

# Status of Science and Technology for 3R in India: What do they imply for Swachha Bharat (Clean India) Mission

## Thallada Bhaskar

Principal Scientist & Head of Area, Bio-Fuels Division

3R Policy & Science Cooperation Session by  
United Nations Centre for Regional Development (UNCRD) & 3RINCs  
March 9, 2016, Venue: Melia Hotel, Hanoi, Viet Nam



**CSIR-Indian Institute of Petroleum (IIP)**  
Dehradun 248005, Uttarakhand, India

# Theme of Special Session

**3R Policy Issues and Needs  
for**

**Scientific and Policy cooperation  
with**

**Regional 3R Forum in Asia and the Pacific**

- Demography of India
- What is Swachh Bharat
- Challenges in India : Missions
- Status of Science and Technology: Case studies
- Role of Science and Technology
- Policy frame work
- 3R intervention with Indicators
- Strategies and Partnership opportunities for sustainable waste management
- Conclusions

New Delhi

# INDIA

States and Union Territories



Creating  
Future  
Fuels



CSIR - Indian Institute of Petroleum

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Dr Ram A Vishwakarma

Director

CSIR-Indian Institute of Petroleum

Dehradun 248005

India

### LEGEND

- International Boundary
- State Boundary
- Country Capital
- State Capital

# CSIR Leadership



Shri Narendra Modi, President, CSIR  
& Prime Minister of India



Dr Harsh Vardhan, Vice President, CSIR  
& Minister for Science, Technology, and  
Earth Sciences, Govt of India



Mr Y Sujana Chowdary, Minister  
for Science, Technology, and Earth  
Sciences (State), Govt of India



**Dr Girish Sahni,**  
**Director General,**  
Council of Scientific and  
Industrial Research (CSIR)



## CSIR Network of R&D Laboratories



*Schematic diagram. Not to scale*

# India and Numerical Data

**States: 29**

**Area: 3,287,590-km<sup>2</sup>**

**Union Territories: 7**

**Languages: 20**

**World's Land area: 2.4%**

**Indian population: 17.5% of world population**

**Population (As per 2015 census): 1.276 Billion**

**Population in Cities: 31%**

**MSW Generation: 1,27,486 TPD**

**MSW Collected: 89,334 TPD (70%)**

**MSW Processed and Treated: 15,881 TPD (12.45%)**

**Average waste generation: 0.11 kg/capita/day**

**Moisture content of SW: 47%**

**Average calorific value: 7.3 MJ/kg (1745 kcal/kg)**



### States

1. Andhra Pradesh
2. Arunachal Pradesh
3. Assam
4. Bihar
5. Chhattisgarh
6. Goa
7. Gujarat
8. Haryana
9. Himachal Pradesh
10. Jammu and Kashmir
11. Jharkhand
12. Karnataka
13. Kerala
14. Madhya Pradesh
15. Maharashtra
16. Manipur
17. Meghalaya
18. Mizoram
19. Nagaland
20. Odisha
21. Punjab
22. Rajasthan
23. Sikkim
24. Tamil Nadu
25. Telangana
26. Tripura
27. Uttar Pradesh
28. Uttarakhand
29. West Bengal

### Union territories

- A. Andaman and Nicobar Islands
- B. Chandigarh
- C. Dadra and Nagar Haveli
- D. Daman and Diu
- E. Lakshadweep
- F. National Capital Territory of Delhi
- G. Puducherry



# Solid Waste Management is essential



**Hazard for animals**



**Health hazard for humans**



**Often not degradable**



**Pollutes air and emits GHG**



**Leachate generation**



**Pollutes / contaminates**



**Chokes city drains**



**Accumulation of Plastics**



**Breeder ground for vectors**

# Swachh Bharat (Clean India) Mission

https://swachhbharat.mygov.in

GOVERNMENT OF INDIA

Skip to main content Login Register A A A A A A



TAKE A PLEDGE

SWACHH BHARAT CHALLENGES

SWACHH BHARAT ACTIVITIES

SWACHH BHARAT PARTICIPANTS

SWACHH BHARAT ULB

Map View



## SWACHH BHARAT MISSION -URBAN



Ministry of Urban Development



SWACHH BHARAT MISSION -URBAN



SWACHH BHARAT ARHIYAN



MINISTRY OF URBAN DEVELOPMENT  
GOVERNMENT OF INDIA



Guidance Note

## Municipal Solid Waste Management on a Regional Basis

DRAFT



GOVERNMENT OF INDIA

MINISTRY OF URBAN DEVELOPMENT  
<http://moud.gov.in>

# MUNICIPAL SOLID WASTE MANAGEMENT MANUAL



Central Public Health and Environmental Engineering Organisation  
(CPHEEO)

May, 2014



# Govt of India Commitment on Solid Waste Management in 2014



## VISION STATEMENT



The Ministry of Urban Development's vision of the National Urban Sanitation Policy states that

'All Indian cities and towns become totally sanitized, healthy and liveable and ensure and sustain good public health and environmental outcomes for all citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women.'

With the support of the Municipal Solid Waste (Management & Handling) Rules, 2000 of the Ministry of Environment & Forest, the Ministry of Urban Development aims to guide all urban areas in the country towards Sustainable Municipal Solid Waste Management, adopting the aspects of waste minimization at source with an emphasis on the 3R principles of reduce, reuse and recycle; with proper systems of segregation, collection, transportation, processing, treatment and disposal in complete harmony with the environment, thereby leading to the achievement of the aim of NUSP.

# Nodal Ministry and Leadership for Swachh Bharat

Organisation Chart of Ministry of Urban Development as on 03.08.2015



**Minister (Cabinet)**

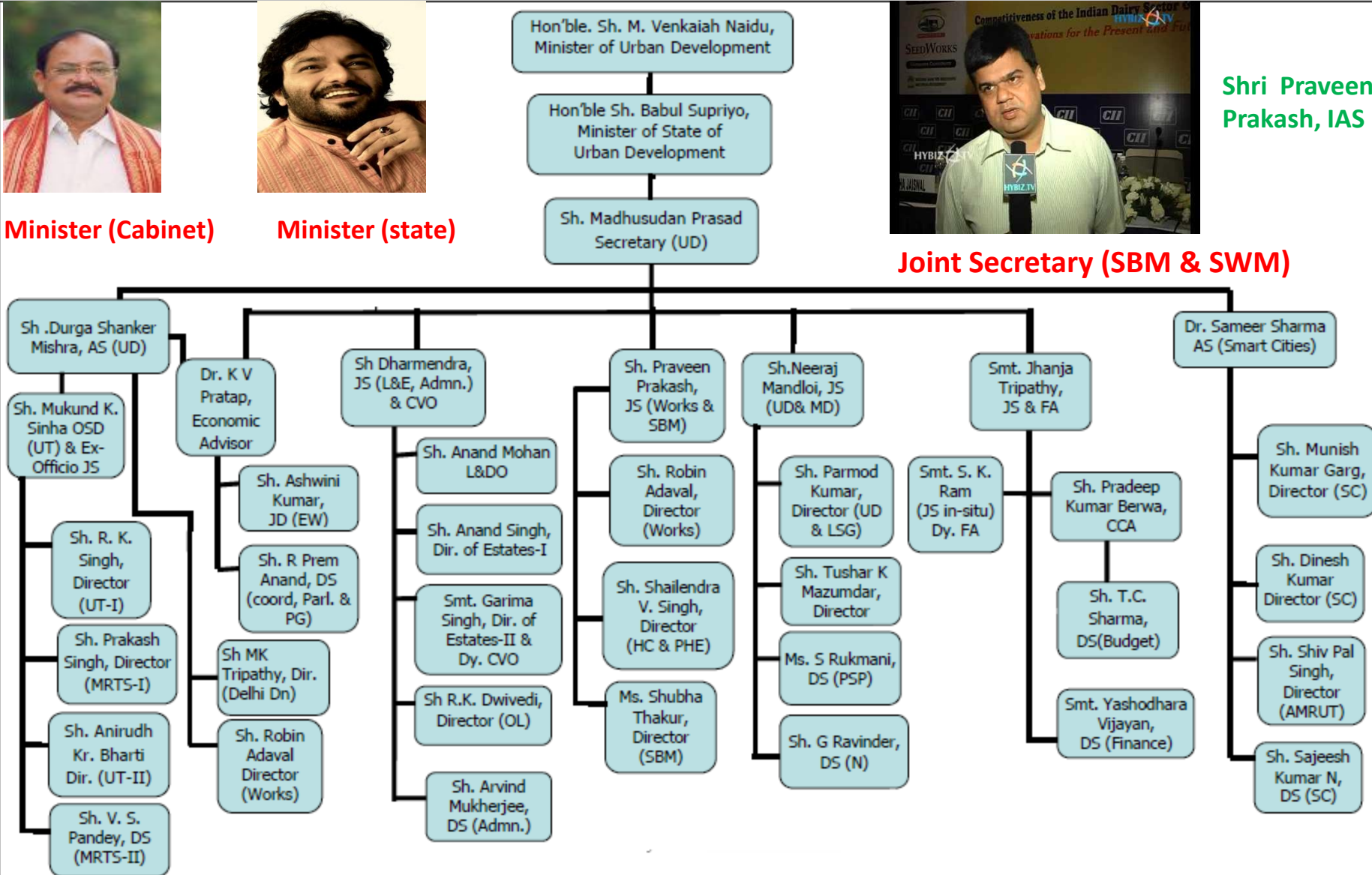


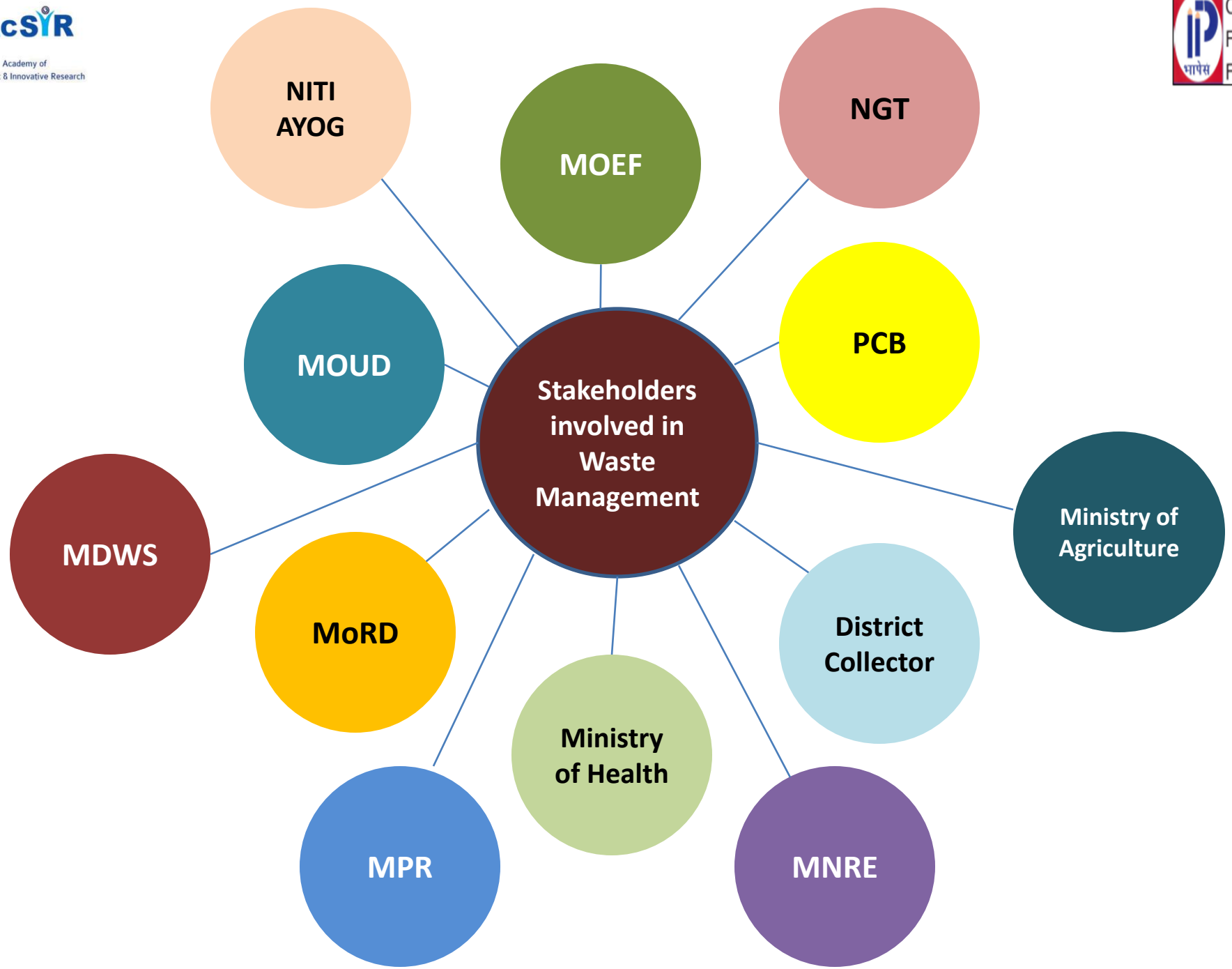
**Minister (state)**



**Joint Secretary (SBM & SWM)**

**Shri Praveen Prakash, IAS**





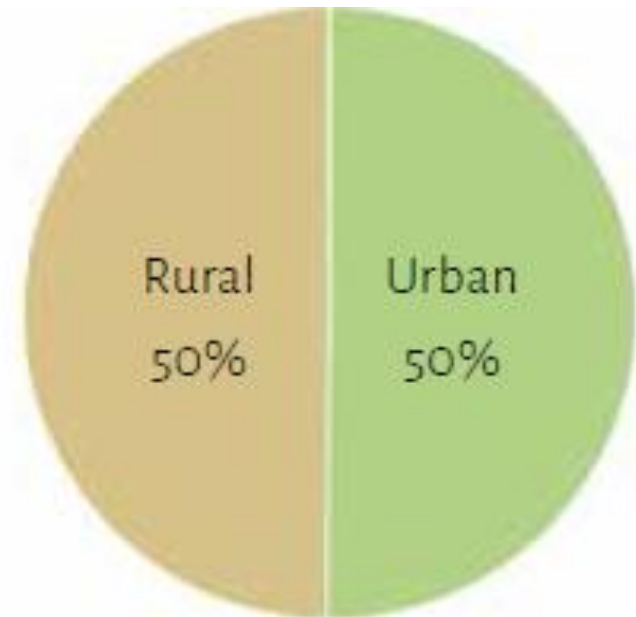
# Generation of Solid Waste in Rural and Urban Area

Waste Generation	TPD <sup>iii</sup>
Urban <sup>i</sup>	154265
Rural <sup>ii</sup>	153210
<b>TOTAL</b>	<b>307475</b>

[i] Assuming a generation of 400 gm/capita/day

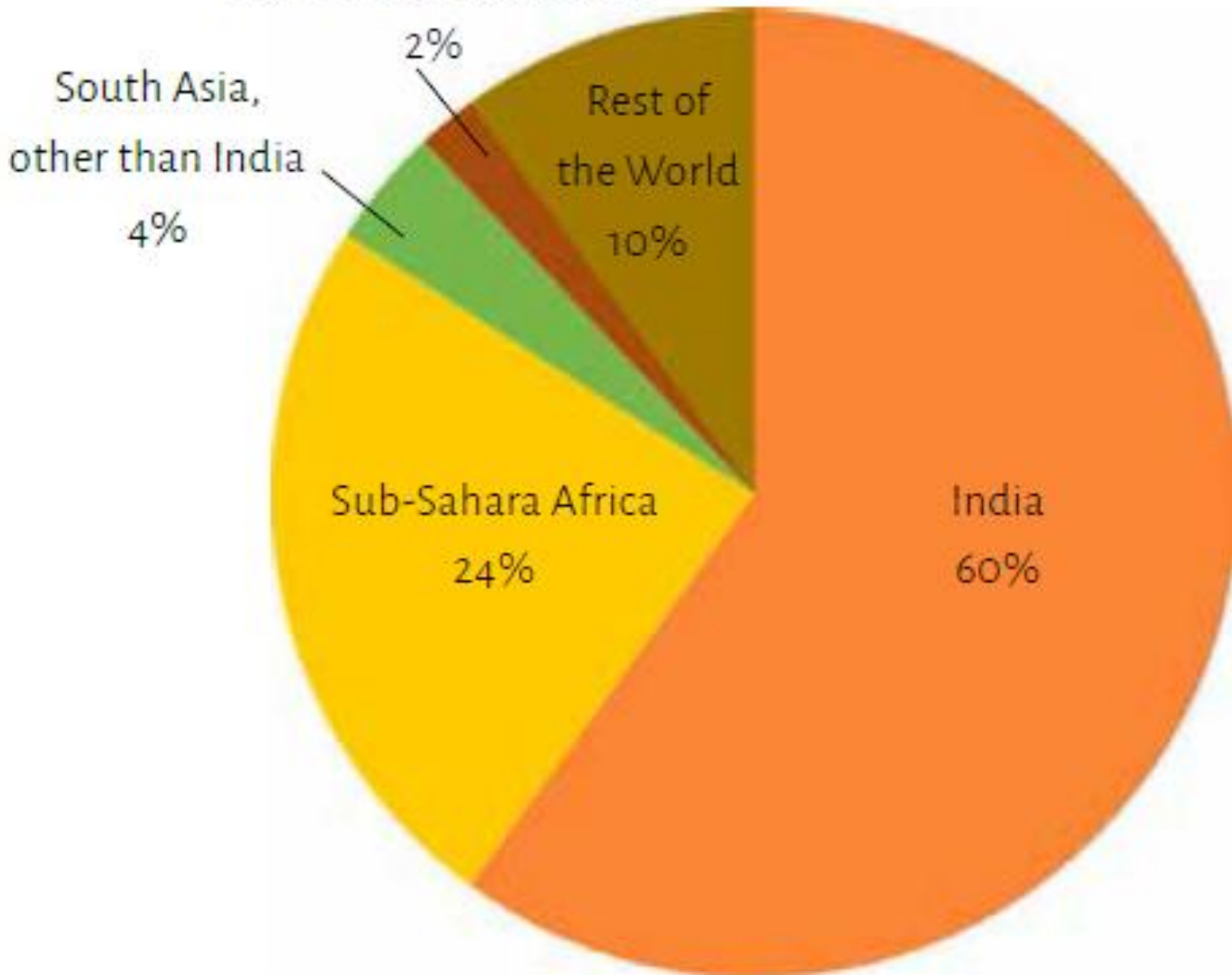
[ii] Assuming a generation of 150 gm/capita/day

[iii] Tonnes per day



# Composition of Solid Waste

BRICS other than India





# Classification of Wastes

- **Municipal Solid wastes:** Solid wastes that include household garbage, rubbish, construction & demolition debris, sanitation residues, packaging materials, trade refuges etc. are managed by any municipality.
- **Bio-medical wastes:** Solid or liquid wastes including containers, intermediate or end products generated during diagnosis, treatment & research activities of medical sciences.
- **Industrial wastes:** Liquid and solid wastes that are generated by manufacturing & processing units of various industries like chemical, petroleum, coal, metal gas, sanitary & paper etc.
- **Agricultural wastes:** Wastes generated from farming activities. These substances are mostly biodegradable.
- **Fishery wastes:** Wastes generated due to fishery activities. These are extensively found in coastal & estuarine areas.
- **Radioactive wastes:** Waste containing radioactive materials. Usually these are byproducts of nuclear processes. Sometimes industries that are not directly involved in nuclear activities, may also produce some radioactive wastes, e.g. radio-isotopes, chemical sludge etc.
- **E-wastes:** Electronic wastes generated from any modern establishments. They may be described as discarded electrical or electronic devices. Some electronic scrap components, such as CRTs, may contain contaminants hazardous toxic metals such as lead, cadmium, mercury, beryllium or brominated flame retardants etc.

# Special Wastes

Special Waste includes any solid waste or combination of solid wastes that, because of its quantity, concentration and physical / chemical characteristics or biological properties, require special handling and disposal to protect human health, as well as the environment and / or to exploit special potentials for recycling. In line with this definition, the following wastes are defined as Special Wastes:

1. Plastics waste

2. Biomedical waste

3. Slaughterhouse waste

4. Electric and electronic waste (e-waste)

5. Waste Tyres

6. Battery Waste

## Sustainable disposal of Plastic waste

co-Processing and co-Incineration of Plastic waste  
As Alternative

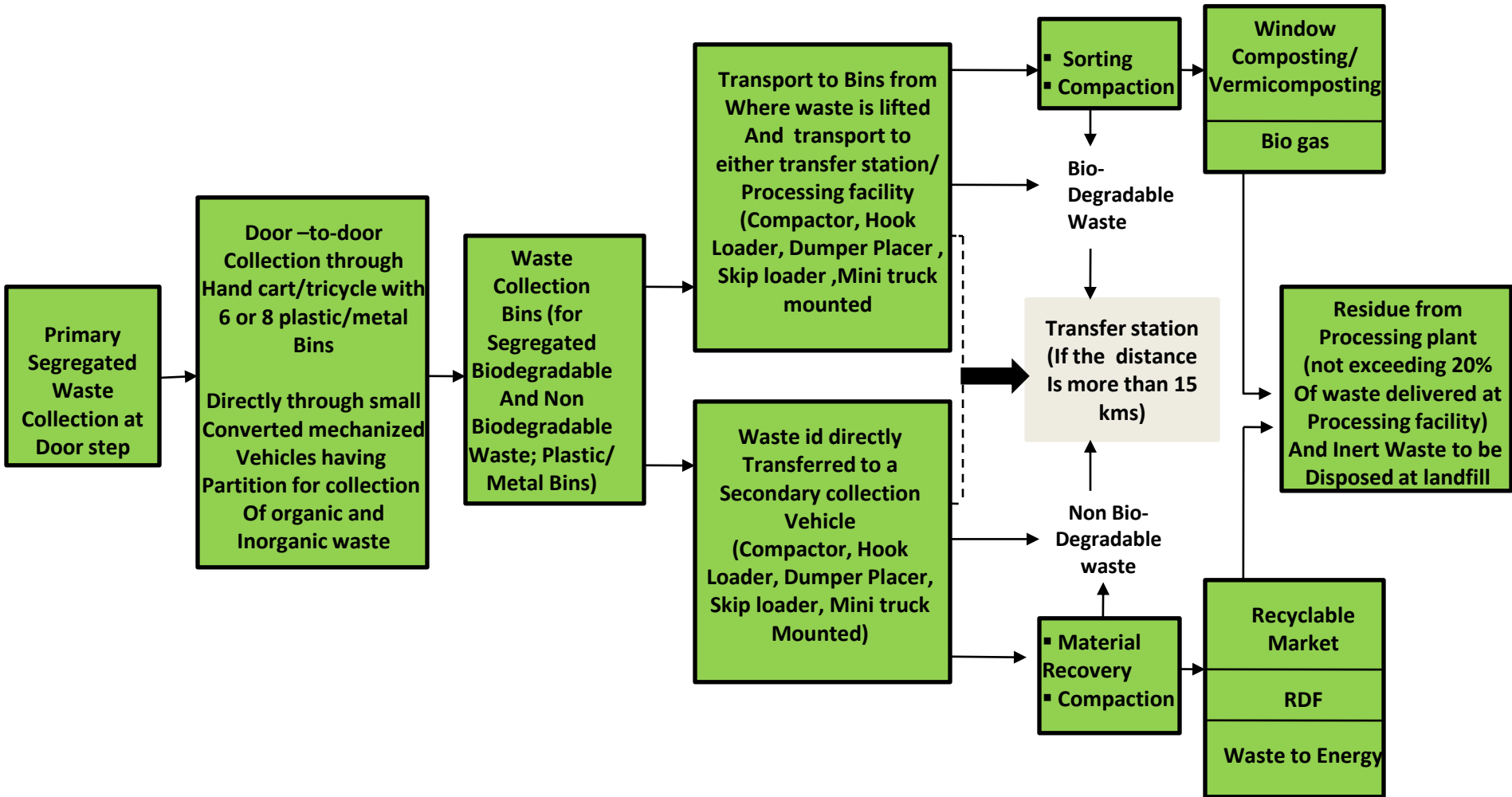
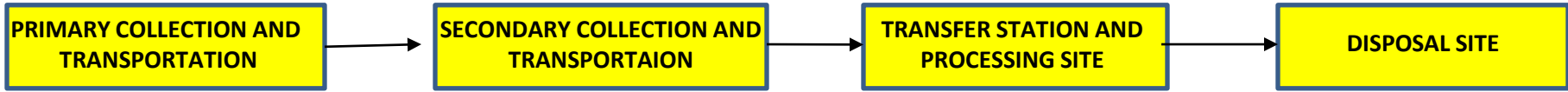
Fuel and raw Material (AFR) in cement Kilns

## Other Plastic waste disposal options

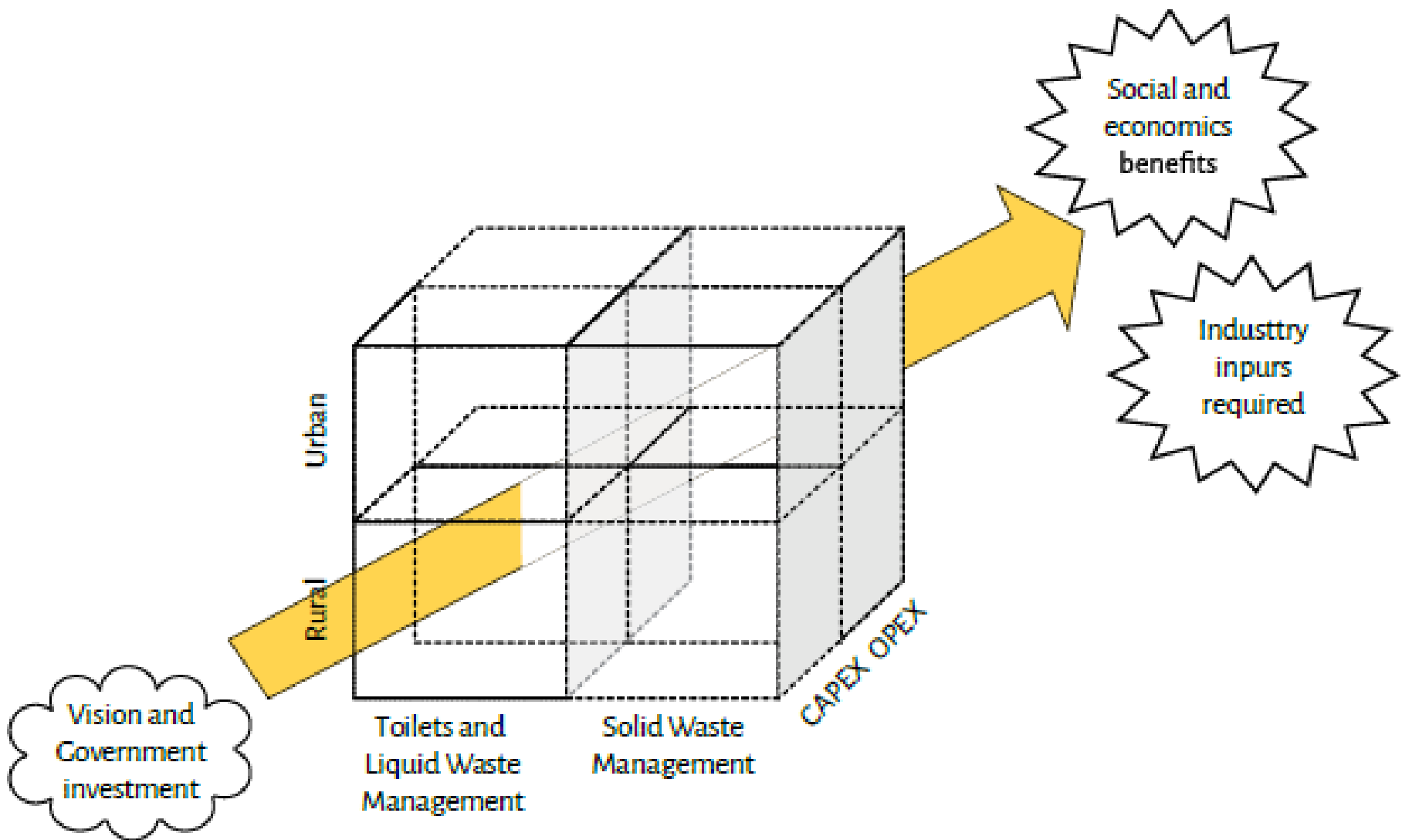
Use of Waste Plastic in Construction of  
bituminous Roads

Conversion of Plastic Waste Into Liquid Fuel  
Incineration of Plastic Waste

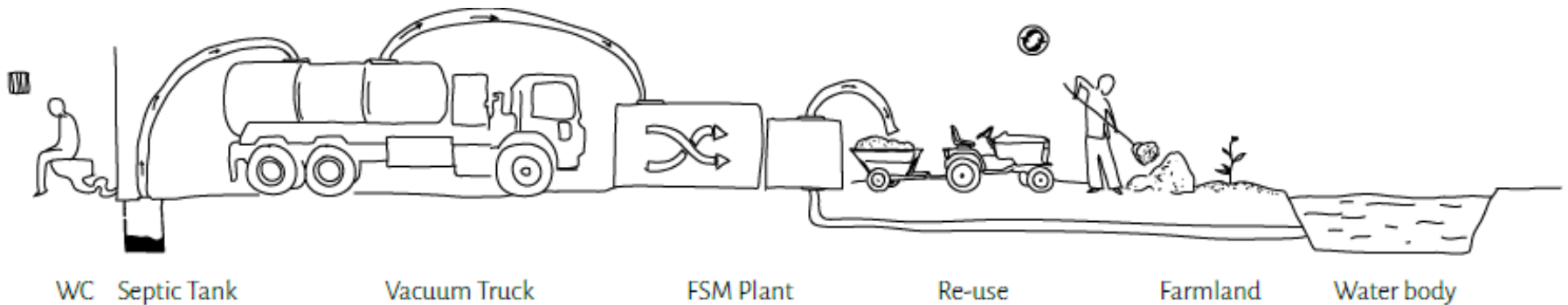
# Flow chart of household waste collection, transportation and disposal



# Challenges in Swachh Bharat Mission



# Challenges Case Study: Sanitation



## Vacuum or De-sludging equipment estimate

Item	No. of Septic tanks	No. of vacuum trucks required
Urban	6,244,788	1,249
Rural	62,280,066	12,456
<b>TOTAL</b>	<b>68,524,854</b>	<b>13,705</b>

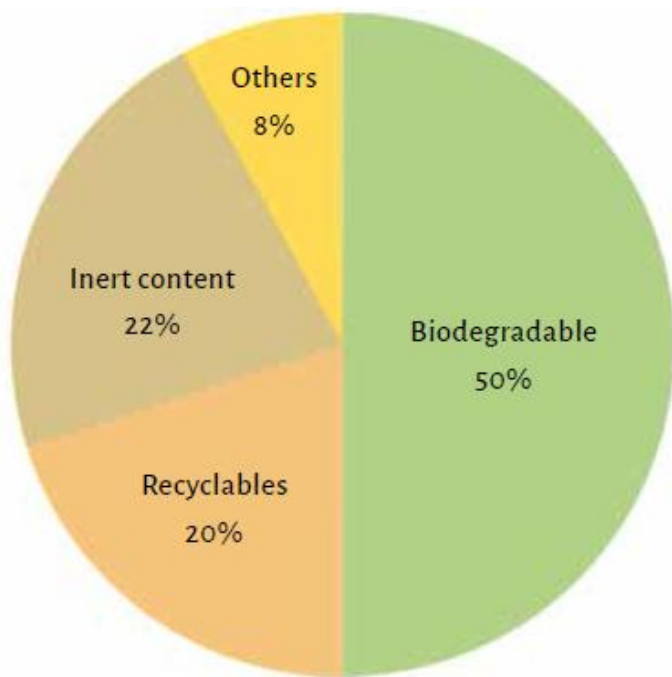
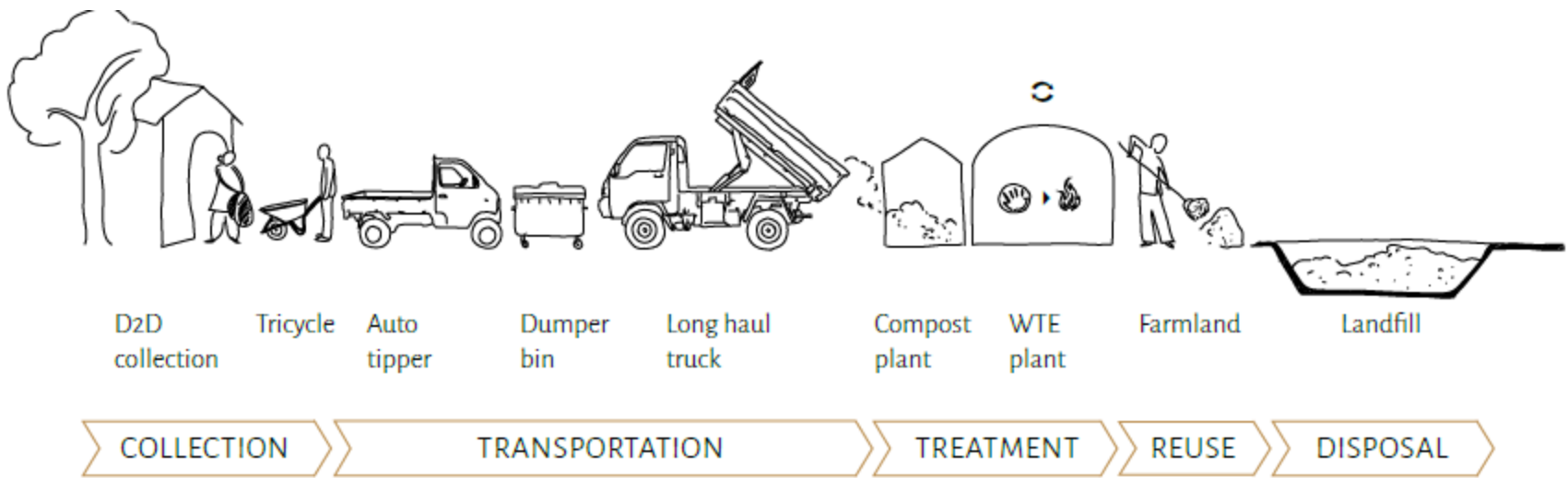


Chart 3: Composition of MSW in India  
Source: CPCB 2010

# Role of Science and Technology: Technical aspects of processing and treatment of MSW

## Recycling and Recovery

- ❖ recycling of Plastics
- ❖ recycling Paper and Board
- ❖ recycling of garden waste/yard waste
- ❖ reuse of Sand & Inert
- ❖ construction & demolition waste
- ❖ e-waste

## Treatment of MSW

- ❖ Composting
- ❖ Waste to Energy  
Incineration & Biomethanation
- ❖ Refused Derived Fuel  
Use in Cement Industry and Boilers
- ❖ Pyrolysis
- ❖ Gasification
- ❖ Bioreactor landfill
- ❖ recycling Paper and Board
- ❖ recycling of garden waste/yard waste
- ❖ reuse of sand & Inert
- ❖ construction & demolition waste
- ❖ e-waste

# Challenges: 3R approach

Reduction



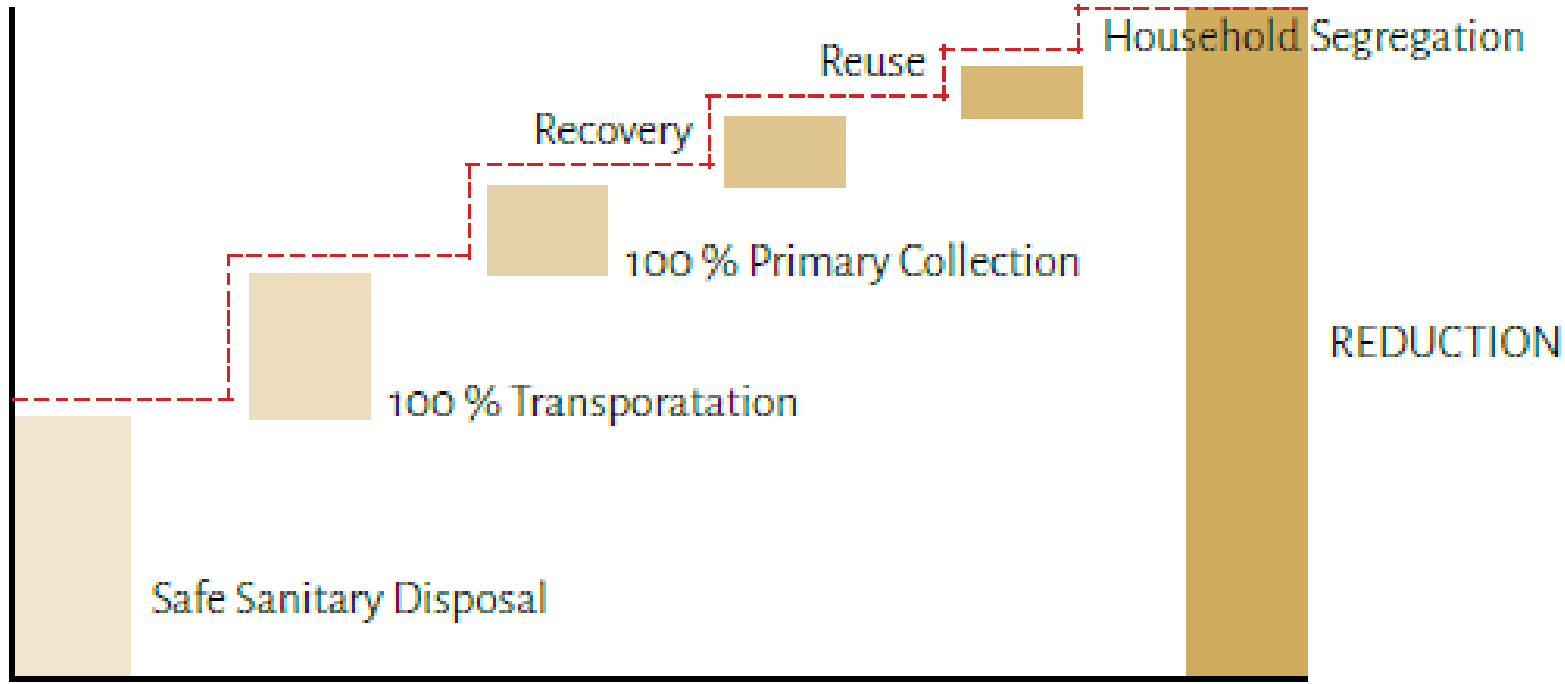
Re-use



Recovery\*



Disposal







# SWACHH BHARAT ABHIYAAN

 Ministry of Urban Development

## Swachh Bharat Abhiyan

 THE NEETI NEEETI  
THE NEETI NEEETI 09 JAN

- Get connected with your Local Community
- Drive cleanliness in your neighborhood
- let us together create Swachh Bharat

Over 1,50,000 citizens have already joined the movement  
To Participate Visit - [www.localcircles.com](http://www.localcircles.com), invite code - SWACHHBHARAT



An initiative by Ministry of Urban Development

 localcircles



Reduce  
Reuse  
Recycle



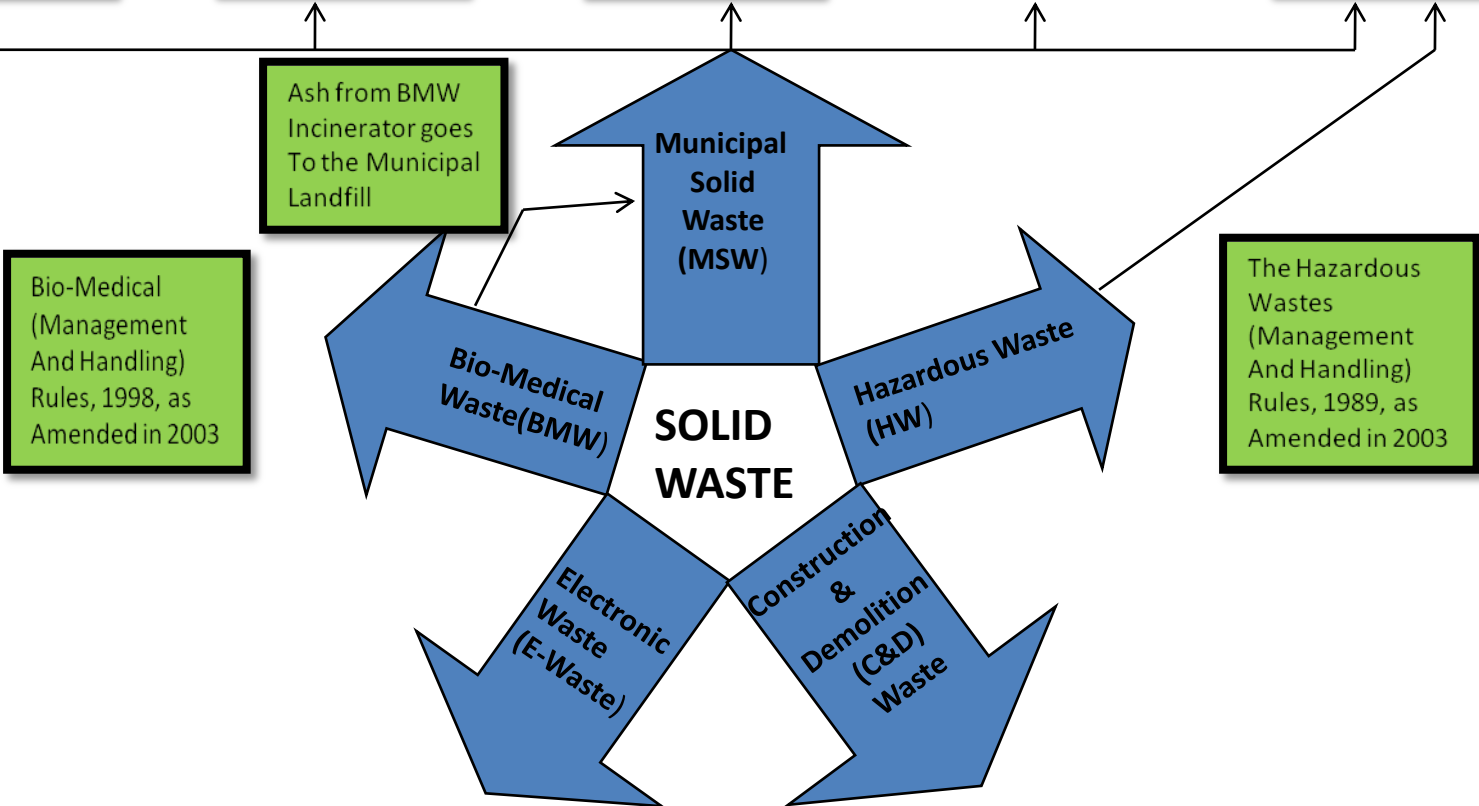
PAPER GLASS PLASTIC METAL

### Solid Waste Management

# Classification of cities for Solid Waste Management

- Class I Town Population of 100000 and above
- Class II Town Population of 50000 – 99999
- Class III Town Population of 20000 – 49999
- Class IV Town Population of 10000 – 19999
- Class V Town Population of 5000 – 9999
- Class VI Town Population below 5000

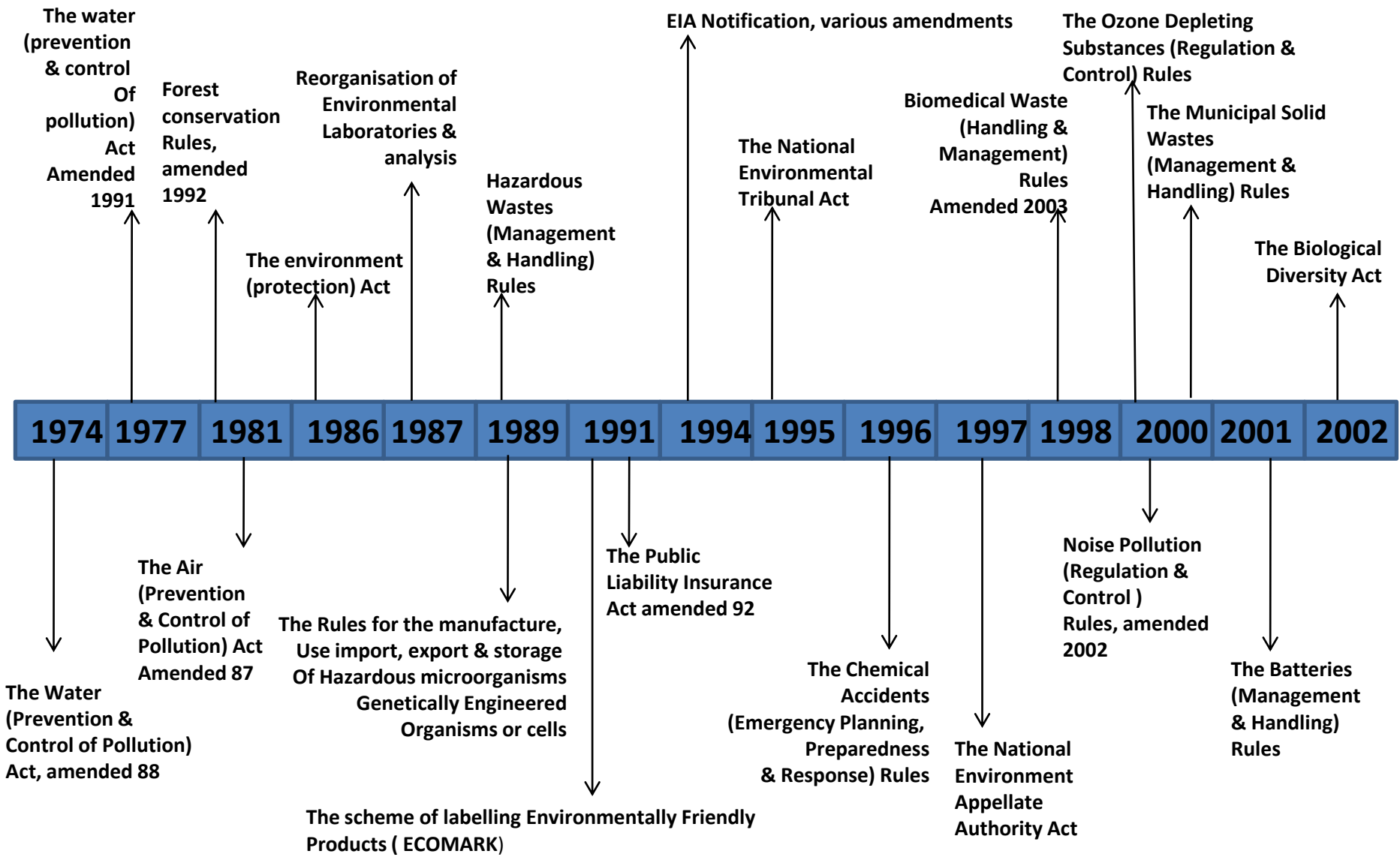
Cities having population 10 lakh and more are considered as metro cities.



State Level Regulations

National Regulations

# Policy frame work: Timelines of Acts related to waste treatment



# MSW Handling Rules and Policies

## MSW Management and Handling Rules 2000 and revised draft 2013

- Municipal Solid Waste (Management & Handling ) Rules, 2000 by MoEF
- ***Revised draft of Rules*** circulated in the year 2013 by MoEF
- Designates Urban Local Bodies responsible for MSWM and lays down the mandatory functions to be performed by various stakeholders
- weblink : <http://www.moef.nic.in/legis/hsm/mswmhr.html>

## Manual on Municipal Solid Waste Management and Handling 2014

- ***Guidelines*** published by Ministry of Urban Development through CPHEEO in the year 2014
- Provide implementation guidelines for all aspects of MSWM, including segregation, collection, transportation, treatment and disposal
- weblink : [http://urbanindia.nic.in/publicinfo/swm/swm\\_manual.htm](http://urbanindia.nic.in/publicinfo/swm/swm_manual.htm)

## National Urban Sanitation Policy (NUSP)

- ***Policy*** prepared by the Ministry of Urban Development in **2008**
- Broadly covers aspects of urban sanitation, with a specific focus to eliminate open defecation in cities
- Focus on re-orienting institutions for developing city-wide approach to sanitation, covering all its aspects including Solid Waste Management
- weblink: [www.urbanindia.nic.in/programme/uwss/NUSP.pdf](http://www.urbanindia.nic.in/programme/uwss/NUSP.pdf)

## Rules for Special Wastes

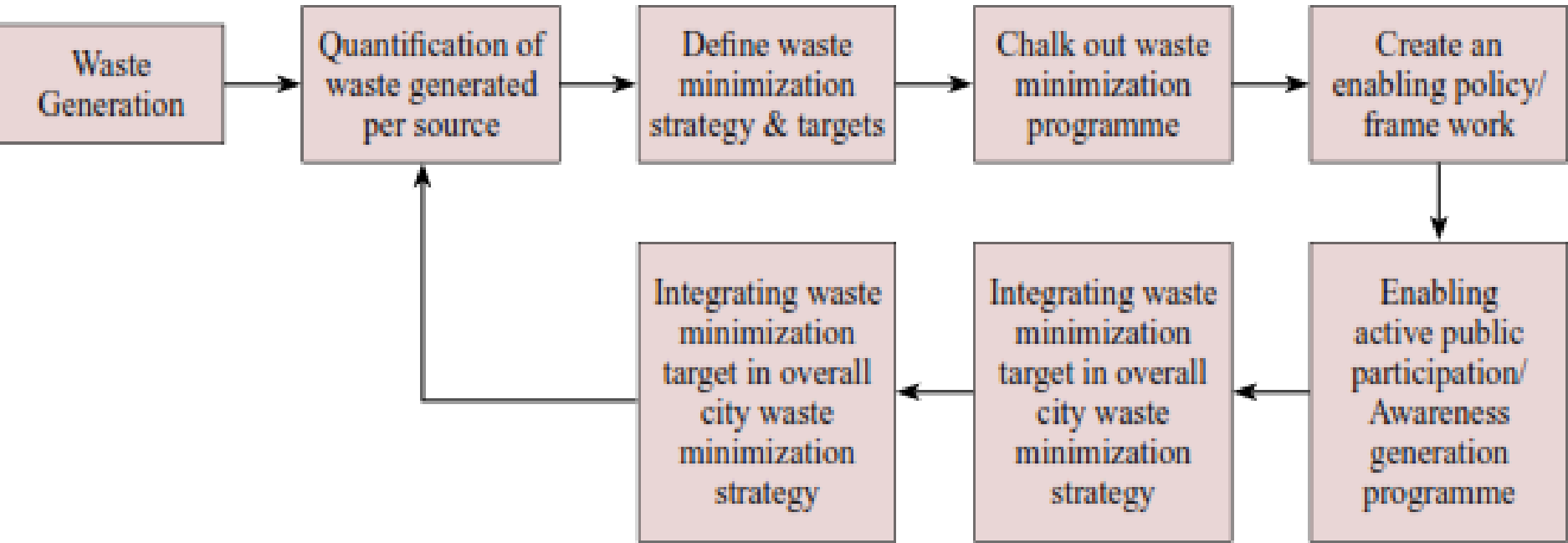
- Plastic Waste (Management and Handling) Rules, 2011
- Bio-medical Waste (Management and Handling) Rules, 2009 and draft 2011
- E-Waste (Management and Handling Rules), 2011
- Battery (Management and Handling Rules), 2001
- Construction & Demolition (C&D) Waste Rules, under consideration

## Other Relevant Rules & Task Force Reports

- Inter-ministerial Task Force on Integrated Plant and Nutrient Management using City Compost, 2005
- Fertilizer (Control) Order (FCO), 2009; PROM, 2013 by Ministry of Agriculture
- Report of the Task Force on Waste to Energy, Planning Commission, 2014

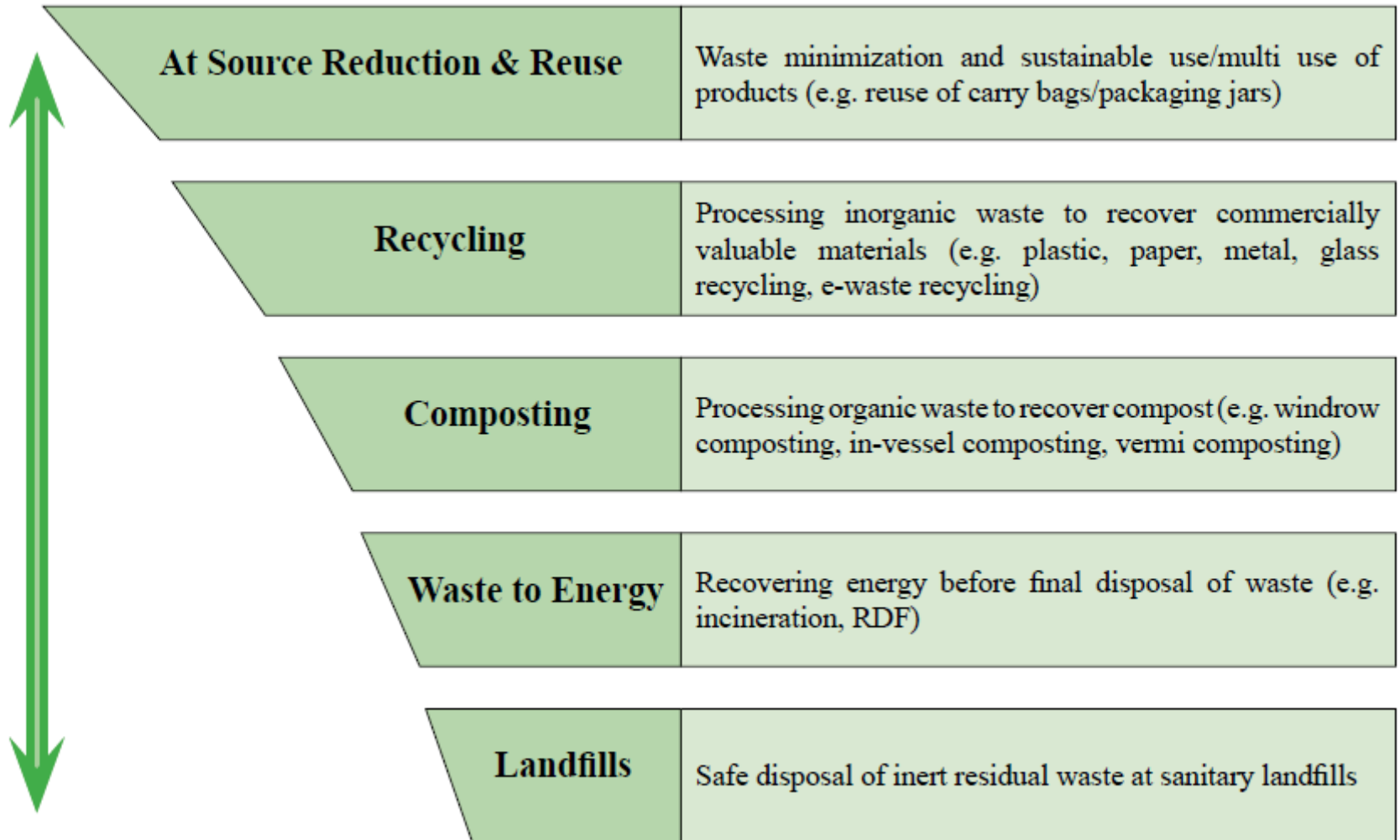
**Special Waste: CFL bulbs, batteries, tube lights, cleaning agents etc**

# Developing a Waste Minimization Program – Linked to 3R approach – 2014 Guidelines



# Integrated Solid Waste Management Hierarchy

**Most Preferred**



**Least Preferred**



# Integrated Solid Waste Management Concept (ISWM) & 3R Concept

➤ The ISWM concept, as described is closely linked to the 3r approach (Reduce, Reuse, and Recycle).

➤ ISWM is also aimed at optimizing the management of municipal solid waste from all the waste-generators (households, commercial and institutional establishments, parks and gardens , construction and demolition activities, urban agriculture, safety and healthcare facilities) and involving all the stakeholders (waste generators, service providers, informal sector, regulators, government, and community/neighbourhoods).

➤ The adoption of the 3R concept helps to minimize the amount of waste to be handled by the municipal authority minimizing the public health and environmental risks associated with it.

# Public Participation and Informal sector involvement Planned in ISWM

- Organization of informal sector workers into legally recognized, membership-based associations and their reflection in relevant policy decisions.
- Official recognition of these informal associations as viable partner organizations for SWM service delivery.
- Motivating private sector / NGOs/ SHGs to involve these informal associations in SWM service delivery by upgrading them from being waste / rag pickers on streets to waste collectors from source.
- Promotion of schemes to provide social security and health benefits to members of these associations.
- Providing low-interest loans to organizations of waste pickers seeking to bid for tenders and contracts.
- Providing incentives to encourage participation of informal sector associations through excise and tax exemptions and other fiscal concessions.
- Giving priority to these associations in taking up small contracts of waste collection and small-scale processing as informal sector enterprises.
- Reserving land in development plans for decentralized processing of bio-degradable wastes, and for setting up material recovery facilities.
- Supporting capacity development programmes for informal sector associations catering to the special needs of women.

# Preferred Waste Management Strategies of Govt of India – 2014

- **At source reduction and reuse at source:** The most preferred option for waste management is to prevent the generation of waste at various stages including at product design stage, production, packaging, use and reuse stages of a product. Waste prevention helps reduce handling, treatment, and disposal costs and reduces various environmental impacts such as leachate, air emissions and generation of greenhouse gases.
- **Waste recycling:** Recovery of recyclable material resources through a process of segregation, collection and re-processing to create new products is the next preferred alternative.
- **Waste to composting:** The organic fraction of waste can be composted to improve soil health and agricultural production adhering to FCO norms.
- **Waste-to-Energy:** Where material recovery from waste is not possible, energy recovery from waste through production of heat, electricity, or fuel is preferred. Bio-methanation, waste incineration, production of Refuse Derived Fuel (RDF) and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted “Waste to Energy” technologies.
- **Waste Disposal:** Remaining residual wastes at the end of the hierarchy, which are ideally comprised of inerts, are to be disposed in sanitary, lined landfills, which are constructed in accordance with stipulations of the MSW Management and Handling Rules, 2014.

The hierarchy implies that all options of waste minimization should be exercised before treatment and disposal technologies are selected and implemented.

# Key Features of India's Urbanization Process

- Increase of 91.1 million persons to urban population during 2001-2011 is not only the highest registered thus far, it is also higher than the increase of 90 million persons to rural population.
- The annual exponential growth rate of 2.76% registered during 2001-2011 has reversed the declining trend observed during 1981-91 and 1991-2001.
- That this rise in urban population growth rate has come during an era of sharp decline in the natural growth rate shows that the push to urban population has come in from other sources, i.e., rural to urban conversion and rural-urban migration

# Landfilling in India

- Landfilling of MSW is emerged as one of the most suitable mode of disposal among all options in India.
- According to CPCB Annual Report, 2011
  - 9/59 completed landfills
  - 376 landfills under planned
  - 1305 landfill sites development identified for future



# Landfilling: Issues

- ▶ Landfill gas (LFG), generated by anaerobic decomposition of organic fractions in buried waste, consists of 55-60% methane ( $\text{CH}_4$ ) and 40-45% carbon dioxide ( $\text{CO}_2$ )
- ▶ Greenhouse gas (GHG) emissions from landfills have been widely discussed due to its linkage to climate change.
- ▶ According to global GHG inventory,  $\text{CH}_4$  in LFG is a significant source of anthropogenic  $\text{CH}_4$  emissions and accounts for more than half of GHG emissions from waste sectors

# Key issues

- **Availability of accurate data open to public**
- **Too many Actors/Agencies – effective and dynamic coordination**
- **Institutional capabilities – weak**
- **Segregation not practiced at all levels**
- **Improper channelization and utilization of the allocated budgets/ funds**
- **Selection of Improper Technologies**
- **Lack of awareness – Motivation lacking among every one**
- **Poor Monitoring**
- **Accountability**

# Integrated Solid Waste Management

- **Integrated Solid Waste Management:** Water, sanitation and solid waste management are integral part of any cleanliness initiative. The Swachh Bharat (Clean India initiatives) by Prime Minister of India leads to have an integrated approach in solving the waste management problem in India
- Good water quality cannot be ensured unless we have a good waste management system and proper sanitation facilities. As part of the integrated waste management, different components need to be strengthened and worked upon in coming years to help cities, small and medium towns and Panchayats in India to deal with the enormous challenge of waste management.
- **Principles of Swachh Bharat (Clean India Campaign):**
  - Creation of Totally Sanitized Environment – By 2019:** The end of open defecation and achievement of a clean environment where human faecal waste is safely contained and disposed.
  - Adoption of Improved Hygiene Practices – By 2020:** All people in the rural areas, especially children and care givers, adopt safe hygiene practices during all times.
  - Solid and Liquid Waste Management – By 2022:** Effective management of solid and liquid waste such that the village environment is kept clean at all times.



- **Waste Prevention:** Waste prevention/source reduction – seek to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials.

Waste prevention help reduce handling, treatment and disposal costs and ultimately reduce the generation of pollutants escaping to atmosphere from waste treatment and disposal processes.

- **Recycling and Composting:** Recycling is a process that involves collecting, reprocessing, and/or recovering certain waste materials (e.g., glass, metal, plastics, paper) to make new materials or products. Some recycled organic materials are rich in nutrients.

Recycling and composting generate many environmental and economic benefits, for examples: they create jobs and income, supply valuable raw material to industry, produce soil enhancing compost leading to better agricultural productivity.

- **Disposal (Landfilling and combustion):** These activities are used to manage waste that cannot be prevented or recycled. One way to dispose of waste is to place it in properly designed, constructed and managed landfills (few working in India today), where it is safely contained.

Another way to handle this waste is through combustion. Combustion is the controlled burning of waste, which helps reduce its volume.

This technology could be properly designed, constructed, and managed landfills can be used to generate energy by recovering methane. Similarly, combustion facilities produce steam as a by-product that can be used to generate energy.

# Integrated Solid Waste Management

- **Developing a Plan for Integrated Solid Waste Management:** Planning is the first step in designing or improving a waste management system. Waste management planners should, for example, take into consideration institutional, social, financial, economic, technical, and environmental factors.
- Based on these factors, each community has the challenge of selecting the **combination of waste management activities** that best suits its needs. Because integrated solid waste management involves **both short and long-term choices**, it is critical to set achievable goals.
- While developing ISWM plan, one should **identify goals or objectives** (e.g., protect human health, protect water supplies, reduce POPs from open burning of trash, increase recycling or composting). The ISWM plan helps through the implementation process. Input from community should also be sought to ensure an informed public and to increase public acceptance.
- **Implementing an Integrated Solid Waste Management Plan:** Once ISWM plan is developed and written, one can begin to implement the various combinations of waste management activities. Implementing an ISWM plan is an ongoing process with adjustments to the plan along the way. System inefficiencies should be evaluated and adjustments should be made to improve or expand solid waste management services.

# Conclusions

- **Given the overall MSWM situation in our society, there is a need to promote multiple options including decentralized initiatives and a supporting policy environment through capacity building of implementing institutions and stake holders.**
- **Need for strong IEC component needs to be institutionalised among all stakeholders for imparting the right information and positive attitude for healthy and hygienic waste disposal practices**
- **The Municipalities/Cities/Towns needs to establish multi disciplinary team within the local bodies for taking entire responsibility of waste management. currently it is handled by the health sections which are totally incompetent in handling waste management.**
- **More effective legislation will support a stronger, coordinated sector but legislation is only effective if there is the capacity to enforce it.**
- **Well defined Roles and Responsibilities among stakeholders for enabling them to practice transparency and accountability mechanisms in work culture.**
- **Integrated Solid Waste Management will lead to sustainable waste management in the long run. This reinforces the importance of minimization of waste generation and 3R strategy of waste management-Reduce, Reuse and Recycle.**

'If we don't do our scientific work someone else would; but if we neglect our social responsibilities as Scientists, there would soon be no science'

-Paul Langevin

THANK YOU VERY MUCH

धन्यवाद

For further details, please visit:  
[thalladabhaskar.weebly.com](http://thalladabhaskar.weebly.com)