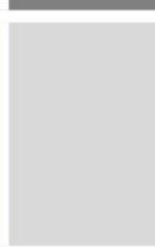
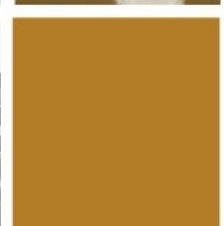
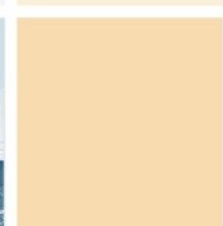
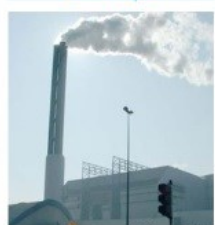


VOW: Value Out of Waste

The Next USD 1.5 billion Opportunity for Indian Industry

February 2015



ASSOCHAM

ASSOCHAM acknowledged as Knowledge Chamber of India has emerged as a forceful, pro-active, effective and forward looking institution playing its role as a catalyst between the Government and Industry. ASSOCHAM established in 1920 and has been successful in influencing the Government in shaping India's economic, trade, fiscal and social policies which will be of benefit to the trade and industry.

ASSOCHAM renders its services to over 3,50,000 members which includes multinational companies, India's top corporates, medium and small scale units and Associations representing all the sectors of Industry. ASSOCHAM is also known as a Chamber of Chambers representing the interest of more than 350 Chambers & Trade Associations from all over India encompassing all sectors.

ASSOCHAM has over 100 National Committees covering the entire gamut of economic activities in India. It has been especially acknowledged as a significant voice of Indian industry in the field of Corporate Social Responsibility, Environment & Safety, Corporate Governance, Information Technology, Agriculture, Nanotechnology, Biotechnology, Pharmaceuticals, Telecom, Banking & Finance, Company Law, Corporate Finance, Economic and International Affairs, Tourism, Civil Aviation, Infrastructure, Energy & Power, Education, Legal Reforms, Real Estate, Rural Development etc. The Chamber has its international offices in China, Sharjah, Moscow, UK and USA. ASSOCHAM has also signed MoU partnership with Business Chambers in more than 45 countries.

cKinetics

cKinetics is a specialized sustainability advisory firm working with investors and businesses in emerging markets. cKinetics provides specialized operational consulting and strategic services with a focus on: (a) Resource Efficiency and Conservation: Energy, Water, Carbon, Waste, (b) Renewable Energy and Smart Infrastructure, (c) Responsible Finance.

With offices in New Delhi and Palo Alto, the team comprises of cross-functional specialists that combine insights in strategy, operations and financing to carve sustainable growth oriented solutions.

From the President's desk



India is currently the world's 2nd second-most populous nation with nearly 17.5% of global population and is expected to grow to 1.6 billion by 2050. During the last decade, India's urban population grew by 31.8% to 377 million, which is larger than the entire population of the US, thereby underlining a tremendous need for waste management services. Additionally, rapid economic growth, urbanization and industrialization have generated significant waste, adversely impacting our environment.

Currently solid waste management (SWM) services face sub-optimal planning, inefficient implementation and heavy expenditure, thereby posing serious challenges to public health, environmental pollution, degradation of natural resources and climate change, impacting the overall quality of life. To address these issues, India's development strategy must be sensitive to these growing environmental concerns, while appropriately evaluating its threats and trade-offs. A multi-stakeholder approach, including the community and the private sector, focused on leveraging innovative technologies and disposal methods as well as increased awareness, must be designed and incorporated in all Government and Corporate CSR models. Further, an integrated approach, encompassing technological, policy, administrative and legal actions to address waste management in India, must effectively incorporate local, regional and national requirements and challenges.

It is imperative to move towards constructive waste management which involves Public-Private Partnerships focused on eventual waste minimization, driven at the community level, using low energy and low technology resources. Additionally, future waste minimization programs must derive greater economic benefits through decentralized waste administration as well as reconciliation of investment costs with long-term goals.

ASSOCHAM has proactively encouraged all its Members to join the '*Swachh Bharat Abhiyan*' initiative and is proactively working with Industry to build and maintain public toilets as part of CSR initiatives. The Chamber is also promoting green growth by urging its corporate members to focus on city waste management as part of their business practices.

I am pleased to present this ASSOCHAM Publication on 'Waste to Wealth' which provides focused solutions on policy and technology, which are critical for this sector. I am confident that this publication will be a useful reference for all stakeholders in long-term planning and development of a Clean India.

Sincerely,

A handwritten signature in black ink, appearing to read 'Rana Kapoor'. The signature is stylized and written over a horizontal line.

Rana Kapoor
President
ASSOCHAM



Image courtesy: The Advocacy Project's Flickr stream

Acknowledgement



The world in general and developing economies like India in particular has experienced rapid changes in the past few decades in technical, industrial and medical evolution. Globalization has increased its impact on human activity as well as on the environment. This growth has resulted in increased consumerism and urbanization leading to massive waste generation. Due to change in lifestyle and inefficient use of resources, waste management has become a matter of great concern. Waste is an expensive resource which needs to be treated in order to maximize both environmental and monetary benefits.

'Waste to Wealth' is an imminent and pertinent topic, which requires the collaborative effort of industrial representatives and policy makers to find sustainable and economically viable solutions.

Therefore looking at the importance of the subject, it gives me immense pleasure that ASSOCHAM is organizing 3rd National Conference on Waste to Wealth: The Action Agenda at New Delhi.

I extend my heartiest thanks to Ministry of Urban Development, Government of India, Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, Government of India, Department of Pharmaceuticals, Ministry of Chemicals and Fertilizers, Government of India, Department of Science and Technology, Ministry of Science and Technology, Government of India, Ministry of New and Renewable Energy, Government of India, GAIL and General Electric for supporting this conference.

I also thank our Knowledge Partner cKinetics for its significant effort in putting up the report on "VOW: Value out of Waste: The Next USD 1.5 Billion Opportunity for Indian Industry"

Lastly, I appreciate the efforts of Dr. Om S Tyagi, Sr. Director, ASSOCHAM along with Mr Sandeep Kochhar, Ms Purnima Dhingra, Mr Vipul B. Ganjingwar, Mr Nitesh Sinha, Mr Amit Bungler and Mr Prashant Singh for organizing this conference.

I wish the conference a great success and believe that ASSOCHAM shall continue to organize such programs for larger public benefits with great degree of excellence.

A handwritten signature in black ink, appearing to read 'D.S. Rawat'. The signature is fluid and cursive, with a horizontal line underneath the name.

D.S. Rawat
Secretary General
ASSOCHAM



Image courtesy: The Advocacy Project's Flickr stream

Preface



With growing urbanization in India, waste management is emerging as a key challenge facing the country. With the impending resource shortage, it is imperative that waste management be viewed not just as a necessity but also as an opportunity to create closed loop systems.

As Government of India focuses on building smarter cities, several measures need to be undertaken to propel India towards being a sustainable economy – waste management in general and generating wealth out of waste in particular would be a key pivot in this transformation.

In light of the surmounting quantum of waste cluttering Indian cities and the on-going technological advancements, waste management is poised to be one of the biggest opportunities in the coming years. To drive the uptake of the necessary technologies and to accelerate the waste management scenario in India, it is important to understand the inter-related policy, technological and operational barriers and promote stakeholder collaboration for streamlined action.

The ASSOCHAM initiatives on Waste to Wealth, supported by this report would provide insights into Value out of Waste (VoW) that can be generated from municipal solid waste as also the potential opportunity this represents for the Indian industry.

This publication is an effort to facilitate easy access to information in this field and is recognition of the need to shape a proactive communication within the industry. I am hopeful the information provided here will enable the Industry participants and help provide the requisite thrust in this emerging field.

A handwritten signature in blue ink, appearing to read 'Upendra Bhatt', with a horizontal line underneath.

Upendra Bhatt
Managing Director
cKinetics



Image courtesy: Shishir Basant's Flickr stream

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Image courtesy: Franklin Oliveira's Flickr stream

Executive Summary

As urbanization is set to almost double in India by 2050 (increase 1.8 times over 2012 levels), the waste in the cities is expected to grow by over 4 times as a result of increased levels of income and consumption – presenting both a challenge and an opportunity. With the announcement of forward thinking plans like ‘100 Smart Cities Initiative’ and the ‘Swachh Bharat Abhiyaan’, the Government of India is clearly working towards creating smarter and cleaner cities with a focus on urban waste management.

While urban waste has various components, this report focuses on Municipal Solid Waste and provides an overview of the current state of municipal waste management in the country and barriers faced in its effective management. ***The objective of this report is to assess the business opportunity and investment potential presented by waste management, primarily focusing on creating Value out of Waste through energy and materials recovery.***

Current State of Municipal Solid Waste Management in India

Municipal Solid Waste management is primarily a function of the municipal bodies. The Government of India has rolled out two key rules for solid waste management in India: **Municipal Solid Waste (Management and Handling) Rules in 2000 and Plastic Waste Management and Handling) Rules in 2011**. Along with these regulatory mandates, the Government of India has also rolled out two key policies (National Environment Policy, 2006 and National Urban Sanitation Policy, 2011) which are expected to provide an Action plan and guidance for improved and effective MSW management in India.

The value chain of municipal solid waste management typically consists of six stages: Waste Generation, Primary Collection, Secondary Collection, Transportation and Storage, Processing and Disposal. Currently there are several gaps and challenges at each step of this value chain in urban India.

According to the Central Pollution Control Board, urban areas in India generated 144,165 metric tonnes of municipal solid waste per day in 2013-14. In 2014, close to 80% of this waste generated in urban centers was collected, which is a significant improvement over 68% which was observed in 2012. However, the amount of waste treated and processed continues to remain dismal.

The primary reason for the low waste treatment efficiency in India is the **lack of waste segregation at source** both at household level as also from the commercial enterprises and **lack of meaningful integration of the informal sector** in the waste management value chain. The lack of waste segregation consequently has a magnifying impact across the rest of the value chain leading to increased transportation and storage challenges, unavailability of suitable waste for processing and ultimate disposal at landfilling sites. Hence, close to 80% of the current waste generated in the country ends up in landfills and unauthorized dumping sites.

Since municipalities/Urban Local Bodies (ULBs) have their own capacity constraints, they partner with various institutions for effective municipal solid waste management in the region. The approach for MSW management could be centralized, decentralized or a combination of both – and can be executed either on a standalone basis by the urban local bodies or through partnerships with private players and/or NGOs.

- In small cities, municipalities typically follow a centralized approach for waste management where they work independently across all aspects of the waste management value chain.
- In larger cities, a decentralized waste management system seems to be preferred since the quantum of waste generated is high, municipalities have insufficient capacities and are likely to incur high costs for end to end waste management. Hence municipalities work with private players and/or NGOs, SHGs in the region depending on the availability and suitability. The NGOs are typically engaged for waste collection, segregation and localized processing (mainly

composting) and the private players are typically engaged for setting up and operating waste processing plants.

The majority of municipal solid waste generated in India is organic matter (40%) which is compostable in nature, followed by 10% of combustible waste, 5% of recyclable materials and the rest of the material (45%) are inert. It is important to highlight that this waste composition is at the dumpsite and not at source, since majority of recyclable material is removed by the informal sector prior to waste dumping.

There are multiple technologies available for extracting value out of waste depending upon the composition of waste. For some wastes like metals, glass, construction and demolition waste etc. it is possible to recover useful materials through recycling. For other wastes like inorganic combustible waste, it is possible to recover energy through various technologies (like pyrolysis, incineration, gasification etc). Organic waste can be used to recover materials through composting as well as energy through bio-methanation.

The USD 1.5 billion VoW (Value out of Waste) market

Currently, municipalities are sourcing funds for waste management from conservancy/property tax, user charges and material recoveries – however these funding sources combined are not adequate for municipalities/ULBs to efficiently manage, treat and dispose municipal waste. This presents an immense opportunity for private players to engage across the entire value chain, particularly for setting up and operating processing and disposal facilities.

While multiple business opportunities are available across the entire value chain from waste collection to disposal, for the purpose of this report, the market size has been estimated for urban waste processing in India. Composting and waste to energy are the two biggest opportunities for generating value out of waste in India (together accounting for 90% of the total waste that can be processed). *Potential market opportunity for urban MSW processing in India has been estimated by assessing the investment requirements for setting up the requisite waste processing capacity for both composting and waste to energy.*

- **Composting**
 - Given the high organic content in Indian urban municipal waste, less upfront capital expenditure, as well as ease of adoption in decentralized setting, **composting is expected to grow from about 26,000 TPD in 2017 to 66,500 TPD in 2052.**
- **Waste to Energy**
 - Though currently, processing waste for conversion into energy has seen little adoption, it has been estimated that this market has a potential of 956 MW by 2017. With technological improvements, improved waste management systems and better quality of source waste due to increased segregation, the potential **capacity for waste to energy plants is expected to grow to approximately 2200 MW by 2030 and 5400 MW by 2052.**

With these estimated waste processing capacities, investment potential **for generating value out of waste is expected to be worth USD 1.5 Billion by 2017.** A large portion of this market continues to remain untapped owing to several operational, policy and technological barriers.

Action Agenda for Urban Municipal Waste Management in India

Given the continually increasing waste generation trends in India, it is imperative to address the barriers faced for efficient MSW management in India. The **Urban Waste Management Framework (UWMF)** has been conceptualized for the creation of a highly comprehensive and integrated urban solid waste management system in India. The three models (Basic, Intermediate and Advanced) have their own focus areas based on which key performance indicators can be developed for tracking the success of waste management system.

Introduction: Waste Management in India's Growing Urban Centers



Image courtesy: Koshy Koshy's Flickr stream

Chapter 1: Waste Management in India's Growing Urban Centers

“By 2052, the level of urbanization is expected to increase by 1.8 times in India, with a corresponding increase in waste generation by more than 4 times.”

1.1 Urbanization and the Waste Management Challenge

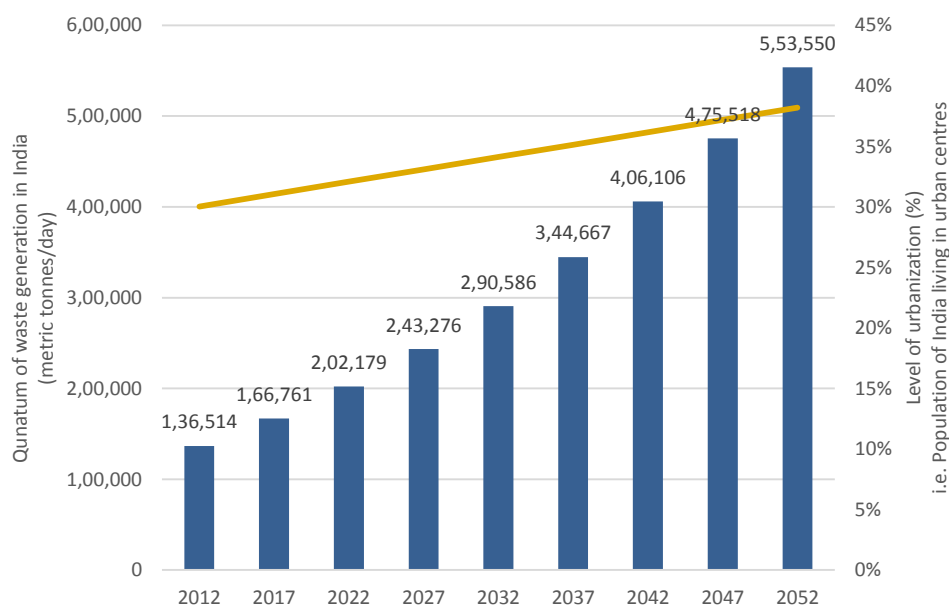
The second most populous country in the world, India, had close to 366 million people dwelling in urban areas in 2012 accounting for 30% of the country's population¹. It is being estimated that this urban population would grow to 672 million by 2052 and account for 38% of the country's population².

As the cities continue to grow and consumptions increase, the waste generated is expected to increase significantly, influenced primarily by increase in the urban dwelling population, increase in income levels and changing consumption patterns.

In 2012, the 30% of the total population living in urban areas³ was generating a total of 136,514 metric tons/day waste in these urban centers⁴. This quantum of waste generation is expected to continue to grow over the next few decades in line with the increasing levels of urbanization (Figure 1). By 2052, the level of urbanization is expected to increase by 1.8 times in India (from the 2012 level) – however the corresponding waste generation is expected to grow by more than 4 times⁵ – owing to the increased levels of income and consumption.

Figure 1: Levels of urbanization and corresponding waste generation in India

The Yellow trendline demonstrates the level of urbanization in India (corresponding to the right axis of the graph).



Source: cKinetics analysis (using data from India Energy Security Scenarios 2047)

The management of this enormous quantity of waste generated is one of the primary problems faced by urban centers. An immediate and focused approach for waste management in the country will go a long way in enabling an appropriate level of living in the urban centres.

¹ India Energy Security Scenarios 2047 (IESS 2047) <http://indiaenergy.gov.in/>

² Ibid.

³ Ibid.

⁴ Ibid.

⁵ Ibid.

“The Government of India is taking forward thinking steps for creating cleaner and smarter cities with increased focus on waste management.”

1.2 Policy push increasing the focus on smarter and cleaner Indian cities

Recently, Government of India has been taking forward thinking steps for creating smarter and cleaner Indian cities with focus on waste management:

1. Creating Smart Cities with focus on urban waste management

Given the tremendous growth of urban centres in the country, the Government of India is focusing on creating ‘smart cities’ which are highly advanced in terms of overall infrastructure and communications while balancing sustainable management of resources. The Government has announced the creation of 100 Smart Cities over the next couple of decades to offer ‘decent living options to every resident’ in urban and urban dependent areas⁶. To fast-track the Smart City movement in India, a high level Expert Committee meeting was held in December 2014, where the leaders reaffirmed the need for creating smart cities as a hub of economic activity with a focus on **generating wealth from waste** especially emphasizing on waste management and waste-water treatment processes⁷.

2. Powering a movement to create a Clean India

Another landmark movement for promoting waste management in the country has been the **Swachh Bharat Abhiyaan**⁸ launched on October 2, 2014 by the Prime Minister – which focuses on achieving a vision of Clean India by 2019. While the objective of the movement is to create a people powered movement on sanitation, the campaign also addresses the much needed aspects of waste management in the country. One of the key focus areas of the campaign is ensuring 100% collection and scientific processing/disposal and reuse/recycle of municipal solid waste and also strengthening urban local bodies to design, execute and operate systems. The campaign also aims to create enabling environment for private sector participation in capital expenditure and Operation & Maintenance (O&M) costs of waste management systems in the country.

1.3 Understanding Urban Waste

Urban waste (primarily being generated in cities) refers to material that is no longer useful and does not manifest any economic value for the waste generator (individuals, households or commercial establishments). Depending on the physical state of the waste, it can be divided into solid waste and liquid waste⁹ (Figure 2).

Urban waste is primarily of two main types: solid waste and liquid waste

- Solid Urban Waste is further classified into following three kinds of waste streams:
 - **Municipal Solid Waste:** The non-hazardous solid waste that is generated by households, commercial establishments, industries and institutions which as **Municipal Solid Waste (MSW)**. Depending upon the source of origin, municipal solid waste can be **residential waste** (generated from households and domestic areas); **treated biomedical waste** (mainly incineration ash resulting from treatment of waste by hospitals and healthcare establishments); and **commercial waste** (non-hazardous waste generated from industries as well as institutions such as hotels, offices, schools etc.).
 - **Electronic Waste:** The waste that is created by discarded electronic devices and components as well as substances involved in their manufacture or use is known as electronic waste. This type of waste is generated by households as well as commercial establishments and includes discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and

⁶ As per Press Information Bureau, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=114163>

⁷ Ibid.

⁸ <http://pib.nic.in/newsite/PrintRelease.aspx?relid=109592>

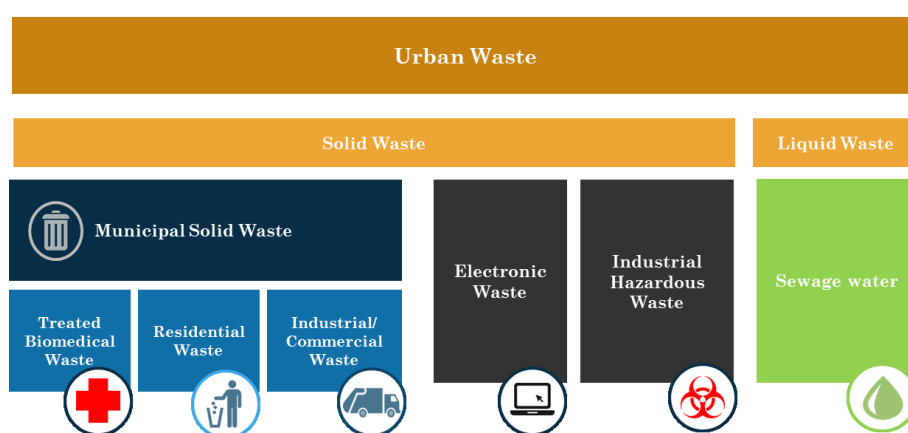
⁹ Sustainable Solid Waste Management in India, Columbia University, 2012

“The Government of India is taking forward thinking steps for creating cleaner and smarter cities with increased focus on waste management.”

refrigerators and other all other electronic equipment meant for reuse, resale, salvage, recycling, or disposal.

- **Hazardous Industrial Waste:** Hazardous waste, generated in industries during various manufacturing and operational processes, could pose adverse effects to human health as well as the environment; and is also considered as urban waste. These hazardous materials includes waste acids, contaminated sludge and chemicals, waste pesticides, motor oil and many other waste products from industries.
- Liquid Urban waste is mainly sewage or wastewater that often contains faeces, urine and laundry waste. Sewage primarily consists mostly of human waste and greywater along with runoff from soaps and detergents.

Figure 2: Classification of Urban waste generated in India



1.4 Focus of this Report: Municipal Solid Waste

This report focuses primarily on **Municipal Solid waste** (which includes residential, commercial and treated biomedical waste¹⁰, as described above). The aim of this report is to provide an overview of the current state of municipal waste management in the country; barriers faced in its effective management; as well as the enormous business opportunity that MSW management presents in a country like India. The report concludes by providing an action agenda reflecting on policy, technology, financing and business models needed to realize the potential of creating value out of waste.

The objective of this report is to estimate the business opportunity and total market for creating Value out of Waste in India, primarily focusing on processing of urban waste to recover energy and materials.

This report is expected to be useful for:

- Policy makers as they are devising programmatic interventions to promote MSW management in the country;
- Businesses which are engaged in or entering the space of MSW management including Solution providers which are devising cost effective and viable technological solutions for MSW management; and
- Catalysts who are monitoring and moderating MSW management conversations within the industry.

¹⁰ Treated biomedical waste includes ash from incineration of any biomedical waste, and waste medicines (which are supposed to be landfilled directly).

Current State of Municipal Waste Management in India



Chapter 2: Current State of Municipal Solid Waste Management in India

This chapter provides an overview of municipal waste management (focusing on value chain, waste composition and waste generated); the current policy framework and prevalent technologies for MSW management in India.

2.1 Understanding Municipal Solid Waste (MSW) Management in India

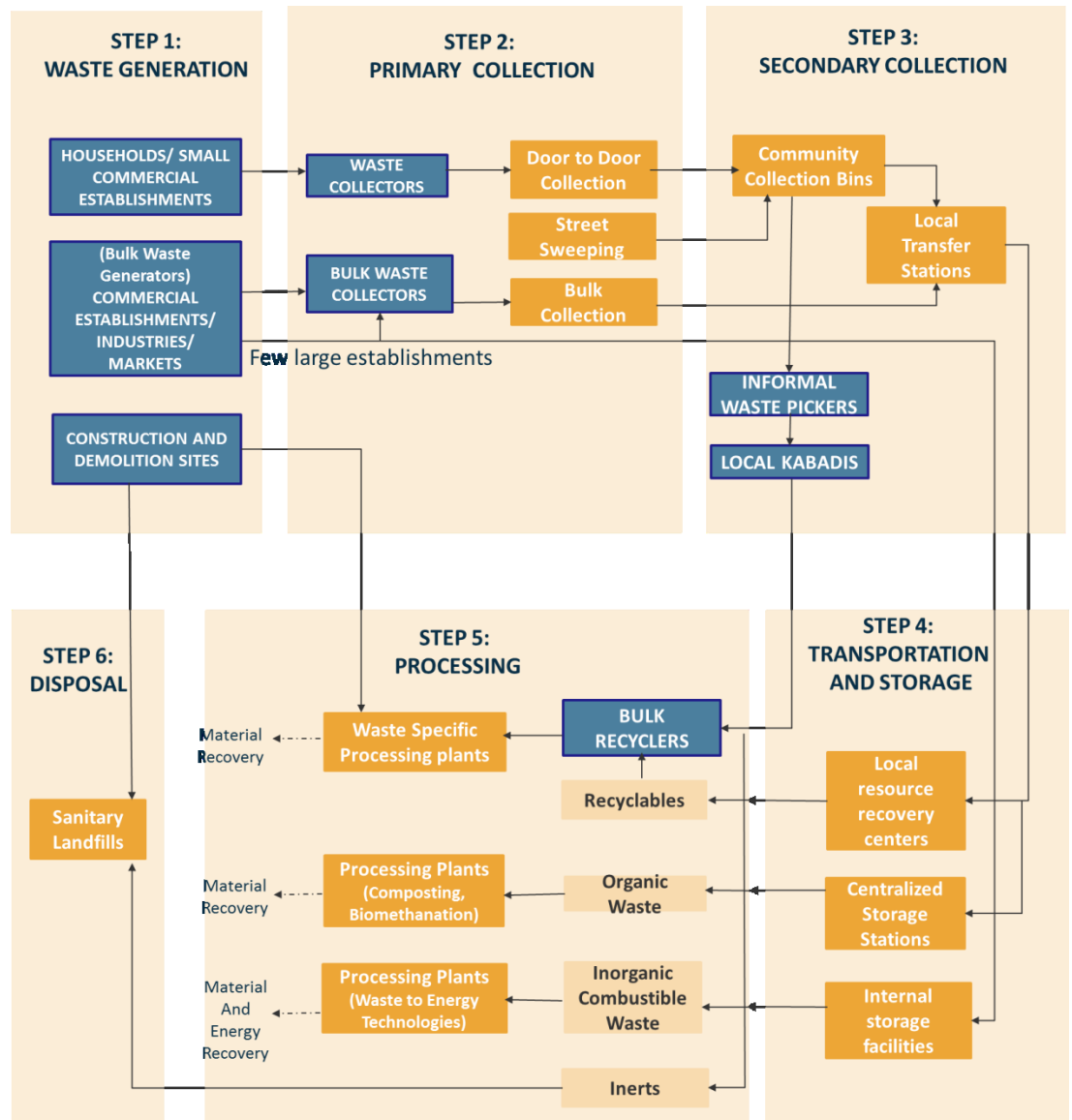
As described in the previous chapter, the non-hazardous solid waste generated by households, commercial establishments and institutions is classified as Municipal Solid Waste (MSW).

2.1.1 Value Chain of MSW Management in India

A typical municipal solid waste management system, as graphically illustrated in Figure 3 below, consists of six main elements: a) Waste segregation at source, b) Primary Collection, c) Secondary Collection, d) Transportation and Storage, e) Waste Processing and f) Disposal.

Figure 3: Value Chain of MSW Management in India

The blue boxes represent the various players across the value chain and the yellow boxes are the components across the value chain.



There are several gaps and shortcomings in the current value chain of MSW management in India as illustrated in Table 1 below.

Table 1: Existing gaps across the MSW value chain in India

Stages of the Value Chain	Residential Waste	Commercial Waste
Segregation	At a household level, waste segregation is usually not done primarily owing to the fact that waste disposal/collection mechanism is common for the various kinds of wastes generated (through door to door collection/ dustbins/common disposal centres).	The smaller commercial establishments are not focusing on waste segregation, however medium to large commercial enterprises typically segregate the waste generated into biodegradable, recyclable and hazardous wastes.
Primary and Secondary Collection	Waste collection is primarily manual with door-to-door collection and the collection efficiency of wastes compared to the overall quantum of waste generated is poor.	Few large commercial establishments have their own facilities for storage, segregation and processing of biodegradable wastes; as well as internal transportation systems.
Transportation and Storage	Transfer stations for residential waste collection are rarely used and usually the same vehicle that collects household waste transports it to the processing or disposal site. Informal waste pickers sort a large quantum of recyclable waste from community bins and transfer stations.	All other establishments continue to rely on the common waste collection, transportation and storage mechanisms (often rendering waste segregation as a pointless activity).
Processing	Some of the reusable materials are manually scavenged by the informal sector however very less amount of the waste generated is processed (owing to the mixed composition of waste).	A few of the larger establishments with adequate infrastructure recover usable materials from the waste and also generate energy.
Disposal	Majority of the waste ends up being untreated and dumped in unsanitary landfills or local dumpsites.	All waste from other sources end up combined with the residential wastes in dumping sites. The waste that is left after manual scavenging mostly ends up in unsanitary landfills.

In order to design a holistic and integrated approach for municipal waste management in India, efforts across the entire value chain are necessary – right from reducing overall waste generation to the amount of waste disposed eventually.

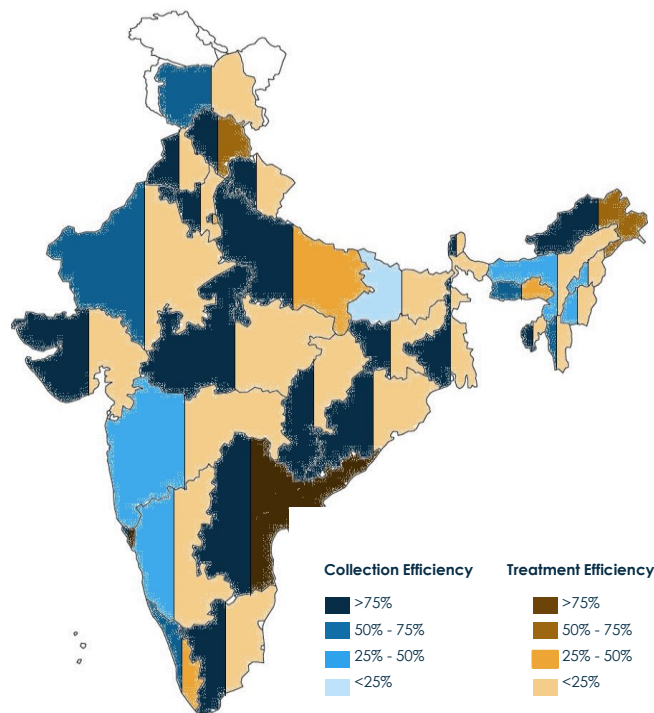
“Almost 80% of total urban municipal waste generated in India was collected in 2013-14, but only 23% of the total urban MSW waste was treated.”

2.1.2 Current State of MSW Generation and Treatment in India

According to the Central Pollution Control Board, urban areas generated 144,165 metric tonnes of municipal solid waste per day in 2013-14. Almost 80% of this waste was collected, which is a significant improvement over 2012 levels when only about 68% of the waste generated in the country was collected. However the level of waste treatment continues to remain dismal with only 23% of the waste being treated as compared to the overall waste generation in 2013-14 – which is a bare improvement from 19% waste treatment done in the previous year.

Figure 4: Trends in municipal solid waste generation, collection and treatment in India (Based on CPCB Data, 2014)

For each state, the collection efficiency (in shades of blue) is represented on the left, and the treatment efficiency (in shades of yellow) is represented on the right - as per legend at the bottom.



As the graphic indicates:

- **The MSW collection efficiency has significantly increased in many Indian states.** 100% MSW collection efficiency is observed in 7 states and 2 union territories¹¹ - this is a significant increase from 2012 when only Maharashtra and Bihar¹² had 100% waste collection efficiency¹³. Six states (namely Andhra Pradesh, Chhattisgarh, Goa, Haryana, Punjab, Tamil Nadu) and 1 Union Territory (Chandigarh) have a relatively higher collection efficiency (of 90% or more) – while most of the other states have moderate collection efficiency. Only four states (namely Kerala, Mizoram, Lakshadweep and Rajasthan) have a low collection efficiency of less than 50% which is a major improvement compared to 2012 when the majority of states had low or dismal collection efficiencies.

¹¹ Andaman & Nicobar, Daman Diu, Gujarat, Jharkhand, Puducherry, Sikkim, Tripura, Uttar Pradesh, Uttarakhand

¹² The collection efficiency of Bihar has not been reported by CPCB for 2014.

¹³ As per Central Pollution Control Board, 2012

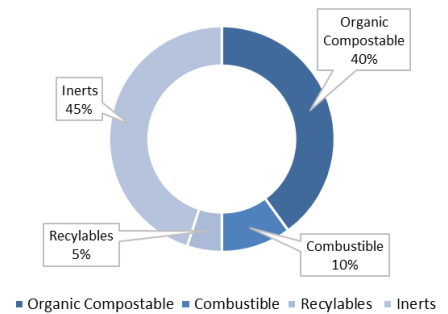
- **The state of MSW treatment efficiency in Indian states is highly concerning.** The treatment efficiency¹⁴ of the waste generated within Indian states is highly concerning given the fact that none of the top waste generating states are currently treating even half the waste generated within the state. While Maharashtra and Uttar Pradesh are responsible for 19% and 13% of overall waste generation in the country, but they end up treating only 18% and 27% of the waste they generate while the rest is directed to landfills. In the seven states with 100% collection efficiency, apart from Uttar Pradesh, all other states have barely any treatment efficiency. In order shape a holistic and successful municipal waste management system, it is important to understand the waste generation trends in various regions and also the reasons for the dismal levels of collection and treatment efficiencies of municipal waste.

2.1.3 Composition of Municipal Solid Waste generated in India

The majority of municipal solid waste generated in India is organic matter (40%) which is compostable in nature, followed by 10% of combustible waste, 5% of recyclable materials and the rest of the material (45%) are inerts (Figure 5).

It is to be noted that this composition of waste is mainly at the dumpsite (and not at the source of the waste generation) – this is because some amount of the recyclable content is removed by the informal sector during the collection, transportation and storage phases prior to dumping of the wastes.

Figure 5: Composition of overall urban municipal waste in India (2012)



Source: Planning Commission

“Majority of municipal solid waste generated in India is organic matter (40%), followed by 10% of combustible waste, 5% of recyclable materials and the rest of the materials (45%) are inerts.”

One key aspect of the **composition of waste generation is the dependence on the level of economic development.** It is observed that there is a negative co-relationship between the level of income of a country and the quantity of biodegradable waste generated. This is demonstrated by the fact that compared to industrialized nations, the municipal waste generated in India has a much higher content of bio-degradable and inert waste.

2.2 Operational Landscape of Municipal Waste Management in India

Since municipalities/Urban Local Bodies (ULBs) have their own capacity constraints, they partner with various institutions for effective municipal solid waste management in the region. The approach for MSW management could be centralized, decentralized or a combination of both – and can be executed either standalone by the urban local bodies or through partnerships with private players and/or communities.

- There are three main approaches for MSW management in India: Centralized (integrated approach), Decentralized Approach or a combination. (refer Table 2)
- There are four main kinds of partnership models involving urban local bodies, private players, and NGOs/Communities (refer Figure 7).

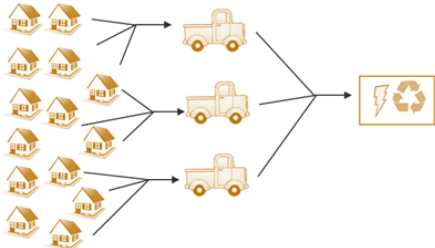
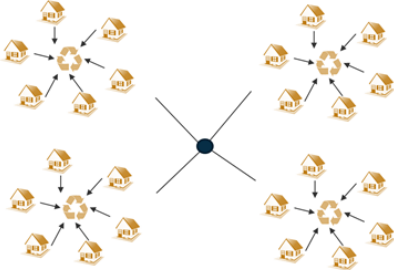
While designing the MSW management system for any city, the urban local bodies can choose to use any approach in combination with any partnership model - dependent on the quantity and quality of waste generated, financial implications and human resource capacity availability.

Approaches for Urban MSW management in India

Depending on the quantum of waste generated in the region as well as the existing capacity at the level of municipality, there are three main approaches for MSW management observed in India: Centralized (integrated approach), Decentralized Approach or a Combination approach.

¹⁴ Treatment efficiency refers to the amount of waste treated/processed compared to the total waste generated in any region.

Table 2: Approaches for MSW management in India

CENTRALIZED (INTEGRATED) APPROACH (Examples: Guwahati, Ahmedabad)	DECENTRALIZED APPROACH (Examples: Chennai, Bangalore)
	
<p>Waste management system primarily meant for handling bulk wastes at a central processing facility.</p> <p>The waste is collected by the implementation agency (ULBs, private entities) and transported to a processing facility where value is derived from the waste.</p>	<p>Waste management system comprises of small waste recovery centres in the locality.</p> <p>The waste is collected door-to-door through the Urban Local Bodies and/or companies for profits/not for profits. The waste recovery centres engage the informal sector for waste collection, segregation and sorting.</p>
SUITABILITY AND CONTEXT	
<p>This type of waste collection is mostly suitable for areas where the organic content of the waste is less and the waste is primarily consisting of inorganic combustible material making it highly suitable for processing in centralized waste to energy plants.</p>	<p>This approach is most suitable for areas where maximum content is organic in nature (which can be composted locally), followed by little quantity of recyclable material (that can be sold to bulk traders for recycling) and very less inorganic material which is then collected by municipalities and landfilled as needed.</p>
ADVANTAGES	
<ul style="list-style-type: none"> ✓ Due to the involvement of only couple of key players in the value chain, there is better coordination. This reduces the need for manual handling of wastes. ✓ The waste can be used for generating energy (as well as compost). ✓ Entire value chain is managed by one or two large entities. ✓ Due to economies of scale, commercially viable state of the art technologies can be deployed. 	<ul style="list-style-type: none"> ✓ This approach promoted segregation of waste at source. ✓ The micro-entrepreneurs owning the waste recovery centers engage the informal sector for waste collection providing livelihood opportunities. ✓ This saves landfilling as well as transportation costs. ✓ This enables effective monitoring of waste processing within the communities.
DISADVANTAGES	
<ul style="list-style-type: none"> X This approach leads to loss of livelihood for the informal sector workers since they are not included in the value chain. X This type of system is not cost effective and involves high capital and operational expenditure. 	<ul style="list-style-type: none"> X The generation of energy is not feasible due to high cost as well as type of waste. X This approach necessitates manual handling of wastes. X There is requirement of local spaces in communities to set up resource recovery centres. X Due to the involvement of a large number of local players, monitoring by the urban local bodies becomes challenging.

Partnership Models for Urban Waste Management in India

Depending on the quantum of waste generated, and the availability of suitable players (Private organizations, NGOs and other Self Help Groups), the various municipalities have adopted different kinds of partnership models (Figure 6).

1. Independently (by Urban Local Bodies)

- This waste management model is observed primarily in smaller cities where the total quantum of waste generation is less and there is adequate capacity within the municipalities to manage the entire waste management value chain.
- Example: Cities like Bokaro and Trichy manage the waste produced on their own. While private contractors might be engaged for street sweeping, but all collection, transportation and disposal is managed by the municipality.

Figure 6: Overview of Partnership Models for MSW Management in India



“Municipalities employ different partnership models for urban waste management based on the quantity of waste generated and the availability of suitable players.”

2. Urban Local Bodies + Private Sector Players

- This model is primarily followed for cities where the quantum of waste generated is high and there is inadequate capacity at the municipality level. For waste processing, there are usually 1-2 waste processing facilities (centralized model). Engagement of private players helps in reducing 50% of the cost that would have been normally borne by municipalities.
- Example: Cities like Hyderabad and Bangalore have partnered with the private sector for waste management.
 - In case of Hyderabad, the municipality engaged 3 private companies primarily for processing of waste. Lately, the municipality has also engaged a private contractor for collecting and transporting all waste.
 - In Bangalore, two kinds of service contracts have been implemented; one for primary waste collection from the door steps and transportation to disposal sites through small contractors and another for integrated treatment and disposal of waste through payment of tipping fees.

3. Urban Local Bodies + NGOs or Self Help Groups

- This kind of model is primarily seen in cities where local communities are proactively interested in managing waste generated in their regions. In these cases, the municipalities either give permissions to NGOs or SHGs or provide financial support to the community based on quantity of waste managed.
- Example: In cities like Pune, the Municipal Corporation works closely with an NGO working with informal sector waste collectors. The NGO helps in door-to-door collection and decentralized waste processing in more than 60% of the city and in the remaining part of the city the municipality itself takes care of waste collection and management.

4. Urban Local Bodies + Private Players + NGOs or Self Help Groups

- This type of partnership model is observed in cities where the quantum of waste generation is high, there is proactive engagement by local NGOs, RWAs and SHGs in waste management, and suitable private players are also existing.
- Example: In Ahmedabad, private contractors are engaged for secondary storage and transportation and also for setting up a waste processing plant (for composting). The door-to-door collection is entirely conducted through RWA associations of sanitation workers and women’s organizations for which the municipality gives a grant for functioning and supervision.

“Collaborative engagement across several stakeholders is key to enabling an effective implementation ecosystem.”

2.3 Current Policy Landscape of Municipal Waste Management in India

Municipal Solid Waste management is primarily a function of the municipal bodies (as per the 12th schedule of the Constitution and the 74th constitutional amendment of 1992). The **Municipal Solid Waste (Management and Handling) Rules 2000** define the regulatory mandate for MSW management as also the latitude available to municipalities for requisite enforcement – however despite close to 15 years of implementation time, the municipalities are nowhere close to optimal enforcement and implementation.

Another significant legislation has been the rollout of the **Plastic Waste Management and Handling) Rules** in 2011, which also place the major onus on municipalities for effective waste management. Although in the recent times, the state governments have been actively imposing fines and conducting raids and surveys to determine the preparedness and effectiveness of the various stakeholders of these Rules, but there is a severe lack of meaningful enforcement of these Rules.

Along with these regulatory mandates, the Government of India has also rolled out two key policies which are expected to provide an Action plan and guidance for improved and effective MSW management in India (Table 3). These policies are used by various State Governments to develop their own municipal waste management plans in keeping with the overall vision. In addition, these also enable strengthening the infrastructural support required by municipalities for the operational aspects of waste management.

Some Actions in 2014

- The directorate of municipal administration (DMA) in Goa provided MSW management equipment worth INR 3.5 crore to 13 municipalities.
- Nashik Municipal Corporation (health department) collected a total of INR 3.14 lakh as fine from the garbage van contractors for flouting Rules.
- Pimpri Chinchwad Municipal Corporation (Pune) was served legal notice for non-enforcement of MSW Rules.
- Tripura Municipal Corporation banned plastic bags.

Table 3: Snapshot of Central Policies for promoting MSW Management in India

BENCHMARKING POLICIES/GUIDELINES	
National Environment Policy, 2006	The MSW Action Plan involves a) Developing viable PPP models for setting up and operating secure landfills, incinerators, and other waste processing technologies; b) Strengthening the capacities of local bodies for segregation, recycling, and reuse of municipal solid wastes; c) Strengthening the informal sector systems of collection and recycling of various materials; d) Promoting biodegradable and recyclable substitutes for non-biodegradable materials.
National Urban Sanitation Policy, 2011	The Policy instructs states to come up with their own detailed state-level urban sanitation strategies and City Sanitation Plans. While the primary focus is on management of human excreta and associated public health and environmental impacts, it is recognized that integral solutions need to take account of other elements of environmental sanitation (i.e. solid waste management).

2.3.1 Role of different Stakeholders and Current State of Implementation

Collaborative engagement across several stakeholders is key to enabling an effective implementation ecosystem. While the Ministry of Urban Development formulated the National Urban Sanitation Policy, prepares guidelines and benchmarks as well as financial support, the Ministry of Environment, Forest and Climate Change formulated the National Environment Policy and is responsible for the rollout and enforcement of the MSW and Plastic Waste Management Rules.

The State Boards are mandated for ensuring the compliance of standards by the municipalities and the Central Pollution Control Board (CPCB) is responsible for coordinating with the State Boards to ensure implementation, reviewing standards and compiling data. The Urban Local Bodies/municipalities are mandated and reviewed by the State Boards for effective implementation of the Rules and can undertake MSW management independently or in public private partnership mode. Multilateral

agencies can provide funding to State Governments as well as Urban Local Bodies/Municipalities for capacity building and waste management. Figure 8 below presents an overview of the roles of various stakeholders.

Figure 7: Role of stakeholders as per MSW and Plastic Waste Management Rules

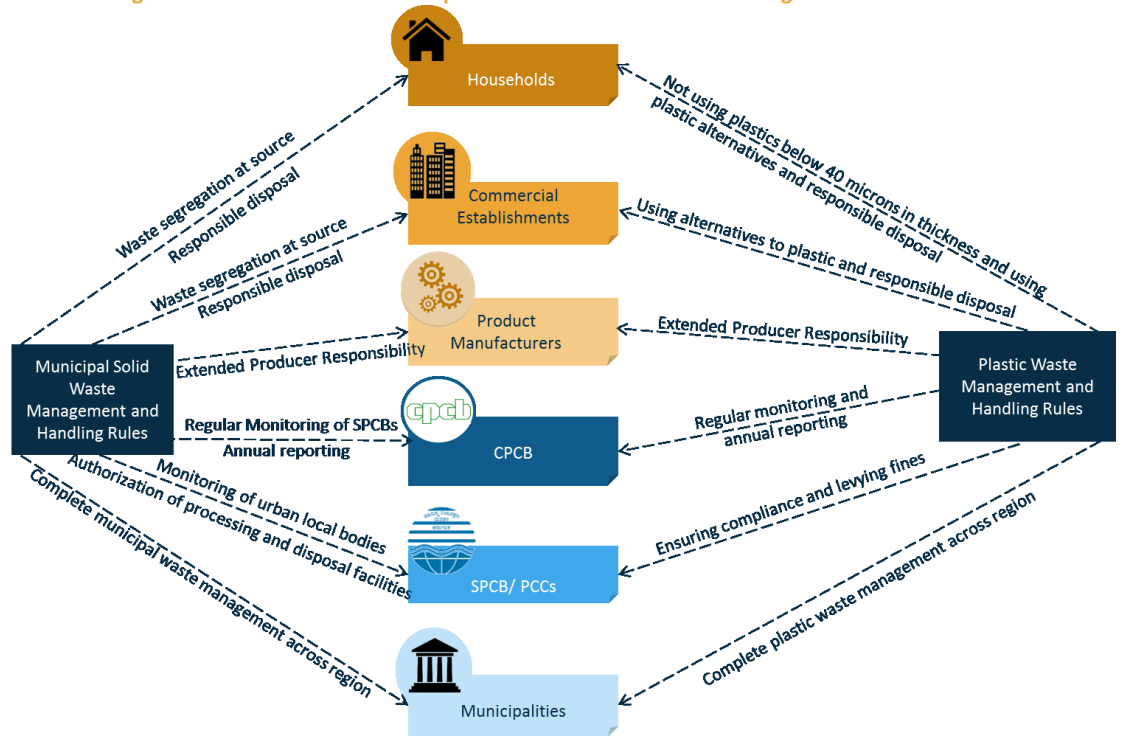


Table 4: Current state of implementation for municipal waste management policies in India¹⁵

Stakeholders		Municipal Solid Waste (Management and Handling) Rules 2000	The Plastic Waste (Management and Handling) Rules, 2011
Households	Very Low	The segregation of waste at generation source continues to be low.	Very Low Households continue to use plastic waste of less than 40 microns and separate waste disposal. Most of the medium and small establishments continue to provide plastic of less than 40 microns to consumers.
Commercial establishments	Med	Many large establishments focus on waste segregation within their facilities.	
Product Manufacturers	Very Low	Companies generating products resulting in Special Wastes (like diapers and sanitary napkins) are not adhering to Extended Producer Responsibility.	Low Manufacturers continue to generate plastic bags which do not adhere to the specifications under the Rules.
State Government	Med	78% of the total 5034 towns reported in the country have constituted urban local bodies which are responsible for waste management in the region.	
Central Pollution Control Board	Med	CPCB ensures annual reporting of implementation from states and union territories – but not able to enforce complete reporting from all.	Low CPCB ensures annual reporting of implementation from stated and union territories but overall reporting levels are poor.
	High	It has been providing annual reports on the overall level of implementation of municipal waste management in the country (last report in Dec 2014).	Med There is no annual report available for the implementation period 2013-14.
State Pollution Control Boards/ Pollution Control Committees	Low	Only 50% (15 out of 29) states have informed about the authorization status of urban local bodies in their regions.	Low Only 58% of the SPCB/PCCs provided the requisite information about the level of implementation in their region.
	Med	70% of the authorization applications by ULBs for setting up processing and disposal facilities were approved in 2013-14	Very Low 45% of the states reported incomplete information about the level of implementation or Rules.
	Very Low	Only 30% of the SPCBs are reported on the monitoring of landfills/waste processing sites in 2014).	Very Low Regulations on stocking, distribution, use and sale of plastic carry bag or sachets or pouches are not being enforced adequately.
	Very Low	Regular committee meetings are not reported to track and discuss progress.	
Urban Local Bodies/Municipalities	Med	Only 70% of the urban local bodies submitted their status of implementation in 2014.	Med The management of plastic waste (excluding use of plastic carry bag or sachets or pouches) is being implemented by many Municipal Authorities.
	Low	Many are undertaking efforts for creating citizen awareness for proper management of waste – but these are restricted to few localities are not done at a city/town level.	Very Low Only some of the municipalities are actively levying fines on garbage collectors and commercial establishments for non-compliance.
	Very Low	Disposal of waste is still continues through open dumping in almost all the states.	Very Low None of the urban local bodies are able to effectively enforce the ban on plastic usage for households.
	Low	Out of 2781 ULBs, authorization applications for setting up waste processing and disposal facilities were received only from 10% of the ULBs during the year 2013-14.	Very Low Clarifications on the Rules are not provided to states leading to overall poor rate of reporting (like definition of “Conventional Plastic” and Compostable Plastic or Material is not provided, also no logo or mark given in the Rules for compostable material/film).
	Low	In many States, several towns have reported setting up of partial composting/ vermi-composting facilities (535 facilities in 375 ULBs) – however much more action is required.	

¹⁵ Table 4 captures the current state of implementation for both these Rules based on the Annual Reports of Central Pollution Control Board. For Municipal Solid Waste Management, the data of implementation is for the reporting period 2013-14 based on the report released by CPCB in January 2015. The official data for Plastic Waste management for this reporting period has not been released yet by CPCB and hence the current state has been evaluated based on the official data of the reporting period 2012-13.

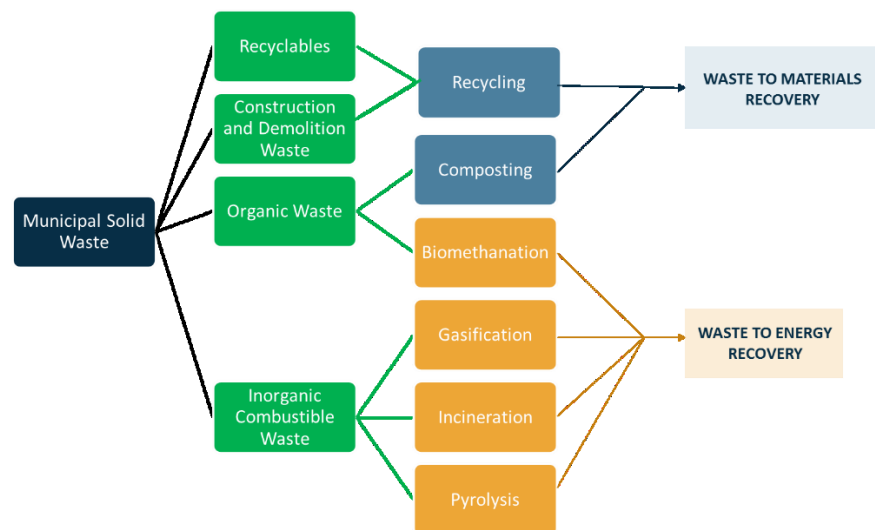
2.4 Creating Value Out of Waste: Current Technology Landscape of Municipal Waste Management in India

For the appropriate treatment and disposal of municipal waste, the judicious selection and use of technology is required. Given the composition of the waste generated in urban centres, there exists significant opportunity for extracting value out of waste before final disposal. However, very limited value is currently extracted due to multiple barriers.

There are multiple technologies available for extracting value out of waste depending upon the composition of waste (Figure 9). For some wastes (like recyclables, and construction and demolition waste) it is possible to recover useful materials, while for other wastes (like inorganic combustible waste) it is possible to recover energy; and organic waste can be used to recover both materials as well as energy based on the technology used). The subsequent sections of the chapter elaborate on the various technologies for extracting value out of waste, either as materials or energy.

Figure 8: Technology snapshot of Creating Value Out of Waste

The green boxes represent the type of waste. The blue boxes represent technologies for recovering materials from waste and the yellow boxes represent technologies for recovering energy from waste.



2.4.1 Material Recovery (Waste to Materials)

A large quantity of municipal solid waste that is generated in the urban centres of India comprises of ‘recyclables’ such as plastic, metal, glass etc. which have a potential to be reused and recycled. Another major proportion of the municipal solid waste is primarily organic and highly ‘compostable’ inorganic waste. Adequate and systematic material recovery from MSW helps in generating true value out of materials which are typically incorrectly disposed off as wastes and dumped at landfill sites.

2.4.1.1 Recycling

Studies have shown that 95% of the environmental impact during the life cycle of a product is during its manufacturing phases when raw materials are extracted. Waste recycling helps in lowering the need for further extraction of raw materials and is also useful for ensuring less quantum of waste being sent to landfill sites. However, **waste recycling is highly dependent on waste segregation** (either during or after collection from source) to ensure the availability of the right type and quality of waste.

At the household level, currently waste segregation to extract recyclable materials occurs at two stages: during collection where newspaper and plastic bottle waste is often discarded separately (sold to kabadiwallas) and at the landfill sites where rag pickers undertake manual scavenging to collect recoverable materials.

The disposal at the commercial level also undertakes a similar route, where waste is sold to bulk waste collector who then further sells the waste to recyclers (depending on the type of waste). Waste

“Adequate and systematic material recovery from MSW helps in generating true value out of materials which are typically incorrectly disposed off as wastes and dumped at landfill sites”

segregation at source is more prevalent in large commercial establishments which also have internal facilities for material recovery - however, such positive actions are hugely dependent on the quantum of waste generated by the commercial establishments.

CASE STUDY 1:
RECYCLING TETRAPAK CARTONS FOR CREATING PAPER BASED PRODUCTS (by Daman Ganga Board Mills)

Type of Waste recycled: Tetrapak cartons (packaging material for storing perishable items)

Timeline of initiative: Ongoing

Key Players/Stakeholders: This is a partnership in Gujarat between Amul (Indian food and dairy major), Tetra Pak (Company generating Tetra Pak packaging material), SEWA (an NGO engaged in women welfare activities) and Daman Ganga Board Mills (a paper mill involved in production of paper products)

About the Initiative: Previously, all post-consumer use Tetra Pak cartons were sent to dumping sites along with other non-recyclable materials. However, under this current partnership, marginalized women workers (from SEWA) are currently engaged in collection, sorting and primary processing of consumed and discarded Tetra Pak cartons from about 42 Amul dairy parlours. The collected waste is segregated, washed and bundled before being sent to the Daman Ganga paper mill for recycling. The processed material yields paper pulp (about 75%) and balance of aluminum + plastic aggregate (25%).

Daman Ganga Mills uses the waste material to manufacture

- a) Indoor use furniture and material such as roofing sheets for the construction industry: Shredded Tetrapak and plastic material are dried and cleaned and spread between two polythene sheets and laid on a hot press bed. Once the sheets emerge from the press, they are given a wave-form shape and left to dry. These Tuff Roof sheets are waterproof, rustproof, and absorb much less heat – and are better than conventional fibrocement and corrugated G.I. sheets.
- b) Recycled Tissue Paper: The tissue paper created uses only 1/3rd of the electrical energy and very low water resources compared to virgin tissue. The grade is truly “Natural” as it is not bleached and also no dyes or chemicals are used during production.



Image(s) Courtesy:^{16,17}

Challenges: While this model has been successfully implemented in Gujarat, the key challenge mainly lies in the scaling up this model nationwide –the success of the model is hugely dependent on finding the right partners, recyclers with appropriate technologies and high level of consumer awareness (to ensure segregation at source).

Market Potential: In 2013, 36,000 tonnes of Tetrapak cartons were sold in India¹⁸. This presents a high market potential for recycling to recover materials which would otherwise be lost to landfills. The Tetrapak recycling model has now also been replicated in Mumbai through partnership with an authorized recycler. About 4,000 tonnes of cartons were sold in Bangalore alone and about 10% of these cartons were recycled by an NGO (Saahas).

¹⁶ <http://www.caleidoscope.in/wp-content/uploads/2013/04/Daman-Ganga-Furniture.jpg>

¹⁷ <http://www.damanganga.com/Products/tissue.jpg>

¹⁸ <http://nutrition-quotient.com/blog/2014/12/recycling-tetra-pak-cartons-a-resource-from-waste/>

CASE STUDY 2: RECYCLING CONSTRUCTION AND DEMOLITION WASTES

Type of Waste recycled: Construction and Demolition (C&D) Waste

Timeline of initiative: Started in June 2009, currently on going.

Key Players/Stakeholders: This is a partnership between IL&FS Environmental Infrastructure and Services Ltd (IEISL) and North Delhi Municipal Corporation (NDMC)

About the Initiative: This pilot project has been developed by IEISL in collaboration with NDMC to demonstrate the potential of scientifically managing C&D waste at Burari (Jahangirpuri), Delhi. IEISL collects 500 TPD (tons per day) of C&D waste from three (3) different zones of Delhi. The C&D waste is thereafter recycled into aggregates, concrete aggregates and silt. Concrete aggregates are further converted into value added products like Ready Mix Concrete (RMC), precast products (pavement blocks, kerb stones, bricks, concrete blocks). The remaining Brick Dust and Granular Sub-base can also be used as building material etc. These products are then sold in the market. The major objective of this project is to separate C&D waste from MSW stream and to reuse and recycle the C&D waste into useful building material. With separation of C&D waste from MSW, processing of both streams of waste becomes easy and it also reduces the stress on present disposal sites and increases the life of existing landfills.



Pavement Blocks



Kerb Stones

Image(s) Courtesy¹⁹

Challenges: There are a few risks and challenges associated with this waste recycling project such as:

- Illegal dumping of the C&D waste in unauthorized sites
- Lack of awareness in the consumer community (especially bulk generators and large construction companies) to utilize recycled construction material
- Taxing of products made from recycled material which adversely impacts the viability of this nascent recycling industry. Ready Mix Concrete (RMC), the major product, attracts VAT of 12.5% and excise of 6.18%. All concrete bricks and reinforced slabs attract VAT of 12.5% and excise of 12.36%. Tiles and kerb stones attract an excise of 12.36%.
- Lack of BIS Codes for recycled C&D which acts as an impediment in selling products to Government Agency

Business Model: IEISL has set up the project on Develop, Build, Operate and Transfer (DBOT) basis in Burari (Delhi)

Market Potential: IEISL has processed more than 1.4 million tons of C&D waste till date at the Burari facility. This translates to saving of land foot print of over 72,000 square meters even after assuming 10 meter tall heap of garbage and specific gravity of the C&D waste to be 1.65. The city of Delhi itself generates about 3000 Tons per Day (TPD) of C&D waste and thus there is a huge market opportunity for more such waste recycling facilities.

¹⁹ IL&FS Environmental Infrastructure and Services Ltd (IEISL)

CASE STUDY 3: RECYCLING PET WASTE INTO FIBRE AND YARN (By Ganesha Ecosphere)

Type of Waste recycled: Polyethylene terephthalate (PET) Waste

Timeline of initiative: The business has been operational since 1994, and is the largest PET recycler in the country.

About the Initiative: PET is used as a preferred packaging medium within large consumer product companies and has a high collection rate post use (of close to 75%). Ganesha Ecosphere Ltd. (GESL) processes PET waste into recycled polyester staple fibre and yarn. The business is headquartered in Kanpur and has manufacturing facilities in Kanpur and Rudrapur with a cumulative production capacity of 66,600 TPA (for recycled polyester staple fibre) and with a production capacity of 3,000 TPA (for dyed yarn). The company has also initiated the production of 7,200 TPA of spun yarn annually from recycled polyester staple fibre (RPSF) at Temra, Bilaspur.



Image(s) courtesy : Polyester Staple Fibre^{20,21}

Operating Model: The company works through a network of 25 raw material collection centres across India employing thousands of rag-pickers. The rag-pickers provide the PET waste to traders (at INR 20-22 per kg) which is then sorted and cleaned. This material is then shipped to the company's manufacturing facilities and purchased at a cost of INR 35 per kg. (For any raw material shortfall, the company also has an import license. Although the transportation of raw materials ends up adding cost but the company has not set up more processing units. This is because a processing unit using this technology is commercially viable only manufacturing capacity of 18,000 tonnes annually (which necessitates assured waste availability). The company products are thereafter sold to diverse industries like fibre mill, spinning, automobiles, geo-textiles, medical, packaging, paper, textiles and various other non-woven sectors. In August 2014, Ganesha also started working with Hindustan Coca Cola Beverages to rollout India's first bottle-to-fibre textile recycling operation²².

Impact: The company recycles more than 2.42 billion PET bottles annually, saving 0.3 million cubic yards of land filling space, 87 million pounds of crude oil and 65 million kg of carbon emission. Over the last five years, the company has recycled more than 10 billion kg of PET bottles into polyester staple fibre with 33-53% lower energy use than virgin fibre, coupled with lower carbon emission by around 55% compared with virgin polyester fibres. The company is engaged in recycling more than eight million bottles a day²³.

Challenges:

- a) A key challenge is the quality and quantity of waste collection. Initially the collected waste comprised of more PBC plastic than PET which was difficult to sort, however this problem was solved by washing and heating the mixed plastic waste wherein the PBC turns yellow and becomes easier to separate. The collection of waste continues to remain the biggest challenge.
- b) The transportation of waste entails additional cost for the company, however setting up more manufacturing facilities is not viable due to the high capex and annual recycling capacity required to be profitable.
- c) Awareness amongst buyers is another additional challenge although over the past decade, most of the textile spinning mills and also other sectors have become increasingly aware of the advantages of using recycled plastic fibre.

Market Potential: In India, PET demand is increasing every year and is expected to reach 1.3 million tonnes by 2016 while recycling capacity is presently estimated at around 0.4 million tonnes annually, creating an attractive business opportunity.

²⁰ http://i01.i.aliimg.com/img/pb/783/570/109/109570783_524.jpg

²¹ http://www.ganeshaecosphere.com/regenerated_polyester_staple_fiber.html

²² http://www.fibre2fashion.com/news/apparel-news/newsdetails.aspx?news_id=166591

²³ <http://www.indiantextilemagazine.in/technology/ganesha-ecospheres/>

“Given that the waste generated in urban centres in India is very rich in organic matter, composting becomes an extremely useful process for extracting value out of waste materials.”

2.4.1.2 Composting

Composting is an aerobic process in which biologically degradable waste is converted through solid state biochemical transformation to yield stable granular material - which could be used as soil conditioners and nutrients²⁴. Given that the waste generated in urban centres in India is very rich in organic matter, composting becomes an extremely useful process for extracting value out of waste materials.

There are different kinds of composting technologies depending on the quantum of waste – while in smaller quantities the waste can be heaped and buried in soil, there are also mechanized processing options now available for larger quantities of waste. Vermicomposting is a type of composting in which earthworms are used after initial pre-processing of waste. The output generated is organic compost which is highly nutrient rich and can be used for agriculture as well as in farm land, parks and gardens for improving soil health, moisture retaining capacity, returns nutrients to soil and is generally called as bio organic fertilizer or soil enricher²⁵.

However aerobic digestion/composting is highly dependent on the type of waste material being processed. The waste should be free of impurities, plastics and other chemicals otherwise the final compost created could lead to heavy metal leaching in the soil – which makes it highly unfit for agricultural use.

Composting is increasingly being taken up by forward thinking business (especially hotels and IT companies) as well as residential areas to process their organic waste being generated (Case Study 4). In fact, there are companies like Daily Dump which have turned composting into a business (Case Study 5).

CASE STUDY 4: COMPOSTING TO TREAT INTERNAL WASTE

Type of Waste recycled: Organic Waste

1. The Orchid Hotel, Mumbai

The hotel ensures the segregation of waste in all kitchens using four separate colour coded bins (dry, wet, recyclable and other waste). A two bin segregation system is used not only in the hotel's common areas but also in guestrooms. The food waste or wet waste is decomposed in the hotels premises through vermiculture. The rich and fertile vermicompost serves as an excellent fertilizer for the hotel gardens and is also distributed to guests and employees.

Impact: Through the vermiculture system, the hotel has generated 360,000 Kilograms of vermicompost from approx. 4,000,000 kilograms of food waste so far.

2. Mantri Tranquil Apartments in Kanakpura road, Bangalore

²⁶Out of the 710 residents in the apartment, close to 60% are undertaking waste segregation. The waste is separated by the residents into five different categories and the wet waste is treated through the organic compost unit. The generated compost is collected and sold by the NGO Saahas and the monthly operational cost of the compost unit (INR 20,000-24,000) is covered through the same.

Impact: The organic compost unit generates close to 3,000 kgs. of compost every month which is used in the apartment gardens and also sold locally.

²⁴ Report of the Task Force on Waste to Energy (Volume I), Planning Commission, 2014

²⁵ Ibid.

²⁶ <http://bangalore.citizenmatters.in/articles/print/3602--mantri-tranquil-adarsh-residency-innisfree-get-first-recyclathon-awards>

CASE STUDY 5:
MAKING BLACK GOLD: TURNING COMPOSTING INTO A BUSINESS OPPORTUNITY
(By Daily Dump)

Type of Waste recycled: Organic Waste

Timeline of initiative: Has been operational since 2007

About the Initiative: The Daily Dump provides simple products to compost organic waste at home. The company manufactures and sells home level and community composters across India and is meant to enable households to treat the 50-60% of organic waste that is generated daily. They have several products like a “Leave It Pot” system for smaller communities to produce rich compost in 2 – 3 months. For larger communities (40-200 families), the company offers “Manthan 300 System” wherein the waste is managed by housekeeping staff and involves an initial investment of INR 3,500 per family.

Recently, Daily Dump has developed “Agha” systems with waste capacity of 550 L which requires no external power supply or use of tools since an innovative breathing tower ensure aeration through the entire waste. The company has more than 35 of such systems in place in various communities. Though it has a relatively higher cost of INR 30,000 per unit (and requires installation of 2 units at the same time), the lifetime of the product is 10 years.

Along with composting products, the company also developed a 100% organic, natural, and non-toxic alternative to cleaning products for households, and Trash Trail which is a day tour travelling with the waste including visiting a landfill and meeting people to – aiming to sensitize people for waste management.



Image(s) Courtesy²⁷

Impact: Daily Dump currently has over 15,000 customers who keep approximately 14 tonnes of wet waste away from the landfills daily. Since being set up, the business has expanded to 23 new stores in Bangalore and 17 stores across major Indian cities. The business closely works with two sets of potters for production (one from Andhra Pradesh and the other from Rajasthan) generating rural livelihood.

Challenges:

- a) The primary challenge faced by the company has been lack of awareness and general mindset of Indian households. Waste is not viewed as a resource and handling waste at home is considered unhygienic. Also people are not willing to shoulder the responsibility of treating their own waste and expected the government and municipalities to manage the same.
- b) Another equally important challenge faced was the lack of a market for compost as well as products created out of waste. Although this has been gradually changing, there is a lot of awareness and marketing required to push such products.
- c) The business case of composting at a household level remains tough to explain (especially for products like Agha) where there is no guaranteed payback period or estimation of compost generated – since it is highly dependent on waste quality and quantity.











Market Potential: Given the high quantity of organic wastes generated at a household level (and also in commercial establishments like hotels), composting as a business opportunity has a high market potential. However given the above mentioned challenges, there is effort required from the government for sensitization of the general public to enable the take off for such businesses and recycled products.

²⁷ Daily Dump

2.4.2 Energy Recovery (Waste to Energy)

Waste to Energy is an important municipal waste treatment and utilization option wherein the waste is treated using biochemical or thermo-chemical technologies to produce energy.

Table 5: Waste to Energy Technology Matrix

	Bio-methanation	Incineration	Gasification	Pyrolysis	Plasma Arc Gasification
About the waste to energy technology	Anaerobic slurry-phase process that can be used to recover both nutrients and energy contained in biodegradable waste	Involves complete combustion of waste with the recovery of heat to produce steam that in turn produces power through steam turbines.	Converts dry organic or fossil based carbonaceous materials into CO, H ₂ and CO ₂ at elevated temp (500-1800oC).	Using heat to break down combustible polymeric materials in the absence of oxygen, producing a mixture of combustible gases	Converts organic matter into synthetic gas and solid waste (slag) through plasma torch powered by electric arc.
Type of technology	Biochemical	Thermo-chemical	Thermo-chemical	Thermo-chemical	Thermo-chemical
Waste Composition	Moisture > 50% Organic/Volatile Matter > 40% C/N ratio 25-30	Moisture < 45% Organic/VM > 40% Fixed Carbon < 15% Total inert < 35% Calorific Value (Net) > 1200 Kcal/Kg			
Desirable properties of waste to ensure optimal performance	Very high moisture content very high organic content, highly segregated waste	Very Low moisture content	Homogenous waste of high calorific value	High calorific value and very low moisture content	No organic waste
Recoveries post processing	  Biogas Compost	  Steam Energy	  Syngas Hydrogen	  Bio-oil Charcoal	  Elemental Slag Gas
Capital Cost	Medium	High	Medium-High	Medium-High	Extremely High
Maturity of technology	Proven technology but existing processing plants are facing performance issues due to quality of input waste.	Mature technology but pilots have shown unsuitability in Indian context due to high moisture content in waste	Emerging technology and yet to be successfully demonstrated for large scale applications. Many pilot plants have been set up in various regions but financial and technological viability is yet to be proven for Indian conditions.	Nascent technology which is in R&D phases worldwide; one pilot plant is expected to be set up in India soon.	
Advantages	<ul style="list-style-type: none"> ✓ Does not create bad odour or rodent menace ✓ Does not cause visible pollution avoiding social resistance. ✓ Has a potential for co-disposal with other organic waste streams from industry and agriculture. 	<ul style="list-style-type: none"> ✓ Can reduce 90% of waste volume ✓ Noiseless ✓ Odorless ✓ Less requirement of land ✓ Can be located within city limits reducing the need for transportation 	<ul style="list-style-type: none"> ✓ Leads to production of fuel gas/ fuel oil which can replace fossil fuels. ✓ SO_x and NO_x emissions are not caused during regular operations ✓ Toxic materials get captures in vitreous mass (which is safer to handle than incinerator ash) 		
Disadvantages	<ul style="list-style-type: none"> ✓ Requires highly segregated waste ✓ Less heat is produced during digestion causing less effective destruction of pathogens 	<ul style="list-style-type: none"> ✓ Plant performance is compromised with waste high in moisture content ✓ High capex and opex costs ✓ Can result in Sox and NOx emissions 	<ul style="list-style-type: none"> ✓ High capex and opex costs ✓ Plant performance is compromised with waste high in moisture content ✓ Pyrolysis oil generated has high viscosity causing challenges in transportation. 		

CASE STUDY 6:
OKHLA WASTE TO ENERGY PLANT (By JTF Urban Infrastructure Ltd)

Type of Waste recycled: Municipal Solid Waste(MSW)

Timeline of initiative: Plant operational since Jan'2012

About the Initiative: A Municipal Solid Waste(MSW) processing plant with 1,950 TPD treatment capacity has been set up in which thermal conversion of waste produces derived fuel which is further used to generate electrical energy (Renewable power). The plant has a power generation capacity of 16 MW. Apart from power, recyclables like Iron / plastics etc. are also generated but they are of negligible value. Power generated from the plant is sold to the local distribution company at approximately Rs 2.6 per unit. The project has CDM registration with United Nations Framework Convention on Climate Change (UNFCCC) for earning carbon credits.



Image(s) Courtesy²⁸

Business Model: Plant set up on Build, Own, Operate and Transfer (BOOT) basis by Timarpur Okhla Waste Management Company Pvt. Ltd. (100% subsidiary of JTF Urban Infrastructure Ltd.) in partnership with North Delhi Municipal Corporation (NDMC) where the land was transferred on lease by the Government of Delhi.

Challenges: Quite a few challenges are plaguing this waste to energy project -

- Protests from nearby residents regarding pollution emanating from plant operations
- Receiving Mixed waste including huge amount of Construction & Demolition Debris(C&D)/ street sweeping dust/ drain silt etc. as against segregated waste from NDMC
- Bureaucratic hurdles in getting project clearances/ support from various Government departments
- Grant of Rs. 10 cr. approved by the Ministry of New and Renewable Energy (MNRE) is yet to be received.

²⁸ Timarpur Okhla Waste Management Company

CASE STUDY 7:

Mahindra World City Chennai- City Level Municipal Waste Management Program

Type of Waste recycled: Municipal Solid Waste (MSW)

Timeline of initiative: Mahindra World City, Chennai was officially inaugurated in September 2002

About the Initiative: Mahindra World City- Chennai extends across 1550 acres and houses more than 60 corporates along with residential facilities, schools, hospitals and hotels. MWC Chennai has an onsite Solid Waste Disposal plan which includes collection & transportation, segregation, composting process and landfilling for managing up to 16 tons per day capacity in order to segregate and dispose the township waste effectively.

- **Segregation:** The waste is segregated manually into degradable waste & non-biodegradable waste. Non-bio degradable waste is further segregated into recyclable plastics, paper cups, glass, cotton and inert materials.
- **Collection:** Waste is collected from companies as per the pre-approved collection schedule depending on the rate of waste generation.
- **Treatment:** The project processes both organic and inorganic waste.
 - Organic waste is converted to compost through the Mechanical Compost Facility present at the site. The process used is bio-degradation after which the digested garbage goes through further mechanical operations like separation, sieving, grading, and clarification using semi-fermented manure, gravity separators and cyclone separators.
 - Inorganic waste is segregated to recover recyclable material to be sold, while rejects are transported to the landfill site located within the SWM facility itself.
 - Non-recyclable wastes are sent to vendors for processing and manufacturing diesel.
 - Other waste generated at the sites such as paint containers etc. are sent back to the manufacturers for recycling. Leftover spent oil is reused as shuttering oil at site locations.



Image(s) Courtesy²⁹

Business Model: MWC Chennai was built under a PPP model with Tamil Nadu Industrial Development Corporation (TIDCO) in a 89:11 partnership. The various companies pay the MWC management overhead and maintenance fees for certain services which include waste management, supply of water, maintenance of infrastructure, etc. MWC in turn, sells recyclable products like bottles, milk packets, cold drink cans, card board, paper cups, plastics, etc. to authorized recyclers to offset waste management costs. The organic compost produced is used for landscaping in the public areas of Mahindra World City and also sold to contractors for housekeeping and gardening services within the various industrial units inside the MWC.

Challenges:

- The bio-digestion process takes a long time (40-45 days) for a single batch.
- In the bio-degradation process, there is liquid seepage which needs to be collected and recycled again.
- The nuisance of flies and odour has to be dealt with by using safe chemicals.
- During collection, the waste needs to be unloaded on concrete platforms to prevent the ground water contamination

²⁹ Mahindra World City, Chennai

Barriers for Municipal Waste Management in India



Image courtesy: Wolfgang Sterneck's Flickr stream

Chapter 3: Barriers for Municipal Solid Waste Management in India

Given the complex value chain, multiplicity of stakeholders, policy gaps and limited enforcement, there are a number of barriers in ensuring efficient and effective municipal solid waste management in India.

Table 6: Barriers for municipal waste management in India and their impact at various stages of the value chain

Impact of Barrier on state of MSW management in India	TYPE OF BARRIER	Impact of Barrier on Various Stages of MSW Value Chain				
		Segregation at Source	Collection	Transportation and Storage	Processing	Disposal
	POLICY AND REGULATORY BARRIERS					
High	There is a lack of consistency in state policies and guidelines for MSW management in terms of mechanisms for waste collection and processing.	✓	✓	✓	✓	✓
High	The role of informal sector: waste pickers, informal recyclers are not integrated within the regulatory frameworks, despite being identified as a key focus area within the National Environment Policy.	✓	✓	✓	✓	✓
High	There is lack of clarity on goals and targets for waste collection and processing for various stakeholders.	✓	✓	✓	✓	✓
Medium	The role of municipalities in regulating the type of waste collection is ambiguous.	✓	✓	✓	✓	✓
Low	Policy regarding decentralized/local waste management practices (like composting) is ambiguous.				✓	
	TECHNOLOGICAL BARRIERS					
High	There is lack of waste segregation at source leading to unavailability of suitable waste required for ensuring optimal technological output.				✓	
High	There is limited awareness in the urban local bodies about suitability of different waste processing and disposal technologies based on the type and quantum of waste.		✓		✓	✓
Medium	There are currently no official performance guaranteed reports available for various waste processing technologies to support decision making at the municipality level.				✓	✓
High	Suitable land for developing sanitary landfilling facilities is not available and selected land often faces resistance from local population.					✓
High	Lack of designated collection mechanisms for inert wastes from construction and demolition sites leading to waste mixing and high cost of processing.				✓	
	FINANCING BARRIERS					
High	There is lack of funds with urban local bodies for adequate waste management.	✓	✓	✓	✓	✓
High	There is lack of standardized documented information about the financial viability of processing technologies.				✓	
High	There is no clear framework established for Public-Private Partnership (PPP) models across the waste value chain	✓	✓	✓	✓	✓
Medium	There is a limited market for sale of compost and RDF (products from waste processing), often affecting the financial viability of the waste treatment effort under question.				✓	✓

Impact of Barrier on state of MSW management in India	TYPE OF BARRIER	Impact of Barrier on Various Stages of MSW Value Chain				
		Segregation at Source	Collection	Transportation and Storage	Processing	Disposal
	OPERATIONAL BARRIERS					
High	Detailed assessments have not been undertaken by municipalities and Urban Local Bodies for understanding the need and accordingly customizing the MSW management in their regions.	✓	✓	✓	✓	✓
High	Many municipalities are facing dearth of qualified staff for ensuring efficient municipal waste management in their region.	✓	✓	✓	✓	✓
High	Due to inadequate infrastructure in SPCBs ³⁰ and PCC ³¹ s (including personnel) there is limited monitoring of urban local bodies.	✓	✓	✓	✓	✓
High	There is lack of awareness and willingness for segregation of waste at source (both households and commercial).	✓				
High	The informal sector is not included as an effective collection model during the development of MSW management models at the municipality level leading to high operational costs for ULBs and loss of livelihood for informal sector.	✓	✓			
Medium	There are no feasibility studies to support creation of landfilling plans by smaller urban local bodies.					✓
High	Many cities lack transfer facilities and authorized landfill sites, leading to local health hazards.	✓	✓			✓
High	There are location restrictions due to public outcry against processing and landfilling sites.				✓	✓

³⁰ State Pollution Control Boards

³¹ Pollution Control Committees

Municipal Waste Management as a Business Opportunity: Creating Value Out of Waste



Image courtesy: The Advocacy Project's Flickr stream

Chapter 4: Municipal Waste Management as a Business Opportunity: Creating Value Out of Waste

“Given the limited financial capabilities of the municipalities, Public Private Partnerships (PPP) can play a key role in developing solid waste management systems in urban areas.”

4.1 Need for Private Sector participation in MSW Management in India

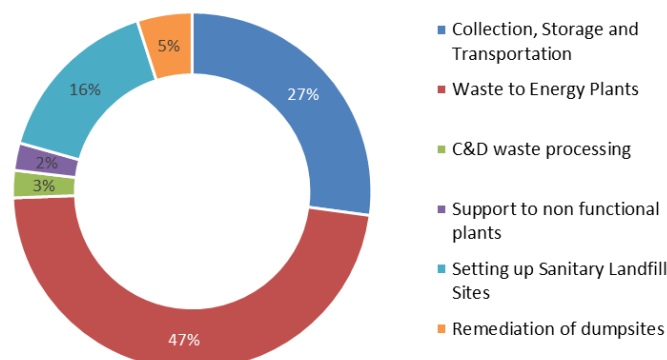
In order to enable holistic solid waste management in India, there is a strong need to improve the overall waste management system across the complete value chain. There is a high cost associated with every step of the value chain of municipal waste management right from procurement of tools, equipment and vehicles for collection and transportation of waste to the setting up of storage facilities and the development of waste processing plants and disposal sites (Figure 10).

The key sources of funds for Urban Local Bodies are:

- **Conservancy/Property Tax:** A part of the funding for setting up municipal solid waste systems is derived from the general municipal fund (including government grants) and most of the municipalities use a percentage of property tax. However, given the low collection levels of property tax in majority of Indian cities, the total funds generated through this process is very low. Some states also have introduced sanitation/ city cleaning tax to cover the cost of collection and disposal of MSW, however, that does not fully cover the cost of service.
- **User Charges:** Municipalities/ULBs also charge a fee from households and commercial establishments for door to door waste collection however this amount is very low and is dependent on income levels of the geography. The user charges are not able to fully cover for the overall service provided by the municipality.
- **Revenue from material recoveries:** The municipalities/ULBs are also able to generate some revenue from the sale of recyclable materials obtained from the waste, although this varies from region to region. Also the amount of recoverable waste is fairly low in regions with a strong informal network of waste collectors.

These funding sources combined are not adequate for municipalities/ULBs to efficiently manage, treat and dispose municipal waste. Assuming that 20% of the required infrastructure is already there in municipalities, there is a total investment requirement of INR 202 billion³².

Figure 9: Total investment requirement for setting up MSW management system in India (in INR Crore)



Data Source: Planning Commission³³

³² Task Force Report on Waste to Energy, Planning Commission, 2014

³³ Ibid.

To support the municipalities, there is financing support available from the central and the state government in the form of grants and subsidies. Some of the key schemes at the central level have been outlined below (Table 7).

Table 7: Financing schemes by GoI for Municipal Solid Waste Management in India

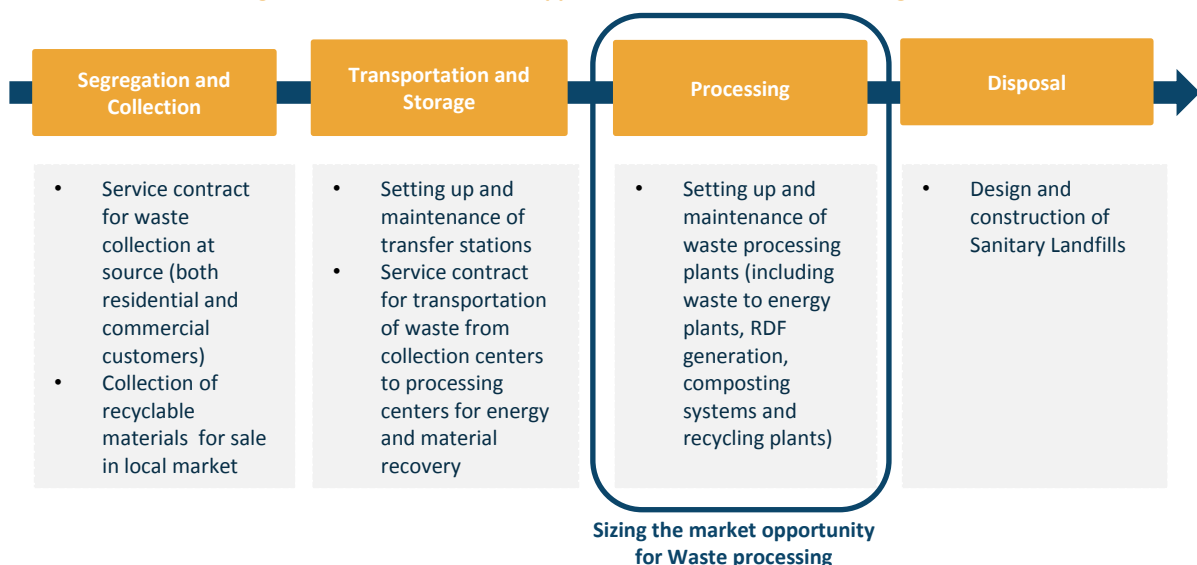
Scheme, Government Agency	About the Scheme
Jawaharlal Urban Renewable Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) Schemes by Ministry of Urban Development (MoUD)	These schemes were developed to enable the implementation of MSW Rules by states and cities. A total of 46 MSW projects were approved in 20 states at a cost of INR 1,925 crore and INR 694 cr was released. As on date, 19 of the 46 plants supported are operational.
Waste to Energy Schemes by Ministry of New and Renewable Energy (MNRE)	The Ministry promotes all technology options for setting up projects for recovery of energy from urban, industrial and agricultural wastes. Currently only five pilot projects based on MSW to energy are being supported. Under the scheme the amount of capital subsidy is calculated on the basis of power generation from MSW. Rs 2 crore/MW upto a maximum of Rs.10 cr per project is available as capital subsidy.
Centrally Sponsored Scheme (CSS) by Ministry of Agriculture (MoA)	This scheme was set up for actively promoting waste composting and for balanced and integrated use of fertilizers. Support is provided to local bodies and the private sector for setting up composting plants for converting municipal solid waste into compost. This grant is available for up to one-third of the project cost, subject to a maximum of Rs 50 lakh per project.
Financial Support Schemes by Ministry of Environment, Forests and Climate Change (MoEF)	The Ministry provides financial support of up to 50% of the capital costs to set up pilot demonstration plants on municipal solid waste composting. The ministry also extends limited financial assistance for waste characterization and feasibility studies.

Given the limited financial capabilities of the municipalities, Public Private Partnerships (PPP) can play a key role in developing solid waste management systems in urban areas. Private players can be engaged across the entire value chain and also specifically for setting up and operating processing and disposal facilities. Such PPPs help in: (i) leveraging the strengths of the municipalities as well as the private players; and (ii) direct the flow of private capital for infrastructure development projects.

4.2 Urban Municipal Solid Waste management as a business opportunity

Urban Municipal Solid Waste management presents multiple business opportunities across the entire value chain from waste collection to disposal.

Figure 10: Potential Business opportunities across the MSW management value chain



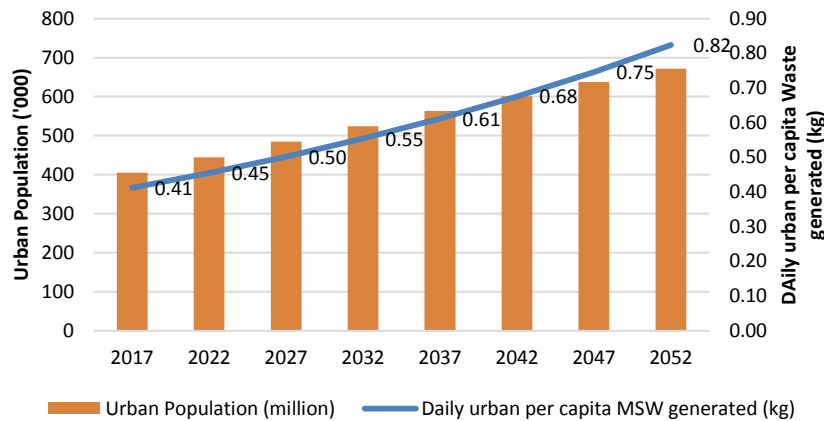
For the purpose of this study, the focus is on sizing the market opportunity for processing urban MSW in India.

4.3 The USD 1.5 billion VoW (Value out of Waste) market

As per the Planning Commission estimates, the urban population of India is expected to increase from 365 million in 2012 to 404 million in 2017 and 672 million in 2052 and the daily per capita urban waste generation is expected to grow at a steady rate of 10% from 0.37kg in 2012 to 0.82 kg in 2052.

“Potential market opportunity for urban MSW processing in India has been estimated by assessing the investment requirements for setting up the requisite waste processing capacity for both composting and waste to energy.”

Figure 11: Growth of urban population and waste generation in India



Source: India Energy Security Scenario 2047, Planning Commission

This implies that the total urban MSW generation is expected to increase from 136,514 TPD in 2012 to 553,550 TPD in 2052. Considering the composition of the total urban municipal solid waste generated, its processing can be broadly classified into three categories (all other waste, primarily inert waste, accounting for nearly 45% of total waste is directly sent to landfills):

- Composting (for organic wet waste)
- Waste to energy (for organic dry waste and inorganic combustible waste)
- Recycling (inorganic non-combustible waste including construction and demolition waste).

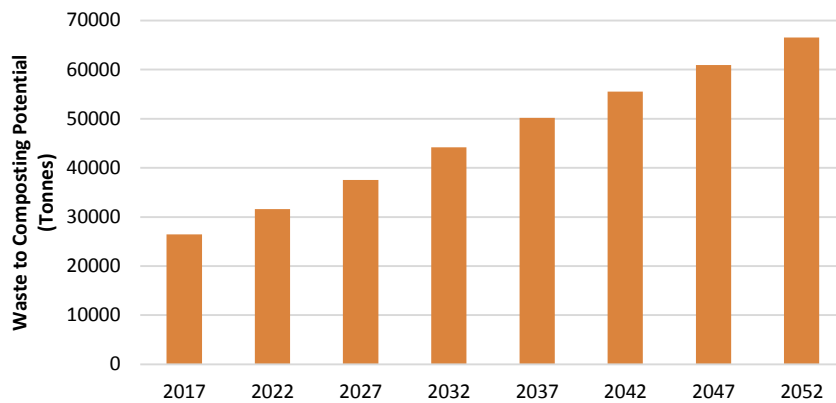
Composting and waste to energy are the two biggest opportunities for generating value out of waste in India (together accounting for 90% of the total waste that can be processed). *Potential market opportunity for urban MSW processing in India has been estimated by assessing the investment requirements for setting up the requisite waste processing capacity for both composting and waste to energy*³⁴.

4.3.1 Potential of Composting Urban MSW in India

The market for composting is expected to grow steadily over the next few years as waste segregation is enforced by municipalities at source as well as after collection and there is greater awareness and action towards waste treatment and processing. Given the high organic content in Indian urban municipal waste, less upfront capital expenditure, as well as ease of adoption in decentralized setting, **composting is expected to grow from 26,000 TPD in 2017 to 66,500 TPD in 2052**. It has been assumed that almost 40% of the organic waste generated in urban centres has the potential to be composted in 2017, with the composting proportion decreasing steadily as there are advancements in technology and more waste is utilized to produce energy.

³⁴ Potential for material recycling has not been considered in this study

Figure 102: Potential capacity requirement of composting urban MSW in India



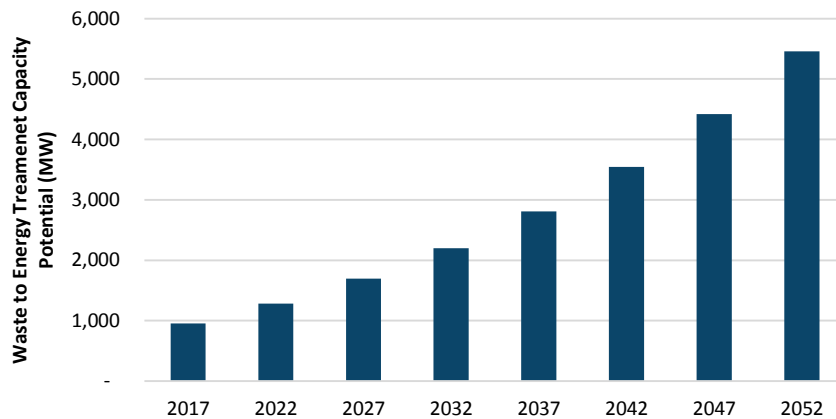
Source: cKinetics analysis

This steady growth in the composting market is predicted to be aided by market incentives to accelerate the purchase of compost by government bodies for horticultural purposes. Also with increased segregation over the years, the quality of compost is expected to improve increasing its suitability for agricultural purposes hence expanding the market.

4.3.2 Potential for Waste to Energy for Urban MSW in India

Given the increasing energy shortage faced by Indian cities and the surmounting municipal waste management problem, waste to energy is foreseen as a key segment for generating value out of waste in India. Depending on the type of waste (organic or combustible waste), different types of technologies such as bio-methanation, incineration, gasification, pyrolysis etc. can be used to convert the waste into energy. Though currently, processing waste for conversion into energy has seen little adoption, it has been estimated that this market has a potential of 956 MW by 2017.

Figure 113: Potential capacity requirement of Waste to Energy for Urban MSW in India



Source: cKinetics analysis

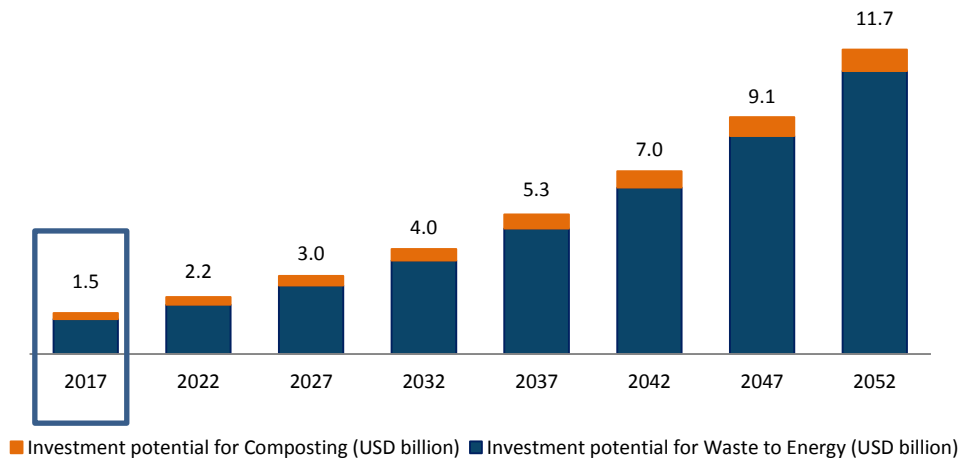
With technological improvements, improved waste management systems and better quality of source waste due to increased segregation, the potential capacity for waste to energy plants is expected to grow to approximately 2200 MW by 2030 and 5400MW by 2052.

“Market for generating value of waste is expected to be worth USD 1.5 Billion by 2017.”

4.3.3 Investment potential for processing urban MSW in India

Assuming the base capital expenditure of ~USD8,750/TPD for composting plants and an average capital expenditure of ~USD1.4 million/TPD for setting up waste to energy plants, **market for generating value of waste is expected to be worth USD 1.5 Billion by 2017**. A large portion of this market continues to remain untapped owing to several operational, policy and technological barriers as discussed earlier in this document.

Figure 124: Investment potential (USD billion) for Urban Municipal Solid Waste processing in India



Source: cKinetics analysis

4.4 Government support needed to attract private participation in urban waste management in India

Setting up waste processing plants (like waste to energy) entail a high capital expenditure cost and the financial viability is dependent on financing structure of the capex along with operating expenditures viz-a-viz the return generated from recoveries.

The main source of revenue for waste processing plants is from the sale of recoveries (electricity, manure, RDF etc). The total recoveries generated from the plant in turn are dependent on both quality and quantity of input waste. Any deviation in input waste from the projected numbers affects the viability of the plant. Other sources of revenue for the plant include tipping fee³⁵ (in case of plants managed by private sector) and carbon credits.

There are hardly any examples of operational waste processing plants in India which are currently financially viable. *There is limited operational data available on the financial performance and viability of waste processing plants in the Indian context and this remains a key challenge for increased adoption of the existing technologies in waste treatment.*

Analysis of the financial viability of an indicative waste to energy plant (using bio-methanation technology) with 500 TPD waste processing capacity operating for 12 hours daily shows that with existing capital subsidy provided by MNRE (max of Rs 10 cr per plant), prevailing average electricity selling price (Rs 3.5/kWh), zero tipping fee and considering 80:20 capitalization with debt @14% interest rate for 7 year term, the plant will not generate a positive rate of return and thus is not financially sustainable.

³⁵ Tipping fee is a charge which municipal authorities are required to pay to a private operator, who undertakes the responsibility of processing the waste aimed at minimizing the waste going to the landfills and in the process derive some useful products to meet part of the cost (Reference: Report of the Task Force on Waste to Energy (Volume I), Planning Commission, May 2014)

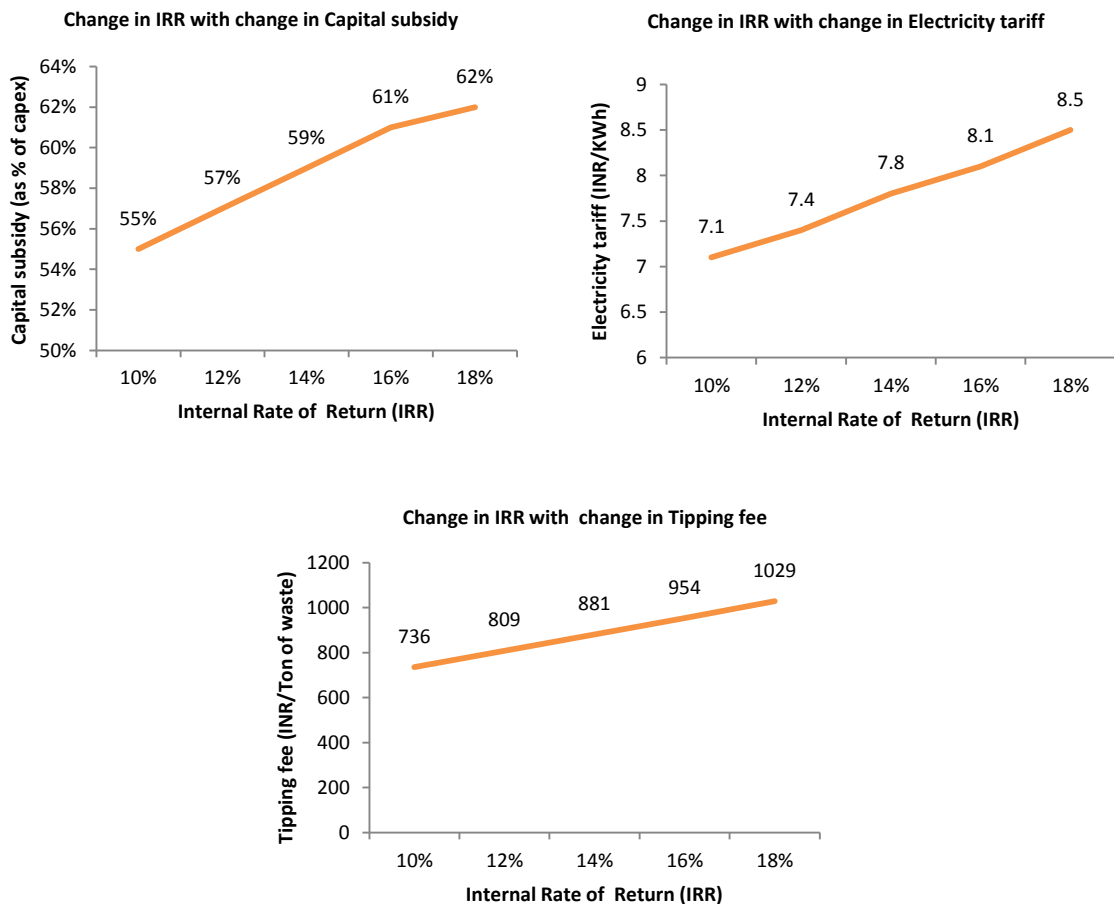
“Setting up waste processing plants entail a high capital expenditure cost and their financial viability is dependent on financing structure of their capex along with operating expenditures viz-a-viz the return generated from recoveries.”

This viability gap between the amount spent by the concessionaire on processing the waste and the income derived from the products for private players in setting up waste processing plants can be bridged by:

- Payment of tipping fee
- Increasing capital subsidy
- Increasing purchase price of electricity generated

For Internal Rate of Return (IRR) to be in the range of 10%-18%, either the capital subsidy needs to be 55%-62% of the total investment or selling price of electricity needs to increase to be in the range of Rs 7.1/kWh to Rs 8.5/kWh or tipping fee needs to be introduced to the tune of Rs 730/ton to Rs 1000/ton. The charts below present the different scenarios of IRR with these changing variables.

Figure 15: Scenario Analysis for indicative Bio-methanation Plant



The government is already mulling some of these incentives as a part of their plan to improve solid waste management in the country. Erstwhile Planning Commission Task Force on Waste to Energy has suggested that the private sector may be provided financial support from the central as well as state government to improve the financial viability of these waste processing projects and thereby increase private participation in the sector.

Suggestions by the Planning Commission for meeting the viability gap include: 40% towards capital expenditure by the central government upfront or 20% viability gap funding each for capital investments and O&M costs linked to performance and another 10% by the state governments for the sustainability of such project. Minimum Feed in tariff for electricity being generated from waste to energy plants as well as a tipping fee is also being explored by the government.

Action Agenda for Urban Municipal Waste Management in India



Image courtesy: American Center Mumbai's Flickr stream

Chapter 5: Action Agenda for Urban Municipal Waste Management in India

While a number of policies and Rules have been rolled out by the Government for effective municipal solid waste management in India, the level of implementation continues to be poor. Given the continually increasing waste generation trends in India, it is imperative to address the barriers faced for efficient MSW management in India.

The **Urban Waste Management Framework (UWMF)** has been conceptualized for the creation of a highly comprehensive and integrated urban solid waste management system in India (Figure 15). The model has three different stages depending on the time frame of action required to meaningfully implement urban solid waste management models - the **Basic Model** corresponds to short term timeframe, **Intermediate Model** corresponds to medium term timeframe, and the **Advanced Model** corresponds to long term timeframe.

The three models (Basic, Intermediate and Advanced) have their own focus areas based on which key performance indicators can be developed for tracking the success of waste management system. Different stages of a successful urban Municipal Solid Waste Management system include:

- **Basic Urban Waste Management Model** (for the short term): complete (i.e. ensuring 100% collection efficiency in all states), convenient (with door to door collection), accessible (including urban poor population) and policy compliant.
- **Intermediate Urban Waste Management Model** (for the medium term): efficient (cost and time wise), streamlined and aggregated.
- **Advanced Urban Waste Management Model** (for the long term): comprehensive (with optimal efficiency across the value chain), inclusive (leveraging both formal and informal waste collection systems) and integrated (all stakeholders and systems working in tandem).

Figure 136: Urban Waste Management Framework (UWMF) for India

URBAN WASTE MANAGEMENT FRAMEWORK (UWMF)			
	Level 1	Level 2	Level 3
	BASIC	INTERMEDIATE	ADVANCED
Focus Area	Access	Efficiency	Systems and Behavior
What does this model encompass	Creating a complete (100% collection), convenient (door-to-door), accessible and policy compliant urban waste management system	Creating an efficient, streamlined and aggregated waste management system for effective waste processing	Creating a highly comprehensive, inclusive and integrated waste management system for reduction of overall waste generation through behavioral tools
Time Frame of implementation	Short Term	Medium Term	Long Term

Based on this model, an action agenda (Table 5) has been created to provide recommendations for addressing the various barriers for municipal solid waste management and to provide a way forward. Collaborative action amongst stakeholders with a long term vision is essential to ensure the implementation of this action agenda and for a successful and sustainable urban waste management ecosystem in the country.

Table 8: Action Agenda for Urban Municipal Solid Waste Management in India

	Short Term Action Agenda (by 2017)	Medium Term Action Agenda (by 2025)	Long Term Action Agenda (By 2050)
For access to data	<ul style="list-style-type: none"> ✓ Conducting detailed surveys to understand waste generation quantum and composition in urban centres. ✓ Technical manuals for each type of waste and end use applications should be prepared for the benefit of all stakeholders. 	<ul style="list-style-type: none"> ✓ Developing national and state level data banks to capture and disseminate information on characteristics of waste generated, potential for segregation, reuse, recycling and management of MSW which is periodically updated. 	<ul style="list-style-type: none"> ✓ Establishing centers of excellence and international knowledge networks for technology transfer and best practice sharing.
For increasing segregation	<ul style="list-style-type: none"> ✓ Generating community awareness about impacts of poor solid waste management practices – to improve segregation of waste 	<ul style="list-style-type: none"> ✓ Setting up sorting sheds by municipalities and local communities to enable local sorting and segregation reducing transportation costs 	<ul style="list-style-type: none"> ✓ Charging penalty from households and commercial establishments providing mixed waste
For improved waste collection	<ul style="list-style-type: none"> ✓ Increasing municipal waste collection to 100% in all urban regions with a focus on source segregation. ✓ Providing color coded waste bins in adequate numbers in commercial areas, markets etc. for collection of segregated waste ✓ Transportation of waste through covered garbage trucks and/or compactors ✓ Creating guidelines for setting up waste collector’s cooperatives and holding consultations with NGOs and SHGs to bring the informal waste collection players under the formal purview. ✓ Collecting data on informal waste picking sector to enable designing of better collection models ✓ Consultations and awareness sessions with retailers to stop sale of non-policy compliant plastic bags 	<ul style="list-style-type: none"> ✓ Capacity building of existing staff and increasing technical staff with sound knowledge in technology and waste management system design. ✓ Promoting informal waste collector’s cooperatives for better integration of the informal sector within the value chain. ✓ Ensuring safety and well-being of informal sector engaged in waste collection and sorting by providing requisite facilities and safety gear. ✓ Enforcing prohibition of open burning of garbage, leaves and other wastes. ✓ Providing waste transportation systems such as hand-carts, tricycles and other simple vehicles which are non-polluting in their localities and municipality sub-divisions ✓ Setting targets for plastic manufacturers for Extended Producer Responsibility. 	<ul style="list-style-type: none"> ✓ Ensuring the informal sector is completely embedded as a part of the formal waste management value chain. ✓ Developing integrated centralized and decentralized waste collection systems based on the type and composition of waste. ✓ Deploying automated vacuum based waste collection systems in the new cities being developed in India. ✓ Setting up sensor based collection mechanisms which inform waste collectors when garbage bins are filled.
For appropriate waste processing and disposal	<ul style="list-style-type: none"> ✓ Creating technical guidelines for enabling municipalities to choose the correct waste processing options based on the composition and quantum of waste ✓ Creating guidebooks to enable better understanding of financial viability of various processing technologies for funders and technology providers ✓ Identifying sanitary landfilling sites in the high priority regions by urban local bodies 	<ul style="list-style-type: none"> ✓ Setting up demonstration units for waste processing technologies (especially plastic) ✓ Designing waste processing plans corresponding to the local context to ensure adequate operational capacity ✓ Providing authorization of sites and plans for waste processing and sanitary landfilling ✓ Promoting composting as a decentralized waste processing method especially for households ✓ Engaging fertilizer companies to market the compost to leverage their existing network of distribution 	<ul style="list-style-type: none"> ✓ Incorporating land required for waste processing and disposal in the land use plans at the district and state levels for each individual municipality.

	Short Term Action Agenda (by 2017)	Medium Term Action Agenda (by 2025)	Long Term Action Agenda (By 2050)
		<p>channels up to the village level.</p> <ul style="list-style-type: none"> ✓ Developing co-marketing policies for compost with chemical fertilizers to make them competitive in the agricultural market. 	
For better policy framework	<ul style="list-style-type: none"> ✓ Ensuring the development of State Policies for municipal waste management ✓ Amendment of MSW Rules to incorporate waste reducing, reusing and recycling methods ✓ Building capacities of the local staff for planning, tendering, supervision and monitoring ✓ Prioritizing/categorizing cities/towns based on population and quantum of waste generation with special emphasis on hilly, coastal and tourist towns and cities for planned implementation of MSW Rules 	<ul style="list-style-type: none"> ✓ Amendment of MSW and Plastic Waste Management Rules for setting targets and timelines for achieving reduction in generation of waste ✓ Increasing inter-governmental coordination between urban, agriculture, and energy departments for clear and targeted policies and cohesive implementation. ✓ Ensuring the development of Urban Local Bodies in all urban centres across India ✓ Developing national guidelines for the siting and operation of composting facilities in conjunction with compost quality standards ✓ Creating specific guidelines for management of special waste (such as sanitary napkins and diapers) 	<ul style="list-style-type: none"> ✓ Strict adherence to compost quality standards for protecting public health and developing confidence of farmers. ✓ Developing registration and certification mandates for composting facilities to raise industry standards. ✓ Creating a Waste to Energy corporation supported by the Government, focused on R&D, data collection as well as catalyzing finance for WTE projects in India
For better financing environment	<ul style="list-style-type: none"> ✓ Including waste to energy projects for financing through the National Clean Energy Fund and clearly defining the modalities for getting waste to energy projects funded through the clean energy fund. ✓ Reducing the subsidies provided to chemical fertilizers to enable the uptake of compost generated locally through solid waste. ✓ Providing tax concessions (Excise/ VAT) on products such as RDF and C&D products 	<ul style="list-style-type: none"> ✓ Developing output based incentives schemes for compliant processing operations ✓ Developing feed-in tariffs to facilitate the sale of biogas and RDF as alternative energy sources. ✓ Developing buy-back and basket approaches for composting ✓ Using carbon financing to support the financial sustainability of waste to energy projects. ✓ Allocating a dedicated Viability Gap Funding vehicle for implementation of de-centralized waste management projects in the country 	<ul style="list-style-type: none"> ✓ Developing schemes for providing incentives and disincentives to local bodies to promote better implementation of MSWM Rules



THE KNOWLEDGE ARCHITECT OF CORPORATE INDIA EVOLUTION OF VALUE CREATOR

ASSOCHAM initiated its endeavour of value creation for Indian industry in 1920. Having in its fold more than 400 Chambers and Trade Associations, and serving more than 450000 members from all over India. It has witnessed upswings as well as upheavals of Indian Economy, and contributed significantly by playing a catalytic role in shaping up the Trade, Commerce and Industrial environment. Today, ASSOCHAM has emerged as the fountainhead of Knowledge for Indian industry, which is all set to redefine the dynamics of growth and development in the technology driven cyber age of 'Knowledge Based Economy'. ASSOCHAM derives its strength from its Promoter Chambers and other Industry/Regional Chambers/Associations spread all over the world.

VISION

Empower enterprise by inculcating knowledge that will be the catalyst of growth in the barrierless technology driven global market and help them upscale, align and emerge as formidable player in respective business segments.

MISSION

As a representative organ of Corporate India, ASSOCHAM articulates the genuine, legitimate needs and interests of its members. Its mission is to impact the policy and legislative environment so as to foster balanced economic, industrial and social development. We believe education, IT, BT, Health, Corporate Social responsibility and environment to be the critical success factors.

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