National Institute of Urban Affairs

सत्यमेव जयते
Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Swachh Bharat Mission

SWM City Cluster Exposure Workshop, 2018

Conducted by

National Institute of Urban Affairs & ICLEI South Asia, iDeCK, ICAP

ICLEI Local Governments for Sustainability

iDeCK

Building Capacity
Enabling Infrastructure

Supported by

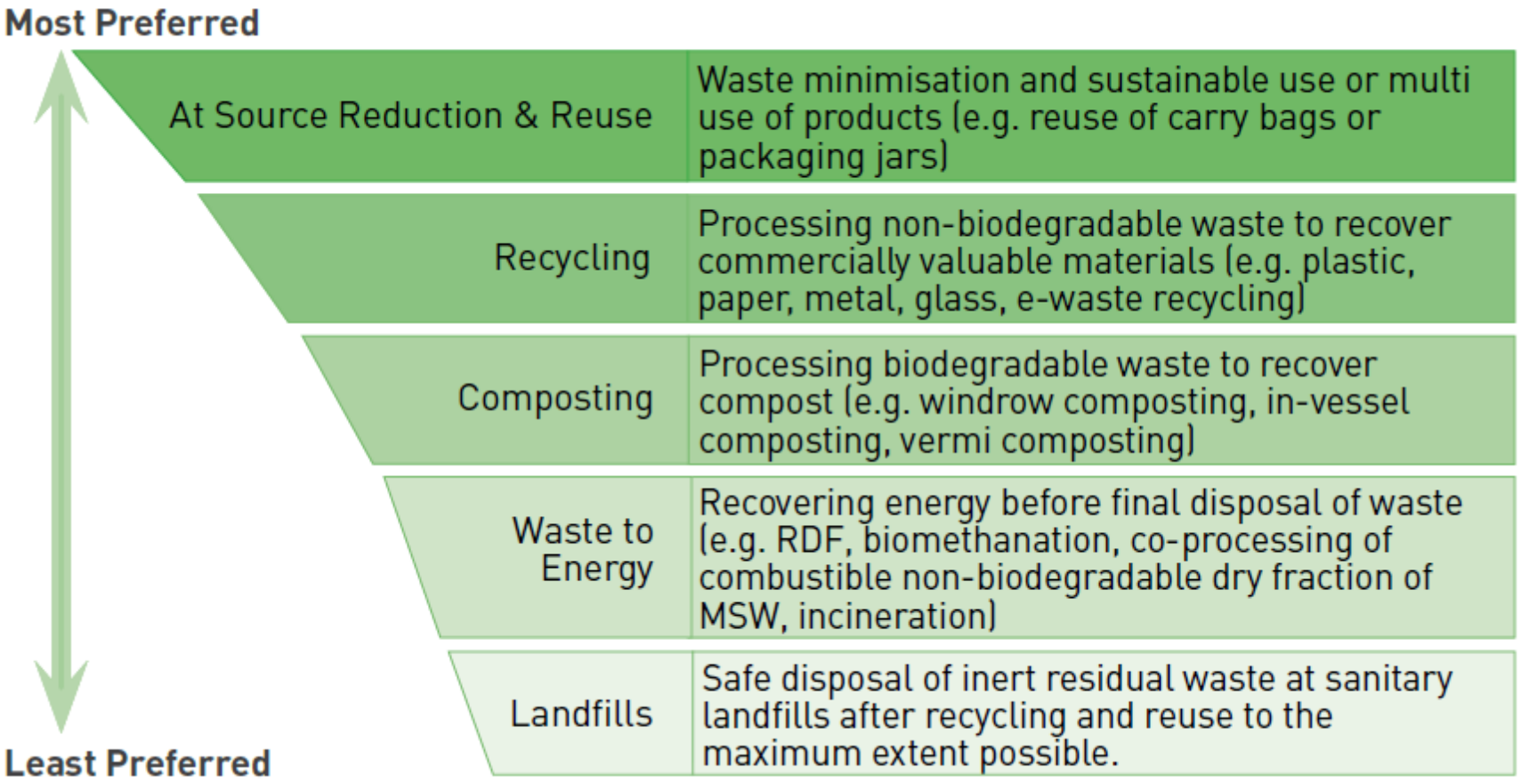
Ministry of Housing and Urban Affairs

Under

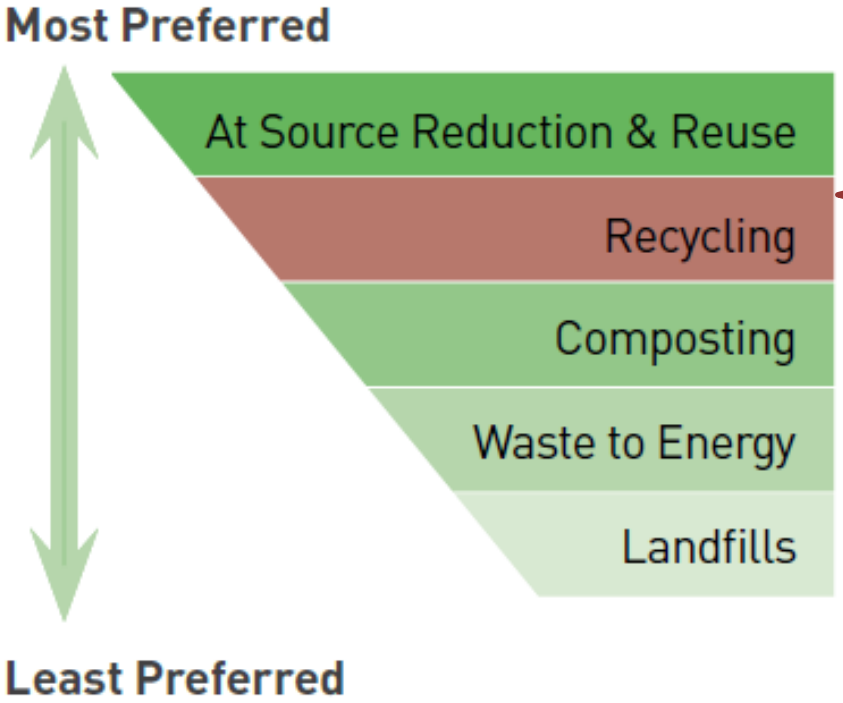
Swachh Bharat Mission - Urban

Waste Management Processing

Selection of waste management processes and technology shall be based on the five-tier ISWM hierarchy



Recycling



Processing non-biodegradable waste to recover commercially valuable materials (e.g. plastic, paper, metal, glass recycling)

SWM Rules, 2016: *Arrangement shall be made to provide segregated recyclable material to the recycling industry through waste pickers or any other agency engaged or authorised by the urban local body for the purpose*

- ✓ Reduces the quantity of waste
- ✓ Increases resource recovery
- ✓ Minimises the financial and environmental burden of MSWM

Recycling:
Promote 3Rs (Reduce, Reuse and Recycle)

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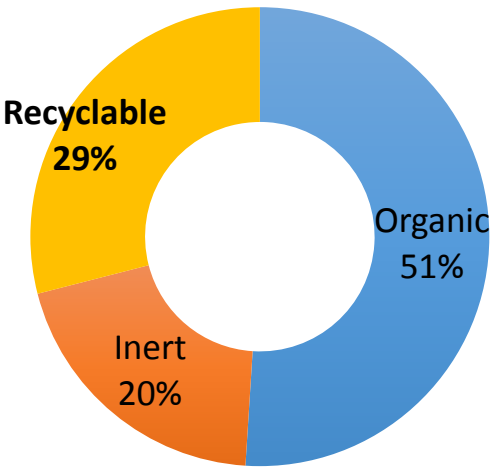
Typical MSW in Indian Cities



CARTON CONTAINERS:

Plastic Bottles

GLASS CONTAINERS

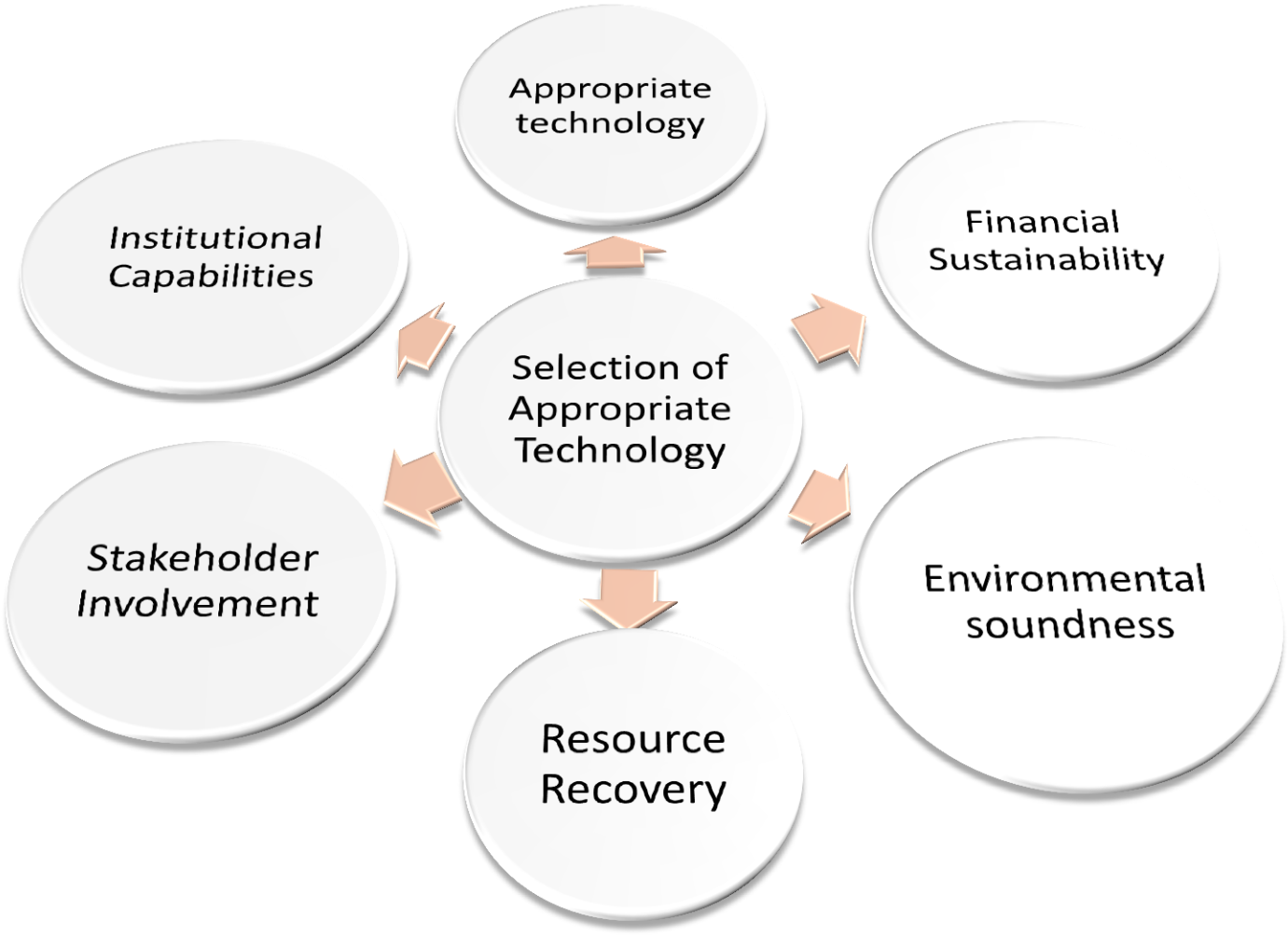
Aluminium

CARDBOARD:

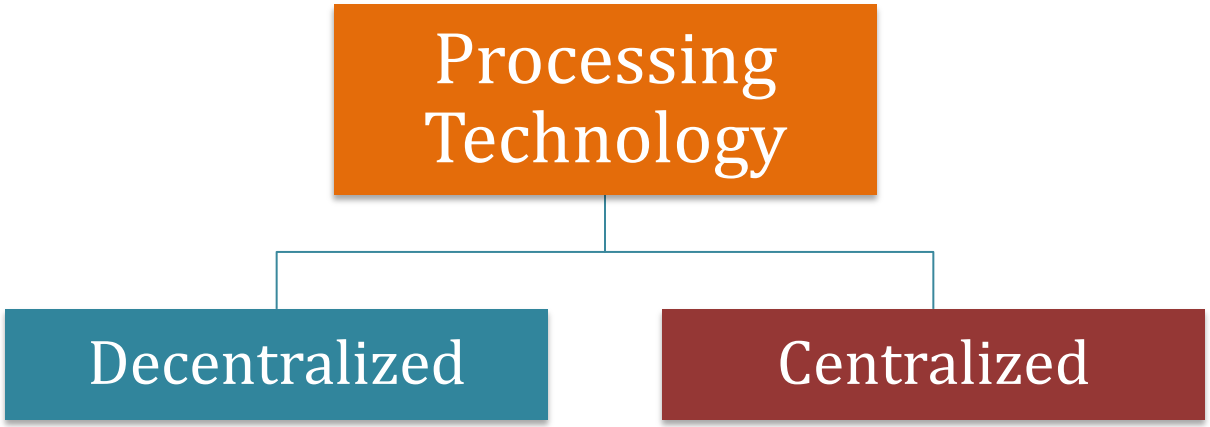
Paper

- ✓ **Informal sector alone recovers as much as 56% of recyclable material**
- ✓ ITC Wealth Out of Waste (WOW) in South India
- ✓ Go Green with Tetrapak" initiative launched by Tetrapak in 2010

Selection of an appropriate technology is dependent on various factors



Centralized or Decentralized ??



- Reduces the burden of handling large volumes of MSW at a centralised location
- Reduction in costs of transportation and intermediate storage

- Economies of scale
- Single monitoring point
- High-end technology
- Environmental controls.

Advantages of Decentralized Systems

- Allow for **lower level of mechanisation**
- Provide job opportunities for informal workers and small entrepreneurs
- Can be **tailor made** for the local waste stream, climate, social, and economic conditions
- **Reduce the cost** incurred for the collection, transportation, and disposal of waste by the ULBs
- **Funding**: community based co-operatives, local NGOs, PPP mode or through municipal funds

Community ownership of decentralized systems is critical for their success and continued operation!!

Criteria to be maintained in Decentralized Systems: HH, Apartments, Colony, Ward

Land is available in neighborhoods

Segregated door to door collection in place

Availability of local expertise/NGOs to handhold the process; Availability of semi-skilled workers

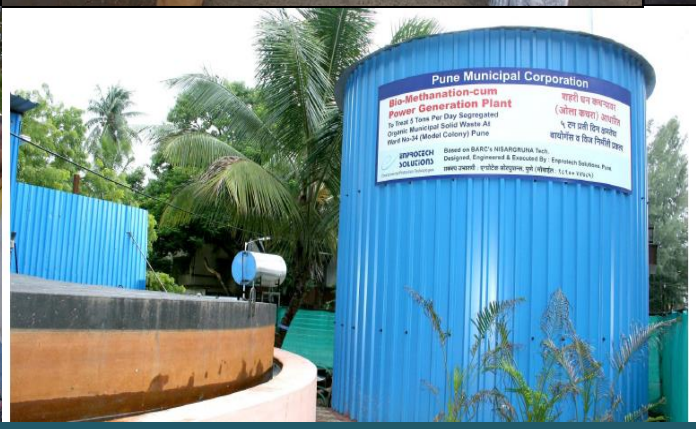
In- house capacity of ULB for effectively monitoring decentralized systems

Quality of end products is ensured

Above 1 TPD should be registered with local authority and monitored by state PCBs!!!

Good examples of decentralized model

- Pune
- Ambikapur: Solid and Liquid Resource Management (SLRM) model
- Coimbatore: Sunya Model



Ambikapur: Solid and Liquid Resource Management (SLRM) model

- 447 SHG women involved in door-to-door collection of waste from 48 wards
- Segregation of waste at household
- Collection of segregated waste- red (inorganic) and green (organic) boxes; Sanitary pads and diapers collected and disposed off separately
- 17 SLRM centres and one tertiary segregation centre.
- Organic waste - compost while inorganic waste- segregated into 156 categories at the tertiary segregation centre.
- **INR 150.38 lakh collected as user charges, INR 3 lakh from the sale of city compost and INR 67.03 lakh from the sale of recyclable items between May 2015 and November 2017**

Coimbatore: SUNYA Model

Public private partnership in segregation and recycling of waste.

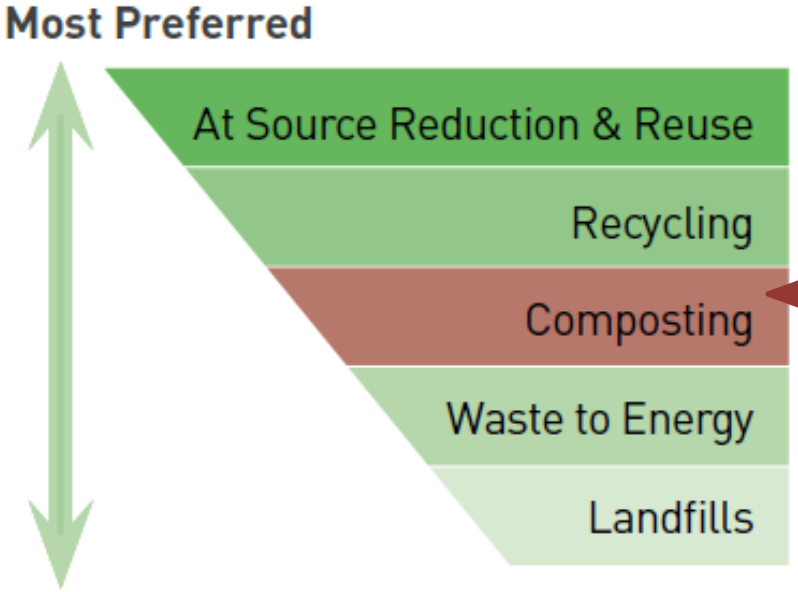
Pilot Project

- Ward No. 23
- Collection of segregated waste from more than 2000 households and 750 shops
- Collection of 130 tonnes of recyclables worth INR 3.97 lakhs
- 4.36 tonnes of wet waste converted into compost
- Strict penal provision for littering
- Declared as Bin Free Ward
- **Extended to 22 and 24 wards**

Variety of stakeholder: ITC, NGOs like Hand in Hand, RWAs and Municipal Corporation

Championship for Guinness Book of World Records: Maximum people participating in litter collection in a cleanliness campaign

Composting



3rd preferred choice in the ISWM hierarchy. It ensures that waste is processed appropriately to facilitate material recovery (e.g. Windrow composting, in-vessel composting, vermi composting)

- Compost because of its high organic matter content, is used as a valuable soil amendment thereby reducing dependence on chemical fertilisers

- **Centralised**: windrow, in-vessel
- **Decentralised**: Bin, Box, Vermicomposting

Quality Parameters for Compost

Parameters	Organic Compost	Phosphate Rich Organic Manure
	FCO 2009	FCO (PROM) 2013
Arsenic (mg/Kg)	10.00	10.00
Cadmium (mg/Kg)	5.00	5.00
Chromium (mg/Kg)	50.00	50.00
Copper (mg/Kg)	300.00	300.00
Lead (mg/Kg)	100.00	100.00
Mercury (mg/Kg)	0.15	0.15
Nickel (mg/Kg)	50.00	50.00
Zinc (mg/Kg)	1000.00	1000.00
C/N ratio	<20	less than 20:1
pH	6.5 - 7.5	(1:5 solution) maximum 6.7
Moisture, per cent by weight, maximum	15.0-25.0	25.0
Bulk density (g/cm^3)	<1.0	Less than 1.6

Parameters	Organic Compost (FCO, 2009)	Phosphate Rich Organic Manure (FCO, 2013)
Total Organic Carbon, per cent by weight, minimum	12.0	7.9
Total Nitrogen (as N), per cent by weight, minimum	0.8	0.4
Total Phosphate (as P_2O_5), percent by weight, minimum	0.4	10.4
Total Potassium (as K_2O), percent by weight, minimum	0.4	–
Colour	Dark brown to black	_
Odour	Absence of foul Odour	–
Particle size	Minimum 90% material should pass through 4.0 mm IS sieve	Minimum 90% material should pass through 4.0 mm IS sieve
Conductivity (as dsm^{-1}), not more than	4.0	8.2

(A sum total of nitrogen, phosphorus and potassium nutrients shall not be less than 1.5% in compost. Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops)

Onsite and Decentralized Composting Methods

Category	No. of Households	Suitability
Category – 1	Up to 10 Households	Individual Households, small Communities, Apartments etc.
Category – 2	11 – 300 Households	Medium sized Communities, Apartments, RWAs, medium sized Offices, medium Hotels, Resorts, medium Schools, Canteens, Marriage Halls
Category – 3	301 – 1000 Households	Large Communities, Apartments, RWAs, high-rise buildings, large Offices, large Hotels, large Schools
Category – 4	Above 1000 Households	Decentralized Composting plants operated by ULBs/Institution/ Outsourced agency

Source: Advisory on On-Site and Decentralized Composting of Municipal Organic Waste, SBM-Urban, Available: http://164.100.228.143:8080/sbm/content/writereaddata/Advisory%20on%20decentralised%20composting.pdf

Category – 1

- Pit Composting
- Pot Composting
- Tri Pot Composting
- Bio-Composter
- Kitchen Bin Composting
- Blue HDPE Digester
- Rotary Drum Composting (Small)
- Composting Basket/Bin

USER'S FEEDBACK

Name of the Unit: Pit Composting Unit
Place of the installation: Lal Bagh, Banglore
Year of installation: 2014
Expenditure incurred at beginning: Rs. 2.5 lakh for digging and preparation of pit
Coverage: 240 acres area of the park
Biodegradable waste treated per day: 700 kg
Processing Time: 4-5 months
O& M cost: Nil (staff costs not included)
Usage of Compost: Used within the garden
Do's & Don'ts: cow dung slurry should be spread; appropriate moisture content should be maintained.
Contact Details: Mr. Chandrashekhar, chandshekhar01@gmail.com

USER'S FEEDBACK

Name of the unit: Shudhlabh HDPE Blue Drum digesters
Place of the installation: Singapore Gardens Layout, Kanakapura Road, Bengaluru
Year of purchase: 2014
Capital cost: Rs. 4,00,000 including infrastructure
Coverage: 120 households
Biodegradable waste treated per day: 50-60 kg
Compost production per day: 10-15 kg
O & M cost: Cost spent towards cocopeat.
Usage of compost: Completely used for gardening purpose within the campus
Do's & Don'ts: The operation and maintenance described should be strictly followed.
Contact details of the user: Mr. Sreenath, e-mail: sreenath.ab@gmail.com

Types of decentralised composting bins

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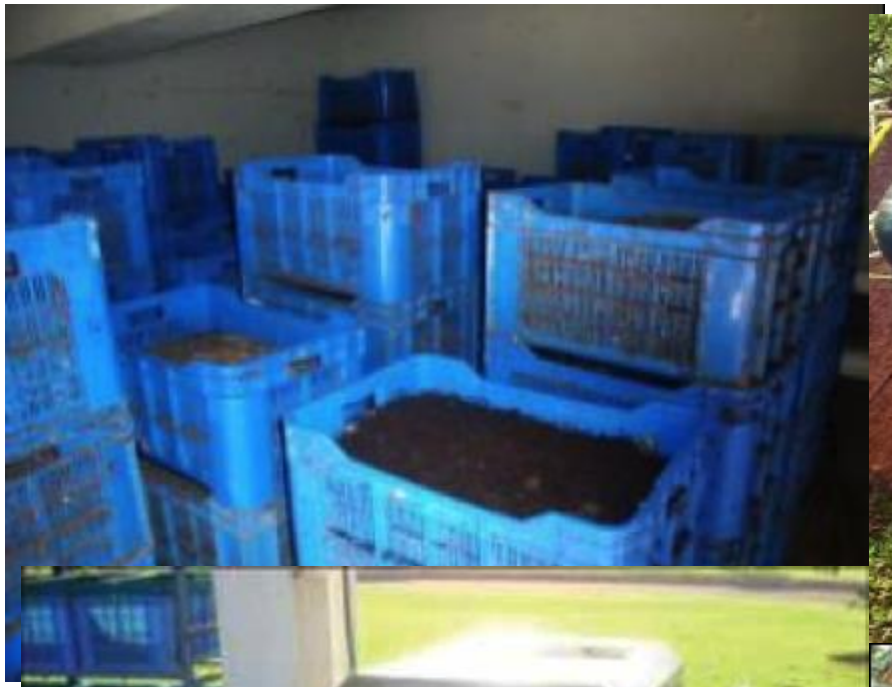
Category – 2

- Vermi Composting
- Portable Household Bio Bin
- Aerobic Bin Composting
- Centralised Masonry Biotank Composting
- Organic Waste Composter
- Byobin, Orbin, Aaga, Bokashi
- Solar Composter
- Plastic crates
- Steel Mesh Composter
- FRP Aerobic Digester
- Drum Composting

USER'S FEEDBACK

Name of the technique: Vermi Composting
Place of the installation: Vishveshapuram, Pammal Municipality, Tamil Nadu
Year of commencement: 2005
No. of pits: 72 nos.
Cost of unit: Rs. 10 Lakh
Biodegradable waste treated per day: 2.5-3 tonnes
Compost production per day: 800 kg – 1 tonne
Processing time: 45 days
Usage of Compost: Given to farmers and local nurseries & gardens at free of cost
Market value of the compost: Rs.5,000-7,000/MT (information by Sikri Farms, Haryana)
O&M cost: Negligible
Do's & Don'ts: Maintenance of temperature and moisture content is essential for the survival of earthworms.
Contact details of the user: Pammal Municipality, Tamil Nadu, e-mail: commr.pammal@tn.gov.in

Examples



Category - 3

- Organic Waste Composting Machine
- Marigold
- Soil and Health SWM consultant Aerobic and Anaerobic Composter
- Large Scale Composting Pits

USER'S FEEDBACK

Name of the unit: Marigold

Place of the installation: Brigade Paramount Apartments, Old Madras Road, Bengaluru

Year of purchase: 2015

Cost of unit: Approx. Rs. 2 Lakh for 8 composters for 80 flats

Coverage: 80 flats

Biodegradable waste treated per day: 50 kg

Compost production per day: ~10 kg

O & M cost: cost towards purchasing cocopeat & dry leaves for mixing

Usage of compost: 50 % is used for gardening purpose within the campus and rest is being sold

Selling price of the compost: Rs. 7-10/kg

Do's & Don'ts: Same as the operation and maintenance procedure, above.

Contact details of the user: Mr. Ravishankar Ayyagari, e-mail: raviasw@gmail.com

Category - 4

- Windrow Composting
- Rotary Drum Composter (Large)
- Vermi Composter
- Tallboy

USER'S FEEDBACK

Name of the unit: Rotary Drum Composter (Large)

Place of the installation: Calangute/Saligao, Goa

Year of Commencement: 2016

Cost of plant: Rs. 2.5 crore for each drum composter including technology transfer cost and erection cost

Biodegradable waste treated per day: 15 tonnes of digestate + 10 tonnes bulking materials (wood chips & paper)

Compost production per day: 10-12.5 tonnes

Processing time: 6 days

Usage of compost: Sold to Zuari Agro Chemicals Limited, Goa.

Selling cost of the compost: Rs. 1.5/kg excluding packing and transportation costs

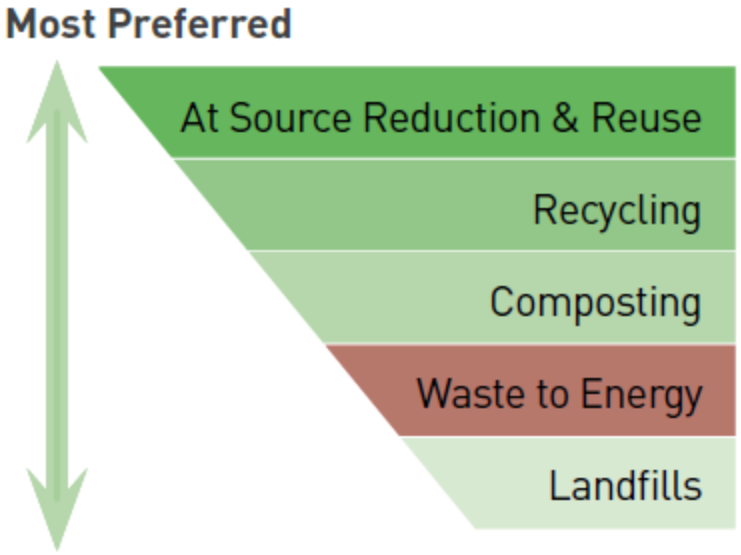
O&M Cost: Rs. 300/ton for 30 tonnes capacity

Do's & Don'ts: C/N ratio is to be properly maintained by adding appropriate materials; the temperature should be maintained between 50-60oC, if there is any decrease in temperature, then the load shall be reduced.

Contact details of the user: Mr. Ganesh, e-mail: ganesh@intergeoindia.com


PULVERIZER
verCHEW™ 200
CAP: 200 TO 500 KG/HR
BIOBIN TBB400
CAP: 25 KG/DAY
BIOBIN TBB1500

Waste to Energy



Recovering energy before final disposal of waste (e.g. RDF, biomethanation, co-processing of combustible non-biodegradable dry fraction of MSW, incineration)

Incineration:
Incineration of municipal solid waste (along with energy recovery) can reduce the volume of waste to be landfilled by 90%

Biomethanation:
Production of biogas under controlled condition; the produced biogas can be used for cooking or for the production of electricity and heat; Can be decentralized (upto 5TPD) and centralized

Refuse Derived Fuel:
Typically consists of high calorific fractions of MSW like paper, textile,etc. used as alternate fuel in industrial furnaces or boilers (co-processing or co-incineration of waste in cement)

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi - culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Technical Criteria						
Waste Quantity which can be managed by a single facility.	500 TPD	1 TPD to 20TPD. Higher capacities can also be planned if adequate land is available along with other necessary arrangements	1 TPD at small scale to 500 TPD at larger scale	100 TPD of segregated waste and above	1000 TPD and above of mixed waste (smaller plants are not Techno-economically viable)	500 TPD and above (economically sustainable above 500 TPD plant size)

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Technical Criteria						
Segregation required	High	Very High	Very High	High	High – Feed stock should be free from inert and low on moisture content	Moderate because both dry and wet fractions are utilized
Rejects	About 30% including inerts if only composting is done; 15% rejects with RDF, if located in the same plant	30% including inerts	30% from mixed waste	30% from mixed waste	Around 15%	Approximately 15-20%

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Technical Criteria						
Potential for Direct Energy Recovery	No	No	Yes	No	Yes	No
Technology Maturity	well established	well established	Feasibility for wet waste is proven. In case of mixed waste, appropriate presorting has to be carried out	Quality of RDF should be based on end use.	Technology is available. Constraints of low calorific value, high moisture content and high amt. of inert waste	Utilisation of rejects from compost plants as input for RDF production and sale. Rejects are only 15-20%

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Financial Criteria						
Indicative Capital Investment	15-20 Cr for 500 TPD plant	1 Cr. per 20 TPD	75-80 Cr for 500 TPD plant	17-20 Cr for 500 TPD plant	Very high capital, operating and maintenance costs. 15 Cr. per MW power production	25-30 Cr for 500 TPD

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Managerial Criteria						
Labour Requirement	Labour intensive	Labour intensive	Less Labour Intensive	Labour intensive	Non labour intensive but requires considerable technical capacity	Labour intensive & requires considerable technical Capacity
Skills for Operation and Management	Technically Qualified; experienced & semi-skilled Staff	Technically Qualified; Experienced & Semi-skilled staff	Technically qualified and experienced staff	Technically qualified & experienced Staff	Technically qualified & experienced Staff	Technically qualified and experienced staff and semi-skilled

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Environmental Criteria						
Concerns for toxicity of product	Generally safe. Can contaminat e the food chain if compost is not meeting FCO norms	Product is generally safe	Product is generally safe. Can contaminate the food chain if compost is not meeting FCO norms	-	-	-
Leachate Pollution	Potential exists; shed to be provided in high rainfall areas	Insignificant quantities	High if not treated appropriately	Low	High potential of leachate at the receiving pit	Potential exists for compost; shed to be provided in high rainfall areas

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Criteria	Windrow Composting	Vermi-culture	Biomethanation	RDF	Incineration	Integrated (Compost+ RDF)
Environmental Criteria						
Air Pollution	Low; Odour issues.	Low; Odour issues.	Low. Leakage of biogas. Odour issues.	Low to Moderate i.e very high if RDF is not burnt at required temperature. Odour issues	Very high if emissions not managed properly. Fly ash should be disposed safely in an engineered landfill.	Moderate, require appropriate emission control systems
Other	Fire and safety Issues.	Fire and safety issues	Fire and safety issues	Fire and safety Issues& chlorinated plastics in RDF	Disposal of bottom ash/ slag. Fire and safety issues	Fire and safety Issues &chlorinated plastics in RDF

Indicative Criteria for Landfill

Technical Criteria	
Facility Location	Must be located at least 500 m away from residential areas and should abide by the criteria mentioned in MSW Rules and state level guidelines.
Natural environment	Should be avoided in marshy land and in conditions where the ground water table is 2 m from the base of the liner. In marshy land, apart from ground and surface water contamination potential, there could be huge risks due to structural safety of the landfill (slippage and complete breakdown).
Land Requirement	For 300 TPD of MSW: 30 ha of land is required for 20 years.
Waste Quantity which can be managed by a single facility	100 TPD inert and above. Smaller landfills are not techno economically viable
Requirement For Segregation prior to technology	Only inert waste may be placed in landfills as per SWM Rules

Technical Criteria	
Rejects	No rejects
Potential for Direct Energy Recovery	Not as per SWM Rules
Technology Maturity	Proven method for safe disposal of waste, practiced world over. However it has environmental implications and efforts have to be made to minimize waste going to landfills. MSW Rules only permit inert wastes to be landfilled
Financial Criteria	
Indicative Capital Investment	High
Market for product/ By-Product	No potential, since it is stipulated by the SWM Rules that only inert wastes are to be disposed in landfills

Managerial Criteria	
Labour Requirement	Only inert wastes are to be deposited in sanitary landfills. Labour intensive but requires considerable technical expertise as well.
Predominant skills for Operation and Management	Technically qualified and experienced, and semiskilled staff.
Environmental Criteria	
Leachate Pollution	Polluted surface runoff during wet weather, groundwater contamination due to leachate infiltration. Moderate to high depending upon the leachate Recycling and control systems. Leachate management during monsoons requires special attention
Atmospheric pollution	Air pollution and problems of odour and methane emissions if not managed properly
Other	Spontaneous ignition due to possible methane concentration. Fire and safety issues to be taken care of.

Thank You