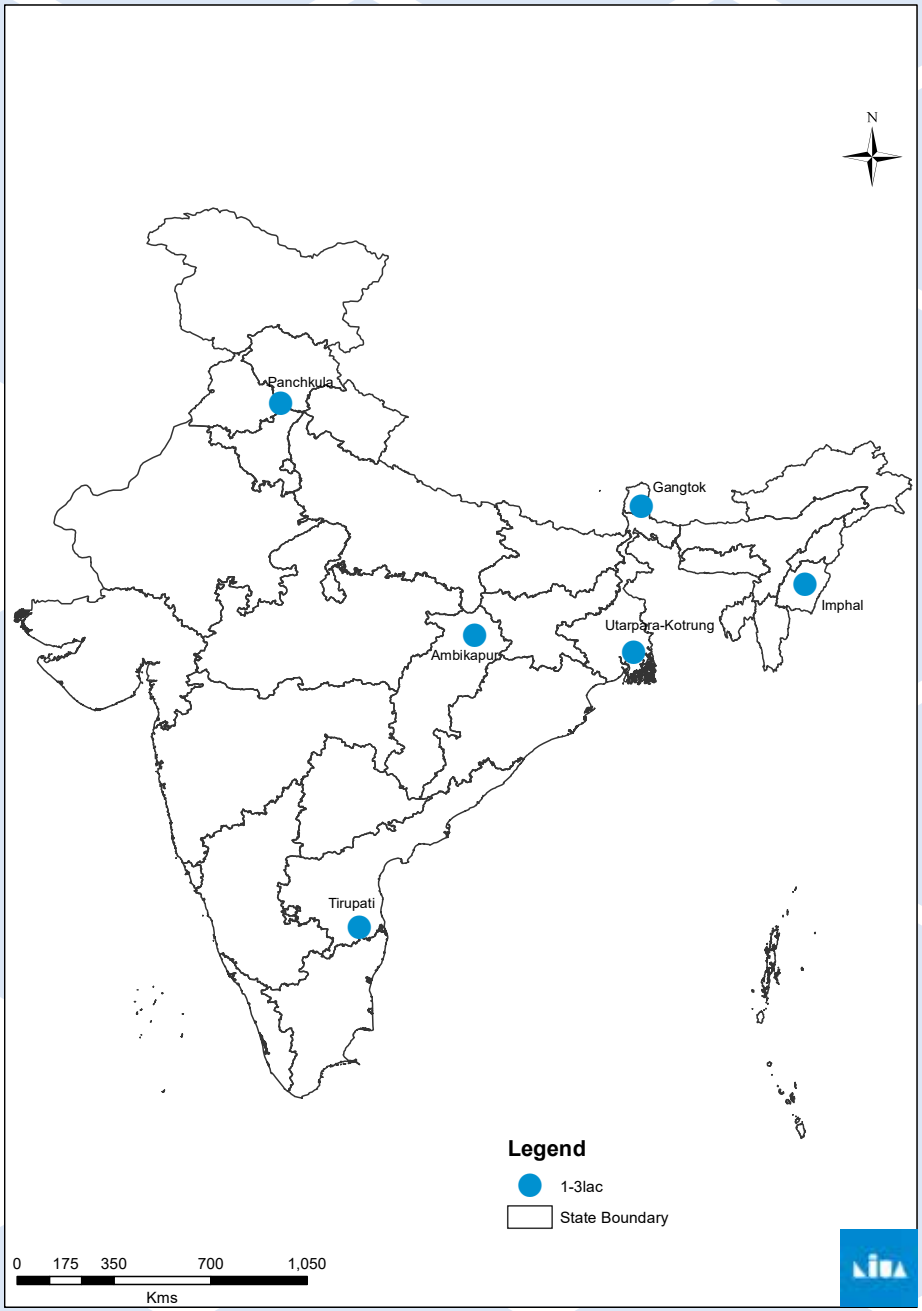
Contact Number: 0571-2405520

Cities with population:

1-3 Lakh



Ambikapur
Municipal Corporation

State: **Chhattisgarh**

Area (in sq. km): **40**

Number of Wards: **48**

Population: **1,12,449**

Waste Generated in Metric Tons (MT) per day: **51**

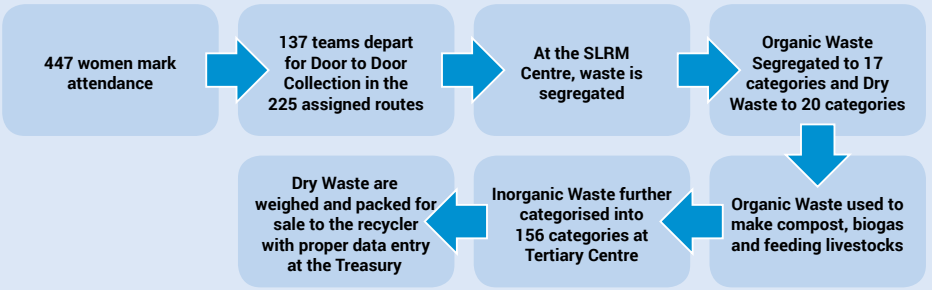
Collection Vehicle used in Ambikapur

Ambikapur is a small city in Sarjuga district with a population of 1.12 lakhs. The city waste was dumped on the 16 acres dumping yard located 3.5 km away from the city. The launch of the Swachh Bharat Mission encouraged the Ambikapur Municipal Corporation (AMC) to find ways to deal with its waste. To tackle the daunting situation and manage the waste in an effective manner, the Solid and Liquid Resource Management (SLRM) project was started under the guidance of the district collector. This was assisted by C. Srinivasan of India Green Service, Vellore that paved the way for "Swachh Ambikapur" project. It is based on community-based model that employs women from Self Help Groups (SHGs) and creates livelihood opportunities. The primary objective was to put in place a system for door-to-door collection of solid waste from homes and commercial establishments in Ambikapur, and to practice scientific disposal of the waste. The efforts have shown positive results, the 16 acre-open dumpsite is now a sanitation awareness park, while the administration has removed the community dustbins that were once overflowing and Ambikapur has become a bin free city. The Ambikapur SLRM model shows that with proper management, we can protect our environment, improve livelihood opportunities for the deprived and live in a clean and healthy environment.

Stages of Project

1. **Preparatory Stage:** Leading citizens, businessmen, women groups, civic administration officials and others were called to attend a meeting of stakeholders. Mr. C. Srinivasan, of Indian Green Service, Vellore was engaged as a resource person to conceptualize the project, provide technical guidance and guide implementation.
2. **Community Based Structure and Training:** Six Hundred women were recruited for orientation and training related to segregation (organic/inorganic) at source and secondary segregation in the work-shed (SLRM Centre). The women were also trained in soft skills: the dynamics of working in a group as a team member, the importance of using mask, gloves, gum-boots and other safety gear, the importance of punctuality, the manner of dealing with hostile homes, personal hygiene.
3. **Infrastructure:** The SLRM Centre is the hub of the entire project. It is an industrial work-shed (approx. 1,500 sq. ft.) with an RCC structure and cement floor, built on an open area of land (approx. 3,000 – 5,000 sq. ft.), fenced on all sides, with a broad gate on the front side.
4. **Information, Education and Communication (IEC):** People from every household and commercial establishment were asked (in batches) to come to the designated spot at a designated hour to collect the red and green bins meant for segregation at source. Recognizing that children can be opinion-leaders at home, over twelve thousand and five hundred school kids were sensitized regarding the project and enlisted as volunteers to promote the initiative.
5. **Monitoring:** Special software was designed in-house and a desk was set up at the District Data Centre. CCTV cameras have been installed in every SLRM Centre. All seventeen Centres are visually monitored from a Central Data Centre.

Conversion of Dumpsite to Sanitary Park



Waste Collection Process

Collection, Segregation and Transportation

AMC has taken the whole process of collection on a *dashboard system online*. It makes the monitoring of the whole activity easy and also makes the workers accountable for their attendance and performance.

The door to door collection of waste is done by 447 women from Self Help Groups (SHGs) who are divided into 137 teams. For efficient collection of waste the city is divided into 225 routes. The waste is collected in uniformly designed e-rickshaws with two separate compartments for wet and dry waste. The rickshaws have a special bell with a distinct ring that serves as a signal for people to dispose of their waste. The rickshaws are equipped with GPS trackers and all the sanitation workers have been provided with cell phones. This helps the workers to keep a track on the daily collection

of garbage and also provides information regarding residents who fail to abide by the waste management code of conduct.

Solid and Liquid Resource Management

After the collection, the waste is brought to the 17 SLRM centres in the city. The centres are designed to ensure uniformity. It is an industrial work-shed (approx. 1,500 sq. ft.) with an RCC structure and cement floor, built on an open area of land (approx. 3,000 – 5,000 sq. ft.), fenced on all sides, with a broad gate on the front side.

Each SLRM Centre is designed to ensure abundant light and ventilation, has a storeroom and a change room. The Centres have tap water connections and adequate number of tubs, forks, tarpaulin spread sheet and other accessories. The entrance gate is wide enough to allow easy entry to the vehicles that bring in the collected waste.

Once the waste is brought to the SLRM centre, the organic waste is divided into seventeen categories and the inorganic waste in divided into twenty categories. The food waste collected from the household is fed to cattle, ducks and hens at the centre. The other organic leftovers are used in biodigester to make biogas and slurry composted.

Arranging for parcels of land within the city was a challenge. To overcome this, unauthorized occupation on government land were mapped and the occupiers were either evicted or rehabilitated elsewhere. Altogether, 6,986.63 sq. m of land valued at Rs 25 crore was freed by December 2015.

Tertiary Segregation Centre

From the SLRM centre the recyclable waste is taken to the tertiary centre located at erstwhile dumpsite, where it is further classified into 156 categories. The various resources recovered by the Tertiary Segregation Centre are deposited in a makeshift known as *Treasury.* Periodically when the resource grows into a substantial volume, it is sold through a transparent process.

According to the data from the district data centre, 127 MT of organic waste and 113 MT of inorganic waste have been collected till date. The waste generated by the city has a resale value. For managing operations and maintenance of the project, a user charge of Rs 50 is collected from houses, Rs 100 from shops, Rs 500 from hotels and Rs 1000 from hostels and ashrams. The total income from the user charges ranges from Rs 12-15 lakh per month.

Recyclables being transported to Treasury for sale

Tertiary Segregation Centre

According to the November 2017 SLRM report, the municipal corporation had collected Rs 150.38 lakh as user charges, Rs 3 lakh from the sale of city compost and Rs 67.03 lakh from the sale of recyclable items between May 2015 and November 2017. In 2012, the annual expenditure of AMC for solid waste management was Rs 1.23 crores, and in 2017, after the implementation of SLRM project, it has reduced to Rs 37 lakhs. The SHGs are federated into a registered Society called "Swachh Ambikapur Mission Sahakari Samiti Maryadit". Ambikapur Municipal Corporation has an agreement with this Society. Each worker earns around Rs 5,000 per month. To encourage SLRM, the corporators of the wards have contributed Rs 1 lakh each for the proper operation and maintenance of the project. In addition to this, the 16-acre dumpsite has been remedied and converted into a sanitation awareness park.

Horticulture Waste Processing at Pushpvatika Sargawan

The horticulture waste processing facility at Pushpvatika Sargawan, Ambikapur was established in the year 2017. The facility receives wet waste and horticulture waste from the households and the parks of the city, which amounts to 150 kg on an average. Vermicomposting is employed to process the waste where each bed measures 3ft by 8ft. The composting facility has engaged 2 staff members for supervision and maintenance of the facility The capital cost of the facility is approximately Rs.10,000/- and the operation and maintenance cost of the facility is Rs. 2,000/- per month.

Facility highlights of Horticulture waste Processing Unit	
Capacity (kg) per day	150
Area of unit	30 sq. ft
CAPEX	Rs 10,000
OPEX	Rs 2,000 per month

Key Highlights

- The sustained efforts have made Ambikapur a bin-free city devoid of dumpsites and landfills.
- 100% user charges collected from households and commercial establishments.
- AMC has also successfully reduced its cost of land acquisition by reclaiming encroached land worth Rs 25 Crore
- As a result of segregation at source, the corporation has earned Rs. 84.81 Lakhs from sale of recycled waste
- The SLRM model has also generated 623 green jobs without putting a financial burden on the state treasury.
- SHG members now have two sources of income, payment from AMC and the sale of recyclables
- As a result of decentralizing the waste management process, the transportation cost has gone down to Rs. 2.1 Lakhs (Oct 2017) from Rs. 7.32 Lakhs (June 2015)

Recommendation

As the households in the city follow source segregation, the next step for AMC should be towards promoting home composting or community composting. This would be helpful in reducing the transportation cost for municipal body for handling solid waste.

To Know More

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Tirupati
Municipal Corporation

State: **Andhra Pradesh**

Area (in sq. km): **27.44**

Number of Wards: **50**

Population: **2,87,482**

Waste Generated in Metric Tons (MT) per day: **157**

Shredding of Waste, Centrlized Compost Plant

Screening machine

Shredding of Waste, Centrlized Compost Plant

Tirupati is a vibrant pilgrim town located in Chittoor district of Andhra Pradesh. The Health department of Tirupati Municipal Corporation (TMC) is responsible for management of solid waste in the city.

The primary collection of waste in TMC is based on a three-pronged approach. In the crowded areas, mostly in the old city, waste is collected through pushcarts, in other areas by tricycles and in the far flung areas where the houses are scattered, motor vehicles are pressed into the service of waste collection from houses. Door to door- waste collection is carried out by the sanitary workers in all 50 wards. All the staff involved in handling of solid waste have been provided with personal protective equipment such as masks, shoes, florescent jackets etc. and use them on a daily basis.

Solid Waste Profile of The City			
Total Waste Generated in the city in MT per day	157 MT per day Wet Waste: 109MT per day; Dry Waste : 48MT per day		
Door to door collection %	100%		
Source Segregation %	100%		
Processing of Waste			
Processing Technique	**Waste processed per day in MT**	**Processing Facility**	
Composting (Centralized)	91 MT per day	Tukivakam Compost yard	
Composting (Decentralized)	18 MT per day	RWAs/ Markets/Hostels/Hotels/ Parks	
Recycling	48 MT per day	Tukivakam	
Total Waste Processed	157 MT per day (100%)		
Quantity of waste disposed at the dump site			
Dump Site	Area	No. of years in use	Daily waste deposited
Ramapuram	25 acres	6 years (SLF under construction)	9 MT per day

Source:https://smartcities.data.gov.in/catalog/solid-waste-management-tirupati?filters%5Bfield_catalog_reference%5D=2913155&format=json&offset=0&limit=9&sort%5Bcreated%5D=desc

Sanitary workers collect segregated waste from the houses in separate bins. The collected segregated waste is then transported to the secondary collection points (SCPs). The rag-pickers collect the recyclable waste and sort them before selling them off to the kabadiwala. The wet waste is transferred to the compost yard situated at Thukivakam site. The remaining waste from the secondary collection points is then transferred to the Transit station at Leela Mahal in ward no 44 spread across an area of 2 acres. Auto-tippers, dumper placer (DP) vehicles, tractors and tipper trucks are being used for the secondary collection and transportation of municipal Solid Waste. From the transit station, the waste is finally transported to the existing dumpsite. Currently, there is only one existing dumpsite which is located at Ramapuram village and it is operational since 6 years. This site is approximately 25 km away from the city centre and is spread across an area of 25 acres. A sanitary landfill facility is

under construction at Ramapuram.

All the notified commercial areas are swept and cleaned twice a day as well as on all Sundays and festive holidays with mandatory night sweeping. Container bins have been placed at all the garbage vulnerable points. In addition to this, almost every commercial area has twin bins, for the convenience of the public. The city has taken a lot of initiatives to process 100% of the waste generated in the city. The major proportion of the bio-degradable (wet) waste collected in the city is processed at aerobic vermi-composting methods at the Thukivakam site.

Centralized Compost Plant at Thukivakam

Thukivakam village is located 10 km away from the center of the Tirupati city where bio-degradable waste is being treated and composted. This centralized waste-to-compost unit has been constructed and maintained by TMC (Tirupati Municipal Corporation). The focus of the plant is to convert wet waste into vermi-compost and assist the farmers in rural areas to get quality manure by incorporating scientific waste management. The facility was commissioned in the year 2010.

Facility Highlight of Thukivakam Compost Plant	
Area of the facility (in sq. m.)	40468
Processing Capacity of the facility (MT per day)	55
Quantity of input (MT per day)	50-55
Products obtained	Manure
Quantity of Manure obtained (MT per day)	15
OPEX (per month)	Rs. 2.5 Lakh
Manpower	15-20

Segregated biodegradable waste received at the facility is fed into the shredding machine. The shredded wet waste is first composted aerobically in the box-composting for a period of 10-15 days. The semi composted matter is then transferred into the pits (size 2m x 1m x 0.75m), on a bed of animal dung, dry leaves and grass. A layer of cow dung is then again spread over the mixture. This process is repeated until a desired height of accumulated waste is achieved. After this, earthworms are released on the upper layer of bed. The pit is kept moist by regular watering. The mix is turned over or mixed periodically for maintaining aeration and for proper decomposition. It takes 45-50 days for the waste to get converted into compost. The compost is then screened and packed. At present the compost obtained is being given to TUDA Horticulture Department and MCT parks at no cost.

Key highlights

- Thukivakam compost unit is a centralized wet waste composting unit which is proved to be useful for composting bulk wet waste in a simple and cost effective way. This facility has also provided employment opportunity to many.

Screening unit

GI Boxes

As the city has achieved 100% source segregation, wet waste can be easily processed to obtain high quality manure in the facility, however, cost of transportation of waste from the city to the facility is quite high since the site is located far away from the city.

In Vessel Onsite Box Composting at Prakasam Park

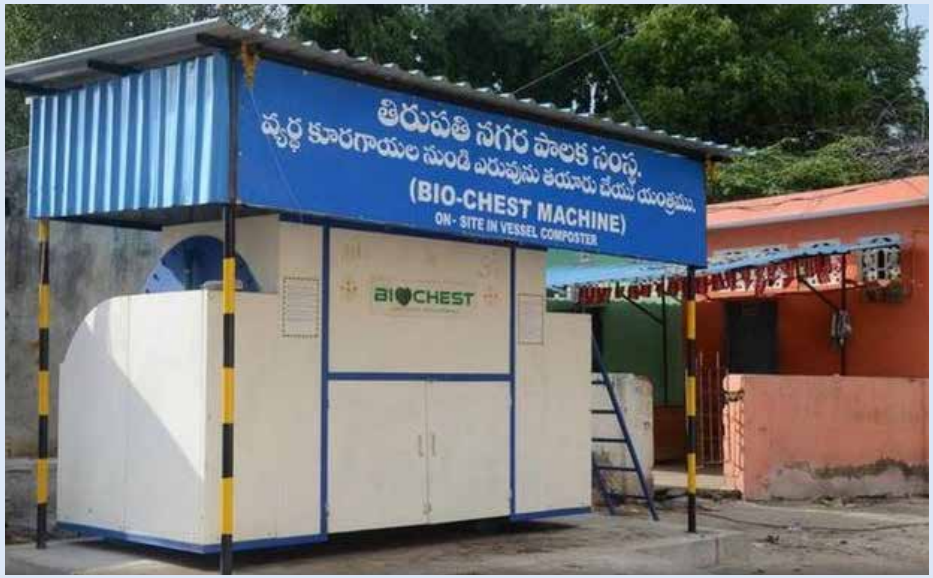
In light of processing the bio-degradable waste generated at source, 100% of the Bulk Garbage Generators (BGGs) in the city have facility for on-site composting of the wet waste generated by them.

Facility highlights of in Vessel Onsite Box Composting at Prakasam Park	
Quantity of input (MT per day)	0.8-0.9
Products obtained	Manure
CAPEX	Rs 1,67,000
OPEX (per month)	Rs. 2.5 lakh (approx.)
Manpower	4

Prakasam Park is the one of the largest parks in the city maintained by Tirupati Municipal Corporation (TMC). It is located in Srinivasa Nagar, around 1.7 km away from the center of the city. The park generates huge quantity of wet waste comprising dry leaves and other plant waste daily, making it one of the bulk generators in the city. An In-Vessel (Box) Composting unit was established by TMC in the year 2017 to process the biodegradable waste within the park itself.

The in-vessel composting process requires preparation of a base with gravel and wooden chips. Over the base, vessel boxes made up of galvanized iron (GI) are placed.

The BIO-CHEST Machine



Wet waste is shredded into smaller particles with the help of suitable machinery. It is then weighed and transferred to those vessels and the transferred waste is further crushed by stamping on it. Diluted cow dung slurry is then sprinkled on the crushed waste. This process is repeated till the vessels get filled completely. The wet waste pile is then watered for two days as the moisture facilitates multiplication of bacteria aiding in faster decomposition of waste. Within a few days the pile begins to compact and the wet waste turns black in colour with an earthy smell. The waste pile is spread and exposed to sunlight for 15 to 30 days for the moisture to dry out. Once the moisture is evaporated it is sent for screening. The product obtained after screening is of high quality and is then ready to be used for nearby nurseries and plantation along streets.

This composting unit is being maintained by the municipality staff. This unit contains 3 GI boxes of 1.8 MT capacity, 2 GI boxes of 2.7 MT capacity and 2 screening machines. The incoming waste comprises around 250 to 300 kg of dry waste from the park and 600 to 750 kg of wet waste from the surrounding residential areas. The output is 30% of the feed, which amounts to around 300 kg on an average. This facility requires 4 dedicated workers for at least for 3 hours a day for operation and supervision. The waste takes around 30 days to get converted to compost. The process however gets delayed during monsoon season as the boxes are placed in the open. The rainfall also adversely affects the quality of the compost.

Bio-Chest Machine at Indira Priyadarshini vegetable market

To process the organic waste produced from the vegetable markets, the Municipal Corporation of Tirupati (MCT) installed two Bio-chest Machines at Rythu Bazaar and the Indira Priyadarshini Vegetable Market in 2017. Bio-chest OWC-A series is installed in both the locations having a per day processing capacity of 500 Kg.

Facility highlights of BIOCHEST machine at Indira Priyadarshini Vegetable Market	
Processing Capacity of the unit (MT per day)	0.45
Quantity of input (MT per day)	0.45
Products obtained	Manure
CAPEX	Rs 14.3 Lakhs
Manpower	3-4

BioChest is an on-site In- Vessel organic waste composting unit. It is a combination of a device and process, targeting the quickest transformation of organic waste into consistent - quality compost at the lowest possible cost and management effort.

The unit for the Priyadarshini Vegetable market is located near the old TPPM School. The unit is being fed with the wet waste collected from the Indira Priyadarshini vegetable market and surrounding restaurants. Everyday municipal workers feed the unit with the collected organic waste and microbial culture. For 500 kg of organic

waste 250 ml of microbial culture is added. BIOCHEST uses forced aeration and mechanical agitation to control conditions and promote rapid composting.

The air blower in the system provides oxygen to the bacteria, which in turn helps in breaking the complex organic matter into simple molecules, resulting in release of energy, and increase in temperature. The inbuilt mixer and blower provide uniform aeration to all the waste materials present in the vessel. By the aeration process the required temperature in the vessel is maintained. The unit has an inbuilt bio-filter, that scrubs all the obnoxious gases produced during the process and releases only the odour free gases out in the environment. The process of converting waste into compost takes a period of 21 days. Once the process is completed after 21 days, the compost from the vessel can be emptied through the bottom door and can be used as a bio fertilizer after curing for 7 -9 days.

Key highlights

- This initiative has helped in reducing the cost of transporting the organic waste to the processing facility.
- Composting via bio chest machine is less power intensive and requires less manpower since most of the operation is automatic.
- Due to its compact design, very limited space and infrastructure is needed for the reactor and the storage bins
- Biochest reactor has an inbuilt Biofilter, which helps remove the entire odour during composting or mixing process.

Aerobic Waste Composting at Tirumala Devasthanam Hill Temple Town

Tirupati is the 'Abode of Lord Venkateswara'. The temple town attracts devotees from all over. Shri Venkateshwara Temple receives around 65,000 pilgrims each day, and on special occasions this number even rises to about 5 lakhs. The Tirumala Tirupati Devasthanam (TTD) looks after the management of the temple.

TTD is making all efforts to keep the Tirumala hills clean & green, keeping in view of the serenity and sanctity of Tirumala. Dual dust bin system (Red and Green dust-bins) is maintained in all areas to collect the bio-degradable and non-biodegradable waste separately. About 36 MT per day of solid waste is generated on normal days and approximately 60 TPD during peak days. The general composition of garbage is 91.00% of organic waste and remaining in-organic waste such as plastics, glass, metals, paper cardboards, leather, cloth, coconut coir/shell etc.

In order to process the biodegrdabale waste, a municipal solid waste management plant was set up at Kakulathippa in Tirumala hills by M/s Mahindra & Mahindra on behalf of

Municipal Solid Waste Plant at Tirumala

TTD in the year 2004. From 2004 to 2011 the plant was maintained by M/s Mahindra & Mahindra. Currently Bengaluru based firm M/s Bright Waste Technologies is looking after the operations and maintenance of the plant. The processing capacity of the plant is 50 TPD.

Key highlights

- The MSW plant has proved immensely beneficial as it handles effectively more than 75 per cent of the daily waste generated in Tirumala helping the TTD administration to keep the hill town more clean winning many national awards.

The segregated wet waste received in the facility is weighed and sent to shredder machine for size reduction. The output from the shredder machine is then made into heaps and kept under a shed. Diluted culture is sprinkled on the heaps followed by thorough mixing. The bacteria in the culture facilitates decomposition of the waste. The heaps are then turned to ensure uniform aeration. The wet waste is exposed to air for around 30 days and in the meantime moisture content is evaporated due to the heat produced by the microbes.

The waste is then fed into the rotary where it is further processed into smaller particles and from there the product is sent to a trommel. The Trommel segregates the waste in various sizes such as 6mm, 14mm and 40mm. The 6mm size waste particles are transferred to the de-stoner where stones are removed. The 14mm and 40 mm waste particles are further processed separately until 6mm material is obtained. The 6mm material thus obtained is exposed to air for few days till the final manure is ready. The remaining rejects are sent to landfill site. For every 100 kg of wet waste 20 to 30 kg of high quality manure is produced which is used for crops, gardens and nurseries. The Final manure is then e-auctioned by TTD. Daily about 30-35 tons of wet waste is received at the plant for processing.

Segregated waste collection

Recommendation

Besides achieving 100% door to door collection and 100% source segregation, the city has managed to process 100% of the waste generated daily. Besides source segregation, the decentralized approaches adopted across the city to manage waste at source have contributed towards the solid waste management in the city. The solid waste management model of the city sets a good example of how to reduce the quantum of waste reaching the landfill.

To Know More

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Panchkula

Municipal Corporation

State: **Haryana**

Area (in sq. km): **33**

Number of Wards: **20**

Population: **2,11,355**

Waste Generated in Metric Tons (MT) per day: **115**

Community composting facility at Sector 12

Panchkula is a satellite town adjacent to Chandigarh. At present, 115 MT waste is generated per day in the city from 20 wards. Out of the total waste generated about 40 MT is being processed. Prior to 2017, the entire 115 MT untreated waste was dumped at the 12 acre dumping ground located in Panchkula extension sector 23, Jhariwala village. This direct dumping of untreated waste created havoc in the area with stink, stray dogs, pigs, vultures, etc. This area is close to sector 23 to 27 and posed to be a severe health hazard to people residing them.

The methane gas produced by the dumping ground, often caught fire during the summers. On May 25, 2018, nearly 93 fire tenders and 123 trucks of sand had to be pressed into service to douse the fire at the dumping ground. The nearby residents brought the matter to the National Green Tribunal (NGT) and blamed Haryana Urban Development Authority (HUDA) for developing a residential area in such close proximity to the dumping ground. Considering the serious health issues and complaints from local residents, NGT directed HUDA and the Pollution Control Board to ensure due compliance with laws governing management of landfill sites. After the NGT order in 2016, HUDA and PMC jointly proposed a waste management plan through waste processing, along with the development of a sanitary landfill site in Jhariwala village.

Key highlights

- Home composting adopted by 250 households and some apartment buildings.
- 80 parks and a temple practicing on-site composting.

Due to unavailability of a centralized processing plant, PMC adopted 3R's (reduce, recycle, reuse) principle and a decentralized processing mechanism. As a strategy, PMC involved local residents, RWAs, school children and other stakeholder to build awareness through IEC activities, awareness campaigns, pride rallies and stakeholder meetings regarding segregation and home composting. As a part of the management plan, 100% door to door collection has been ensured in all 20 wards through waste pickers. To encourage segregation, waste pickers (erstwhile rag pickers) were provided with painted carts (blue and green) to collect the waste and take it to the common point from where the waste is transported to the dumping ground through 82 vehicles (varying from dumper to carts) having separate blue and green compartments. As an important strategy to empower waste pickers, PMC has provided them with official ID cards, safety kits, medical facilities, toilet and drinking water facility at the dumping ground. Waste pickers are employed on a payroll basis and are also allowed to earn benefits by selling the recyclable and reusable dry waste collected from households. Pilot Composting and MRF at Sector 12.

Community composting facility

Panchkula generates 70 MT of wet waste and 40 MT of dry waste. Out of the total wet waste generated, 15 MT is processed through onsite composting in 80 parks and 10 MT by composting at various levels (such as household, community and BGG).

The community composting facility at sector 12 consists of 18 composting pits of size

Demonstration of Home Composting

SHG womens at community composting facility

3ftx4ftx7ft approximately, processing around 8 MT waste comprising of dried leaves, grass, vegetables, fruit peels, rice, leftover food, bread and curd etc. Waste pickers are not only collecting waste but are trained to carryout composting and are responsible for functioning of the community composting facility at sector 12. The manure thus produced is used by the PMC for horticultural purposes. As a result of the awareness program and necessary facilitation by PMC, 250 households are now practicing home composting by using Khamba composter while some apartments are using Aagha composter for the same.

Facility highlights of Community composting facility	
CAPEX	Rs. 15,00,000
Revenue Generated (if any)	Compost supply to PMC
Manpower	7

Material Recovery Facility (MRF)

MRF facility that has a capacity of 20 MT at a cost of 15 lakh was established in October 2018. It processes about 6-7 MT/ day of the dry waste that is being collected from two wards - Sector 12 and Raila village comprising 1500 households (952 and 550 households respectively). These wards include residential societies, hospitals, schools, offices, restaurants, hotels, etc. The waste collection is carried out between 7 a.m. to 11 a.m. through three e-carts with two persons per e-cart. The dry waste composition includes tissue paper, paper cups, tetra packs, cans, files, newspapers, books, copies, polythene, plastic, bottles, aluminum foil, metals, cardboard, rubber, electrical waste, etc. The collected waste is segregated and compressed at the MRF and sold to the recyclers for further processing.

Key highlights

- Waste Pickers empowerment by formal hire on payroll system and capacity building by PMC is the first model of NULM and SBM convergence in Haryana.
- A SHG of 12 waste pickers training in Bangalore under Hasirudala through CSR fund.

Facility highlights of Material Recovery Facility	
Area of the facility	25 (in sq. m.)
Processing Capacity	20 MT per day
Quantity of waste processed	6 MT per day
Products (for C & D/ Upcycling)	Sold to recyclers
Manpower	10
CAPEX	Rs. 15 lakh

OWC at Mansa Devi Temple

Religious sites that experience a huge daily footfall have also supported the onsite composting initiative. The famous Mansa Devi temple, where 2000 pilgrims visit daily, generates around 30 kg flower waste per day. In order to manage this floral waste, the

Home composting at Sector 12

Park composting

Community composting at Sector 12

Bailing of Dry waste at MRF facility

OWC machine at Mansa Devi Temple

Biogas plant at Nada Sahib Gurudwara

temple has installed a composting Organic Waste Converter (OWC) of 30 kg capacity in 2016. The compost produced here is being used for horticulture purposes. Only one person is required to operate this facility.

Biogas plant at Nada Sahib Gurudwara

Key highlights

- Gurudwara is using organic waste from its kitchen to produce bio gas for cooking.

A biogas plant that has a treatment capacity of 100 kg has been installed by BEIL Research And Consultancy Private Limited at Nada Sahib Gurudwara. The plant is based on the Double Digester Biomethanization (Aerobic & Anaerobic Biomethanization) technology provided by Indian Institute of Chemical Technology, Hyderabad. The Gurudwara community kitchen caters to more than 2000 people per day. The organic waste from community kitchen is processed in the plant to convert it into biogas. The Gurudwara has employed one person to operate this plant. The 100 kg gas produced per day at this facility is being used for cooking purpose. The sludge and 35-40 litre leachate generated daily is used as manure and fertilizer for gardening within the premises.

Recommendation

As a result of successful IEC and awareness program by PMC, some of the residential sectors and parks have started segregation at source and have implemented onsite composting. It is recommended that PMC should endeavor to achieve 100% source segregation waste in all the 20 wards. PMC needs to further promote decentralized waste management facilities so that most of the generated waste goes to the processing plant and least to the secured landfill site.

To Know More

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Gangtok
Municipal Corporation

State: **Sikkim**

Area (in sq. km): **19.02**

Number of Wards: **17**

Population: **1,00,286**

Waste Generated in Metric Tons (MT) per day: **50**

Waste Collection in Gangtok

Gangtok is the capital city of Sikkim and is located on a ridge at a height of 5500 metres. Gangtok city generates about 50 MT of solid waste daily. The major solid waste generation sources are households (60%), markets (15%), hotels & restaurants (10%), tourists (10%), and street sweeping (5%). 58% of the waste generated in Gangtok is compostable organic matter and 32% is recyclable waste (paper, plastic, metal and glass). Inert materials comprise 10% of the total waste.

The city of Gangtok practice of systematic and scientific disposal of solid wastes. The city has a system of primary collection, secondary collection, transportation and their safe disposal. The segregation of solid wastes starts at households as wet and dry wastes which are transported through a system of primary and secondary collection vehicles, to the compost plant and sanitary landfill site at Martam, where the wet wastes are composted after due mechanical processes and the dry wastes again segregated into inerts and recyclables. The inerts are scientifically disposed into the sanitary landfill that is constructed near the compost plant and the recyclables are sold to the recyclers.

Integrated Solid Waste Management Plant, Martam

The Integrated Solid Waste Management Plant consists of 50 MT Compost Plant, Resource Recovery Centre (RRC) and Scientific Sanitary Landfill. Gangtok had already constructed and commissioned a 50 MT capacity compost plant at Martam. But the plant stopped its operations since 2009 due to breakage of the shaft of second trommel (cylindrical rotating screen).and there was no proper O&M arrangements. Under the guidance of Urban Development and Housing Department (UD&HD) the plant was made operational and the adjacent dumping yard near the compost plant was redesigned as a scientific sanitary landfill. The compost and scientific sanitary landfill was funded by the Ministry of Housing and Urban Affairs and the Asian Development Bank (ADB) and inaugurated in November 2017.

Facility highlight of ISWM	
Area of facility (in hectares)	4.65
CAPEX	Rs 4.12 crore (including Compost Plant, Resource Recovery Centre and Sanitary Landfill)
Quantity of Waste processed in Compost Plant (in MT/day)	29
Quantity of Waste processed in Resource Recovery Centre (in MT/day)	16
Quantity of Waste going to Landfill (in MT/day)	5

Once the waste reaches Martam, all recyclables can be recovered and linked with scrap dealers to be sent for recycling through the recsource recovery centre. Second, from the segregated biodegradable waste is sent for composting in the composting plant. The rejects from the compost plant, and non-biodegradable waste, i.e. construction/ demolition waste silt, rejects from recyclable waste (not collected by rag pickers and scrap dealers) are to be disposed off in the Sanitary landfill.

Dry Waste for Recycling near the RRC Centre

Dry Waste for Recycling near the RRC Centre

The covered compost plant shed is built up in an area of 3,960 square meters (m2) which include 2,760 m2 for windrow area (70%) and 1,190 m2 for machineries (30%). This area is divided into five bays each measuring 54.5 m length and 14.5 m width. The total windrow length available is 380 m and 5.5 m width with vehicle movement width of 3.5m.

Reengineering the Existing Waste Dump to Scientific Landfill Site

The uneven waste landfill surface is upgraded as a scientific sanitary landfill site. The development of the landfill site is expected to serve the requirement of about 20 years . The task included preparation of subgrade by excavating earth, dressing and consolidating with 8/10 ton road roller including making well the undulations etc. in the existing landfill site and forming the landform from the wastes at the landfill site. Waste was deposited in layers not exceeding 50 cm and compacted to attain a placed waste density of 0.8 tons/m3. Over this landform a soil layer of 50 cms.

The project involved construction of retaining walls to support the cells, laying of geomembrane over geo-synthetic clay liners which prevents seepage of leachate coming from the waste into the ground.

The leachate collection system for landfill includes laying of perforated HDPE feeder pipes of size 110 mm through the drainage layer placed over the landfill bottom liner. Header pipes with a size of 160 mm is laid with spacing of 25 m to take the flow from feeder pipes to leachate collection sump. Additionally, as a protective measure to remove any leachate buildup in the landfill, a pipe of 450 mm diameter is connected inside with 315 mm diameter with five submersible pump. This will be provided at the lowest portion of the landfill to pump leachate to the sump. There is a leachate collection sump with 5.0 m diameter x 2.5 m height. For the treatment of leachate collected from land fill a Facultative aerated lagoon (FAL) of total capacity 2,400 m3 is constructed.

Engage 14 Outreach Initiative

Phase 1
Engage Quiz competition is a program designed for sudents of classes 4, 5 and 6 to propagate the message of reduce, reuse and recycle. The quiz addresses issues such as reducing waste from households, intelligently reusing household items and not discarding them just after one use.

Phase 2
The outreach program involves panel discussions on Reduce, Reuse and Recycle and Creative exercises such as poster making, essay writing on themes such as 'Urban Gangtok– Leading the Sanitation change'. This phase is designed to engage students of classes 7, 8 and 9.

Phase 3
Engage-14 called the 1 KM initaitive is envisioned as a race towards positive change for students of classes 10, 11 and 12. As part of the race, students will be given a specific timeline and budget to visit 5 sites in the city pre-decided by GMC. The students will visit these sites to understand better the solid waste and sanitation situation in and around Gangtok. Once the students reach the site, they will be given specific activities and tasks which they will need to complete before moving to the next site

The 'Engage 14' outreach initiative was launched in January 2014 by the GMC in collaboration with 24hours Inspired, a personality development and leadership enhancement firm that facilitatesworkshops and leadership programs in schools, colleges and corporate firms. GMC and 24hoursInspired designed a program to engage school students from classes 4 to 12 in the process

Awareness Programme by GMC for school children

Compost Plant at Martam

ofunderstanding aspects of waste management. The program was designed as a three-phase intervention with Engage Quiz for junior school students, Engage Discussion for Secondary school students and Engage Race for Senior Secondary Students.

The yearlong program helped to sensitize the younger generation on the adverse effects of pollution and their responsibility towards keeping their surroundings clean and spread awareness about recycling and waste management.

Recommendation

Currently, the Construction and Demolition (C&D) waste is not being processed in the city and is being disposed in the landfill as inerts. So, it may be recommended to take steps to manage the C&D waste and produced upcycled products out of it.

To Know More

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Scientific Sanitary Landfill Site, Martam

Imphal
Municipal Corporation

State: **Manipur**

Area (in sq. km): **28**

Number of Wards: **27**

Population: **2,68,243**

Waste Generated in Metric Tons (MT) per day: **120**

Team members of Chanu Associates

Ecofriendly Pens

Solid Waste Treatment Plant, Lamdeng

Plastic Recycling Unit

Imphal is capital of Manipur known for its scenic landscapes and greenery. The Imphal Municipality generates 120 MT of waste per day. The Imphal Municipal Corporation (IMC) consists of 27 wards. IMC has collaborated with 6 NGOs namely, namely, centre for Research on Environmental Development (CRED), Workers' Union Manipur (WUM), Seven Security Force (SSF), TACDEF Solid Waste Management, Khaba Waste Management System (KWAMS), and Social Upliftment & Welfare Organization (SUWO) to carry out the management of municipal solid waste. The collected waste is taken to Lamdeng.

Solid Waste Treatment Plant, Lamdeng

The Solid Waste Treatment Plant at Lamdeng, constructed by the Manipur Government has been upgraded from its "Waste to Compost" policy to "Waste to Compost and Energy". The treatment plant operates on Public Private Partnership (PPP) model, without any further investment from the State Government. Imphal Municipal Corporation dumps 120 MT of solid waste daily. Separation of dry and wet, biodegradable and non-biodegradable waste was not done at source.

Facility highlights of Solid Waste Treatment Plant	
Area of Facility (in acre)	12
Plant Capacity (in MT/day)	120
CAPEX	Rs. 41,75,00,000
Output	Bio-Compost and Electricity
Manpower	19

The plant gives output of 14 percent high-grade bio-composes daily. It also generates 2MW power with the process of thermal gasifier. The responsibilities of the operation, upgradation, and maintenance of the plant on PPP mode has been given to Eco Care Pvt. Ltd, a private agency based in Ahmedabad. The end product of bio compost is being outsourced to one private firm, A1 Agro Company and has been marketed under the brand name of Nongin Bio-Compost.

Plastic waste Recycling, Imphal

S. J. Plastic Industries started by Mr. Itombi Singh and Sadokpam Gunakata has established a successful operation of Plastic waste recycling programme in Imphal in the year 2007. The plant collects 2 MT of plastic waste from the city with the help of small enterprises. The industry pays Rs. 8 per kg for collection and segregation of plastics into different categories. Out of the 120 categories of plastic waste, 30 categories are directly recycled across Manipur. The industry buys plastic waste at Rs. 8 per kg and sells the end product at Rs. 65 per kg to the wholesaler.

Waste plastics are segregated, cut in shredder, washed with water, dried and granulated for new product moulding to make end products such as flower pots, bins and pipes.

Innovative eco-friendly Pen, Chanu Associates

Chanu Associates is a Manipur-based start-up firm. A brainchild of a young and talented ecopreneur, Ngangom Monalisa Chanu, Chanu Associates, under the brand name 'Chanu' deals with a plethora of products that range from environment friendly pens with seeds, pencils, direct filling pens, paper bags, non-woven bags etc. Chanu Associates started its operation from 5th June, 2017.The venture started at a nominal investment of Rs. 20,000. Chanu envisions scaling new heights and avenues as an entrepreneur by production of environment friendly class 16 items.

The innovative eco-friendly pen, is a great alternative to plastic ballpoint pens, do not just address the plastic menace but also contain seeds that can grow into plant. Once the pen has been used up, it can be just planted into soil, the seed will sprout from the bottom of the Pen. These eco-friendly paper pens reduce plastic waste and also contribute in growing trees.

Once the ink of the pen gets over or the pencil is used up, it can be planted in 30 degree angle with sands. The capsule covered ultimately gets off and implanted seed get exposed to soil, moisture leading germination.

Presently the startup produces 200-300 units and gets a profit of Rs. 50,000 per month. Recently, the firm was given loan by state government under Startup Conclave to upgrade machineries for a target of producing 3000-5000 units per day.

Key highlights

- Provide sustainable employment to at least a few unemployed job seekers from the region.

To Know More

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Uttarpara-Kotrung
Municipality

State: **West Bengal**

Area (in sq. km): **11.71**

Number of Wards: **24**

Population: **1,59,147**

Waste Generated in Metric Tons (MT) per day: **13**

Centralized Compost Plant at Uttarpara-Kotrung

Uttarpara-Kotrung Municipality lies in Hoogly district of West Bengal and is a part of the Kolkata Metropolitan Development Authority (KMDA). It is located about 10 km from Kolkata. The town currently generates 13 MT of solid waste on a daily basis. The Kolkata Solid Waste Management Improvement Project (KSWMIP), which has been assisted by Japan International Cooperation Agency (JICA) is an innovative project that KMDA has taken up in six Urban Local Bodies (ULBs) of Kolkata Metropolitan Authority (KMA) viz. Uttarpara-Kotrung, Konnagar, Rishra, Serampore, Baidyabati and Champdani. The project aims at management and disposal of solid waste in the six ULBs by introducing separate collection system, utilization of biodegradable waste for compost material, discontinuation of open dumping and scientific sanitary landfill with leachate treatment. The project targets a population of 1.1 million with an estimated project cost being Rs.170 crore. The project has seen major success in successful in Uttarpara-Kotrung Municipality which has achieved 60-80% segregation of waste at its source. Transfer of waste directly to a sanitary landfill site, or through a transfer station, has reduced open dumping in the town by 35%. Among the 13 MT of waste that is collected, 8 to 9 MT of waste is processed at the centralized compost plant, about 4 to 5 MT of waste is segregated and sold by waste pickers and the remaining waste is disposed at the sanitary landfill at Baidyabati.

Collection, Segregation and Processing of Solid Waste at Uttarpara-Kotrung

To generate awareness regarding source segregation of waste and sustainable waste management among the residents, a group of six women have been engaged as "Social Mobilizers". Municipal workers collect wet and dry waste in segregated form from the households. The waste is carried in vans having separate compartments to the transfer station near Grand Trunk Road. The wet waste is sent to the adjacent centralized compost unit for production of manure. The municipality sells the bio-manure produced at the plant named 'Basudha' from its counter and through marketing agents. The compost plant has a processing capacity of 9 MT per day. It currently produces about 3.5 MT of compost on a daily basis. The dry waste is further segregated manually. More than 25 waste-pickers have been engaged by the Municipality for this purpose. The dry waste is then compacted and sold to the dealers. The waste pickers are provided with masks, gloves, gumboots and uniform by the Municipality.

Manual segregation of waste at Centralized Compost Plant

Facility highlights of Solid Waste Management at Uttarpara-Kotrung	
Processing Capacity of the compost facility	9 MT per day
Quantity of Compost obtained	3.5 MT per day
CAPEX of the KSWMIP Project	Rs. 170 crore

Key highlights

- The initiatives of Uttarpara-Kotrung municipality helped the Kolkata Solid Waste Management Improvement Project win a global award, defeating nearest contenders Auckland and Milan in urban solid waste management category in the C40 Mayors' Summit.

Recommendation

Uttarpara-Kotrung has taken commendable initiatives in source segregation and processing of wet waste in the town, more efforts are required to manage the dry waste. Material recovery Facillity (MRF) dedicated to the dry waste processing would make the solid waste management in the town more effective and sustainable. Currently, the only scope of recovering the expenses is by the sale of manure. Collection of user charges from the households in addition to the sale of manure would ensure future financial viability of the project.

To Know More

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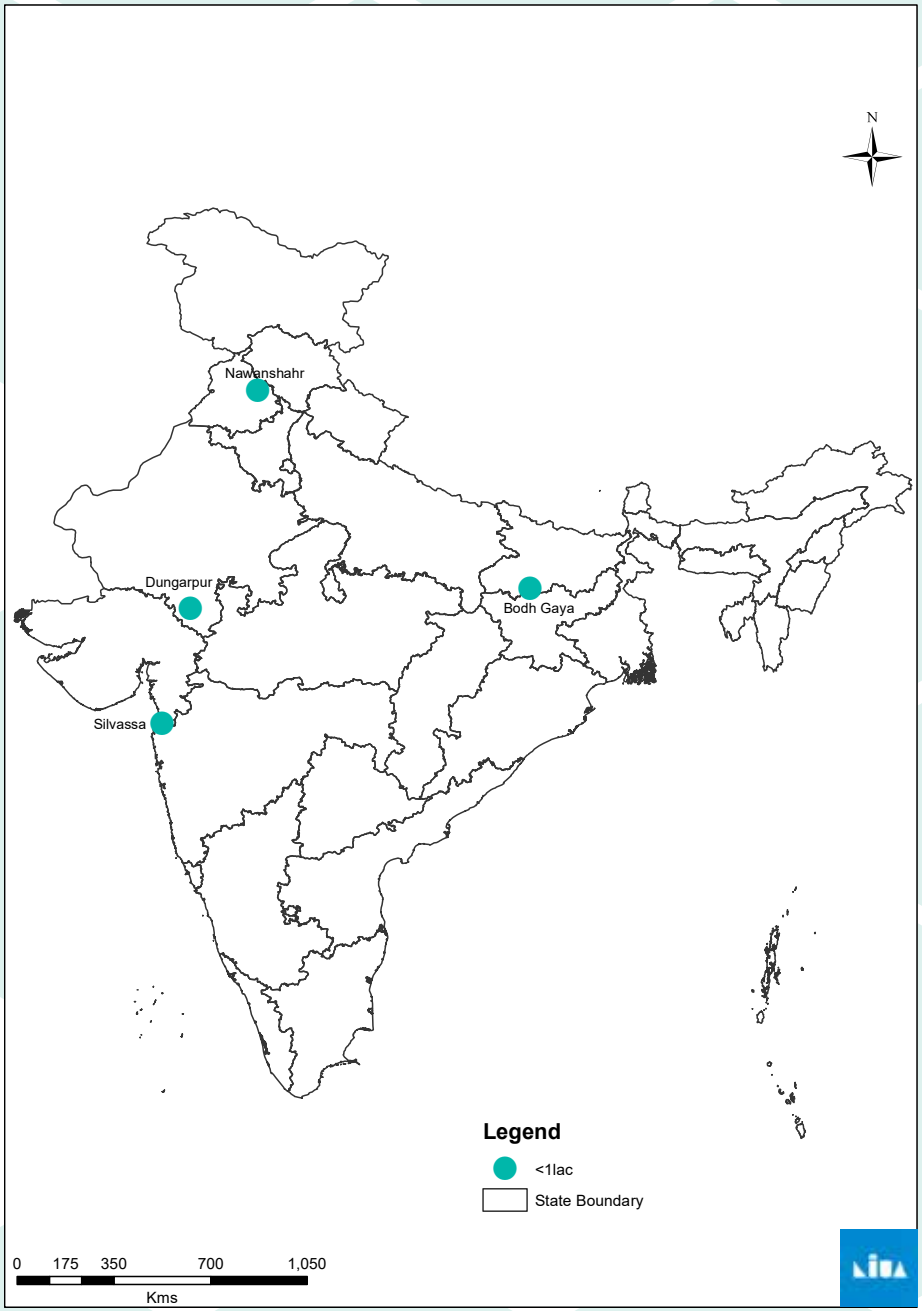
Cities with population:

Less than 1 Lakh



Dungarpur

Municipal Council

State: **Rajasthan**

Area (in sq. km): **14**

Number of Wards: **30**

Population: **47,706**

Waste Generated in Metric Tons (MT) per day: **15.5**

Auto tripper used in Dungarpur for waste collection.

Solid waste management in Dungarpur comes under the purview of the Dungarpur Municipal Council. Dungarpur today generates approximately 15.5 MT of garbage a day and all of it is collected from the source whether it is a household or commercial establishment. The total wet waste generation is 9.5 MT per day and dry waste generation is 6 MT per day. Nagar Palika Dungarpur has conducted door to door collection and transportation of municipal solid waste from all the 30 wards. The initiative started in 2015 and is managed by two NGOs, namely Urban Management Center and FINISH Society. The wet and dry waste are completely processed in the garbage management center, which is situated 5 km away from the city. The Nagar Parishad has also freed the city from plastics and has strictly enforced the ban on usage of plastic and polythene bags.

Segregation, Collection and Transportation

Dungarpur ensures 100% coverage of wards through its door to door collection system. 100% segregation of waste at source is being practiced in the city. In Dungarpur, for the primary collection of waste, there are around twenty vehicles (Auto-tippers and cycle rickshaws) that are used, while for the secondary collection, five vehicles such as tractors, tractor loaders and refuse compactors are used. The waste is collected from the residential and commercials areas on a daily basis at a specified time. Sensor based smart bins are placed at various locations in the city (especially in the public areas) which are cleared on a daily basis.

Facility highlights of Segregation, Collection and Transportation	
Wards covered	30
Technology used	GPS
Manpower	175
CAPEX	NA
OPEX	Rs. 9,00,000 per month

Source: Dungarpur Municipal Council

In addition to this, Dungarpur Nagar Palika is using Global Positioning System (GPS) to track movement of garbage trucks to ascertain whether they are rendering their duty regularly. Furthermore, Dungarpur has deployed Sensor Based Smart Bins in the city which indicates the filling of containers on a real time basis and sends optimized routes directly to the drivers to reach the filled bins.

Key highlights

- Use of GPS tracking system for tracking the movement of garbage trucks.
- To check on the situation of waste, CCTV has been installed at the GVP points.

Integrated Solid Waste Management Facility

Dungarpur city has a Centralized Processing Unit situated at Bhandariya Ghata. The site has a combination of technologies. This centralized processing unit has the following facilities:

Facility 1: Material Recovery Facility

Facility 2: Biomethanation Plant

Facility 3: Vermi- composting Facility

Facility 4: Sanitary Landfill Facility

1. **Material Recovery Facility :** The dry waste collected from all the 30 wards of the city is bought to the MRF where the waste is further sorted into different categories. Most of the recyclable waste is sold to the waste dealers and the inert is sent to the sanitary landfill site.
2. **Biomethanation Plant:** Two biomethanation plants have been developed and managed by Nagar Palika Dungarpur. The plants have a feeding capacity of 6.3 MT

FINISH Society women helping in collecting waste

Waste being further segregated in the MRF

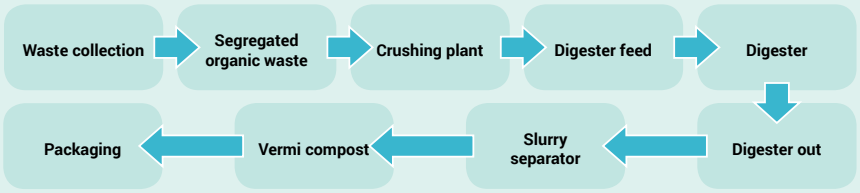
Biogas Plant

per day and a gas generating capacity of 300-350 cu.m. It is the largest biogas plant in Rajasthan and is used to dispose wet waste, septic and animal waste simultaneously. The dimension of plant is 35' deep and 43' diameter. The gas produced is used for cooking and a 4 KVA Genset converts this biogas into electricity. The total compost generated is approximately 2.7MT per day. The total expected revenue generation from the plant is approximately Rs. 0.5 Million per month.

Facility highlights of Biomethanation Plant	
Capacity of the facility	6.3 MT per day
Plant type	Floating Dome
CAPEX	Rs. 90 lakhs
OPEX	Rs. 77,000 per month.
Products obtained	Gas and manure
Quantity of Gas Produced	300cu.m. per day

Source: Dungarpur Municipal Council

3. **Vermi-composting Facility:** The Vermi Composting Site at Bhandariya Ghata has been developed and managed by a private contractor in association with the Nagar Palika. The vermi composting facility has a capacity of 0.5 MT per day. The goshala adjacent to the waste disposal centre becomes especially useful as cow dung generated from this centre is treated with vermi culture. It takes 45 days to convert cow dung to compost with the help of worms. The capital cost incurred for this process is 20 lakh and the operational cost is 0.3 lakh per month.



Process being followed in the vermi-compost plant

Vermi-compost Shed

Organic Fertilizer Packaging

Sanitary landfill site in the integrated unit

Drainage Treatment Plant

4. **Sanitary Landfill Facility:** The inert waste that remains after segregation is disposed at the Sanitary Landfill. This plant has a life period of 25 years. It also includes a Leachate Treatment plant for the treatment of leachate. The capital cost for construction of the sanitary landfill is 20 lakh.

5. **Drainage Treatment Plant:** The plant is located Behind Patidar Hostel, Gapsagar Ring Road, Dungarpur which is managed by Nagar Palika Dungarpur. This waste water treatment plant has a capacity of 10,000 litre per day. The plant helps to maintain the BOD, COD of water which keeps the Gapsagar Lake clean. The capital cost of the plant is approximately 10 lakh and the operational cost of the plant is 0.1 lakh per month.

Recommendation

Dungarpur city has effectively implemented 100% door to door collection and 100% source segregation along with proper processing, disposal and management of the entire waste generated in the city. Only a small percentage of the waste which is inert is being sent to the sanitary landfill site. This model is the most recommendable model for the Class II cities and it can be achieved within a small time frame.

To Know More

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Nawanshahr

Municipal Council

State: **Punjab**

Area (in sq. km): **125**

Number of Wards: **17**

Population: **46,024**

Waste Generated in Metric Tons (MT) per day: **12.6**

Solid waste management in Nawanshahr comes under the purview of the Nawanshahr Municipal Council. Nawanshahr today generates approximately 12.6 MT per day of garbage a day and all of it is collected from the source whether it is a household or commercial establishment. The total biodegradable waste generation is 7.2 MT per day, non- biodegradable waste generation is 2.7 MT per day, combustible waste generation is 1.8 MT per day and inert waste is 0.9 MT per day. The households of all the 17 wards are covered by the door to door collection system. The city also ensures that the waste is treated efficiently in a decentralized or centralized waste processing plants. The city has integrated 100% of the informal waste pickers into the system. Furthermore, the city has initiated sweeping of the town twice or thrice daily to prevent littering. Various IEC activites were adopted for motivating the people to make their city clean.

The city was awarded the title of "North Zone's Cleanest City - No. 1" in the Swachh Survekshan 2019.

Segregation, Collection and Transportation

Nawanshahr ensures 100% coverage of wards through its door to door collection system. 100% segregation at source is being practiced in the city. In Nawashahr, door-to-door collection of waste is done with the help of 32 pheries (rerhi's) deployed for this purpose each having a capacity of 400kg. The pheries are specially designed with separate compartments for wet and dry waste. In this way, waste is segregated efficiently at the source as per specification. The fleet of vehicles includes small carriers, rickshaws and motor bikes fitted with the collection system. The administration has taken an intelligent step by collecting the leftover fruit residue from the juice vendors in the evening. So that such waste is not disposed in waste bins and left untreated. A total of 55 workers are involved in this process.

Waste collection into segregated tricycles

Facility highlights of Segregation, Collection and Transportation	
Wards covered	17
Technology used	Specially designed waste collection vehicles
Manpower	55
CAPEX	Rs. 55,00,000
OPEX	No cost- using their existing manpower
Revenue Generated	Approx. Rs. 3,221,700 (through user charges)

A cost of 15 Lakh (through donation made my residents) was used for designing cycle rickshaws and motorcycle rickshaws for collecting the biodegradable and non-biodegradable waste in separate compartments. Total fund raised for starting the project is 55 lakh, through public and people with local businesses.

Key highlights

- The Nawanshahr model is a community financing model: public donations and funds from civil society organizations.
- Specialized collection vehicles

Participation by various organizations: 150 waste bins were provided by a local cooperative sugar mill. The rotary club in Nawanshahr helped to purchase 150 pairs of PPE like gloves, masks, etc.

Participation by various organizations: 150 waste bins provided by local cooperative sugar mill. The rotary club in Nawashahr helped to purchase 150 pairs of PPE like gloves, masks, etc.

Processing of the Waste

Composting

Nawanshahr administration took steps to undertake a complete makeover of the dumpsite, and constructed an aerobic honeycomb composting pit unit within the dumpsite to effectively treat the collected bio-degradable waste by converting it to marketable compost. The pits are constructed with latticework walls to facilitate proper aeration and avoid foul odour. There are approximately 100 composting pits that are

spread over an area of around 526 sq. m.

Facility highlights of Composting Unit	
Area of the facility (pits + premises)	865 sq.m.
Pit size	3 m x 1.5 m x 1 m (100 pits)
Processing Capacity of the facility	7.2-9 MT per day
Quantity of input	7.2 MT per day
Products obtained	Manure
Quantity of Manure obtained	1.8 MT per day

The compost is prepared in 90 days. After 90 days, the compost so formed is taken out and dried in sun. Larger chunks are broken into small pieces and then sieved to collect the fine compost. A locally engineered legacy separator machine is additionally used to in segregate legacy waste lying in the dumpsite.

The capital expenditure is based on donations by various organizations and for the operation and maintenance of the pits a total of 6 workers are directly involved in this process along with the existing manpower from the Municipal Council.

De-centralised Composting Units in Schools, Colleges & Sabzi Mandi in Nawanshahr

Nawanshahr has taken the concept of composting beyond a centralised set up to decentralised units. Various decentralised composting units are built in schools, colleges and the vegetable market area, which are being managed by the respective authorities.

Material recovery facility centre: Dealing with Plastic Waste

Though the city performs 100% source segregation, for further segregation of the dry waste collected, it is done at the dumpsite both manually and mechanically. Identified waste pickers segregate the plastic wastes (polythene bags, plastic bags and other plastic waste) manually. The segregated waste is then sold to the recyclers (waste dealers).

Disposal of the Waste

The rejected material and segregated non-biodegradable waste is deposited at the dump site. The waste disposed of does not have any wet component in it; hence, the dumpsite remains odour free. Any bio-degradable component if present gets automatically decomposed in the dumpsite, which is again sieved out with the use of the locally engineered segregation machine. Remediation process of the dumpsite is ongoing.

Composting Units in Nawanshahr


Remediation of the existing dumpsite

IEC Activities for motivating the residents

Various activites were adopted for motivating the people and encouraging them to make their city clean. Some of the initiatives were Prabhat pheri for Swachhta, organizing meeting at the ward levels, meetings with senior citizens, meeting with the residents of Model Town(RWA), spreading awareness at Gomti Nath Mandir where people were gathered for religious function, meeting with all Religious leaders and NGO's, sensitization of the waste collector boys. Other awareness rallies were organized by the students and other residents themselves.

Along with this, for effective community engagement various safai abhiyans were organized, cloth bags around 10,000 were donated by an NGO to the residents so that the use of plastic bags can be reduced, 2000 HH waste bins (green and blue) were donated by Municipal Commissioner Dr. Kamaljit Lal to the residents so that residents are motivated to segregate the waste at source, the CEO Mr. Ajoy Sharma reviewed the SWM Project undertaken by the city, city level poster competition between school students on the Swachhta Topic, organizing regional workshops and visit from various officials from Gujarat and Himachal Pradesh.

Recommendation

Nawanshahr has effectively implemented 100% door to door collection and 100% source segregation along with proper processing, disposal and management of the entire waste generated in the city. 10-12% of the waste generated in the city is inert which is being sent to the dumpsite. The city has effectively managed to engage the community, which has made this model a huge success.The model of the city's door to door collection, pit composting and community engagement are the most recommendable models for the Class II cities. Along with this, the self-financing model of the whole process is something which needs to be promoted in other cities as well. Furthermore, the city needs to reduce the amount of waste being dumped to the dumpsite.

To Know More

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CEO Mr. Ajoy Sharma monitoring the SWM facility

Prabhat Pheris for Swachhta

Poster making competition organized for school students

Silvassa
Municipal Council

Union territory: **Dadra and Nagar Haveli**

Area (in sq. km): **17.17**

Number of Wards: **15**

Population: **98,265**

Waste Generated in Metric Tons (MT) per day: **45**

Silvassa is the capital of Dadra and Nagar Haveli. At present, 45 MT waste is generated per day in the city from 15 wards. There is 100% door to door collection by SMC. Due to the lack of segregation of waste in most places, almost all the collected waste is dumped untreated at the Kharadpada dumping site which is 9 km away from the city. At present, M/S. Rurban Cleantech Pvt. Ltd. are carrying out the entire SWM activity in all the wards, under PPP mode. This includes door to door collection and transportation to dumping site. The agency involves about 70 workers and 18 vehicles in the management process. At Kharadpada, SMC has provided 5.27 hectares land to M/S Rurban Cleantech Pvt. Ltd. to develop the processing facility with a capacity of 100 TPD. SMC has conducted extensive IEC campaigns to create awareness and to educate the citizens on waste reduction and segregation. Through bye-laws, SMC also mandated waste management within premises for bulk generators like hotels, restaurants, societies, etc. As a result, two societies and two hotels have initiated the waste segregation and onsite composting facilities respectively.

Segregation at source at Thakur Complex

Spread over an area of 13,300 sq. m, the Thakur Complex society generates 250 kg of waste per day from 500 flats. The dry waste is 100 kg while the wet waste is 150 kg. The society has started segregation at source into two categories (wet and dry). All 500 flats were provided with two bins by SMC. The segregated waste is collected door to door by 5 waste pickers (between 6:00 am to 10:30 am). The segregated waste is then collected by the SMC vehicle from the complex gate. The composting unit within the complex, is under construction. Once built, SMC will only collect the dry waste from the society. The monthly expenditure for the salary of 5 waste pickers is Rs. 28000.

Facility highlights of Segregation at source at Thakur Complex	
CAPEX	Rs. 2,50,000 (CSR funded)
OPEX	Rs. 1100 per month
Manpower	1
Compost produced	18-20 kg/bin/month

Aaga Composter at Government Officers

Colony Organic Waste Converter Machine

Decentralized Composting at Government colony and Brahma Kumari Rajyog Kendra

It is a colony of 15 households with an area of 0.2 hectares. The colony has been managing its wet waste since September, 2017 within premises and only dry waste is collected by the SMC. This initiative has been sponsored by Jai Crop Ltd. under its CSR activity wherein the company has provided four "Aaga" composters. The "Aaga" composter is made from UV stabilized, moulded plastic and is ideal for composting in flats, apartments and institutions. Its size is 3.5 feet in diameter and a height of 3 feet.

Facility highlights of Decentralized Composting	
Capacity	Rs. 50 kg per day
CAPEX	Rs. 2,75,000
OPEX	Rs. 1000 (saw dust)
Manpower	1
Compost produced	15-20 kg per day

A single composter has the capacity of handling 18-20 kg wet waste per day and in this colony four such composters has been installed. The compost is used in the garden and excess is distributed to the farmers. Till now 87 kg of compost has been prepared. The composters are operated and maintained by 1 person appointed by colony under the supervision of SMC. The O & M cost is taken care of by the SMC.

Key highlights

- After installation of Aaga composter, 330 kg of wet waste is diverted from landfill every month.

Brahma Kumari Rajyog Kendra

Brahma Kumari Rajyog Kendra has 5 members staying at the centre, while during their camps and activities the numbers substantially increases, making them a bulk waste generator. With the awareness and education campaigns conducted by SMC, they have initiated a decentralized composting system at the centre. They have installed a composter unit Khambha-3 tier made out of terracotta. The unit has been obtained from a Bangalore based company - Daily Dump. The capacity of each container is 2 kg and the one-time cost is Rs. 2200. In this centre, 1 kg of wet waste is processed daily. Presently the microbial cultures is provided by SMC. In this process one person operates and fills the composter. The compost is used in the garden of the centre.

Home composting through Khamba

Daman Ganga Valley Resort

Daman Ganga Valley Resort is located on the Naroli road is under BGG. It is spread over an area of 4.4 hectares. They have installed an OWC to treat their organic waste onsite. The OWC of capacity 50kg/day was procured from Unique Fabchem. An OWC is a self-contained system capable of performing pasteurization of organic waste, sterilization of pathogenic or biohazard waste, grinding and pulverization of refuse into unrecognizable output, trash compaction and dehydration. The output is compost which is used directly in the gardens. The space required for the instrument is approx. 10x10 ft. The consumption of electricity is around 7 kW/hr.

Key highlights

- For hotels, resorts OWC is favorable options for onsite waste management.

Recommendation

As a result of stringent byelaws and policies of SMC, Silvassa has been able to achieve 100% door to door collection and transportation to a common dumpsite. Also, some of the bulk generators like hotels, apartments, colonies, etc. have started segregation at source and have implemented onsite composting. They have unfortunately not been able to be achieve large scale source segregation of waste or processing of different waste streams as envisaged in the Solid Waste Management Rules 2016. It is recommended that SMC should endeavor to achieve 100% source segregation of different waste streams in all the 15 wards and establish processing plants so that the least amount of waste (6-8%) of waste goes to the landfill site.

To Know More

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Bodhgaya

Nagar Panchayat

State: **Bihar**

Area (in sq. km): **19.6**

Number of Wards: **19**

Population: **38,439**

Waste Generated in Metric Tons (MT) per day: **920**

Bodhgaya is a small town of international renown with immense religious and cultural significance located in Gaya district where Lord Buddha attained enlightenment. The competitive advantage of Bodhgaya lies in the fact that it is one of the most prominent Buddhist pilgrimage sites and also houses a UNESCO World Heritage site within its boundaries.

Bodhgaya generates 18 MT of waste per day. About 60% of the waste generated is collected while the rest is unattended. There are about 15- 20 collection points earmarked in the town. The city has so far has not been able to achieve complete compliance of SWM Rules 2016, but have made efforts towards as part of the mission. These efforts are worth evaluating and emulating.

Floral Waste to Khadi Dye, Mahabodhi Temple

The Mahabodhi Temple Complex is one of the four holy sites related to the life of the Lord Buddha, and particularly to the attainment of Enlightenment. Around 50-60kg flowers are offered by devotees at Bodhgaya's Mahabodhi Temple. As per the records of Bodhgaya Temple Management Committee (BTMC), around 50-60kg flowers are being used every day at the temple during the lean pilgrim season and 300-400kg flowers are used during peak season - particularly between December and February.

Taking a cue from the problem, Praveen Chauhan, a NIFT alumnus started a social enterprise MATR to pursue two goals through the organisation: recycle waste and promote the use of Khadi in international market. MATR manages the temple's waste by converting floral waste into natural dyes and increase Khadi sale by banking on people's sentimental value towards the flowers and leaves of the temple.

Floral Waste in Mahabodhi Temple

Retails Store of Because of Nature

MATR on a joint venture with Because of Nature, an Australian based sustainable clothing label unfurled the "Happy Hands Project". The initiative was conceived with the goal of bringing sustainable employment to the local women by repurposing discarded floral waste from the ancient Mahabodhi Temple to make natural dyes for the Khadi products.

The Bodhgaya Temple Management Committee (BTMC) signed a Memorandum of Understanding (MoU) with "MATR" and "Because of Nature", to implement the project "Happy Hands Project". The project was launched on September 15, 2018.

In the initial ten days, a training workshop was conducted for 50 women. In the workshop they not only learnt but also gave their inputs on different shades of dyes that can be made from the flowers. Since 95 per cent of flowers offered at the temple are marigold that come in only three colours (orange, yellow and dark brown) the team came with innovative ways to make our khadi clothes attractive. After days of experiments, it was concluded that the dye can be reused multiple times giving a lighter shade on every use.

Process of Making Natural Colours from Floral Waste

Five women from the organisation visit the temple every morning, collect the temple waste and bring it to a small cluster, 6 kilometres outside the town. The marigold flowers are segregated colour-wise and kept for drying. Once dried, the flowers are ground by using hands and then kept for boiling. Mordanting (a method where a mordant or dye fixative is used to set dyes on fabrics) is the next step. Before drying the fabric, it is covered with amla juice and washing soda. Depending on the skill of the dyer hundreds of shades can be produced on Khadi from marigolds.

MATR manufactures several khadi garments ranging from women's clothes to robes used by the Monks, and most of them are sold internationally at Australia and Japan where people are willing to spend on authentic khadi clothes. The prices range is anywhere between 100 and 400 Australian dollars. From the profit earned ninety percent is divided among "MATR", "Because of Nature" and the women. The remaining 10 per cent of the money earned on Khadi sales go to the Bodhgaya Temple.

Key highlights

- The enterprise is helping in solving the floral waste problem in the temple and providing sustainable livelihood opportunity to the local artisan and women through a social revenue generating model without increasing the burden on the treasury of the temple trust. The idea of the project is simple and could be easily scaled up in other holy pilgrim sites of the country.

The future plan of the project is to cater to the 60-70 big temples and hundreds of small temples in the holy town of Bodh Gaya. The "Happy Hand Project" hopes to reuse each of the temple's floral waste and hire 200 more women from the villages and expand the enterprise. Currently, the fabric is purchased from retailers. From next year onwards, the team will spin and weave the fabric on their own.

To Know More

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Natural Dyes making process

Colourwise Segregation of Marigold flowers

GLOSSARY

AEROBIC COMPOSTING - A controlled process involving microbial decomposition of organic matter in the presence of oxygen.

ANAEROBIC DIGESTION - A controlled process involving microbial decomposition of organic matter in absence of oxygen.

BAILING - A machine used to compress recyclables into bundles to reduce volume. Balers are often used for newspaper, plastics, and corrugated cardboard.

BIODEGRADABLE WASTE - Any organic material that can be degraded by micro-organisms into simpler stable compounds.

BIO-METHANATION - A process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas.

BULK WASTE GENERATOR - Includes buildings occupied by the Central government departments or undertakings, State government departments or undertakings, local bodies, public sector undertakings or private companies, hospitals, nursing homes, schools, colleges, universities, other educational institutions, hostels, hotels, commercial establishments, markets, places of worship, stadia and sports complexes having an average waste generation rate exceeding 100kg per day.

BYE-LAWS - A regulatory framework notified by local body, census town and notified area townships for facilitating the implementation of these rules effectively in their jurisdiction.

CAPACITY BUILDING - Enabling people, organizations, and societies to develop, strengthen, and expand their abilities to meet their goals or fulfill their mandates is referred to capacity building. . It is a long-term and continuous process that focuses on developing human resources, organizational strength, technology know-how etc involving all stakeholders and is strengthened through the transfer of knowledge and skills that enhance individual and collective abilities to deliver services and carry out programs that address challenges in a sustainable way.

COMPOSTING - A controlled process involving microbial decomposition of organic matter.

COMPACTOR VEHICLE - A collection vehicle using high-power mechanical or hydraulic equipment to reduce the volume of solid waste.

CONSTRUCTION AND DEMOLITION WASTE – The waste comprising of building materials debris and rubble resulting from construction, re-modelling, repair and demolition of any civil structure.

CONVEYOR BELT-A wide belt made of rubber, textile, nylon or more commonly composite material, which moves on wide rollers. In compost industry chain drive is popular as the belt moves in a guided manner, directed by the chain sprockets. Conveyor belts are used for material movement in different stages.

CURING - Allowing partially composted materials to reside in a pile for a specified period of time as part of the maturing process in composting.

DECENTRALIZED PROCESSING - Establishment of dispersed facilities for maximizing the processing of biodegradable waste and recovery of recyclables closest to the source of generation so as to minimize transportation of waste for processing or disposal.

DISPOSAL- The final and safe disposal of post processed residual solid waste and inert street sweepings and silt from surface drains on land as specified in Schedule I to prevent contamination of ground water, surface water, ambient air and attraction of animals or birds.

DOMESTIC HAZARDOUS WASTE-Domestic hazardous wastes means waste contaminated with hazardous chemicals or infectious waste such as discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles, gauge and syringes, etc. generated at the household level.

DOOR TO DOOR COLLECTION - Collection of solid waste from the door step of households, shops, commercial establishments , offices , institutional or any other non-residential premises and includes collection of such waste from entry gate or a designated location on the ground floor in a housing society , multi storied building or apartments , large residential, commercial or institutional complex or premises.

DRY WASTE - Waste other than bio-degradable waste and inert street sweepings and includes recyclable and non-recyclable waste, combustible waste and sanitary napkin and diapers, etc.

DUMP SITES - A land utilised by local body for disposal of solid waste without following the principles of sanitary land filling.

E-WASTE - Means electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded as waste.

EXTENDED PRODUCER RESPONSIBILITY (EPR) - Responsibility of any producer of packaging products such as plastic, tin, glass and corrugated boxes, etc., for environmentally sound management, till end-of-life of the packaging products.

FACILITY - Any establishment wherein the solid waste management processes namely segregation, recovery, storage, collection, recycling, processing, treatment or safe disposal are carried out.

FINE - Penalty imposed on waste generators or operators of waste processing and disposal facilities under the bye-laws for non-compliance of the directions contained in these rules and/or bye- laws.

HANDLING - Includes all activities relating to sorting, segregation, material recovery, collection, secondary storage, shredding, baling, crushing, loading, unloading, transportation, processing and disposal of solid wastes.

INERT - Wastes which are not bio-degradable, recyclable or combustible street sweeping or dust and silt removed from the surface drains.

INCINERATION- An engineered process involving burning or combustion of solid waste to thermally degrade waste materials at high temperatures.

INFORMAL SECTOR-The part of an economy that is characterized by private, usually small-scale, labour-intensive, largely unregulated, and unregistered manufacturing or provision of services.

INFORMAL WASTE COLLECTOR - includes individuals, associations or waste traders who are involved in sorting, sale and purchase of recyclable materials.

INTEGRATED SOLID WASTE MANAGEMENT (ISWM)-ISWM refers to a strategic initiative for the sustained management of solid waste through the use of a comprehensive integrated format generated through sustained preventive and consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.

LEACHATE - The liquid that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it.

MATERIALS RECOVERY FACILITY (MRF) - A facility where non-compostable solid waste can be temporarily stored by the local body or any other entity mentioned in rule

2 or any person or agency authorized by any of them to facilitate segregation, sorting and recovery of recyclables from various components of waste by authorized informal sector of waste pickers, informal recyclers or any other work force engaged by the local body or entity mentioned in rule 2for the purpose before the waste is delivered or taken up for its processing or disposal.

MUNICIPAL SOLID WASTE (MSW)-Includes the domestic waste, commercial waste, institutional waste, market waste and other non-residential wastes, street sweepings, silt removed/collected from the surface drains, horticulture waste, construction and demolition (C&D) waste and treated bio-medical waste excluding industrial hazardous waste, and e-waste generated in any municipal authority area in either solid or semi-solid form.

NON-BIODEGRADABLE WASTE - Any waste that cannot be degraded by microorganisms into simpler stable compounds.

OPERATOR OF A FACILITY - A person or entity, who owns or operates a facility for handling solid waste which includes the local body and any other entity or agency appointed by the local body.

PRIMARY COLLECTION - Collecting, lifting and removal of segregated solid waste from source of its generation including households, shops, offices and any other non-residential premises or from any collection points or any other location specified by the local body.

PROCESSING - Any scientific process by which segregated solid waste is handled for the purpose of reuse, recycling or transformation into new products.

RECYCLING- the process of transforming segregated non-biodegradable solid waste into new material or product or as raw material for producing new products which may or may not be similar to the original products.

REFUSE DERIVED FUEL (RDF) -Segregated combustible fraction of solid waste other than chlorinated plastics in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting combustible components of solid waste that can be used as fuel. Residual solid waste - And includes the waste and rejects from the solid waste processing facilities which are not suitable for recycling or further processing.

SANITARY LAND FILLING - The final and safe disposal of residual solid waste and inert wastes on land in a facility designed with protective measures against pollution of ground water, surface water and fugitive air dust, wind-blown litter, bad odour, fire hazard, animal menace, bird menace, pests or rodents, greenhouse gas emissions, persistent organic pollutants slope instability and erosion.

SANITARY WASTE - Wastes comprising of used diapers, sanitary towels or napkins, tampons, condoms, incontinence sheets and any other similar waste.

SECONDARY STORAGE - The temporary containment of solid waste after collection at secondary waste storage depots or MRFs or bins for onward transportation of the waste to the processing or disposal facility.

SEGREGATION - Sorting and separate storage of various components of solid waste namely biodegradable wastes including agriculture and dairy waste, non- biodegradable wastes including recyclable waste, non-recyclable combustible waste, sanitary waste and non-recyclable inert waste, domestic hazardous wastes, and construction and demolition wastes.

SLUDGE-A semi-liquid residue remaining from the treatment of municipal and industrial water and wastewater.

SORTING - Separating various components and categories of recyclables such as paper, plastic, cardboards, metal, glass, etc., from mixed waste as may be appropriate to facilitate recycling.

STABILISING- The biological decomposition of biodegradable wastes to a stable state where it generates no leachate or offensive odours and is fit for application to farm land ,soil erosion control and soil remediation.

STREET VENDOR - Any person engaged in vending of articles, goods, wares, food items or merchandise of everyday use or offering services to the general public, in a street, lane, side walk, footpath, pavement, public park or any other public place or private area, from a temporary built up structure or by moving from place to place and includes hawker, peddler, squatter and all other synonymous terms which may be local or region specific. and the words “street vending” with their grammatical variations and cognate expressions, shall be construed accordingly.

TIPPING FEE - A fee or support price determined by the local authorities or any state agency authorised by the State government to be paid to the concessionaire or operator of waste processing facility or for disposal of residual solid waste at the landfill.

TRANSFER STATION - A facility created to receive solid waste from collection areas and transport in bulk in covered vehicles or containers to waste processing and, or, disposal facilities.

TRANSPORTATION - Conveyance of solid waste, either treated, partly treated or untreated from a location to another location in an environmentally soundmanner through specially designed and covered transport system so as to prevent the foul odour, littering and unsightly conditions.

TREATMENT - The method, technique or process designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its volume and potential to cause harm.

TROMMEL-An improved version of rotary screen, which is driven from outside, preferably using hydraulic power packs to keep the movement smooth, especially while starting after a power cut. The screen is covered from outside to control dust.

URBAN LOCAL BODY - Includes the municipal corporation, nagar nigam, municipal council, nagar palika, nagar palika parishad, municipal board, nagar panchyat, town panchayat, notified area committee or any other local body constituted under the relevant statutes where management of solid waste is entrusted to such agency including the body in notified industrial township, notified area, villages declared outgrowth in urban agglomeration by the Registrar General and Census Commissioner of India from time to time.

USER FEE - a fee imposed by the local body and any entity mentioned in rule 2 on the waste generator to cover full or part cost of providing solid waste collection, transportation, processing and disposal services.

VERMI-COMPOSTING - The process of conversion of bio-degradable waste into compost using earth worms.

WASTE GENERATOR - And includes every person or group of persons, every residential premises and non-residential establishments including Indian Railways, defense establishments, which generate solid waste.

WASTE HIERARCHY - The priority order in which the solid waste is to should be managed by giving emphasis to prevention, reduction, reuse, recycling, recovery and disposal, with prevention being the most preferred option and the disposal at the landfill being the least.

WASTE PICKER – A person or groups of persons informally engaged in collection and recovery of reusable and recyclable solid waste from the source of waste generation the streets, bins, material recovery facilities, processing and waste disposal facilities for sale to recyclers directly or through intermediaries to earn their livelihood.

WASTE-TO-ENERGY SYSTEM (WTE) -A method of converting MSW into a usable form of energy, usually though combustion.

WINDROW - Long trapezoidal heaps or piles. Long composting heaps are referred to as ‘windrow’. The base is wider and the top is narrower.

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