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**EIGHTH REGIONAL 3R FORUM IN ASIA AND THE PACIFIC,  
9-12 APRIL 2018, INDORE, MADHYA PRADESH, INDIA**

**A 21<sup>st</sup> Century Vision on Waste to Energy in India: A Win-  
Win Strategy for Energy Security and Swachh Bharat Mission  
(Clean India Mission)**

**(Background Paper for Plenary Session 7 of the Programme)**

**Final Draft**

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This background paper has been prepared by Mr. Upendra Tripathy, for the Eighth Regional 3R Forum in Asia and the Pacific. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

# **A 21st Century Vision on Waste to Energy in India: A Win-Win Strategy for Energy Security and Swachh Bharat Mission (Clean India Mission)**

**Background Paper**

**8<sup>th</sup> Regional 3R Forum in Asia and the Pacific**

**9-12 April 2018, Indore, Madhya Pradesh, India**

**Author: Mr. Upendra Tripathy**

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## Foreword and Acknowledgement:

The Regional 3R Forum in Asia and the Pacific is an annual signature event and there are currently more than 35 member countries of the Forum from the region. The past Regional 3R Forums were hosted by different countries- Japan (2009), Malaysia (2010), Singapore (2011), Hanoi (2013), Surabaya (2014), Maldives (2015) and Australia (2016). UNCRD serves as the Secretariat of the Regional 3R Forum in Asia and the Pacific and in this role has rendered tremendous service globally in several climate related areas-including waste management.

The 8th Regional 3R Forum in Asia and the Pacific, 9-12 April 2018, Indore, Madhya Pradesh, India, is co-organized by the Ministry of Housing and Urban Affairs (MoHUA) of Government of India, the Ministry of the Environment of the Government of Japan (MOEJ), and the United Nations Centre for Regional Development (UNCRD), under the overall theme of "Achieving Clean Water, Clean Land and Clean Air through 3R and Resource Efficiency- A 21st Century Vision for Asia-Pacific Communities".

Recently, Swachh Bharat Mission is bringing a sea change in the space of waste management in India. And yet, as India moves along the path of progress, wastes of all types have made cities, towns and even villages a part of a big policy challenge. This is despite the fact that Indian policy and policy makers have been struggling with waste management right from the early 50s. Against the backdrop of collapse of a mound of solid waste around Delhi in early September and the unprecedented smog and air pollution in New Delhi during December 2017, this assignment – writing a background paper for the Eighth Regional 3 R Forum in Asia and the Pacific on - A 21st Century Vision on Waste to Energy in India: A Win-Win Strategy for Energy Security and Swachh Bharat Mission (Clean India Mission) – is an important and laudable step where the author brings out some practical lessons and recommendations to better guide the 21<sup>st</sup> century Indian policy makers on how waste to energy policy, programmes, institutions and technologies could be promoted as an integral part of 3R Programme towards energy security, circular economy, employment generation, and environmental benefits under the 2030 Agenda for Sustainable Development. This paper, written in the Indian Context to serve as a background paper for policy consultation at the 8<sup>th</sup> Regional 3R Forum in Asia and the Pacific, can be suitably linked to similar studies of other countries in the Asia Pacific in a synergetic and symbiotic manner.

Author

## **Abbreviations and Acronyms:**

### **List of Abbreviations**

1. Agency for Non-conventional Energy and Rural Technology (ANERT)
2. Atal Mission for Rejuvenation and Urban Transformation. (AMRUT)
3. Association of Municipalities and Development Authorities (AMDA)
4. Cement Information System (CIS)
5. Central Financial Assistance (CFA)
6. Central Public Health and Environmental Engineering Organization (CPHEEO)
7. Climate and Clean Air Coalition (CCAC)
8. Corporation of the City of Panaji (CCP)
9. Dudh Sagar Dairy (DSD)
10. Energy Efficiency Service limited (EESL)
11. Global Waste Management Outlook (GWMO)
12. International Solid Waste Association (ISWA)
13. Municipal Energy Efficiency Project (MEEP)
14. Ministry of New and Renewable Energy (MNRE)
15. Ministry of Urban Development (MoUD)
16. Municipal Solid Waste (MSW)
17. Mysore City Corporation (MCC)
18. National Environmental Engineering Research Institute (NEERI)
19. Public Sector Undertaking (PSU)
20. Public-Private-Partnership (PPP)
21. Refuse Derived Fuel (RDF)
22. Segregation at Source (SAS)
23. Solar Energy Corporation of India (SECI)
24. Solid Waste Management Park (SWMP)

25. Tons per day (TPD)
26. The United Nations Centre for Regional Development (UNCRD)
27. United Nations Environment Programme (UNEP)
28. Viability Gap Funding (VGF)
29. Waste to Energy (WtE)
30. World Health Organization (WHO)
31. Zero Waste Management (ZWM)

## **Executive Summary:**

In early December, 2017, the air pollution in Delhi became so alarming that it made world news. On 1<sup>st</sup> September, 2017, a massive heap of garbage came crashing from the Ghazipur Landfill site, a mound as high as a ten-story building in Nation's Capital Region, killing two people on the spot and sweeping away several vehicles from the road at the foothills to the adjacent Hindon. These incidents capture the seriousness and importance of the subject of Municipal Solid Waste (MSW) Management in India and its impact on air, water and land and thereby on human health and ecosystems.

This background paper has architecture of seven chapters. Chapter One captures an overview of waste management in India, critical policy, institutional and governance challenges in respect of energy security, the history of the regulatory framework of waste management and the vital statistics of the sector in India, current policies and programs at various levels of government and society, and role of waste to energy to energy as a part of overall waste management strategy. It further explores managerial interrelationships, constitutional and legal connections, and practical understanding of field level problems which will sharpen the ability of the policy makers to better formulate 21<sup>st</sup> Century policies and programs relating to the Indian solid waste sector. Chapter Two analyses the issues of energy security and sustainable development, including an analysis of the synergies between waste to energy and 3R (Reduce, Reuse, Recycle of waste) and Sustainable Development Goals (SDG) - Goal numbers 7, 11 and 12. Chapter Three deals with the economics of waste in India, prospects of circular economy with mass scale introduction of waste to energy policies / programs / technologies. Chapter Four explores the role and scope of prospect of cooperative recycling for energy and material security in the Indian context. It delves into areas such as cooperative recycling for energy with aggregation of demands, resources and raw materials at community levels – village, panchayat, district and provincial levels and how such policies have been embedded in the current policies and programs in India. Chapter Five takes a look at some best practice cases and examples on waste to energy and circular economy in the Indian context, covering areas of policy initiative, technology application and public private partnership to generate energy from waste. Chapter Six deals with the most important part of the study - Conclusions and 18 recommendations, including recommendations on developing a comprehensive waste to energy policy and programs on upgrading existing institutions, ideas, and programs, to have a sustainable waste management and waste to energy policy.

The most important recommendation is that of holding of a mega global investment summit at national level to attract investment into the waste management sector with policies that address issues of land, labour, capital, and technology and create massive awareness on the subject, with partnership from subnational and supra national agencies, corporate sector, and social actors. The model referred to is RE-INVEST 2015 organized by the Ministry of New and Renewable Energy which put renewable energy in a different orbit altogether in the Indian agenda. It also recommends that Solar Energy Corporation of India, a Public Sector Undertaking, can expand its activities to construct and manage waste to energy plants,



keeping in view the importance of round the clock monitoring of air quality around such plants and the rehabilitation of rag pickers who could be displaced by such voracious plants.

Chapter Seven proposes the way forward – vision towards creating enabling policies, programs, institutions and governance mechanisms for optimising the contributions of waste to energy in the context of climate benefits, energy security, environmental objectives, and economic opportunities. This chapter also captures the benefits from implementation of recommendations brought out in the preceding chapter. The win-win part will be that an integration between these two thematic areas, i.e. Waste to Energy and Swachh Bharat Mission with Solid Waste Management policy, will result in a number of socio-economic and environmental benefits, such as - (a) better energy security, (b) promotion of circular economy, (c) employment generation, and higher investments and (d) environmental benefits under the 2030 Agenda for Sustainable Development.

However, it is important to have a caveat. India is a huge subcontinent. Some of the provinces are bigger than many sovereign countries elsewhere. Hence no policy recommendation can be universally applicable. Each policy or programme works in a unique ecosystem of actors, individuals, and institutions. The ecosystems enable policy makers and implementers to perform, reform and transform, set standards, goals and performance parameters with newer skills, scales and speed. One hopes that the lessons recommended in the paper are always applicable, *mutatis mutandis*, to all similarly placed countries and contexts. The Indian experience is a grand example, worth being analysed by all, given the subcontinental dimensions of her democracy, demography and size of social demand and supply in a variety of goods and services. The recent statement by the Honourable Minister for Power and Renewable Energy in the Parliament that 58 MW of Waste to Energy plants are operational is an eye opener. Some Pilot projects are yet to take off. In essence, the ecosystem to be created to streamline these projects and bring in fresh investment into the waste management sector is a critical challenge that needs singular attention of policy makers in the near future.

## **Summary on India's waste sector:**

### **1Status of Urbanization in India**

As per Census 2011, India's total population stands at 1.21 billion, which is 17.7% more than the last decade, an increase of 181.9 million persons in absolute number of population during 2001-11. Out of that, the total urban population in the country is more than 377 million constituting 31.16% of the total population. By the year 2050, it is expected that 50% of the country's population will be urban. Total no. of Class-I cities/Urban Agglomerations (UA) having population more than 1.0 lakh is 468 which constitutes 70% of the total population. Out of this 53 cities/UA\_having population of one million or above are known as Million Plus Cities/UAs, these are the major urban centres in the country. Around 161 million (or 42.6% of the urban population) live in these Million plus UAs/Cities.

Among the Million plus UAs/Cities, there are three very large UAs with more than 10 million persons in the country, known as Mega Cities. These are Greater Mumbai UA (18.4 million), Delhi UA (16.3 million) and Kolkata UA (14.1 million).

### **MSW Generation and its Composition**

In comparison to the levels of the developed world, of 1 to 2.5 kg capita/day, average MSW generation is 450 gm/per capita/day in the country. The MSW generation rate reported for small towns is 200-300 gm/capita and 300-400 gm/capita for medium cities and between 400-600 gm/capita for large cities.

As per the latest report of CPCB, published in February 2015, *the total quantity of waste generation in the country is estimated at around 1.43 lakh metric tons per day. Out of which, 1.18 lakh metric ton (82%) is being collected and remaining 18% is littered. Out of the total collected waste, only 0.33 lakh metric tonne (28%) is being treated and disposed.*

However, if the current 62 million tonnes annual generation of MSW continues to be dumped without treatment, it will need 3,40,000 cubic meter of landfill space every day. Considering the projected waste generation of 165 million tonnes by 2031, the requirement of land for setting up landfill for 20 years (considering 10 meter high waste pile) could be as high as 66,000 hectares of precious land, which our country cannot afford to waste.

As per the Task Force Report on WTE published by NITI Aayog (erstwhile Planning Commission) in May 2014, it has been estimated that the Urban Local Bodies (ULBs) spend about 60-70% of total expenditure on street sweeping, 20-30% on transportation, and less than 5% on final disposal of waste, which shows that hardly any attention is given to scientific disposal of waste. The waste collection efficiency in India ranges between 70% and 90% in major Metro cities, whereas in several smaller cities it is below 50%.

#### **Composition of MSW**

Bio-degradable 45 - 55 %; Paper 8-13%; Plastics / rubber 9-10%; Metal, Glass and Rags 1 - 1.5 %; and Inerts 20 - 25%;

### **Waste to Energy Potential in India**

The solid waste generated from the cities/towns in India has present potential to generate power of approximately 500 MW, which can be enhanced to 1,075 MW by 2031 and further to 2,780 MW by 2050.

### **Development of Policy and Regulatory Framework for Promotion of 3 Thematic Areas in the context of 21st Century Vision for Waste to Energy in India**

A 21st Century Vision on Waste to Energy in India: A Win-Win Strategy towards Energy Security and Swachh Bharat Mission (Clean India Mission) must integrate all the

three segments – waste energy and cleanliness - serving one another and ultimately leading to a zero waste society. Keeping this central focus in view, policy makers could (a) develop a comprehensive waste to energy policy and programs (b) build and reengineer suitable and required institutions and (c) adopt innovative and appropriate technologies. They could also ensure proper integration of these policies and programs with the 3R - Reduce, Reuse and Recycle policies and programs. The win-win part will be that the integration of two thematic areas, i.e., Waste to Energy and Swachh Bharat Mission with Solid Waste Management Policy will lead to a number of socio-economic and environmental benefits like (a) energy security, (b) promotion of circular economy (c) employment generation, and (d) environmental benefits under the 2030 Agenda for Sustainable Development.

### **Role of Waste to Energy in Waste Management Hierarchy**

Electricity generation from waste is not the most efficient way of generating electricity. It is a way of resource recovery from municipal solid waste and should be considered as a by-product of waste management. Enthusiasts sometimes speak of waste-to-energy as a solution to our energy problem — this may not be entirely correct. However, if implemented to global emission standards, it could be a pathway to scientific and sustainable disposal of municipal solid waste, given the scarcity of urban land in the country, while also generating some much needed electricity.

### **Perceived Conflict between Waste to Energy and Recycling**

Of late, RDF Combustion /Incineration-based waste-to-energy technologies have emerged as the preferred policy option for managing the growing problem of waste in India. These technologies require a continuous supply of waste inputs of sufficient quantity and quality - high calorific value and low moisture content - to be viable. Government and Industry proponents suggest that WtE and recycling are compatible systems for managing the waste while their critics disagree. The key arguments are – i) the developer is usually given end-to-end control over the entire waste management chain to make the project viable and sustainable, displacing the existing informal sector engaged in reuse and recycling of waste or the 3R activities cannot be taken up later unless corrective provisions *a priori* are put in the contract; ii) if one removes 100% recyclable and reusable material and organics from Indian waste, no substantial quantity of waste with high calorific content will be left any more in the waste collected and render waste technically unsustainable for incineration/combustion. Therefore, both the solutions /options are not compatible and are in fact in competition with each other over the same set of material resources. Hence the Indian Policy Makers have to realise the long-term impact of the WtE policy while formulating strategies for the waste management policies of the 21<sup>st</sup> Century.

### **Circular Economy /Zero Waste disposal**

The Circular economy is ‘an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the

maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. This will negate the dependence on landfills and incineration where waste from one product serves as an input for another. However, the concept of Circular Economy and/or Zero Waste disposal is yet to be conceptualized and demonstrated in the country. This is very important particularly in the areas of e-Waste (Electronics Waste) and solar applications. The future waste management in these areas are going to be throwing up many challenges. The target of 40000 MW of solar rooftops, over the years, in cities and villages, will require recycling of solar panels. Similarly, recycling and safe disposal of many electronic items, in the absence of many hazardous waste disposal sites in the country, will be a great challenge and need a lot of focus in the 21<sup>st</sup> century.

### **Synergies between Waste - to - Energy, 3R (Reduce, Reuse, and Recycle of waste), Energy Security and Sustainable Development**

Process of recycling of recyclable materials takes time, demands large amounts of water and energy as well as produces some pollutants. But it does less environmental damage and reduces the quantity of waste that is required to be sent to landfills and/or incinerators compared to extraction of the raw materials/ natural resources involving mining, quarrying and logging /production of virgin materials - all of which pollute the air, water & soil and also reduces damage to the forests, rivers, and other habitats. Citizens personal and climate friendly efforts to recycle contribute to reclaiming valuable materials as well as saving water, energy, and other resources.

India has a very strong recycling base but all is managed by the informal sector and specific data on investment required and employment are not available. Some important insights are:

- i) You may be surprised to know that your phone is made from more than 62 metals and metalloids, of which some are extremely rare and even irreplaceable. According to a study conducted by researchers from the Yale School of Forestry & Environmental Studies, not a single metallic ingredient in phones today has a substitute that could be considered 'just as good'. In other words, there will be no real effective substitute in existence at all once we use up all the essential metals that make our phones. If most of the resources can be reclaimed from already existing products, a zero waste society would have little need for obtaining raw/virgin materials. This would significantly reduce the number of mining and excavation sites. By being conscious consumers and buying goods that last longer, we can put less pressure on manufacturers and production industries to supply more goods. These changes will have a positive impact on the amount of energy, water, and raw materials we use every day.
- ii) To produce steel for the average car, it takes a staggering 80,000 gallons (364,000 litres) of water; not to mention the energy and other resources needed to get it to finished product. The majority of manufacturing companies produce different

types of toxic waste in the course of production, which often requires specialised treatment. This process is not only expensive, but is also heavily reliant on the use of water. The burying of hazardous waste adds a further risk to air, water, and soil contamination.

India needs an eco-innovation index, like Sweden, where less than 1% of its rubbish gets sent to landfills. Indicators that make up the indices include: health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, and climate and energy.





# 2 killed as 50 tonnes of waste hurtles down Ghazipur landfill

Vehicles Swept Into Drain; Toll May Increase

Somreet Bhattacharya & Pankhuri Yadav | TNN

New Delhi: Fifty tonnes of garbage came crashing down the 16-storey-high mountain of waste at east Delhi's Ghazipur landfill site in a deadly 'avalanche' that swept away a car and three two-wheelers, killing two people and injuring five on Friday afternoon.

Heaps of garbage dropped into the Kondli canal running alongside the landfill around 2pm, creating a giant wave of slushy water that hit the road next to the canal. It washed away the four vehicles — an

**FULL COVERAGE: P 2 & 3**

Accent car, a scooty and two bikes — which fell into a drain on the other side of the road.

Fire officials, divers, police and NDRF teams searched the drain for three hours to rescue people who were swept into it and fish out the two bodies.

Police suspect more people working at the landfill site could be trapped under the debris. Officers said ragpickers from the area usually climbed up the mound searching for things to pick up.

The dead were identified as Rajkumari, 30, who was on the scooty along with two others, and a 20-year-old youth, Abhishek. Those rescued from the drain include Ayub Ansari (driver of the Accent), Pankaj and Karan (who were on the

## AN AVALANCHE OF GARBAGE



**1** Triggered possibly by an internal blast due to a build-up of gases, a part of the 50m high Ghazipur garbage pile flows down

**2** Nearly 50 tonnes of garbage fills the Kondli canal

**3** A slush of garbage and water hits the road and heads to a drain on the other side

**4** Two bikes, 1 scooty and a car swept into the drain. 2 dead, 5 injured. Everything happens in 30 seconds

## Local lad pulled out driver of sinking car

The toll in the Ghazipur disaster would have been higher but for the quick response of the local people who jumped into the drain searching for commuters who were swept in, minutes after the tragedy. A braveheart, Ali, pulled out the driver of the Accent car that was sinking in the water. **P 2**

scooty), Deepak (riding the bike on which Abhishek was sitting) and Amit, who was on another bike. They are being treated at different hospitals.

Eyewitnesses said the disastrous sequence of events last-

## AAP govt, EDMC blame each other

Calling the Ghazipur accident a man-made disaster, CM Arvind Kejriwal blamed the municipal corporation for it while the EDMC mayor cited lack of land as a problem and pointed a finger at the Delhi government for not implementing the report of the Delhi Fourth Finance Commission. **P 3**

just a few seconds. "I could not believe my eyes when I saw the mountain falling. Initially, I thought many more people had died as the water and garbage struck the vehicles with immense force," said Asghar,

## Why tragedy was waiting to happen

The Ghazipur landfill, which reached its exhaustion level in 2002, is just one of the city's ticking time bombs. Complacent municipal bodies are yet to adopt modern techniques, resulting in landfills getting saturated, while lack of space in a land-starved city has resulted in few other alternative sites coming up. **P 2**

resident of Khoda colony in the area. Many other commuters had a narrow escape as their vehicles stopped at the edge of the canal.

► **Build-up of gases, P 3**

## Introduction

On 1<sup>st</sup> September, 2017, a massive heap of garbage came crashing down from the Ghazipur<sup>2</sup> Landfill site; a mound as high as a ten-story building in Nation's Capital Region, killing two people on the spot and sweeping away several vehicles from the road at the foothills to the adjacent Hindon. This incident captures the seriousness and importance of the subject of Municipal Solid Waste (MSW) Management in India. The landfill has only 73 acres of land, against a requirement of 200 acres. Land is a big constraint in cities, particularly when the objective is to site a landfill, with ghastly sights of soaring scavenging birds, stray bovines, rag pickers, moving rickety trucks, and smoking fires. This is over and beyond the foul smells drifting along the direction of the wind, public protests, and falling land prices and rentals around the particular site. Why not burn everything and be done with it? That is usually a policy response. But is that or should it be the policy response? What are the choices in the 21<sup>st</sup> Century? How are the issues of energy security and Swachh Bharat, the two recent and emerging policy themes in India, intertwined with the MSW story? Does energy security justify the total conversion of all unsegregated wastes into electricity, despite its implications on rag pickers and possible air pollution? How has the recent mission of Swachh Bharat impacted the Indian psyche in terms of better disposal of waste in villages and cities by involving citizens and encompassing institutions? How can India implement the waste hierarchy in a country where citizens and systems are yet to internalize the duties and responsibilities that its implementation entails and mandates? The 21<sup>st</sup> Century is also the story of artificial intelligence, robotics, genomics, 3D printing and Higgs Boson. How are these technologies going to play out in the management of the same old city garbage over the course of the remaining part of this Century? What will be the role of policy makers in India? How can they bring capital into this sector, bridge the investment gap, aggregate demand, reduce costs of goods and services related to the waste disposal sector, and make the sector vibrant, and relate the same to each rung of the waste hierarchy? They need to address issues of skillsets, speed and scale. Policy makers also need to perform, reform and transform the sector given that many Ghazipurs are waiting to happen.

## Scope of the paper

The scope of this policy relevant background paper includes, *inter alia*, the following conceptual framework and broad guidelines:

Chapter One captures an overview of waste management in India, critical policy, institutional and governance challenges in respect of energy security, the history of the regulatory framework of waste management and the vital statistics of the sector in India, current policies and programs at various levels of government and society, and the role of waste to energy as a part of the overall waste management strategy. It further explores managerial interrelationships, constitutional and legal connections, and practical understanding of field

level problems which will sharpen the ability of the policy makers to better formulate 21<sup>st</sup> Century policies and programs relating to the Indian solid waste sector.

Chapter Two analyses the issues of energy security and sustainable development, including an analysis of the synergies between waste to energy and 3R (Reduce, Reuse, Recycle of waste) and Sustainable Development Goals (SDG) - Goal number 7, 11 and 12.

Chapter Three deals with the economics of waste in India, prospects of circular economy with mass scale introduction of waste to energy policies/programs/technologies.

Chapter Four explores the role and scope of the prospect of cooperative recycling for energy and material security in the Indian context. It delves into areas such as cooperative recycling for energy with aggregation of demands, resources and raw materials at community levels – village, panchayat, district and provincial levels and how such policies have been embedded in the current policies and programs in India.

Chapter Five<sup>3</sup> takes a look at some best practice cases and examples on waste to energy and circular economy in the Indian context, covering areas of policy initiative, technology application and public private partnership to generate energy from waste.

Chapter Six deals with the most important part of the study - Conclusions and 16 recommendations, including recommendations on developing a comprehensive waste to energy policy and programs on upgrading existing institutions, ideas, programs, and institutions to have a sustainable waste management and waste to energy policy.

Chapter Seven proposes the way forward – vision towards creating enabling policies, programs, institutions and governance mechanisms for optimising the contributions of waste to energy in the context of climate benefits, energy security, environmental objectives, and economic opportunities. This chapter also captures the benefits from implementation of recommendations brought out in the preceding chapter. The win-win part will be that an integration between these two thematic areas, i.e., Waste to Energy and Swachh Bharat Mission with Solid Waste Management policy, which will result in a number of socio-economic and environmental benefits - (a) better energy security, (b) promotion of circular economy, (c) employment generation, and higher investments and (d) environmental benefits under the 2030 Agenda for Sustainable Development.



## Chapter I

### **1.1 Overview of history and regulatory framework of waste management and waste to energy in India as sources of critical policy for executive action:**

The history of waste management in India, like in many other countries, has an implicit link with many Sustainable Development Goals in general and Goal numbers 7, 11 and 12 in particular. To understand this and to plan for the 21<sup>st</sup> Century, a policy maker needs to understand the past and the constitutional context. The Indian Constitution puts “Water, that is to say, water supplies” within the legislative jurisdiction of the State Governments vide item 17 of the List II-State List under the Seventh Schedule referred to in Article 246(3) of the Constitution. States are vested with the constitutional right to plan, implement, operate and maintain water supply projects; sanitation and solid waste are included. This is why waste disposal in India is mostly an act of local administration – of village Panchayats, Town and City Municipalities. And yet, the Central Government has several major Ministries dealing with the subject, primarily due to the role of multilateral funding and multilateral environmental treaties. It will be interesting to capture the regulatory history of how the Indian Government and the Governments of the States have attempted to regulate the waste sector since India’s independence.

The subject of waste management is so vast and pervasive in India that a number of national, provincial, and local government agencies such as the Ministry of Health & Family Welfare, Ministry of New and Renewable Energy, Ministry of Food and Agriculture, Ministry of Urban Development, NITI Aayog (Former Planning Commission), Ministry of Power, Ministry of Chemicals and Fertilisers, Ministry of Coal, Ministry of Environment and Forests, Central Pollution Control Board, State Governments, State Government Pollution Control Boards, Gram Panchayats, Town Municipalities and City Corporations- all have been involved in the sector for decades. There are also a number of parastatal agencies, corporates and civil society organizations who play an important role in this sector. Hence any policy and program in areas of waste management need to be sensitive to this wide network of stakeholders in India.

Some important sources of policy formulation in the waste sector, commencing from 1950s, are summarised below. The point that connects all these policy measures is that waste management has been a constant theme for administration at all levels since the early 1950s. However, waste to energy has been more recent, unless one takes into account composting, for which the Ministry of Agriculture provided loans to farmers during the early 1960s. Central Public Health and Environmental Engineering Organisation (CPHEEO), the central think tank in the government sector, was established way back in 1953. The Environmental Protection Act in 1986 gave a big boost to the sector. The 90s were a critical period. The J.L. Bajaj Committee, constituted by the erstwhile Planning Commission, recommended for waste segregation at source, primary collection, levy of user charges, use of appropriate equipment

and vehicles focus on landfills and composting, and private sector participation on pilot basis. The Ministry of Health and Family Welfare launched the National Mission of Environmental Health and Sanitation program. The Central Public Health and Environmental Engineering Organization (CPHEEO) estimated financial requirements of Municipalities and funding issues. In the late 1990s, a number of Public Interest Litigations in courts resulted in the constitution of the Asim Barman Committee which made wide ranging recommendations on institutional, financial, health, and legal aspects of MSW management. Subsequently, the Central Government formulated a number of rules covering biomedical waste (1998), Fly Ash (1999), MSW Management and Handling Rules (2000), battery management (2001), Integrated Plant and Nutrient Management Taskforce (2005), National Urban Sanitation policy (2008), Plastic wastes (2011), e-Waste (2011), Waste to energy (2014), Revised Manual of Municipal Solid Waste Management, (2013), Task Force on Waste to Energy (2014), Swachh Bharat Mission (2014) and Construction and Demolition Waste rules (2017). As can be seen, there was no comprehensive look at waste to energy until the Planning Commission appointed the Task Force on Waste to Energy<sup>4</sup> of which the author was a member in his ex-officio capacity. The Task Force declared that **“It is recognized that any waste processing plant, small or big, which produces biogas, syngas, ethanol, electricity, liquid fuel or any other fuel is in fact a Waste to Energy plant and should be deemed eligible for support.”**<sup>5</sup>

## **1.2 Basis for policy formulation: Statistics of MSW and waste to energy in India; role and potential of energy generation from waste to electricity;**

The report of the Task Force summarised the parameters very well and provides an authentic source. To quote<sup>6</sup>:

“Currently, of the estimated 62 million tons of MSW generated annually by 377 million people in urban areas, more than 80% is disposed of indiscriminately at dump yards in an unhygienic manner by the municipal authorities leading to problems of health and environmental degradation. The untapped waste has a potential of generating 439 MW of power from 32,890 TPD of combustible wastes including Refuse Derived Fuel (RDF), 1.3 million cubic metre of biogas per day or 72 MW of electricity from biogas and 5.4 million metric tons of compost annually to support agriculture. The existing policies, programs and management structure do not adequately address the imminent challenge of managing this waste which is projected to be 165 million tons by 2031 and 436 million tons by 2050. Further, if the current 62 million tons annual generation of MSW continues to be dumped without treatment; it will need 3, 40,000 cubic meter of landfill space everyday (1240 hectare per year). Considering the projected waste generation of 165 million tons by 2031, the requirement of land for setting up landfill for 20 years (considering 10 meter high waste pile) could be as high as 66 thousand hectares of precious land, which our country cannot afford to waste. The Task Force (TF) has taken a serious view and considers it imperative to minimize the wastes going to landfill by at least 75% through processing of MSW using appropriate technologies. The processing will not only generate revenue and new products from waste,

but also improve public health and quality of life of people. World Health Organization (WHO) has observed that 22 types of diseases can be prevented/ controlled by improving the MSW management system. This will indirectly save huge financial resources currently spent on health and medical services. The thrust of the task force is therefore to minimize the quantum of waste for disposal by optimal utilization of the potential of all components of MSW by adopting the “concept of 5-R” – Reduce, Reuse, Recover, Recycle and Remanufacture – and through integrated Municipal Solid Waste Management, derive energy and other useful products and ensure safe disposal of residual waste. The ultimate objective should be zero waste going to landfills..... As per realistic estimates, potential of waste to energy projects in India can produce 32,890 tons of RDF each day which can currently support 88 power plants of 5 MW each in a foreseeable future of 5-7 years based on incineration, gasification or pyrolysis technologies. The number of power plants can increase to 215 plants by 2031 and 556 power plants by 2050 generating 2,780 MW power.” The above-mentioned quote summarises the vital statistics of municipal solid waste and waste to energy with all its complexities.

### **1.3 Institutional and Governance Challenges in respect of waste management:**

Institutional and Governance challenges with respect to energy security and waste management surface at four levels – Land, Capital, Technology, and Skillsets. To put all waste into energy generating assets, India needs large scale availability and allocation of land. In theory, large tracts of land are available. Rajasthan has 2, 00,000 square kilometres of desert. Abandoned mines are available for landfilling. Three million hectares of waste land are available. And yet, land acquisition is a common problem for all projects of waste management, energy security, and Swachh Bharat Mission. One of the problems in getting land for waste disposal is the foul smell emanating from the landfill sites for which there are no regulations earlier.

Further, the long term perceived environmental dangers and lack of scientific awareness among stakeholders is another problem. The author had a personal experience of locating a hazardous waste site near Bangalore in the early part of this century. The Karnataka Pollution Control Board, of which the author was the Chairman, had a collaboration project with GIZ to establish a disposal facility for hazardous waste of 40000 MTs, produced annually in Karnataka. The Board had chosen a site at Dobbasapete, near Bangalore, as there was local opposition in Siddalaghatta, another location. There was a lot of public opposition at Dobbasapete too. But the Board selected a large team of local stakeholders, including representatives from Industry, civil society and local authorities who were sent to Germany on a study tour. They were shown how such landfills were working without any problem there. They were fully involved in the decision making process. The resistance gradually disappeared and the disposal facility now works there in a public private partnership mode. The emerging bad odour and foul smell are a big problem.

Currently, so far as surrounding odour issues are involved, the Central Pollution Control Board<sup>7</sup> has issued draft notifications to set standards for such emissions and bring the matter under notified regulations. Once such regulations are legally in place, acquisition of land may become easier. Further, provincial governments have found many innovative ways of land acquisition. The Government of Andhra Pradesh has built its capital with voluntary surrender of land by all farmers as they get some compensation in the form of a ten year annuity and return of a portion of their land by way of residential and commercial plots with much higher value addition. Around 33000 acres of land have been pooled in this model. The Ahmedabad Municipality in Gujarat has been historically acquiring land on land sharing basis, on which the Amaravati model was based.

The story of the Government of Karnataka who has pooled almost 11000 acres of uncultivable land at an annual lease rental basis for establishing a 2000 MW solar park in Pavgada taluka of Tunkur district is similar. The problem of land will be obvious if one has a glance at the statistics below. Five highest solid-waste-generating cities (millions of tons per year) are Delhi (3.3 Million MT), Mumbai (2.7 MMT), Chennai (1.6 MMT), Hyderabad (1.4 MMT) and Kolkata (1.1 MMT). More than 70% of all collected urban waste is dumped at landfills. And most of these landfills are brimming or overflowing.

**Table 1: Known landfills and their area (hectares) (Source: MNRE)**

Sl no	Name of the city	Number of landfills	Area in Hactares
1	Delhi	3	66.4
2	Jaipur	3	31.4
3	Greater Mumbai	3	140
4	Chennai	2	465.5
5	Greater Bangalore	2	40.7
6	Greater Hyderabad	1	121.5
7	Ahmedabad	1	84
8	Tiruvantapuram	1	12.15
9	Kolkata	1	24.7
10	Chandigarh	1	18
11	Ranchi	1	15
12	Raipur	1	14.6
13	Gauhati	1	13.2

14	Srinagar	1	30.4
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**Table 2: Types of waste generated per year in India (In MTs) (Source: MNRE)**

Hazardous	07.90
Plastic	05.60
e-waste	01.50
Biomedical	0.170
Others	46.83
Total	62 00

As can be seen above these cities need a lot more areas for landfill sites. The second common challenge is the absence of low cost capital and systems in which low cost technology can be deployed, demand for goods and services can be aggregated and costs of goods and services can be reduced and bankable projects can be developed. The Swachh Bharat Mission is mostly driven through public funding and Corporate Social Responsibility resources from the corporate sector. In the Waste to Energy sector, each Municipality finds its own supplier of technology. Goods and services required to generate and utilise 439 MW of power from 32,890 Tons per day of combustible wastes including Refused Derived Fuel (RDF), 1.3 million cubic metre of biogas per day or 72 MW of electricity from biogas and 5.4 million metric tons of compost annually to support agriculture can indeed be huge. None of the three sectors have an ecosystem to attract private capital in a big way, although potential to benefit the environment, create employment and attract investment is substantial in each of the three sectors. The capital requirement is projected to be USD 4 2780 Million by 2050 at current levels of assumption of one Million US 4 per MW of waste to energy.

The third institutional and governance challenge lies in the area of technology selection, acquisition and costing. However, the recommendations in the Kasturirangan report have been a great source of strength to policy makers and has been quoted below.

“<sup>8</sup>Selection of appropriate technologies for processing of MSW waste, learning from past experience, it was considered essential to identify suitable technology or combination of technologies for processing all treatable components of MSW. It was observed that there are several technologies currently being advocated for processing of waste world over. These technologies can be classified into two broad categories namely: 1. Bio-chemical conversion of biodegradable MSW 2. Thermal processing of MSW. Group one covers technologies such as composting and biomethanation, whereas Group 2, include technologies like gasification, pyrolysis, incineration and mass burning. Refuse Derived Fuel (RDF) can also be prepared from combustible MSW and xiii used as a feedstock for W to E plants. Technology for production of syngas also merits consideration. Besides conventional W to E technologies,

new technologies are emerging in India for converting polymeric wastes to liquid fuel called "catalytic conversion of waste plastic to liquid fuel" and blending chopped plastic waste with molten bitumen for enhancing the strength of roads. These technologies can also be used for profitably utilizing plastic wastes which are not currently recycled.

Strength, Weakness, Opportunities, Threat (SWOT) analysis and environmental footprint analysis of existing W to E technologies: In order to select appropriate technologies, SWOT analysis as well as environmental footprint analysis have been carried out in respect of each technology; its relative strengths and weaknesses have been examined in detail and a framework for appropriate technological options has been worked out for adoption by various cities depending on their population, quantity and quality of waste generated.

Appropriate Technological Options: In the Indian context, the following technologies are identified for processing of MSW:- a. Biomethanation for wet biodegradable wastes b. Conventional microbial windrow/mechanized/ vermi composting for wet biodegradable wastes c. Preparation of briquette/ pellets/ fluff as Refuse Derived Fuel (RDF) from dry high-calorific value combustible wastes d. Incineration / Gasification / Pyrolysis for dry high-calorific value combustible wastes e. Plastic wastes to fuel oil.

A combination of aforesaid technologies has been identified based on the range of population and quantity and quality (percentage of biodegradable) of wastes generated. In addition, the cost of setting up of processing plants along with the expected quantities of value added products and by-products have also been considered. Choice of suitable technologies for various classes of cities as per 2011 census is given below. Cities with population of 2 million and above, which generate more than 1100 TPD of MSW thermal route are suitable for setting up standalone waste to energy plants. These cities should also setup a combination of biomethanation, and composting plants besides setting up of W to E plants to optimally utilize biodegradable wastes. Conversion of waste plastic to fuel oil which is an emerging technology is also suggested as an option. Cities with population of one to two million, which generate more than 550 TPD of MSW are suitable for setting up a waste to energy plant based on thermal route only -- with the support of adjoining cities supplying RDF to make the W to E plant viable. These cities should also setup a combination of biomethanation, and composting plants to optimally utilize biodegradable wastes. Conversion of waste plastic to fuel oil has also been suggested as an option. In respect of the 415 Class I cities which have a population range of 1 lakh to 1 million generating 30 to 550 TPD of MSW, the technological options are a combination of biomethanation and composting (VC/CC) plants to optimally utilize biodegradable wastes. However, these cities may set up a common /regional W to E plant after ensuring adequate availability of RDF on a regular basis from participating cities. Conversion of waste plastic to fuel oil is also suggested. Hill stations are also included in this set of cities and local bodies will have to ensure that recommendations made for hill cities in respect of technological options be used for ensuring proper disposal of MSW. For towns with population below 100,000 including peri-urban areas (although known as villages but declared as census towns and included in urban population), which generate less than 30 TPD waste and have 30 to 65% of biodegradable fraction of MSW, a combination of biomethanation, composting (VC/CC) and RDF preparation is considered the most suitable technological option for management of MSW. These cities should segregate dry waste, prepare RDF and supply RDF prepared as fuel to W to E plants established in cities with over a population of 1 million. The biogas generated from biomethanation plants can be utilized for direct supply through pipelines or converted to power. In case of plants with 10 TPD and above capacity, biogas can be commercially bottled and marketed. Process flow diagram: Looking at the size of the cities and volume of the wastes generated, process flow diagrams have been drawn to enable local authorities to integrate waste management as well as processing and disposal of waste. A

typical process flow diagram for cities above 2 million which have potential of setting up waste to energy plants is given in ... Viability of W to E plants: As W to E plants are viable only when the plant has a capacity to process 300 TPD or more segregated waste, it should only be set up in large cities with population above 2 million or for a group of cities exceeding that population. The combustible waste generated in small towns and cities should therefore be utilized for preparing RDF and used as feed stock for power plants or cement or metallurgical plants.”

The fourth area of institutional and governance challenge is manpower planning and training for the waste to energy sector and integration of the formal and the informal sector. To quote from the Task Force’s report again:

“The existing policies, programmes and management structure do not adequately address the imminent challenge of managing this waste which is projected to be 165 million tons by 2031 and 436 million tons by 2050.” Hence India needs large scale man power planning for the waste management sector as a whole – in areas of input and output management in the waste to energy sector, i.e., in areas of composting, biomethanation, gasification, pyrolysis, incineration and mass burning, Refuse Derived Fuel (RDF) as feed stock, new technologies in India for converting polymeric wastes to liquid fuel called "catalytic conversion of waste plastic to liquid fuel blending chopped plastic waste with molten bitumen for enhancing the strength of roads. The scope also includes large scale training and retraining of stakeholders in areas of 3R (Reduce, Reuse and Recycle)

#### **1.4 Understanding of constitutional and legal connections among the three thematic areas in the context of 21st Century implementation of policies and programs:**

A 21st Century Vision on Waste to Energy in India: A Win-Win Strategy towards Energy Security and Swachh Bharat Mission (Clean India Mission) must integrate all the three segments – waste energy and cleanliness - serving one another and ultimately leading to a zero waste society. Keeping this central focus in view, policy makers could (a) develop a comprehensive waste to energy policy and programs (b) build and reengineer suitable and required institutions and (c) adopt innovative and appropriate technologies. They could also ensure proper integration of these policies and programs with the 3R - Reduce, Reuse and Recycle policies and programs. The win-win part will be that the integration of two thematic areas, i.e., waste to energy and Swachh Bharat Mission with Solid Waste Management policy will lead to a number of socio-economic and environmental benefits like (a) energy security, (b) promotion of circular economy (c) employment generation, and (d) environmental benefits under the 2030 Agenda for Sustainable Development. The newly emergent policy paradigm of 21<sup>st</sup> Century India is mentioned below in a diagram wherein the synergetic interaction and intersection among the three thematic areas are well projected.



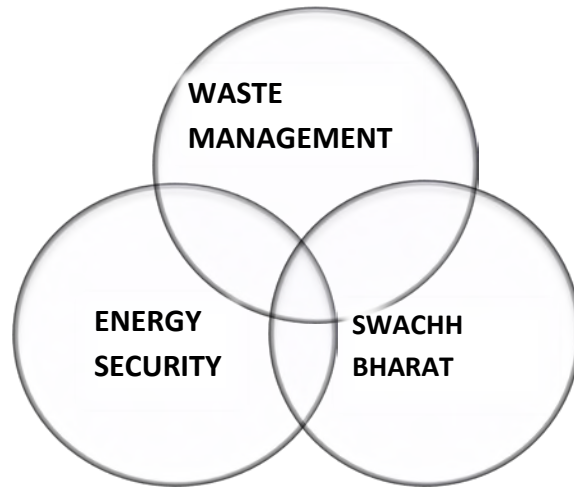


Figure 1: SYNERGY OF WASTE MANAGEMENT, ENERGY SECURITY AND SWACHH BHARAT (Source: Self)

## Chapter II

### **2. Energy Security and Sustainable Development: Analysis of the synergies between waste to energy, and 3R (Reduce, Reuse, Recycle of waste). Linkages with SDG Goal numbers 7, 11 and 12.**

Chapter II deals with energy security, sustainable development, regulatory framework of the energy sector, energy security issues in India and analysis of the synergies between energy security, waste management sector, waste to energy and 3R (reduce, reuse, and recycle of waste), and relationship with and implications towards Sustainable Development Goals (SDG) numbers 7, 11 and 12, as well as institutional and governance challenges in respect of energy security in India.

#### **2.1 Emerging critical policy parameters and interrelationship among (a) waste management, (b) energy security and (c) Swachh Bharat in India, in the context of solid waste management:**

<sup>9</sup>“Incineration-based waste-to-energy technologies have recently emerged as the preferred policy option for managing the growing problem of waste in India. These technologies require a continuous supply of waste inputs of sufficient quantity and quality—high calorific value and low moisture content—to be viable. Government and industry proponents suggest that WtE and recycling are compatible systems of managing waste while their critics disagree. This article argues two main points. First, the government’s preference for WtE



contradicts the empirical evidence, which suggests that the physical, chemical and biological characteristics of Indian waste render it technically unsuitable for incineration. Second, to be viable, WtE technologies will require end-to-end control over the entire waste management chain, thus displacing those in the informal recycling sector from their means of subsistence. Far from being compatible, the two systems are in fact in competition with each other over the same set of material resources.”

As can be seen from the above-mentioned quotation in the article by Prof. Aman Luthra, the Indian policy makers and regulations they put in place to manage the waste sector since the 1950s were not woven around the theme of waste hierarchy. Neither did the policies preemptively capture the needs of a nation on the rise, both demographically and in terms of rising consumptions and GDP. The measures adopted were more top-down in nature, made at federal levels, and sent out for implementation at lower levels. The Central Government made the rules and sub-national state agencies implemented them. Initially, there were no market instruments in place to create an attractive market for waste management, supported with adequate generation of mass awareness and education. Designing and manufacturing sectors were not geared up to use fewer materials for production and manufacturing, become fiercely energy efficient, have increased shelf lives of products, and use less hazardous and waste producing factors of production. Wastes were not highlighted as a valuable resource of the economic systems and society. People in general believed that waste was something that should be just thrown away, buried or burnt. In essence, prevention of generation of waste, zero waste economies and circular economy are not yet a part of the policy discourse.

However, the story over the 21<sup>st</sup> Century has changed a lot and is changing for the better. To sum up I reproduce brief articles recently published in a national daily for its balanced coverage of the latest in the field of waste to energy scenario in India. **Cities at crossroads: Not letting it go waste**<sup>10</sup>

Waste to energy plants could sustainably dispose of municipal solid waste, while generating electricity.

“In my recent columns on management of solid waste or garbage in our cities, I have emphasised that a credible solution must have three elements. The first element is segregation of biodegradable or wet waste from dry waste at source. The second is that once segregation is achieved, municipal governments can use wet waste to produce compost and biogas in biomethanation plants. And the third is that the dry waste, after removing recyclable elements, should go to waste-to-energy plants: This will reduce the volume of waste that remains to be sent to landfills. In this column, we focus on what we know about waste-to-energy plants.

A number of waste-to-energy plants are coming up in urban India, using incineration, Refuse Derived Fuel (RDF)-based combustion or conversion technologies such as pyrolysis and gasification. There is a great deal of confusion about what the different technologies entail, and also apprehension about the potentially damaging impact of waste-to-energy plants on the environment in general, the quality of air in particular, and consequently, on public health. There are also questions about whether these plants are financially viable.

The controversial waste-to-energy plant based on incineration of unsegregated municipal

solid waste at Okhla, South Delhi, processes almost 2,000 tons of unsegregated municipal solid waste every day to feed into its boilers to produce 16 MW of electricity. The plant came under fire initially because it did not comply with emission requirements. It has been recently cleared for operations by the National Green Tribunal (NGT), which has certified that it now meets the emission standards of the Central Pollution Control Board (CPCB).

A more recent waste-to-energy plant at Ghazipur, East Delhi, based on controlled combustion, produces RDF from segregated dry waste and uses the same in onsite boilers to generate electricity, performing at EU standards of emissions. The plant receives 1,300 tons of mixed waste every day from the East Delhi Municipal Corporation, which is reduced to about 40 per cent of the total after segregation. From 550 tons of feedstock, the plant produces 12 MW of electricity.

Incineration-based waste-to-energy plants rely on mass burning of municipal solid waste, which involves complete combustion of miscellaneous waste materials into ash. The latter is also true of RDF combustion-based plants. Depending on what is being combusted (and this is a huge challenge to determine with municipal solid waste), the gases generated may contain dioxins and furans, which are toxic and can be lethal. These plants therefore need to put in place emission control filters of a very high standard to check the release of harmful gases into the atmosphere. There is a need for continuous monitoring of emissions and sharing information openly, if public apprehensions are to be put at rest.

Singapore uses incineration with due environmental precautions in managing its municipal solid waste after recycling 60 per cent of its waste (among the highest rates in the world). Japan and a number of European countries also rely on incineration, with due precaution, as they try to minimise the waste that needs to go to landfills. The United States had a long free run with incineration plants, but thanks to the environmental movement, there has been a significant tightening of regulations with respect to emissions since the 1970s. The abundance of land in the US led to greater recourse to landfills. But incineration plants are making a comeback and with these, so is the need for vigilance on emissions.

The innovations in waste-to-energy technologies worldwide have been focusing on pyrolysis, gasification and plasma gasification, which can deliver cleaner emissions but are considerably more expensive. These technologies involve heating of solid waste at very high temperatures in an oxygen-controlled environment, such that the thermal reactions produce synthesis gas (or syngas) which has the advantage that it can be burned directly or transported through pipelines and/or tankers for use in electricity generation, refining, chemical and fertiliser industries. While syngas can be scrubbed and converted into a clean energy source, the technologies are expensive, compromising the commercial viability of plants based on conversion technologies.

A waste-to-energy plant based on pyrolysis-gasification technology was set up in Pune in 2012, but it has failed to deliver after repeated trials. It failed, not only because of the high cost of cleaning syngas, but also because of a number of technical snags, including the fact that it had overestimated the calorific value of the waste and underestimated the moisture content. The company now produces RDF using 300 tons of dry municipal waste per day — less than half of what was intended in the design of the original plant.

Pollution control boards set up by the government of India and state governments were expected to provide technical assistance and keep a check on the emissions/environmental footprints of waste-to-energy plants. Unfortunately, they have not kept pace with the rapidly

evolving technology in the field of pollution control and were not able to check routine defaulters. Recognising the need for a more empowered body that could enforce adherence to environmental regulations, the National Green Tribunal was set up in 2010, as an independent judicial body under an act by the Parliament of India. As a judicial body in charge of supervisory jurisdiction over all environmental matters, NGT has, in many cases, prodded the pollution control authorities and catalysed action from State Pollution Control Boards/Municipalities, especially in waste management. It has been setting the rules of the game and putting the weight of legal compensation and enforcement behind its rulings. Hopefully, NGT will receive full support from the Central Pollution Control Board in its quest for scientific evaluations of the environmental impact of waste-to-energy plants.

The level of subsidy required to make waste-to-energy plants financially viable presents another set of problems. These plants involve significant capital investment and the cost of energy produced is higher than from the grid, unless there are government subsidies. Considering their contribution to resource recovery and saving on the energy cost of transportation, which would otherwise be incurred to haul waste to a landfill, there is a good case for subsidising these plants.

Municipal bodies give benefits to waste to energy plants, such as land for free or at token amounts plus a tipping fee for each ton of waste processed. However, this does not suffice to make the cost of electricity produced from these plants competitive with conventional sources. The talk of waste to wealth in this context is misleading. A subsidy is still needed; a transparent method must be found to determine the maximum subsidy feasible through competitive bidding.

It is also important to emphasise that electricity generation from waste is not the most efficient way of generating electricity. It is a way of resource recovery from municipal solid waste and should be considered as a by-product of waste management. Enthusiasts sometimes speak of waste-to-energy as a solution to our energy problem — this is not correct. However, if implemented to global emission standards, it could be a pathway to scientific and sustainable disposal of municipal solid waste, given the scarcity of urban land in the country, while also generating some much needed electricity.”

## **2.2 The role of waste hierarchy<sup>11</sup> in waste management:**

In essence, there were no integrated policies that reflected the waste hierarchy<sup>12</sup> given below. However, now most of the Municipalities, stakeholders and policy makers are aware of the waste hierarchy and the movement is catching up<sup>13</sup>. Policy makers have discovered the value in waste and its environmental and health implications, perhaps since the Surat Plague crisis. More and more policies and programs, culminating in Swachh Bharat have come up with a focus to address the issues of the waste management sector. This is proven by the fact that out of the eight Missions adopted under the National Action Plan on Climate Change (NAPCC), almost each Mission impacted the waste sector or had interconnections with it - National solar mission, the national mission for enhanced energy efficiency, national mission on sustainable habitat, national water mission, national mission for sustaining the Himalayan ecosystem, national mission for a green India, national mission for sustainable agriculture, and national mission on strategic knowledge for climate change.

“<sup>14</sup>The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. The proper application of the waste hierarchy can have several benefits. It can help prevent emissions of greenhouse gases, reduces pollutants, save energy, conserves resources, create jobs and stimulate the development of green technologies.”



Source: Figure 2: HIERARCHY OF WASTE PYRAMID(Source: <http://www.sswm.info/content/nusp-overview>)

## Goal numbers 7, 11 and 12 in SDGs

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

Goal No: 7

Despite tremendous expansion of energy infrastructure, one in five people still lacks access to modern electricity. Three billion people still rely on wood, coal, charcoal or animal waste for cooking and heating, despite an abundance of solar and other renewable sources. Although availability of energy defines the nature of our civilization, energy is the most dominant contributor to climate change, accounting for around 60% of the total global greenhouse gas

emissions. Reducing the carbon intensity of energy is a key objective in long-term climate goals, as rightly reflected in the Paris Accord.

To quote from UNDP document on SDGs:

“Between 1990 and 2010, the number of people with access to electricity has increased by 1.7 billion, and as the global population continues to rise so will the demand for cheap energy. A global economy reliant on fossil fuels and the increase of greenhouse gas emissions is creating drastic changes to our climate system. This is impacting every continent.

Efforts to encourage clean energy have resulted in more than 20 percent of global power being generated by renewable sources as of 2011. But still one in five people lack access to electricity and as the demand continues to rise there needs to be a substantial increase in the production of renewable energy across the world.

Ensuring universal access to affordable electricity by 2030 means investing in clean energy sources such as solar, wind and other renewables. Adopting cost-effective standards for a wider range of technologies could also reduce the global electricity consumption by buildings and industry by 14 percent. This means avoiding roughly 1,300 mid-size power plants. Expanding infrastructure and upgrading technology to provide clean energy in all developing countries is a crucial goal that can both encourage growth and help the environment.<sup>15</sup>”

### **2.3 Behavioural change among climate friendly citizens:**

All policies aim at some level of behaviours changes among the climate conscious citizens. Once a conscious citizen follows the waste hierarchy, waste no more poses as a risk or nuisance. These behavioural changes make waste into industrial and agricultural inputs. To quote:

<sup>16</sup>“By now (*once you follow the philosophy of waste hierarchy*) you are an expert in refusing unwanted items. You buy only what you truly need and your home is clutter-free. However, despite introducing these steps you will still come across items, especially packaging, that you won’t be able to easily reuse or compost. In this case, the only thing you can do is to recycle these materials. That is, if they are recyclable.....Recycling takes time, demands large amounts of water and energy as well as produces some pollutants. However, considering that extraction of raw materials involves mining, quarrying, and logging—all of which pollute the air, water, and soil—the recycling process brings less environmental damage and reduces the number of items we send to landfills and incinerators.

Here’s a list of top 10 reasons why recycling is a sound solution:

1. it’s good for economy. Many companies rely on recycling programs to provide less expensive raw materials for new products.
2. It creates jobs. For example, recycling in America alone is a \$240 billion industry. More than 56,000 recycling and reuse facilities provide 1.1 million jobs nationwide.

3. It reduces waste. The average American discards 7.5 pounds of garbage each day. Most of this garbage goes into landfills, where it's compacted and buried.
4. it's good for the environment. Recycling requires less energy, fewer natural resources, and keeps waste from piling up in landfills.
5. It saves energy. Recycling offers substantial energy, which saves virgin materials from being manufactured.
6. It preserves landfill space. No one wants to live next to a landfill; recycling slows down the rate in which we fill up landfills, hence it reduces the need for more new sites.
7. It prevents global warming. Recycling of solid waste prevents the release of carbon dioxide into the air. The current UK recycling scheme is estimated to save more than 18 million tons of CO<sub>2</sub> a year.
8. It reduces water pollution. Making goods from recycled materials generates substantially less water pollution than manufacturing from virgin materials.
9. It protects wildlife. Using recycled materials reduces damage done to forests, rivers, and other habitats.
10. It creates new demand. Recycling and buying recycled products creates a demand for more recycled products, decreasing waste, and helping economy."

These reasons hold true for India too for recycling. Citizens personal and climate friendly efforts to recycle contribute to reclaiming valuable materials as well as saving water, energy, and other resources. However, specific data on investment and employment on the Indian recycling sector were not easily available.

**SDG Goal 7 Targets<sup>17</sup>:** Goal seven lays down targets of universal energy access to affordable, reliable and modern energy services by 2030; increase in share of renewable energy in global energy mix; doubling of energy efficiency; access to clean energy research and clean fossil fuel technologies, and prioritization of small island countries and LDCs to share benefits. Clearly SDG 7 goals go well beyond energy security. Waste to energy plays its role in many countries to promote energy access, even though in India, given the size and relative cost, it will play rather a limited role in promoting energy security in grid connected areas. However, in or nearby cities, energy from waste can contribute to meet energy shortages at peak hours, manage base load, and enable injection of a higher volume of renewable energy into the grid. However, a total of 440 MW from solid waste constitutes a microscopic share in the Indian scene where more than 300000 MW installed capacity works today. Hence more and more priority should go for recycling.

**SDG Goal 11 Targets:** To quote from UNDP document<sup>18</sup>:

"More than half of the world's population now live in urban areas. By 2050, that figure will have risen to 6.5 billion people – two-thirds of all humanity. Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban

spaces.” Goal 11 talks about making cities safe and sustainable in terms of improvements to urban slums, and affordable housing. Very clearly, Goal 11 is not realizable without the management of urban waste. One thus finds a clear and direct linkage between solid waste management, waste to energy and Swachh Bharat and SDG 11.

To quote<sup>19</sup>: “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.”

This makes it very clear that without the realization of Swachh Bharat and energy security, SDG Goal 11 will remain incomplete, and vice versa.

**SDG Goal 12 Targets:** To quote<sup>20</sup>:

“Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources. Agriculture is the biggest user of water worldwide, and irrigation now claims close to 70 percent of all freshwater for human use.

The efficient management of our shared natural resources, and the way we dispose of toxic waste and pollutants, are important targets to achieve this goal. Encouraging industries, businesses and consumers to recycle and reduce waste is equally important, as is supporting developing countries to move towards more sustainable patterns of consumption by 2030.

A large share of the world population is still consuming far too little to meet even their basic needs. Halving the per capita of global food waste at the retailer and consumer levels is also important for creating more efficient production and supply chains. This can help with food security, and shift us towards a more resource efficient economy.”

To quote<sup>21</sup>:

“Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.

By 2030, achieve the sustainable management and efficient use of natural resources.

By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

**By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.**

Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.

Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.

Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities”.

SDG Goal 12 is an integral part of waste management and energy security.

## **2.4 Swachh Bharat Mission (SBM)<sup>22</sup>, Waste to Energy and SDGs**

Globally, almost 2.4 billion people lack access to basic sanitation services, such as toilets or latrines. More than 80% of waste water resulting from human activities is discharged into rivers or sea without any pollution removal. Each day, nearly 1,000 children die due to preventable water and sanitation-related diarrhoeal diseases. These global phenomena are also true of India. Hence there are very strong links between waste management in a country and realization of SDGs.

The Swachh Bharat Mission is linked to **Goal 7, 11 and 12** of the Sustainable Development Goals.

**Linkages between Swachh Bharat Mission and waste management In India:**



SBM is being implemented by the Ministry of Urban Development (MoUD) and by the Ministry of Drinking Water and Sanitation (MoDWS) for urban and rural areas, respectively. The Swachh Bharat Mission document specifically mentions about solid and liquid waste management both in rural and urban areas. In the rural areas of India, its emphasis is to bring awareness that creates demand for waste management from grassroots levels. Once the demand is created, to ensure that the resources are used efficiently, Solid and Liquid Waste Management (SLWM) is to be taken up in project mode for each Gram Panchayat (GP) with financial assistance capped for a Gram Panchayat on the basis of the number of household to enable all GPs to implement sustainable SLWM projects. This is a brilliant example of both cooperative models and demand aggregation to improve on scaling.

To quote: <sup>23</sup>

“5.10.1 The objective of Swachh Bharat Mission is to bring about improvement in the cleanliness, hygiene and the general quality of life in rural areas. Solid and Liquid Waste Management (SLWM) is one of the key components of the programme. To create clean villages, it is essential that the IEC interventions focus on Solid and Liquid Waste Management so as to create a felt need for these activities amongst the population. This must lead to the setting up of systems for the scientific disposal of waste in such a way that has a tangible impact on the population. The Community /Gram panchayat has to be motivated to come forward and demand for such a system, which they have to subsequently operate and maintain.”

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## Chapter III

### **3. Economics of waste in India; prospects of circular economy with mass scale introduction of waste to energy policies/programs/technologies.**

Chapter III deals with the economics of the waste sector in India, i.e., cost of WtE in comparison with other forms of energy like hydro, thermal, solar and wind, and the special treatment of WtE under the National Tariff Policy 2016 as an example of policy push and existing policy perception about WtE in India. Further, it examines the economics of waste in connection with the emerging prospects of circular economy with large scale introduction of waste to energy policies/programs/technologies under the new push of Swachh Bharat Mission and the economics of Clean India Mission or Swachh Bharat Mission.

#### **3.1 Synergies between waste - to - energy, 3R (Reduce, Reuse, and Recycle of waste; energy security and sustainable development:**

“Over the past few years, energy security and sustainable development have moved up the global agenda. There are two main reasons for this: first, the impact of high and often volatile energy prices; second, concerns over environmental sustainability and particularly about the global climate. Both issues are critically important.... You may be surprised to discover that your phone is made from more than 62 metals and metalloids, of which some are extremely rare and even irreplaceable. According to a study conducted by researchers from the Yale School of Forestry & Environmental Studies, not a single metallic ingredient in phones today has a substitute that could be considered ‘just as good’. In other words, there will be no real effective substitute in existence at all once we use up all the essential metals that make our phones. If most of the resources can be reclaimed from already existing products, a zero waste society would have little need for obtaining raw/virgin materials. This would significantly reduce the number of mining and excavation sites. By being conscious consumers and buying goods that last longer, we can put less pressure on manufacturers and production industries to supply more goods. These changes will have a positive impact on the amount of energy, water, and raw materials we use every day. For example, it takes a staggering 80,000 gallons (364,000 litres) of water to produce steel for the average car; not to mention the energy and other resources needed to get it to its finished product. The majority of manufacturing companies produce different types of toxic waste in the course of production, which often requires specialised treatment. This process is not only expensive, but is also heavily reliant on the use of water. The burying of hazardous waste adds a further risk to air, water, and soil contamination.”<sup>24</sup>

India needs an eco-innovation index, like Sweden, where less than 1% of its rubbish gets sent to landfills. Indicators that make up the indices include: health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, and climate and energy. However, the general waste discourse in India, as evidenced from various newspaper reports and articles, do not talk about circular economy and / or zero waste futures. This is important particularly in the areas of electronics and solar applications. The future waste management in these areas are going to be throwing up many challenges. The

target of 40000 MW of rooftops, over the years, in cities and villages, will require recycling of solar panels. Similarly, recycling and safe disposal of many electronic items, in the absence of many hazardous waste disposal sites in the country, will be a great challenge and need a lot of focus in the 21<sup>st</sup> century. Some of the areas for monitoring and research in 21<sup>st</sup> century India, in order to avoid excessive consumption and unnecessary accumulation, will be:

How many items are there in an average Indian home in urban areas?

Increase in average size of homes in urban areas?

Increase in availability and renting of offsite storages and ware houses to store household goods?

Number of houses with more than one garage?

Average number of plastic toys in middle class homes?

Number of mobile phones per family?

Similarly, reusing of materials when these are usable but are lying idle at homes and garages, have both social and economic implications, particularly in the context of India, where many households still lack access to energy in the electrified villages due to lack of affordability<sup>25</sup>. Recently, due to PM's emphasis on a clean and green India, a number of local authorities, corporates, NGOs and other related agencies and institutions have started several measures to bring in awareness in the areas of reusing, covering questions, such as:

“What is reusing and why we should do more of it?”

Environmental benefits of reusing:

Energy and resource efficiency issues of reusing metals such as Aluminium; (Aluminium can be repurposed using less than 5 percent of the energy used to make the original product) Plastics; (Producing new plastic from reclaimed material uses only two-thirds of the energy required to manufacture it from raw materials); glass (Producing glass from virgin materials requires 30 percent more energy than producing it from crushed, used glass); Tin cans (Tin Cans contain 99 percent steel and by reusing this material, we can save between 60 and 74 percent of the energy used to produce tins from raw materials.), papers (Reusing 1 ton of paper saves between 15 and 17 mature trees.) etc.

Reusing<sup>26</sup> and its linkages to circular economy and how it creates opportunities for investment, employment and prevents unnecessary exploitation of natural resources has been demonstrated in many countries and Indian policy makers have to take note of such global developments<sup>27</sup>.

Waste is usually considered to be a useless nuisance. The vast stretch of useless plastics lying on the railway tracks or near city and village suburbs make a ghastly sight. In economic terms in India, waste is mostly an undesired commodity of negative value. But the good news is that in many quarters, it is getting its place of importance now. Policy makers being tired of dealing with waste for decades, and being overwhelmed with its management are trying to bring in durable projects in the new era of Swachh Bharat

The other collateral problem is litigation in the waste management regime. In 2007, Ministry of New and Renewable Energy went for five waste to energy plants. One NGO went to the court challenging the technology adopted. The cases are still pending – except that these cases have moved from the Supreme Court to the Green Tribunal. There is no end in sight still. But things have moved on.

Further, in most local bodies and municipalities, most of the budget is being spent to collect and transport waste to the landfills. It is a spending activity. Given the scarce resources of local bodies, planners and policy makers would like to get rid of the waste as soon as possible. And that is not an easy task. Hence waste is always a drain in the purse of the local bodies that have been entrusted to manage the ever growing waste generation.

### **3.2 Economics of viability gap funding to promote usage:**

Subsequent to the Task Force recommendation in 2014, and having decided that it is a desired activity to generate power from waste, Government have various scales of subsidising these activities up to a percentage of the capital cost. Recently in 2016, a preferential tariff line has been opened up for the waste related power sector. State Utilities have been told to buy power from paying up to INR 7 per Kwh (10 Cents US). This is almost three times the cost of solar power which came down to almost 3 Cents US in Rajasthan. However, the logic is that once the volume of power generation grows, the cost will come down. That was the case with solar. In the year 2010, the cost of solar power was almost three times more than what it is now. However, the logic holds good only up to a point as the total capacity of generation from waste may not be more than 2780 MW by 2050. However, one MW of waste power is equal to 3 MW of solar capacity as waste plants work round the clock, unlike solar, although the cost per MW from waste plants is much higher.

**Source: Google Images of 3 Rs**

### **3.3 Economics of reuse, recycle, and recovery:**

“<sup>28</sup>The three R's – reduce, reuse and recycle – all help to cut down on the amount of waste we throw away. They conserve natural resources, landfill space and energy. Plus, the three R's save land and money communities must use to dispose of waste in landfills.”

Economics of reuse is well established. This reduces landfill emissions. For example, a ton of wood in the landfill produces 600 kg of Carbon dioxide. One can well monetise this benefit. Many reusable products reduce pressure at the source of raw material. For example, reuse of wood products or paper reduces pressure on forests. To make some product reusable, consumes almost one tenth of power than producing the product again. Hence reuse of a

product results in less wastage of energy. Reuse as an industry also creates employment and attracts investment.

Preparation for rendering products reusable generates activities like checking, cleaning, repairing, refurbishing of whole items or spare parts, etc. This came up largely due to the role of the informal sector and the large number of people who sought employment through these gainful activities. There were no declared state policies on reuse of goods and products in India. Poverty and lack of employment also made people reuse, recover and locally recycle materials. The practice of “Garage Sales” to promote reuse is common in the cities in the West, wherein households sit at the front of the garage or front yard during the brief summer and displaying the used, semi-used and disposable products for others to pick up, mostly by migrants and students or other people in need. Similarly, well organised chains of NGO type organizations, like Salvation Army, open and operate large chains of donation based second hand clothing, housewares and toy sales centres or thrift stores. Such practices are not very common in Indian cities. But it is not a bad idea to promote them.

In the technology front, of late, many cyber portals are active in this area of resale and goods do change hands for reuse. Online shopping, and related portals like Quikr, Olx, Ebay, Vintagedesi, and Cartrade have created a market for second hand products estimated to be USD 12.3 billion, excluding the automobile segment, according to a report by ASSOCHAM. Quikr operates in 940 cities in a meet online and collect offline mode. Cartrade operates with 4000 traders and 4 million visitors visit its website every month. Books, apparels, sports goods, gadgets, cars, bikes, and luxury items are the most traded items. The most significant impact of this sector is in terms of both refuse and reuse of most items bought. The buyers postpone their purchase of new items, thus prevent depletion of new resources. And there is direct impact on prevention of e-waste and other solid wastes and avoidance of wastes of similar types due to delayed use of fresh resources which would have been used, had not so many customers satisfied their desires with old and used products. Amazon.com also operates a ‘Used & Refurbished Store’ section which is very popular.

Another type of portal is now emerging wherein you can share or borrow after connecting with people and making them share and borrow their stuff, instead of buying and selling “<sup>29</sup>”. However, one comes across very innovative reuse and recycling of objects. In Annex 1, are some pictures of reuse of a steel frame of gas stove for a traditional *Chula*, use of broken clock on the wall again, use of syntax tank for parking of two motorcycles, and reuse of a coke bottle as a water pipe for bating. These are cases representing many people from the vast subcontinent, who reuse materials and help the environment and economy.

Recycling waste into a new substance or product was not much visible in the Industrial sector. The only remarkable policy measure was the provisioning of loans for composting of solid waste in the early 60s. But such composting of local solid waste by farmers in India in the rural areas was a very common practice where they store animal dungs in identified pits, mix other organic matters and periodically mix the same and use in their fields as organic manure.

Recovery activities, in the form of anaerobic digestion, incineration with energy recovery, gasification, pyrolysis producing energy, heat and power, and producing valuable materials from waste, were neither widespread activities nor were widely discussed in the policy discourse. There were no industrial or investment policies, programs and targets for prevention of waste, promotion of reuse and recycling or other recoveries. Increasingly recovery is picking up in India and an industry is emerging. To quote:

“<sup>30</sup>Solid waste management in India currently faces a great challenge in handling rapidly increasing waste amounts and changing disposal behaviour. After a recent shift in policies, the Indian government has released several incentives for national and international waste management experts to enter the Indian market. However, waste management projects have to overcome the various problems arising from the unique system characteristics in India. If certain requirements can be met, waste management in India offers great opportunities for national and international knowledge and technology transfer.”

Prospects of circular economy:

A common perusal of literature of press coverage in India on solid waste doesn't give the impression that circular economy is a hot topic. The author, an important policy maker in the Indian scene, first heard of the word 'Circular Economy' from the director in charge of HRD in Solar Energy Corporation of India in a workshop a year back. This shows how distant is the concept to Indian policy makers at present. Given this background, it is a necessity to throw some light on what this concept is.

“<sup>31</sup>Inspiration comes from Graham Wiles. He was paid to collect the cardboard and sold it to equestrian centres as horse bedding. Then he put it into worm recomposing systems which produced worms, which he fed to Siberian sturgeon which produced caviar, which he sold back to the restaurants, the original producer of waste!

He identified a path of turning a common waste product into a high value end product. A linear process to a closed loop model is completed.

People tend to extract the resources, then turn them into short life products and then dispose them. In ecosystem, the waste from one organism becomes the nutrient for something else in that system. Holding the vision of zero waste, we come up with the idea of Recycle Trade or circular economy.”

Apart from Graham Wiles, one can take up the example of numerous cement plants in India.

<sup>32</sup>Cement Information System (CIS) of the Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Government of India gives a list of 90 major cement companies who have several factories each. “<sup>33</sup>A Cement Plant can be considered as an Energy Recovery Plant. The mineral waste (Ca, Al, Si, Fe) can be used as secondary raw material or as an additive in cement (slag, fly ash, synthetic gypsum). Items that can be classified as Calorific Waste (used tyres, used oils, spent solvents, biomass, etc.) can be used as a substitute to fossil fuels. This reduces fuel cost and simultaneously solves a waste problem besides reducing the overall CO<sub>2</sub> emissions. Therefore, burning of

calorific waste in cement kilns is effective, ecological and cheap while energy is totally recovered. It also reduces the need for new dedicated incinerators.”

These are the powerful examples and analogies of circular economy that can be linked to the dreams of a zero waste society. Due to space and time constraint, it is not possible to examine the possibility of how to identify and implement circular concepts in various industrial sectors in India. But it remains a very rich option for future research. Mass scale introduction of waste to energy polices, program, and technologies will presuppose intensive efforts for identification of scope and R&D to make it possible and profitable. This is an area where global best practices will be useful. Identified institutions can help in networking and dissemination of ideas and skills across countries. In this regard, the rich reference materials and guidelines produced by UNCRD<sup>34</sup> will be extremely useful to the Indian policy makers as a rich source of knowledge for action.

## Chapter IV

### 4. Prospects of cooperative recycling for energy and material security in India (note: cooperative implies partnerships among various stakeholders including private and corporate sector).

Chapter IV examines the prospects of cooperative recycling for energy with aggregation of demand, resources and raw materials at community levels – village, panchayat, district and provincial levels and how such policies have been embedded in the current policies and programs in India.

To quote Bruno: “In this century of progress, with our knowledge of chemistry, and with the most complete machinery at our disposal, it seems to me like a lapse into barbarism to destroy this most valuable material simply for the purpose of getting rid of it, while at the same time we are eager to obtain these very same materials for our fields by purchase from other sources. — Chemist Dr Bruno Terne at the Philadelphia Franklin Institute in 1893 arguing against burning natural fertilisers in incinerators while at the same time extracting and transporting fertilisers from continent to continent.” (Chemist Dr Bruno Terne, 1893, Philadelphia)

## What's cooking in India's largest biogas plant: Nidhi Jamwal (15<sup>th</sup> March 2003) Down To Earth



📷-- (Credit: Preeti Singh / CSE)



A community biogas plant:

Methan village in Sidhpur tehsil, Patan district of Gujarat saves 500 metric tons of fuelwood annually. They've been doing it for the last 15 years. This village is home to India's largest biogas plant, run by Silver Jubilee Biogas Producers and Distributors Cooperative Society Limited. "The biogas plant has been running since April 25, 1987, with minor repair works, and supplies gas to the villagers. Our cooperative runs the plant with no external assistance. This is the largest biogas plant in the country," claims Kasimbhai Khan, former supervisor of the cooperative society.

Mehsana-based Dudh Sagar Dairy (DSD) and the state government's Gujarat Energy Development Agency had initially helped set up the plant. DSD officials approached the villagers with their plan for the plant, and educated them in the utilisation of cow dung to produce biogas. This, they said, would reduce both indoor pollution and dependence on firewood. With an aid of Rs 19.91 lakh from the then department of non-conventional energy sources (now, ministry of non-conventional energy sources) of the Union government, the biogas plant was inaugurated.

The biogas plant has eight digesters with a total capacity of 630 cubic metres (cum). Six digesters have a capacity of 85 cum each, and two have a capacity of 60 cum each. When the plant was used for the first time, 25 tractor trolleys of cow dung were fed into the digesters. Now the plant needs only one trolley of cow dung per digester. The digesters are used on a daily rotation basis.

Every day, one digester is filled with a trolley of cow dung that is mixed well with water in a mixer-well. The cow dung then passes from the mixer-well to the digester. The temperature inside a sealed digester is maintained at 35c to 55c. Microorganisms in the cow dung get metabolised at this temperature. The end products of the process are biogas and digested substrate.

Methan, with its high cattle population, is never short of cow dung. One trolley of cow dung weighs two and a half tons, and costs INR 125. Dry waste, digested substrate, from the biogas plant is used in the fields as rich manure. This manure is sold at INR 300 per trolley, and is much in demand in the village.

"When the plant was first used, it took 22 days to produce gas. Since then, it has been producing gas daily," says Kasimbhai. Two persons from Methan have been employed to run the plant. They are paid Rs 50 each per month. Biogas is transported from the plant to individual households through underground pipelines. Supply timings are fixed: 6 am to 8 am and then from 6 pm to 8 pm. "Fixed timings ensure that we can regulate use and wastage of biogas. In case we have to cook in between, we use kerosene. But that is rare. We prefer the smoke-free gas stove," says Reshamabehan, a resident of Methan.

All households that have biogas connections pay Rs 50 a month. "The gas charges must be paid by the 15th of every month. Those who pay before the 15th get a rebate of Rs 5," says Salimabehan, who has a biogas connection at home. Kasimbhai explains that this encourages people to pay on time. Apart from the monthly charge, every household pays one-time charges: Rs 100 for connection and Rs 200 for maintenance. As of now, 320 of the 500 households in the village are covered by biogas.

All households that are connected are members of the cooperative society. The management committee has 11 members, which has women representatives as well. While it is mandatory for the committee to have women members, no number has been fixed. This committee looks into the management and monitoring of the biogas plant. "We carry out repair work of the biogas plant on our own. For instance, if the iron of the digester gets rusted, we get it painted. Also, once the gas is made, the top cover of the digesters moves up and sometimes breaks. So we have developed structures to hold down the digester covers," says Imranbhai Khan, a member of the cooperative society. The community manages the system; the plant uses local supply of cow dung; villagers use waste from the plant in their fields; the village saves huge quantities of fuelwood; and kitchens have cleaner, smoke-free fuel. Clearly, the biogas plant has changed more than just the way Methan cooks its food.

Biogas regime in India: It will be interesting to look into the biogas scenario in India, although this has been mostly a rural and semi-urban story. But this has been a successful mechanism with a lot of future potential in the future of Swachh Bharat. Biogas which is mainly a mixture of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) and traces of other gases [such as hydrogen sulphide (H<sub>2</sub>S), nitrogen (N<sub>2</sub>) and ammonia (NH<sub>3</sub>)] is produced through anaerobic digestion of cattle dung and/or other biodegradable organic wastes, generated in hostels, schools, hotels, and community centres etc. It is an efficient gaseous fuel, having a calorific value of about 4500 - 4800 kcal/m<sup>3</sup>. It can be used for cooking, heating and lighting, space cooling and refrigeration and in dual-fuel or 100% gas engines for motive power and when attached with alternators for generation of electricity. The digested slurry produced as by-product has high quantity and quality of Nitrogen, Phosphorus and Potassium (NPK) and is used as organic bio-manure, which helps not only in sustaining soil health but also providing nutrients for obtaining higher crop yields. Manure from biogas plants has been approved as organic manure under the Fertilizer Control Order, 1985 of the Ministry of Agriculture. It has the potential for leveraging livelihood development as well as tackling the issues related with health hazard, local sanitation and environmental issues together with in combating the climate change.

Ministry of New and Renewable Energy (MNRE) has been promoting family type biogas plants (FBP) since 1981-82 under National Programme on Biogas Development (NPBD)/National Biogas and Manure Management Programme (NBMMP). The cumulative achievements under the Programme since inception till March, 2016 is over 49.4 lakh which is about 41.1 % of the total estimated potential based on cattle dung waste only. The households beneficiaries, particularly women and children, are getting benefits in terms of reduced drudgery and saving in their productive time which otherwise spent in collecting fuel wood from long distances/ forests.

## **4.1 Community Biogas Plants (CBPs)/Institutional Biogas Plants (IBPs) and Cooperative biogas in India:**

Since small capacity biogas plants was not able to meet other energy requirements of the community/village such as electricity, drinking water, flour milling and village level industries, the concept of CBPs/ IBPs emerged as a possible solution. A large capacity biogas plant, fed by dung contributed by the cattle-owning families of the village, could provide cooking gas to the entire village as well as energy for other operations. The plants were managed by the community/ institution itself, with technical and financial support from the Government.

Ministry started promoting such plants under a demonstration scheme in 1982-83 with 100 % subsidy which was later on in 1993-94 launched as a scheme of setting up of large sized biogas plants with the following key objectives - :

- Caters to the needs of village communities and urban institutions; and
- Utilization of biogas for generation of motive power and electricity besides cooking

The programme was mainly implemented through State Nodal Departments and State Nodal Agencies and the plants were based on the design developed by the Planning and Action Division (PRAD) of the State Planning Institute of UP and the Khadi and Village Industries Commission (KVIC). Total cost of CBPs/IBPs which include cost of construction of the plant and gas distribution system, procurement of machinery and equipment and contribution for operational cost for 3 years was provided as subsidy under the scheme. The Cumulative achievement was 3,902 plants up to 31st March 2002. The scheme was discontinued thereafter as per direction of the erstwhile Planning Commission to reduce no of central sector schemes.

### **Learnings from the Programme**

- i) The plants installed based on KVIC design were considered to be most successful whereas the drum less design developed by PRAD has technical problems. Thus KVIC design was used in most of the plants.
- ii) The plants were working satisfactorily in areas where dung availability was high and existence of milk cooperatives was successful such as Gujarat, Punjab and Rajasthan. The other strong binding force for successful operation was in those areas where biogas was converted to electricity to use for drinking water supply and reliable domestic illumination.
- iii) The common reasons for failure of the plants were – improper selection of sites (soil conditions, availability of common land, inadequate availability of water and /or supply of dung); Social Factors (community cohesiveness, village leadership, timing of gas supply, insufficient supply of gas particularly in winter prompting the beneficiaries to continue their dependency on dung cake and reduce their contribution of dung); techno – economic factors (timely technical back support from the state agencies, economic viability of model).

The need for goods and services being universal, cooperative recycling for energy with aggregation of demands, resources and raw materials at community levels, will have universal and need-based applications. In case of India, like cooperatives in agriculture, credit management, finance and community biogas, cooperatives can play a big role in waste recycling and management.

## **Chapter V**

5. Chapter V deals with best practice or Win-Win cases and examples of waste management in India and outside, both in the context of linear and circular economy. The chapter

highlights some successful international and national cases, including cases on policy initiative, on technology initiative, and on public-private-partnership in waste to energy and waste management space.

### **5.1 Best Practice Case Study 1: Mysore Case Study<sup>35</sup>**

The “Swachh Survekshan 2016”, under the Swachh Bharat Mission, had declared Mysore as the cleanest city in India. These rankings are based on the extent of open defecation and solid waste management practices in these cities. This credit came to the city of Mysore mostly due to its innovative waste management practices.

Mysuru is the second largest city of Karnataka and is situated in southern part of the state at a distance of around 149 km from Bengaluru city. The city has been divided into 65 municipal wards and having a population of 887446 as per census 2011.

The total estimated quantity of Municipal Solid Waste generated per day in Mysore is approximately 402 MT. The health department of Mysore City Corporation (MCC), which is headed by a Health Officer, supervises the MSW management activities in the city. The entire waste management program in Mysore is divided into primary collection, street sweeping, secondary collection and transportation, segregation, treatment and landfilling.

Mysore has adopted both Integrated and Centralized as well as Decentralized Zero Waste Management (ZWM) technology. From an effective management, the entire city is divided into nine waste management zones and five zones out of the nine has set up zero waste management plants which is responsible for shipping of biodegradable waste to few mini units and process them to produce manure

The households contribute nearly 84% of the total municipal solid waste collected in the city and contain an average of 60% wet waste and 40% dry waste. Thirteen percent of wet waste is sent to the decentralized ZWM plant and the remaining to the compost plant. Thirteen percent of dry waste is sent to the decentralized ZWM plant and the remaining to the centralized ZWM plant. Similarly the waste generated from hotels, restaurants, marriage and community halls, which consist of organic food and paper etc. are sent to the compost plant. Recyclable wastes from commercial establishments are sent to the centralized ZWM plant.

Recyclable waste items like plastic, metals, leather etc. from the centralized ZWM plant, wet & dry wastes from the decentralized ZWM plant and organic products from the compost plant are sold out to the market. The rejected materials from centralized ZWM plant, decentralized ZWM plant and Compost plant along with of silt from the street sweeping are sent to landfill site.

Apart from this, the MCC has taken some new initiatives like distributing bins to the households to segregate dry waste (plastics, paper, glass, metals, tetra packs, aluminium foils, etc.) and wet waste (vegetables, fruits, flowers, leaves, wood, kitchen waste, etc.) at homes. The green bins are assigned for wet waste and the red bins for the dry waste. Plastic wastes are separately collected once in a week from every household which would reduce their burden of segregation.

Some of the technological interventions adopted by MCC include deployment of 240 auto tippers and 396 pushcarts for the collection of waste throughout the city. One auto tipper is allotted to 1000 houses to collect wet waste and dry waste from the localities and one pushcart for 250 houses, which dump them at the Zero Waste Management units. Five auto tippers and one canter are collecting the chicken and mutton market wastes separately.

Like any other successful waste management program, Mysore has also adopted a public-private –partnership model for collection and treatment of different kind of waste within the city. The Mysore City Corporation carries out door to door collection of solid waste from all the 65 wards within its limit. Out of which, 62 wards are handled by outsourced labour and three wards are handled by federation of Mysore City Wards parliament. The Mysore City Corporation is responsible for Street sweeping activities for all the 65 wards of Mysore city every day. Out of which, 17 wards are handled by MCC Pourakarmikas (sanitary workers), and one ward is handled by federation of Mysore City Wards Parliament.

## **5.2 Best Practices Case Study 2: <sup>36</sup>Panaji**

Panaji, the capital of Goa, is a major city of attraction for both national as well as international tourists and houses many critical infrastructure facilities that supports vast tourism activity in the area. Though as per 2011 census the population of Panaji is around 114,759, the city also has a high floating population because of the large number of tourists both from India and abroad. Consequently, the pollution proportionately increases with population and effective disposal of all kind of waste become an emerging area of significance importance.

The City Corporation of Panaji (CCP) is the civic body responsible for managing the municipality solid waste. Panaji is responsible for generating approximately 55 tons of municipal waste every day.

Recently CCP launched a comprehensive city revitalizing campaign with major focus on municipality solid waste management (SWM). CCP rollout the SWM program on a public-private-partnership basis and was part of a multi-pronged campaign aimed at the revitalization of the city, called “Together for Panjim”. The campaign encompassed improving the civic infrastructure and conserving the city’s heritage, thereby fostering civic pride among the citizens. It had the support of local as well as state-level political representatives. The wives of sailors and its associates had also joined the campaign to explain the significance and demonstrate waste segregation in individual houses. The unique feature of the city revitalization campaign was the way in which it harnessed local talent, by seeking widespread involvement from the city’s residents at various stages of the program.

Panaji has adopted a 3R (Reducing, Reusing and Recycling) method of waste management and comprised of collection and segregation, transportation and intermediate storage, and

treatment and processing. It also undertook many positive steps in eliminating community bins and starting schemes such as the door to door collection scheme and Segregation at Source (SAS). Panaji has now become bin-free, with an excellent color-coded five category waste segregation system.

CCP has initiated an extensive waste segregation and management program which involves four-way waste segregation for commercial establishments, as well as residential units. Apart from this, bio medical waste and wet waste was collected separately.

Under this program, the institutional set-up includes adaptation of bin-free system was complemented by a door to door collection scheme and rolled out in the entire city. CCP has a separate cell for managing MSW, headed by a municipal engineer who supervises the waste management in the entire city. The 115 residential colonies of Panaji are divided into 12 waste management zones, each under a supervisor who manages the collection and transportation for the zone. The same workers carry out the street sweeping and door to door collection. CCP charges INR 365 per year as sanitary fee from every household for SWM; this fee is linked to the property tax. Hotels are charged INR 300-10,000, depending on the quantum of waste generated. Panaji has set up 12 sorting centre to segregate dry waste. Apart from this 99 composting units has been set up in the city.

Some of the technological interventions under this program include deployment of five compactors for collecting organic waste, tippers, dome-shaped trucks and rickshaws for transporting dry waste to the sorting centre. The waste is transported to Panaji's 12 sorting centre (one in each zone) to segregate them into sub-waste streams.

Green and black coloured bins were sold at a subsidized rate to households. The bins came with a locking system, which eliminated the chances of tipping over by stray dogs or cats. Separate vehicles were deployed for collecting bio-medical, hotel and household wastes. Wet waste is collected on a daily basis and dry waste three-times a week. Wet waste is handled in the composting units built within housing colonies and the rest is sent to the big composting unit in the market area. Organic waste converters were also deployed to process waste from hotels, markets and households. Mondays and Thursdays are designated for collecting the household waste, Tuesdays and Fridays for hotel waste and Wednesdays, Saturdays and Sundays for sorting waste at the centre.

On a policy perspective, stringent norms have been set for systematic management of waste segregation of garbage and imposing of penalties on violators helped the Corporation of the City of Panaji (CCP). Certainly this helped in bringing some order in the hotel waste problem which previously contributed nearly 70% of the total waste produced in the city. Clear directives has been given to hotel industry in the city where the biodegradable waste had to go in green bags, paper and cardboard in pink bags, plastic in brown, metals and glass in black, non-recyclable items such as thermocol and multi-layered packets and other waste which do not fall in any of the above categories in white bags.

The entire program cost approximately USD 88,900 and had certainly generated many employment opportunities for local youth and has a very high avoided CO<sub>2</sub> mitigation potential.

### **5.3 Best Practices Case study 3: Alappuzha<sup>37</sup> (Kerala)**

Alappuzha having a total number of 52 wards in its vicinity is one of the densely populated municipalities located in the southernmost state of the country Kerala. As per the 2011 census, the total population of the Alappuzha municipality is around 1.97 lakh.

During the 1990s, the Alappuzha municipality used to have a centralized waste disposal system and Sarvodayapuram is used as the dumping yard. As per study conducted during 1996 by the National Environmental Engineering Research Institute (NEERI) the total municipality solid waste generated by Alappuzha was around 50 tons/day.

After a strong public protest by the residents of Sarvodayapuram, the Alappuzha municipality during 2012, launched its first decentralized solid waste management project in the name of “Nirmala Bhavanam Nirmala Nagaram” which means ‘make the houses clean and thereby the streets’ in a public-private-partnership model (PPP). The program has an objective to process the bio degradable waste at the source itself by formulating a suitable techno-commercial business model based on policy which will invite more investment and thus creating job opportunities for the local youth.

Under the policy initiative, the local government empowered the panchayats or municipal bodies to formulate and develop plans and execute them with the help of self-help groups. Extensive public awareness program were conducted by those self-help groups supported by the local government with an additional motive to sensitize the public to participate in wide number. Water and sanitation clubs have been set-up in schools to encourage students with a motive to get through to their families. This program was launched on sponsorship basis. Students were encouraged to gather plastic waste at home and bring it in. One kg of plastic waste fetched them a book coupon worth INR 20 from school. Municipal workers collected the plastic later from school for recycling.

With the help of Agency for Non-conventional Energy and Rural Technology (ANERT) and IRTC (technology providers), the Alappuzha municipality developed biogas plant, pipe compost and aerobic units. Apart from this the Kerala Veterinary and Animal Science University and Kerala Agriculture University has also played a key role in providing the necessary technical know-how of the bio gas, pipe compost and aerobic units.

Households having enough space had been provided with 1m<sup>3</sup> and ½ m<sup>3</sup> biogas plants to the subsidy of 50%. Those who had no space had opted pipe composting which was cost effective and an easy method of waste disposal. Then through technological intervention, aerobic composting units were set-up in eight places specially for disposing biodegradable waste. Through aerobic composting units nearly 1200 households are facilitated to dispose their waste scientifically.



Alappuzha municipality has been carrying out the scientific disposal of solid waste using 824 biogas plants, 525 pipe compost units and 112 aerobic composting units. Four tons per day of bio degradable municipal solid waste is being collected, segregated and processed in the municipality. Food waste from restaurants is collected by a private agency and is used as animal feed. Under a public-private-partnership model, regular streets sweeping is done by the municipal workers and the biodegradable waste thus collected is segregated and processed in the aerobic units of the respective wards. Apart from this surveillance cameras has been installed all across the city which linked to the police control room to catch those littering public places.

As a result of implementation of the project 4107 tons of solid waste and 4431 tons of liquid waste were successfully managed per year at the source itself. Apart from this, an equivalent total amount of 114966 LPG gas has been produced per year for the fellow residents of the Alappuzha municipality. Due to decentralized disposal of waste, there is an additional saving of approximately 20525 liters of diesel per year (due to abandoning of transportation of waste).

#### **5.4 Best Practices Case Study 4: <sup>38</sup>Bobbili, (AP) Case Study**

Bobbili municipality is the only city in Andhra Pradesh and one among 10 cities in India to have 100% collection of garbage in place, as reported by 'Centre for Science and Environment', a New Delhi based environment think tank. The Bobili municipality has won many environmental awards including the prestigious 'Prayavaran Mitra' award & 'Swachh Bharat' award in 2016.

Bobbili municipality city is in the district of Vizianagaram, Andhra Pradesh and divided into 30 wards. As per census 2011, it has a population of around 56,819. As per a report prepared by Feedback Infra in October 2016, the total Municipal Solid Waste (MSW) produced in Bobili town was nearly 17 tons per day (TPD), of which around eight tons are wet, around four tons are dry organic and five tons are classified inorganic & inert. Households and commercial sectors contribute the major share of total waste generated in the city.

Supported by the Urban Finance & Infrastructure Development Corporation of Andhra Pradesh, Bobbili Municipal Corporation set up a centralized waste processing facility. The total project cost INR 584.47 lakh. Under this initiative, an 8.5 acre solid waste management park (SWMP) was set up in Bobili municipality, with landscaping done for the site, giving it an aesthetic look. The site has a garden with a lake inside and farm animals and birds were also inhabited. An organic waste-processing unit was set up inside the park that creates compost and biogas. Paper is also segregated from other kinds of waste and sold to paper mills.

Waste is segregated at the household level into wet and dry waste. Waste is then temporarily stored in the secondary collection points prior to its transportation to transfer station and disposal site. For collection of waste from slum areas small size wheeled community dustbins are placed on the outer boundary of each slum. The waste dumped in open places is loaded

manually or with the help of loaders (in case of huge accumulations) in trucks / tractors. From here, segregated waste is transported to waste management Park.

In the park, there's further segregation. Organic waste is converted into compost, which can be used for gardening and agriculture. Animal dung is used in 7 biogas production units, which provide cooking gas within the premises, which is used by the workers to prepare their meals. As per a report prepared by New-Delhi based Think Tank-“Centre for Science & Environment” a 14 CMT/day biogas plant was set up with the help of NEDCAP at Bobbili. Also biogas is used to produce electricity which is used to illuminate the park during night time. The organic waste, about 2.5 tons to 3 tons a day, is also used to make compost. Using the slurry from the biogas plant, vermi-compost is prepared. At the SWMP, a pulveriser machine reduces the wet waste into tiny pieces while hydraulic baler is used to compress the dry waste, make them into 50-80 kg bundles and sell off to recycling industries. These include paper, leather, metals, and cardboards and so on.

These initiatives in addition to clean the urban environment also generate significant value in terms of organic fertiliser, electricity and reused materials for paper and other industries. The combined economic value of the interventions is over INR 1 lakh every month.

In a **policy level intervention**, during 2011, the municipality passed a resolution banning use of polythene bags, plastic water sachets, and plastic carry bags. A special Task Force committee was formulated to periodically check the ban and penalises if there's any violation. The penalty for violators is also innovative and effective, including taking affirmative actions like planting trees, constructing tree guards and so on.

The processing technologies adopted for waste management at Bobbili municipality include Anaerobic Windrow Composting, Refuse Derived fuel (RDF) manufacture and Continuously Stirred Tank Biogas Reactor (CSTR) are some of the technologies deployed SWMP and composting unit at Bobbili municipality.

## 5.5 Best Practices Case Study 5: <sup>39</sup>Pune Municipality

Pune is the second fast growing urban agglomerations in the State of Maharashtra and ranks eight at national level. Pune with a geographical area of around 243.84 Sq. Km with a population of 3.1 million as per 2011 census and composed of 76 general electoral wards and 14 administrative wards under Pune Municipal Corporation.

The Pune Municipal Corporation (PMC) also known as “Pune Mahanagar Palika” is responsible for overall administration of the city including the waste management system. As per PMC, during 2016, the total quantity of waste produced in Pune is about 1600 to 1700 tons per day, most of which are from households, commercial establishments e.g. hotels, restaurants, shopping complexes, hospitals etc. Out of the total waste produced, dry and wet wastes are approximately of equal proportion.

The philosophy of waste management program in PMC is based on the 3R (Reducing, Reusing & Recycling) principles and the entire program is designed as per the “Municipal Solid Waste Management Rules-2000” which is again in line with the public health protection guidelines.

Pune Municipal Corporation (PMC) is responsible for collection, storage, segregation, transportation and disposal of all solid waste generated in the city. The Pune municipality has

deployed 160 numbers of trucks for door-to-door-collection (DTDC) of waste. Apart from this, 563 containers and 116 compactor buckets has been deployed all around the city for successful collection of various kind of waste.

Geo Spatial tools like RS, GIS and GPS are deployed to monitor the successful day-to-day operation of the waste management activity like tracking of garbage vehicles, UHF RFID readers used for vehicle identification; IOT Sensors are used to identify the status or level of waste bins if it is empty or filled.

The PMC follows a public-private-partnership approach which is combined with both integrated as well as decentralized waste management strategy that encourages NGOs and private sector participation. Pune's success in waste management is its ability to persuade, and work with, private CSR (corporate social responsibility) initiatives such as the "Adar Poonawalla Clean City Movement (APCCM)" which pledged Rs.100 Crore to the city's waste management efforts. The NEX project, including the land, is fully funded by APCCM. In addition, it has contributed to awareness building, welfare measures for grassroots workers and providing litter bins and mechanized cleaning at specific public spots. Pune based NGO-SWACH (Solid Waste Handlers and Collectors' Society) has played a key role in efficient waste sorting and collection in the city.

Some of the technological excellence adopted in Pune municipality include the 25 number of decentralized bio-methanation plants which produce compost together with 600 kW of electricity; A 300 TPD NEX plant that converts food waste to bio-CNG, 300 TPB (total plumbum) vermi-compost and compost projects (Ajinkya Biofert and Disha), Rochem Separation Systems which processes mixed waste to produce 300 TPD producing RDF (refuse derived fuel). Apart from this 13 composting plants has also been set up in the city. Townships such as the unique Magarpatta city in Pune takes pride being a near-zero garbage as just a part of its focus on eco-sustainability.

In a policy level initiatives segregation of waste is made mandatory for all residents with a levy of user charges. At the same time, 5% tax rebate has been imposed for those who have onsite waste disposal facilities. PMC makes it a point to highlight and celebrate those who adopt innovative solutions and practices in solid waste management and sanitation, through awards and recognition.

The waste management program in Pune municipality has certainly created job opportunity for the local youth and reduction in CO<sub>2</sub> and other GHG gas due to various MSW projects implemented in the Pune municipality.

Best practices case study of technology:

<p><b>Name of the Project:</b> Establishment of Solid Waste Management Systems in Rural Tamil Nadu</p> <p><b>Project Location:</b> Tamil Nadu</p> <p><b>Implementing Agency:</b> Government of Tamil Nadu</p> <p><b>Project Description:</b> The Tamil Nadu government's '<b>Thooimai Kaavalar (Environmental protectors)</b>' scheme, under which garbage collection and segregation is done by self-help groups. Under the "<b>Mahatma Gandhi National Rural Employment Guarantee Scheme</b>" (MGNREGS) funds are used to pay the salaries of the staff for 100 days and the rest is borne</p>
--

by the State government from its **Solid Waste Management Fund**.

One Thooimai Kaavalar takes care of 150 households in selected 9,000 village Panchayats.

**The SWM activities in the state involve:**

- a) Door-to-door collection, weighing and segregation of waste
- b) Dumping of biodegradable waste into compost, and non-biodegradable, non-recyclable waste into landfill site.
- c) Sale of recyclable waste to scrap merchants.

Various provisions are made to ensure proper SWM in the state involving excavation of compost pits under MGNREGS. There are three pits for each cluster: two for bio-degradable waste and one for non-biodegradable waste with one Kaavalar assigned for 150 households and one supervisor responsible for every cluster. Payment of wages is done on the MGNREGS wage rate (INR 203) with separate rural schedule of worker rate based on special time. The role and responsibilities of Kaavalars, worksite supervisor and VPRC (nodal agency) is clearly specified to ensure clarity and completion of tasks on time. In 2015–16, modifications were made to provide infrastructure in SWM VPs like a tricycle for every 300 households, provision of jacket, gloves, cap, etc. to ensure safety of kaavalars, segregation cum storage shed, usage of cleaning implements such as brooms, aluminium basket, spade, long handle steel fork, scrapper, first aid kit, etc.

In Tamil Nadu, another major initiative to ensure better waste management has been online reporting of SWM activities. In terms of revenue generation, around Rs.10.69 lakh has been realized by SWM panchayats through sale of 1.07 lakh kg of compost and Rs.28.07 lakh through the sale of 11.49 lakh kg of recyclable waste.

Name of the Project: Swachta Doot Project

Project Location: Nagpur-Maharashtra

Implementing Agency: Nagpur Municipality Corporation

Project Description:

In our country municipal corporations are primarily responsible for solid waste management. Government of India has framed Municipal Solid Waste (Management and Handling) Rules 2000, under the Environmental Protection Act, 1986.

One of the major requisite of these rules is to establish door-to-door garbage collection system in the cities. Nagpur which is located in centre of India has taken initiative in implementing MSW Rules 2000 by introducing 100% door-to-door garbage collection. It has enabled:

1. Livelihood creation for 1600 people from most deprived segment of the society.
2. Clean environment as 75% of the total waste generated is being collected from doorstep.
3. Successful Public Private Peoples Partnership.
4. Use of ergonomic tools for managing waste.
5. Use of appropriate technology for waste management, also creating entrepreneurship opportunities.
6. Effective recycling of waste for useful purposes.
7. Partnership of Waste Producers Partnership is going on successfully for last 3 years.

The Nagpur Municipality Corporation has successfully implemented “Swachta Doot Project” which is a major solid waste management program in the country and includes the following aspects:

- |    |                                       |
|----|---------------------------------------|
| A. | Daily door-to-door garbage collection |
| B. | Waste segregation                     |
| C. | Garbage lifting and Transportation    |
| D. | Employment Generation                 |
| E. | Awareness building                    |

## 5.6 Best Practice Case Study 1: Scaling of LED from CFL:

Four Public Sector undertakings have created a Special Purpose Vehicle called Energy Efficiency Service limited<sup>40</sup> (EESL) to promote energy efficiency measures in 2009 which was transformed in 2015-16 to bring in disruptive changes in India.

The Ujjala Scheme is a 21<sup>st</sup> Century example of how waste to energy, Swachh Bharat and energy security can be combined for the betterment of all. Replacement of CFL bulbs with more durable and energy efficient LED bulbs, which can be easily combined with solar, by EESL, <sup>41</sup>a Public Sector Undertaking created by NTPC Limited (India's largest power generating company | Market Cap as on March 2016 – USD 15.5 billion), Rural Electrification Corporation Limited (India's leading public infrastructure finance company in power sector | Market Cap as on March 2016 – USD 2.4 billion), Power Finance Corporation Limited (India's financial institution and backbone of Indian power sector | Market Cap as on March 2016 – USD 3.1 billion), and Power Grid Corporation of India Limited (India's largest power transmission company | Market Cap as on March 2016 – USD 10.7 billion) is an innovative example. As of July, 2017, over 255 million LED bulbs, over 3.06 million LED tube lights and around 1.15 million energy efficient fans have been distributed in the country under the Ujjala Scheme. This is leading to an annual energy savings of over 33.4 billion kWh and resulting in avoidance of over 6,725 MW of peak demand. Through the scheme the estimated cumulative cost reduction in bills of consumers annually is over INR 1, 33,460 million and is leading to reduction of approximately 27 million tons of CO<sub>2</sub> every year. Solid waste generation of CFL bulbs avoided is huge.

EESL has a contribution of USD 72 million from its promoter companies and additional credit line of Euro 250 million from KfW (German Development Bank), Euro 50 million from AFD and USD 200 million from ADB for the implementation of energy efficiency programs in India. The turnover of the company for FY 2015-16 has increased by ten times as compared to its previous financial year. FY 2016-17 witnessed that the turnover had increased by two times as compared to the previous financial year. <sup>42</sup>Other social impacts have been as follows:

- Share of LEDs in Indian lighting market increased from less than 1% to 15% in 1 year.
- Retail prices reduced by 1/3<sup>rd</sup> in one year. Bulk prices reduced by over 80% in 2 years.
- Domestic manufacturing increased significantly.

Under AJAY scheme, EESL will install 300,000 solar street lights, and under MEEP, it will replace inefficient municipal and sewerage pump sets in 500 AMRUT cities. The price reduction due to demand aggregation has been phenomenal.

Source: [https://eeslindia.org/User\\_Panel/CareersView.aspx](https://eeslindia.org/User_Panel/CareersView.aspx)

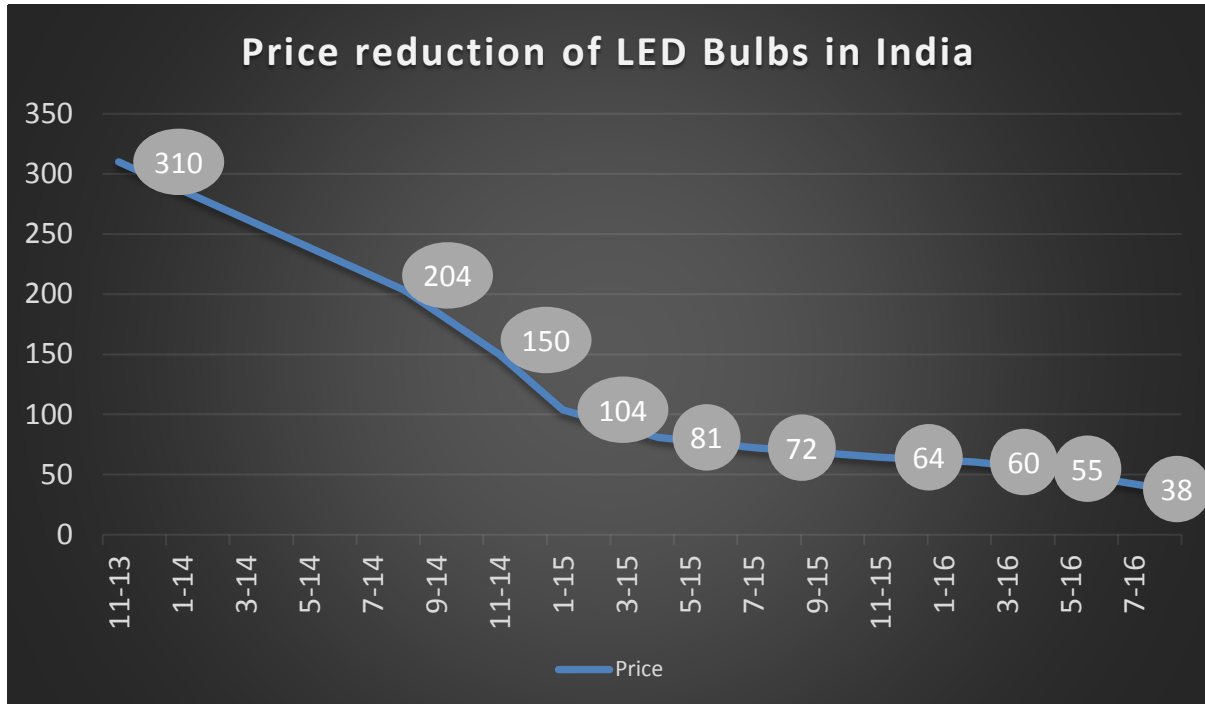


Figure 3: PRICE REDUCTION OF LED BULBS IN INDIA FROM 2014-16. (Source: [https://eeslindia.org/User\\_Panel/CareersView.aspx](https://eeslindia.org/User_Panel/CareersView.aspx))

The press release below gives an excellent glimpse of its synergetic reach and spread across sectors in India. Recently, EESL has opened offices in London and Singapore to take up similar activities on a cross country basis.

## 5.7 A best practice case study in technology 7: Oil from non-recyclable plastic wastes<sup>43</sup>:

**A best practice technology 2: oil from non-recyclable plastic wastes: Hindu Business Lines 20<sup>th</sup> January 2016. Ventana, Ramky Environment partner to set up plastic-to-fuel plants**

V RISHI KUMAR

**HYDERABAD, JANUARY 20:**

Ventana, a waste to energy company, has announced its partnership with Ramky Environment, a provider of comprehensive waste management services, for setting multiple plastic-to-fuel plants in India.

The goals of the partnership shall be divided into phases. In the Phase-I, the companies shall work together to establish a 15 Tons per day (TPD) plant at Ramky's integrated solid waste management site at Hyderabad, where the company has a municipal concession till 2037. Both partners shall co-invest in the project.

In Phase-II the companies shall setup multiple plants to convert the 400 plus tons of low-grade waste plastics received by Ramky at the Hyderabad municipal site every day. The companies also plan to setup other plastic-to-fuel plants across different locations in India to convert waste plastics to high economic value industrial fuels.

Ventana's CEO Amit Tandon, in a statement said, "Globally almost 2/3rds of waste plastics having an economic worth exceeding \$300 billion are dumped to landfills for lack of a recycling solution. At Ventana, we have developed a depolymerisation engine that accepts such low-grade plastics and converts them to high value industrial fuels similar to diesel."

"Unlike variants of the past, our patent-pending process enables a fully-continuous (non batch) process, providing therefore a utility scale solution to address a city's plastic waste management concerns. By joining hands with Ramky will help address the challenge of recycling waste plastics and cleaning up of Indian cities," he said.

Goutham Reddy, MD and CEO, Ramky Environment, said, "Everyday, we receive several hundred tons of non-recyclable waste plastics across our waste management operations in India. We are happy to partner with Ventana to convert such low-grade plastics to high value petroleum fuels. We see this as a win-win – both for environmental sustainability and for the economic bottom-line of our waste management operations."

In 2013, the Indian Supreme Court taking cognizance of the plastic litter menace labelled it 'a ticking time bomb' and issued directives to environmental bodies to figure a way to deal with the problem. By offering a next life solution (as fuel) for end of life waste plastics, Ventana's technology will enable recycle of such 'non-recyclable' plastics while also providing calorific

recovery in the form of useful commodity fuels.

### 5.8 Best practice in Technology3: Clothes from Plastics:

The company turning 4 billion plastic bottles into clothes

by Parija Kavilanz [@CNNTech](#) May 16, 2016: CNNMoney (New York)

Some 400,000 college students will accept diplomas this year while wearing Gowns made entirely of plastic bottles. It's not a joke or a gimmick. It's a statement on how to keep trash out of landfills, said Jay Hertwig, VP of global branding for textile maker Unifi. Unifi, based in Greensboro, North Carolina, produces 300 million pounds of polyester and nylon yarn annually. "As a manufacturer, we asked ourselves what we could do to be more innovative and a socially responsible company," said Hertwig. Repreve was the answer. It's the firm's flagship fiber brand made from recycled materials. Unifi's Repreve recycling centre is a 50,000 square foot facility in Yadkinville, North Carolina, where plastic bottles, fiber waste and fabric scraps get deposited. The company collects clear plastic bottles from processors around the country who first shred them into plastic flakes. "We purchase these plastic flakes and convert them into small pellets," said Hertwig. The pellets are then melted, extruded and spun into polyester yarn. Repreve makes three types of recycled yarn: 100% from used plastic bottles, a hybrid of plastic bottles and fiber waste, and a hybrid of plastic bottles and used fabric. Since the brand launched in 2009, Hertwig said production has increased about 20% every year.

[Related: She's recycling carbon dioxide](#)

Repreve yarn is used to make everything from jackets and T-shirts to dress pants and even car upholstery. It's used in brands like Patagonia, The North Face, Levi's, Adidas, Nike ([NKE](#)) and Ford ([F](#)).

Another customer is Oak Hall Cap & Gown, which makes graduation gowns from the 100% Repreve yarn spun from plastic bottles. It takes 27 used bottles to make one gown, Hertwig said.





Plastic bottles  
are recycled into  
polyester yarn to make  
T-shirts, shorts, even  
graduation gowns.

He said more than 1,250 schools are using its Repreve-based graduation gowns, including Brown University, Michigan State, Yale, Notre Dame and University of North Carolina at Chapel Hill.

"Schools want their campuses to embrace sustainability in terms of waste management, energy conservation and environmental protection," said Hertwig. "The gowns are a great way for them to spread that message, especially among millennials." The recycling centre is currently able to produce 72 million pounds of Repreve fiber annually. Hertwig said they plan to increase production to about 100 million pounds by next year. Unifi has turned 4 billion used plastic bottles into yarn in the last seven years. At the same time, there's an opportunity to recycle other plastic like food storage containers and plastic cutlery.

"If it's made from PET, we can recycle it," said Hertwig. "This is all about educating consumers that high-quality products can be made from recycled waste."

## Chapter VI

6. Chapter VI deals with the most important Conclusions and Recommendations to policy makers of the 21<sup>st</sup> Century, who will have access to not only ordinary means of steam power, mechanics, electronics, and information technology, but also to means such as Artificial Intelligence, Robotics, Drones, Driverless Cars, 3D printers, Internet of things, decentralised and distributed energy with cheap and clean storage tools, DNA engineering and bio economy<sup>44</sup>. This chapter offers practical recommendations in the Indian context. Given the present state of affairs of solid waste in India, business as usual approach by policy makers is going to land the country into serious trouble in the future. Ghazipur, in that sense, was a big warning to the failed policies so far. So the policy makers cannot just perform and carry on in business as usual mode. They have to examine the second step of reforms. But the history of waste management and waste to energy in India only tells that many opportunities in the past have been wasted. Such mismanagement of waste is not desirable in the developing world. In view of this, one concludes that this sector needs transformation in the 21<sup>st</sup> Century. A good start has come through the Swachh Bharat Mission which guarantees political support for policies. This is the most difficult part indeed. With the open and assured support of the political executive in a democracy, if things cannot be transformed, then the blame can be laid on the doors of the bureaucracy who are supposed to help with making and implementing policies. What are the recommendations for such a course of action? The author makes ten practical recommendations.

**Recommendation 1: Hold biannually a Swachh Bharat Global Investors Meet only in the area of waste to energy in India. Waste to Gold Global Investors Summit – 2018. The motto can be waste to gold-no wasting.**

There are several Ministries who look after the issue of waste to energy in piece meal. The Ministry of Urban Development has to be mandated as the lead and nodal ministry that will coordinate and drive the agenda for holding the Global Investors Meet to ensure availability of land, labour and capital in the sector. Business as usual scenario is not going to transform the sector. If this sector is a trillion Dollar industry, it must be given the right treatment it deserves. The model for Swachh Bharat Global Investors Meet 2018 can be the equivalent of REINVEST 2015 of the Ministry of New and Renewable Energy (MNRE). REINVEST helped MNRE to create awareness, get global attention, put innovative policies in place, obtain commitment letters from companies aggregating to 277000 MW and financial commitment of 77000 MW. The event became a game changer in the history of renewables in India

**Recommendation 2: Strategy to transform the sector should be based on creating an eco-system of market forces as was the case for the Solar Mission.**

The Solar Mission was a comprehensive policy document built around Land, Labour, Capital and Technology. This Mission document did not go into micro details of implementation of solar projects, as has been currently envisaged under the Swachh Bharat policy. This document put fiscal and financial instruments in place and strived to create market forces to enhance solar generation capacity. In the subsequent journey, all solar sectors equally

benefitted. Solar Thermal Power Plants came up for the first time. Tariffs of wind power came down, downsizing the sector's earlier profitability and procurement methods. (Procurement strategy changed from Feed in Tariff to Tender based ). So the waste sector in India needs a similar treatment. The Mission can identify lands for landfilling on a scientific basis, with landfills conforming to international standards. If public land is not available, private land can be pulled on such terms that farmers greatly benefit from the project. Waste processing companies could give employment and equity shares to the ex-land owners so that they remain active partners in the running of the waste project. Rag pickers can be trained through an apprentice scheme so that they become agents of technology change all along the value chain of waste - refuse, reuse, recycle, and landfill. The rag pickers can even be trained to be agents of transformation.

**Recommendation 3: Solar Energy Corporation of India (SECI) can be named as Renewable Energy Corporation of India and expand its mandate to take over waste management on an outsourced basis based on demand aggregation.**

After the Solar Mission was launched, the Government of India also established the Solar Energy Corporation of India (SECI) as a Public Sector Undertaking (PSU). In the Indian context PSUs play an important role. The bureaucracy feels much safer to deal with PSUs. There is generally no audit or oversight of issues. The investing agencies also normally do not find fault when the execution of a project has been done by a PSU. People and NGOs too have more trust and faith in the transparency and fairness of these organizations. In view of this, there is need for establishment of a central PSU in the waste sector. But establishment of a new PSU may find it difficult to get clearances at all levels and that too within a short time frame. Moreover, which Ministry will it report to? One practical way is to examine whether SECI, which could be renamed as Renewable Energy Corporation of India and which has recently tendered 1000 MW of wind power, can also go for 500 MW of WtE sector. The tariff ceiling set under Tariff policy is high and Municipalities, Corporations and Regulatory bodies may not mind contracting it out to SECI on a nomination basis. Aggregation and common procurement of technologies may drive down cost and help expedite use the piles and mounds of waste lying unused in many places, for power generation. In the meantime, mass awareness will drive field level segregation of waste at household level. However, as of now, there is no PSU that actually deals with waste at national or subnational level. Hence utilising SECI as a central PSU to generate electricity from solid, liquid and other types of waste will open up the sector for government and private sector where the Local Government will have more agencies to choose from. This move will not shut down the private sector, but will put a mega player in the waste sector which can take commercial decisions, and at the same time, derive benefits of being in the public sector and being able to aggregate demand and drive down costs. Competition for feed stock will result in a price hike which will help the rag pickers and intermediaries. As a PSU, SECI can have a sound rehabilitation and training of the rag pickers by suitably linking their training with the Ministry of Skill Development. SECI can also look into the growing e-waste sector in India, which currently recycles less than<sup>45</sup> 2 % of the e-waste. Even permitting SECI to compete with private sector players will have far reaching implications for the Indian waste sector. India has no

institutional process to recycle, reuse, dispose electronic waste and is the fifth largest producer of e-waste globally. Hence there is a sovereign responsibility to put an institution in place to reasonably and responsibly handle the vast waste sector, both existing and emerging.

SECI can plan nationally, keeping in mind that waste to energy is one of the options for solid waste management. In most Indian cities and towns, MSW has high moisture content and lower plastic and paper content. This leads to a low calorific value, rendering the MSW unsuitable for conventional direct combustion routes, unlike other developed countries with high plastic/paper content and low moisture content. Hence, Indian MSW is more suited to biological processes such as anaerobic/aerobic digestion, pyrolysis or gasification. However, these processes can work properly if the waste is properly segregated and the organic matter used for energy recovery. In some exceptional cases, plasma gasification can be used which is quite expensive. Hence, effective waste to energy policy needs good policy for segregation and recycling. SECI can aggregate usage of computer modelling and simulation tools that help in estimating the economic viability and tariff for MSW projects, considering the physical cultural and chemical characteristics of Indian waste generated as municipal solid waste.

#### **Recommendation 4: Linkages between plant technology and waste characteristics.**

Indian policy makers of the 21<sup>st</sup> Century must bear in mind that incineration-based waste to energy technologies have recently emerged as the preferred policy option for managing the growing problem of waste in India. As these plants can work round the clock, they need a continuous supply of waste inputs. So the quantities required are huge. Moreover, the quality of waste required by these round the clock plants need to be of high calorific value and low moisture content. Indian waste, like Indian coal with high ash content, are known for low calorific value with heavy inert components and high moisture content. Hence the economics<sup>46</sup> of these upcoming plants needs to be calculated cautiously and correctly. With the new Bankruptcy code, the companies in the space of urban waste should be viable and sustainable. This presupposes that the policy makers take empirical evidence on waste characteristics of each city or cities which will act as the catchment area for inputs and raw materials of the waste energy plant. Some solid waste plants in the past have found out that the feedstock they got was unsuitable for the imported plants machineries they had so laboriously installed. One pattern of technologies may not fit all cities. And sustainability was not only a concern of the plant owner or the investor, but of the public authorities as well. Given that waste volumes are going up and their health and environmental impacts are vital, the plants cannot stop suddenly without political and health consequences. Hence technology choice will be critical for the policy makers.

#### **Recommendation 5: Waste to Energy vs. Recycling**

The Indian policy maker of the 21<sup>st</sup> Century cannot afford to have a closed mind on the issue of compatibility of WtE plants who could be voracious eaters of waste in the absence of recycling and reuse technologies and practices in most cities and towns. In fact, if one removes 100% recyclable and reusable material and organics from Indian waste, no

substantial quantity of waste with high calorific content will be left any more in the waste collected in most towns and cities. This will make the plants unsustainable in the long run. If an agreement is made by the local authorities with the plant about supply of composite waste without reuse and recycling of components, the 3R activities cannot be taken up later. Hence the policy makers have to realise the long-term impact of the WtE policy in their long-term waste management policies. Important will be if they give the Company end to end management of waste systems solutions, such as segregation, transportation, incineration in the waste management chain, etc. then activities under reuse and recycling may suffer, unless corrective provisions *a priori* are put in the contract. This is important as some have argued that “<sup>47</sup>First, the government’s preference for WtE contradicts the empirical evidence, which suggests that the physical, chemical and biological characteristics of Indian waste render it technically unsuitable for incineration. Second, to be viable, WtE technologies will require end-to-end control over the entire waste management chain, thus displacing those in the informal recycling sector from their means of subsistence. Far from being compatible, the two systems (i.e. *WtE and recycling*) are in fact in competition with each other over the same set of material resources.” However, the assumption that this competition will necessarily harm the rag pickers and the intermediate industry may not be full proof and needs further research.

#### **Recommendation 6: WtE vs. Livelihood of rag pickers<sup>48</sup> in India**

Policymakers in India cannot and should not ignore the rag pickers, given that they are important from the point of view of equity and economics. Millennium India Education Foundation<sup>49</sup> did a study way back in 2013 and brought out these shocking facts about rag pickers in India. To quote:

- Many rag pickers start working at the age 4-5 years. In a recent study, in Patna and Raipur ~20% of total rag pickers were between of 5-14 years, and 40% of the total dump site waste pickers were children. New Delhi and Mumbai have about 300,000 rag pickers and around 120,000 are under the age of 14.
- Many rag pickers come from rural areas into huge cities for better living and are unable to find opportunities and end up collecting trash.
- Many rag pickers live on the street, are homeless and have no access to education or healthcare.
- Rag pickers mostly work barefoot in the Indian heat, get exposed to chemicals and hazardous substances and often suffer from life threatening diseases as a result.”

IndiaSpend<sup>50</sup>, a report of the Spending & Policy Research Foundation, came up with another study in 2017. The estimated numbers of rag pickers were between 1.4 million to 4 million, with 500000<sup>51</sup> in Delhi alone.

“A lot of garbage clearing thus is the done informally, by rag pickers who work without any job security, salary or dignity. Not just that, they are regularly exposed to cuts, infection, respiratory diseases and tuberculosis apart from poverty, humiliation, harassment, and sexual abuse on the streets, as IndiaSpend investigations found.” <sup>52</sup>

To quote<sup>53</sup> Shashi Bhushan Pandit, president of All India Kabadi Mazdor Mahasangh,

“According to the law under which a municipality is set up, it places dustbins according to the size of the population. It is assumed that the generator of the waste will drop it in the bin. After that, it is the responsibility of the municipality to collect it from there (the transfer station) and treat it at the landfill,” Pandit said. “However, it is not the responsibility of the municipality to pick up the garbage from the source. That’s why the informal sector has filled this gap....In Bogota, Columbia; every rag picker is paid \$2 per day by the municipality. In Brazil, they have made sure that only the rag picker can pick the waste (from the source). Why can’t India do it?”

Declining price of rag is an important concern for them. And the rag pickers are a vulnerable community<sup>54</sup> with compromised health conditions. They suffer from a multitude of health problems which seem related to their occupation<sup>55</sup>. Rag pickers have no legal recognition, no pension or health insurance. And yet, they have traditionally played a very important pro-environmental role. To quote from *Darkness Under the Lamps* –

“When waste is disposed in India, it is done with little concern for those who will be handling it later. For example, both soiled diapers and sanitary napkins need to be treated as medical waste: According to the Bio-Medical Waste (Management and Handling) Rules, 1998 any waste with faecal, blood, body fluid must be treated separately. But usually these are thrown into a common dust bin.”

Hence a waste to energy policy cannot deprive the source of livelihood to millions of rag pickers without proper rehabilitation plans in case all waste goes to energy production without much scope for reuse and recycling. In turn, it must focus at making them more skilled, trained and employable with higher incomes and far better social benefits which are easily possible with better focus and planning.

### **Recommendation 7: Inclusive role of actors, ideas, and institutions within and outside government systems in the value chain.**

Policy makers have to continuously scan 360 degrees for new and innovative ideas, actors and institutions. Can there be new Start-ups, new ideas, new R&D, new catalysts? Can there be a forwards market, a waste exchange portal that will incentivise the middle class and youth to easily monetise their waste? Can there be active dissemination of ideas so that sustainable and well supported policies are initiated successfully. For example, government and industry proponents suggest that waste to energy and recycling are compatible systems of managing waste while their critics disagree. The 21<sup>st</sup> Century policy makers will raise and answer many more debates so far as an integrated approach to waste management is concerned. Various actors, ideas and institutions play important role in the value chain of waste to wealth that need to be identified and addressed. Actors, ideas and institutions permeate various levels both within and outside the government systems. And waste management policies and programs need to be fully inclusive to be successful and sustainable. What is the role of scrap dealers? Do they indirectly violate laws relating to child labour and children? If they do, does it mean enforcement needs to be strengthened? What about the role of households who do not segregate waste at source? What about companies who have organised resources but do not care about waste management? Who are the beneficiaries and losers in the current waste management system in India? Should there be a ban on landfills? Should zero waste targets be achieved with fiscal and financial instruments? What incentives and disincentives Indian budget should provide for promoting scientific management of solid waste<sup>56</sup>? Should zero

waste companies and zero waste Municipalities be provided with tax concessions and other financial incentives? How would the future preferences for organic products in agriculture and horticulture influence composting and thus energy from waste? These and many other questions will have to be addressed and planned for by the 21<sup>st</sup> Century policy maker in areas of waste management in India.

**Recommendation 8: India chapter of Zero Waste Europe by the Association of Municipalities and Development Authorities (AMDA).**

The idea here is not to copy Europe. But India has its great institutions which can both teach and learn. Association of Municipalities and Development Authorities (AMDA) is an example since 1983 in India. Zero Waste India will be a long-term goal, difficult but not impossible. In some Municipalities, the idea has caught on. AMDA may take an initiative to formulate an Indian chapter<sup>57</sup> or several local chapters to spread the idea of Zero Waste Europe, which supported since 2013 a growing number of groups of individuals, cities, and business taking significant steps towards the elimination of waste in societies. Elimination or reduction of waste is far better than reusing, recycling, burning, and burying. Even recycling is actually down cycling into products and materials of lower value as there is loss in quantity and quality in the conversion process. Zero waste policy is based on waste audit and zero budgeting of resources and processes, based on a through re-examination of all goods and services used in the production process, so that all unnecessary waste is completely eliminated and all that is produced could be reused, repaired, composted or recycled back into a circular process of production. The mix of individuals, institutions and ideas will empower communities to implement redesigned waste policies of India. To quote from the web page of Zero Waste Europe - Empowering Our Communities to Redesign: Waste policies & best practice

“We support the transition from a throw-away society to a zero waste world through policies and best practice of waste reduction at source, repair, re-use and recycling.”<sup>58</sup>

**Recommendation 9: <sup>59</sup>Zero Waste Municipalities with facilities for local R&D on waste and information dissemination centres.**

Indian policy makers, with the help of AMDA, must plan for a network of Zero Waste Municipalities with the help of UNCRD. The Network of European Zero Waste Municipalities lists out 364 Municipalities who have committed to work for zero waste status, covering 7.8 million people. A zero waste society or association of Indian municipalities, with study tours and discussion forums, with similar challenges and problems, will provide a destination worth pursuing. This network will bring together Zero Waste India, a sort of Swachh Bharat, and will provide a new identity to a set of Municipalities who have openly committed to (a) the goal of continuously reducing waste generation, (b) improving waste separate collection and processing, (c) endeavouring to redesign the relationship between people and waste management sector, and (d) continuously applying upgraded technologies. There can be an indexing of Municipalities to reflect their zero waste status and release of finance from federal and provincial governments can also be linked to this index.

**Recommendation 10: India's Zero Waste Association as a part of ISWA and zero waste auditing as a business policy.**

Unlike slums and small towns in India, companies and corporates operate on a different footing. There is no shortage of knowledge or awareness or means. Hence tackling industrial waste to make it complaint with near zero waste status or circular economy should not be a problem. Some of these big public sector companies and corporations, as well as private sector companies, may in fact invest Social Corporate Responsibility funds, which are to be spent statutorily in India for certain activities, may indeed examine if they could spend the same towards zero waste status. There can be a zero waste audit of companies by expert agencies. Most of India's eight Missions - National Solar Mission, National Mission on Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Eco-system, National Mission for a Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change – will in fact be complimentary in nature to minimizing waste generation and zero waste postulates<sup>60</sup>.

To quote again from the web page of Zero Waste Europe - the ZW Business<sup>61</sup>:

“Waste is a sign of inefficiency of a system and/ or a process. Therefore it is no surprise that successful companies try to optimize processes and eliminate waste. A company that is generating excessive waste whilst at the same time obtaining good results is because it is loading the burden on the shoulder of some other actor in the society. In the current situation of a globalised economy, companies with zero waste strategies are more likely to survive in the long term.”

**Recommendation 11: Zero packaging shops and modern Indian malls.**

There are a number of pioneering shops that sell unpackaged food and beverages. Examples are: Effeccorta<sup>62</sup> in Italy, Granel, Vic, and Eivissa in Spain, Unpackaged in London, Unverpackt, Original Unverpack, Biosphare in Germany, La Recharge, Jean Bouteille, Leger & Local in France, Mass-Greisselerei in Austria, Almata in Belgium. They are all zero packaging shops that have started a new trend to minimise solid and liquid waste in cities. With a growing middle class in India and a huge market for such products dealt by these shops – including local produce and all kinds of liquids – India has tremendous scope to operate big chains of such shops, particularly the modern malls that are better than some of the western malls to spread out the practice of zero packaging to a growing middle class who are environmentally very conscious.

**Recommendation 12: Awareness at all levels.**

Solid waste management and awareness about 3R can be imparted to the young and the old alike. For example ISWA services include (a) sharing of experience, knowledge and information within its network of waste professionals, (b) its professional knowledge base as a sharable resource amongst its members, covering social, economic and legal aspects, and (c) running of activities like waste related publications, educational and training programs, study tours, summer schools, tailored trainings, job exchange platforms, and expert services like “ask an expert.” Many Municipalities have such centres. The policy makers have to institutionalize the same.

**Recommendation 13: Role of GWMO promoted by UNEP and ISWA.**



It is important that the waste management policy of India of the 21<sup>st</sup> Century must have a holistic approach, addressing backward and forward linkages and based on a bottom-up approach. The policy must be linked to the SDGs and it should be ensured that the people at the lower rungs understand the critical connections between the practice, policies and future goals. Both policy makers and people should understand that waste is not to be wasted any further, and its proper management with the aim of zero waste and near-zero landfilling should be a priority issue and priority item. The expressed ambitions of the joint study by UNEP and ISWA could be a good example for what the Indian policy maker aims at. To quote<sup>63</sup>:

“Ambitions of the Global Waste Management Outlook (GWMO)

**HOLISTIC APPROACH:** Waste management within context of sustainable development.

**WASTE A PRIORITY:** Why waste should be a priority – both for decision makers AND the people

**SITUATION ANALYSES:** Showcase the real progress made as well as remaining challenges

**PARADIGM SHIFT IN THINKING:** Move upstream – reduce consumption, consider waste management as a resource, improve resource efficiency and create jobs for green growth.

**RENEWED FOCUS:** Focus on governance, implementation and financial sustainability – technical solutions alone are not enough.

**COMING TOGETHER:** Promote partnerships and inclusive approach.

**Recommendation 14: Waste governance and financing of waste projects in the 21<sup>st</sup> Century.**

Policy makers also have to address challenges on how to put waste management as an agenda item at the top of political priority? Luckily, the Swachh Bharat Mission of the Indian Prime Minister has played a historical role in putting greater emphasis on waste management. Issues of monitoring of waste management systems in cities and towns have been incorporated into a scientific system. Issues of waste governance have been identified and addressed. Issues of waste management financing have also been addressed in the Swachh Bharat Mission. But if we need to move towards becoming a zero waste society with a circular economy, the need for greater focus on larger financing issues are inevitable and will seize long-term attention of policy makers with global implications of cross border flow of waste in and out of India.

**Recommendation 15: Incorporate lessons from Climate and Clean Air Coalition (CCAC) MSW initiative.**

The 21<sup>st</sup> Century waste management policy must encourage twining of cities at different levels of waste management hierarchy so that they can learn from each other. One example is the City Exchange Programme between the City of Copenhagen (mentoring) and the City of São Paulo (mentored) under the <sup>64</sup>CCAC MSW Initiative. India being a vast country, the concept of twining both within and outside India, under this initiative will be very useful to

Indian cities. Twinning to learn waste management practices will promote mutual learning and address urban air quality issues originating from solid wastes sources. To quote: “<sup>65</sup>What is the importance of the solid waste sector in improving air quality and climate change mitigation? Globally, landfills are the third largest source of anthropogenic methane emissions, accounting for approximately 11% of estimated global methane emissions. The municipal solid waste sector is also a significant source of black carbon through the open burning of uncollected or unsoundly disposed waste, and the transportation of waste with outdated and polluting vehicles. Waste is not only an important climate and air quality challenge but one that affects every aspect of life for millions of people around the world. Today, more than half the global population lives in cities. Recognizing that urbanization is growing, especially in the developing world, and that rising incomes also increase waste generation, addressing the downstream consequences of municipal solid waste is clearly a priority.”

**Recommendation 16: Pricing mechanism for Bio-CNG and model document for purchase/sale agreement with oil and gas marketing companies.**

In order to accelerate the proliferation to harness the potential of waste, to improve local hygiene and to reduce emission of greenhouse gases into the environment, it is desirable to have appropriate mechanism for pricing of Bio-CNG and model document for purchase/sale agreement with oil and gas marketing companies. These documents and pricing can be borrowed from the power sector, and institutions in that sector can also be given additional jobs for deciding such issues from the Waste to Energy (WtE) sector. This will help in developing a market for WtE, which is very nascent at this stage.

**Recommendation 17: Rationalization of financial support for projects on Waste to Energy (WtE).**

At the central level, 3 ministries – i) Ministry of New and Renewable Energy (MNRE); ii) Ministry of Urban Development (MoUD); and iii) Ministry of Drinking Water and Sanitation are supporting treatment and recovery of energy from solid/liquid waste generated in urban and rural areas. However, the admissible Central Financial Support varies from 20% to 70% of the project cost and is being provided in the form of Viability Gap Funding (VGF)/Subsidy. MNRE is currently implementing a Programme on Energy from Urban, Industrial and Agricultural Wastes/Residues and provides for Central Financial Assistance (CFA) of INR 20 million for production of Bio-CNG from 12000 m<sup>3</sup> of biogas per day. Seven full scale projects are already in operation and about another 8 projects are under various stages of implementation. The Bio-CNG and digested residue (manure) projects are currently marketed by the developers with their own marketing arrangements. It is therefore, proposed that an Inter-Ministerial Group may be constituted to align the financial support and other incentives provided by the Central Government under the Swachh Bharat Mission, Nirmal Bharat Abhiyan and Programme on Energy from Urban, Industrial & Agricultural Wastes/Residues to such projects. The group can also deliberate on universalising fiscal and financial measures and look into ease of doing business practices across all sectors of waste management.

### **Recommendation 18 Recommendation on Institutional and policy reforms:**

This recommendation is on institutional reform / mechanism that could set in motion the real ground implementation of waste-to-energy with an objective to achieve zero waste society / clean environment (land, water and air) in India.

The waste to energy policy in India has to take cognizance of India's strengths: demography, democracy and rising demand as the middle class expands and more and more people rise over the poverty line. The programs must have targets for skill, scale and speed. Together, policies and programs have to take note of timely need to perform, reform and transform the sector. India need not repeat the past experiences of other countries and follow the same growth path. Programs proposed under policies at various levels of governance must be doable and sustainable. Under this institutional reforms will play a major role. Institutional reforms will bring in new and innovative mechanisms that could set in motion the real ground level or grassroots level implementation of waste to energy with an objective to achieve a zero waste society / clean environment involving land, water and air in India. Currently the roles of various ministries are fragmented. For example, there is no National Institute for R&D support to waste management in India. Ministry of New and Renewable Energy, with three autonomous National Institutes working under aegis, such as National Institute of Solar Energy, National Institute of Bio Energy, and National Institute of Wind Energy, can allocate more energy, time and resources to issues involving waste management. Dedicated country specific R&D is a must to have future zero waste societies. Alternatively, ministry of Environment and Forests can also take up these issues. But as of now, R&D is not a major theme at all in any of the Ministries or Departments, either at the federal, provincial or local levels. Nor there is much country specific R&D activity in waste management in the private sector. In the area of policy and institutional linkages, greater emphasis is needed on inter-Ministerial convergence, cooperation and connectivity. This can be ensured by Global Summit and Expo at national level, where governments, R&D players, private businesses and corporate sector, civil society, knowledge players like Think Tanks and Foundations – can meet annually or biannually and churn out ideas, while addressing issues of land, labour, capital, and technology at national and local levels. As already stated such events will attract new technology players, create awareness, and nudge actors and institutions to put fiscal and financial policies in place to realise zero waste societies. Interlinked and cooperative activities, both pre and post such events, will lead to both scientific advancement and new business developments towards energy security Vis a Vis zero waste society in India. The importance of triangular cooperation (between government-private/business sector-R&D/technological institutions) in India is critical to the future roadmap to zero waste society and a vibrant circular economy, which is not the current or dominant policy discourse in India. But critically important are the cooperative and interlinked actions of policy makers and stakeholders that will lead to both scientific advancements and new business developments towards energy security vis-a-vis zero waste society in India.

## Chapter VII

7. Chapter VII deals with a five year Vision Plan and Way Foreword; a vision towards creating enabling policies, programs, institutions and governance mechanisms for optimizing the contribution of waste to energy in the context of climate benefits, energy security, environmental objectives and economic opportunities. This five year action plan must address issues of land, labour, capital and technology and issues of inclusive governance.

A priority area could be the installation of 100 waste to energy plants in cities where large scale accumulation of waste over the years like hillocks in Ghazipur killing people in landslides, would prevent a lot of environmental pollution of air, underground water and land. They also will stop becoming health hazards for the urban people and present unpleasant scenes all-round the year. When such waste hills are near airports, the preying birds around constitute a great danger for the incoming and outgoing flights. The plants will also create employment for local people and help balancing renewable energy from the sun and wind as energy from waste is a round the clock operation and can be controlled depending on need.

Swachh Bharat has raised a lot of expectations. And it is not merely cleanliness at streets or stations. It has started changing the minds of the people, especially younger generations and school going children. That is great promise and good sign. Hence policies in the next five years must utilise this political support and get transformative integration between the two sectors. The political representatives will be more willing to help resolve land issues. There is great scope for the policy makers and implementers to bring in out of box idea and convince the Ministers, public, civil society and the press to support the same. The main plank for seeking support will be based on the obvious gains in the areas of (a) better energy security and clean energy, (b) promotion of circular economy (c) employment generation, (d) higher local investments and (d) health benefits of a clean environment – of surrounding air, land and water.

The five year plan must also aim at realising the estimated potential in in State. The breakup of 500 MW province wise is given below. The next five year must extend same policy provisions they did for the solar and other renewable sector in India in recent years where India became a global leader in terms of its renewable energy programmes.

**Table 3: State wise potential for power generation from MSW<sup>66</sup>. (Source: MNRE)**

S. No.	State	Power Equivalent (MW)
1.	Andaman & Nicobar	1
2.	Andhra Pradesh	43
3.	Arunachal Pradesh	1

4.	Assam	2
5.	Bihar	6
6.	Chandigarh	1
7.	Chhattisgarh	7
8.	Daman Diu & Dadra	1
9.	Delhi NCT	28
10.	Goa	1
11.	Gujarat	31
12.	Haryana	13
13.	Himachal Pradesh	6
14.	Jammu & Kashmir	7
15.	Jharkhand	17
16.	Karnataka	35
17.	Kerala	6
18.	Madhya Pradesh	19
19.	Maharashtra	62
20.	Manipur	1
21.	Meghalaya	1
22.	Mizoram	2
23.	Nagaland	1
24.	Orissa	9
25.	Puducherry	2
26.	Punjab	15
27.	Rajasthan	19
28.	Sikkim	0
29.	Tamil Nadu	53

30.	Tripura	1
31.	Uttar Pradesh	72
32.	Uttarakhand	5
33.	West Bengal	32
<b>Total</b>		<b>500</b>

### 7.1 Operational Plants:

In India, as of now, there are only 8 functional Waste to Energy thermal plants with a total capacity of 94.1 MW. The provincial distribution is as follows - Maharashtra 2, New Delhi 3, Madhya Pradesh 1, Himachal Pradesh 1). The companies operating these plants are Rochem, ORSPL, JITF, IL&FS, Ramky, Essel, and Elephant Energy Private Ltd). The next five years road map must have continuous and strict monitoring of the air quality in the WtE plants which are operational. The monitoring must be institutionalised and should not depend on Court directives.

Apart from aiming at fast utilization of accumulated mounds of waste, the next five years must be planned to complete the incomplete projects of around 398 MW in the pipe line or delayed or stranded for a variety of reasons – legal complications, lack of financial support from Banks, non-availability of land etc. The basket may also include WtE plants which have been initiated, but are held up at different stages. This is possible given the fact that the latest Tariff policy gives a preferential tariff to power from solid waste and this tariff has been a powerful attraction for public private power partnerships. Quick completion of these 50 projects which have already been initiated will help many cities and towns, such as Guntur, Tirupati, Vizinagaram, Tadapalligudam, Machilipatanam, Rajmahmundry, Ongoli, Kadappa, Anantpur, Nellore, Karnul, Visakhapatanam, Patna, Surat, Karnal, Sonapat, Bandhmadi, Faridabad, Srinagar, Bengaluru (7 plants) Kochi, Bhopal, Rewa, Indore, Gwalior, Nagpur, Nashik, Kalyan Domvili, Imphal, Kidwai Nagar, Bhubaneswar, Cuttack, Amritsar, Jaipur, Jodhpur, Rameswaram, Coimbatore, Paramkudi, Pallavapuram, Tambaram, Venkatmangalam, Perambalur, 18 ULBs in Telengana, Greater Hyderabad Municipal Corporation, Kanpur, Agra, Rampur, Lucknow, Meerut, and Roorkee (Cluster of 18 Urban Local Bodies.) This will ensure utilization of 30000 MTs of solid waste per day for power generation of 398 MW which is equivalent to three times i.e 1194 MW of solar (1:3)

Table 4: List of 50 Under Construction/Agreement Stage/Bidding/Tender to be Floated is given below:

S.No.	State	City	Input Capacity (MTPD)	Input Capacity (MTPA)	Production Capacity (MW)	Status (Under construction/ Tendering/DP R)	Date of Commissioning	Concessionaire Name & Contact Details
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1	Andhra Pradesh	Guntur	1202	438730	15	Under Construction	Oct-18	M/s. Jindal ITF M.V chary, M.VC@jindal ecopolis.com , 9000866626
2	Andhra Pradesh	Tirupati	374	136510	6	Land acquisition in progress	Oct-18	M/s. Jindal ITF M.V chary, M.VC@jindal ecopolis.com , 9000866626
3	Andhra Pradesh	Vizianagaram	203	74095	4	Under Construction	Dec-18	M/s. Essel Group Ravi Bhatnagar, ravi.bhatnagar@utility.esselgroup.com, cell no. 91009 37449,
4	Andhra Pradesh	Tadapalligudam	342	124830	5	Under Construction	Dec-18	M/s. Essel Group Ravi Bhatnagar, ravi.bhatnagar@utility.esselgroup.com, cell no. 91009 37449,
5	Andhra Pradesh	Machilipatnam	196	71540	4	Land acquisition in progress	Dec-18	M/s. Essel Group Ravi Bhatnagar, ravi.bhatnagar@utility.esselgroup.com, cell no. 91009 37449,
6	Andhra Pradesh	Rajmahundry		0	-	Under tendering		Under tendering
7	Andhra Pradesh	Ongoli		0	-	Under tendering		Under tendering
8	Andhra Pradesh	Kadappa	317	115705	5	Under Construction	Dec-18	M/s. Essel Group Ravi Bhatnagar,

								ravi.bhatnagar@utility.eselgroup.com, cell no. 91009 37449,
9	Andhra Pradesh	Anantapur	283	103295	4	Under Construction	Dec-18	M/s. Essel Group Ravi Bhatnagar, ravi.bhatnagar@utility.eselgroup.com, cell no. 91009 37449,
10	Andhra Pradesh	Nellore	296	108040	4	Under Construction	Jun-19	M/s. Envikare Vivek Deshmukh, dr@envikare.com, cell no. 98499 09966
11	Andhra Pradesh	Karnul	316	115340	1	Under Construction	Sep-18	M/s. NexusNovus Rutger de Bruijn rmdebruijn@nexusnovus.com 9916304841
12	Andhra Pradesh	Vishakhapatnam	942	343830	15	Under Construction	Oct-18	M/s. Jindal ITF M.V chary, M.VC@jindal.ecopolis.com, 9000866626
13	Bihar	Patna	1000	365000	10	Agreement signed	Mar-18	Patna green energy pvt. Ltd.- a.ajitraj@gmail.com- 09931498369
14	Chattisgarh		500	182500	5			
15	Chattisgarh		500	182500	5			
16	Gujarat	Surat	1000	365000	11.5	Under Construction	Nov-17	ROCHEM SEPERATION SYSTEM (I) PVT LTD.,



								Mr. Ramesh Sharma M.No. 070163 45884, 9719701819 ramesh.sharma@infra.es selgroup.in
17	Haryana	Karnal	350	127750	3.5			
18	Haryana	Sonepat	500	182500	5			
19	Haryana	Bandhmadhi	1000	365000	10			
20	Haryana	Faridabad	1000	365000	10			
21	J&K	Srinagar	450	164250	6.5	Under Tendering	Dec-19	Under tendering
22	Karnataka	Bengaluru (7 plants)	2000	730000	20	Under Tendering		Under tendering
23	Kerala	Kochi	500	182500	10	Tender Finalized	Dec-18	MIS GJ Eco Power (P) Limited Sanjeev Prabhu-9633929833
24	MP	Bhopal	1000	365000	23	Tender Awarded	May-19	M/s Essel Infra Projects Mr Vikas Jha, Mob: 0887899996 2, E-mail:vivek678@gmail.com

25	MP	Rewa	600	219000	6	Tender Awarded	Aug-19	M/s Rewa MSW Holding Limited ,R.M.Rao (13th Floor , Ramky Grandiose , Ramky Towers, Gachibowil ,Hyderabad 500008, rmrao@ramky.com, 914023015000,8008675050
26	MP	Indore	1100	401500	20	Tender Awarded	Dec-18	Essel Infra Ltd Suresh Singh 9811263457 suresh.singh@utility.esselgroup.com
27	MP	Gwalior	600	219000	15	Tender Awarded	Jan-20	M/s Ecogreen energy Gwalior Pvt.Ltd (Bijendra Raghav, Mob - 9911524169, bijendraraghav@ecogreenenergy.co.in) Plot No-131, Sharda Vihar, City Center , Gwalior
28	Maharashtra	Nagpur	700	255500	11.5	Tender awarded	Jul-19	M/s. Essel Infraproject Ltd. Mumbai & Hitachi Zosen India Pvt. Ltd. (JV) Mr. Ravi Bhatnagar, ravi.bhatnagar@utility.esselgroup.com,

29	Maharashtra	Nashik	25	9125	0.25	Under Construction		Ramky Enviro Engineers, Hyderabad, 040-2301 5000, +91 93212 90193
30	Maharashtra	Kalyan Domvili	600	219000		Under Construction		
31	Manipur	Imphal	100	36500	2	Under Construction	Jul-17	M/S IEC-TSL Ingenious Energy LLP, A-103, Sagun Plaza, Vastrapur, Ahmedabad - 380015 Mr. Ravi Kalantri, Vice President Mobile # 09586299988 ravi_kalantri@yahoo.com
32	New Delhi	Kidwai Nagar	70	25550	1.6	Under Construction	Pending	M/s Elephant Energy Private Ltd. (EEPL). Sh. Neeraj Bharati, Director (Project/IT)  Contact No. 41501383, 9582948603
33	Odisha	Bhubaneswar & Cuttack, Odisha	700	255500	11.5	Tender Finalized	Jan-17	M/S MSW Bhubaneswar Ltd. Prashanta Majumdar, AGM - 07064310457 prashanta.majumdar@ut

								ility.esselgro up.com
34	Punjab	Amritsar	700	255500	11.6	Under Construction	Dec-17	
35	Rajasthan	Jaipur	1000	365000	15	EC awaited, PPA Submitted to RERC for tariff finalization	Dec-19	JITF Urban Infrastructure, New Delhi (Deepak.Pandey@jindalecopolis.com; neesh.gupta@jindalecopolis.com (9873930842)
36	Rajasthan	Jodhpur	200	73000	3	EC awaited, PPA Submitted to RERC for tariff finalization	Dec-19	JITF Urban Infrastructure, New Delhi (Deepak.Pandey@jindalecopolis.com; neesh.gupta@jindalecopolis.com, 9873930842)
37	Tamil Nadu	Rameswaram		0	0.01	Machinery Erection Under Progress		
38	Tamil Nadu	Coimbatore		0	0.02	Completed		
39	Tamil Nadu	Parakkudi	0	0	0	Completed		
40	Tamil Nadu	Pallavuram & Tambaram Venkateswaram Project	300	109500	4	Under Construction	Mar-18	

41	Tamil Nadu	Perambalur		0	0	Completed		
42	Telangana	Cluster of 18 ULBs (M/S Shalivahana MSWM Green Energy Ltd)	1000	365000	12	Dormant (Issue with PPA and Tipping Fee)	Aug-17	Komurayya 9848011100
43	Telangana	Cluster of 16 ULBs (M/s Hemasri Power Projects Ltd.)	1000	365000	12.6	Under Construction	Aug-17	Brijesh Reddy- 9963279990
44	Telangana	Greater Hyderabad Municipal Corporation (RDF Power Projects Ltd.)	1000	365000	11	Plant Ready Presently in Trail Run	Aug-17	Appy Reddy- 7680909042

45	UP	Kanpur	1000	365000	15			IL&FS
46	UP	Agra	500	182500	5	Tender Finalized	Jan-19	Spaak Bresson PVT. LTD Company New Delhi Mr. Pnkul Rathore CEO Spark Bresson 2nd floor EIBI Block Mohan com. operative Indusial area New Delhi 11004 4 Tel No 0114132145 4 info@sspaak global.com
47	UP	Ram pur	500	182500	8	Tender Finalized	Dec-17	Shivri Green Energy
48	UP	Lucknow	1000	365000	15		Mar-19	Ecogreen Energy Pvt. Ltd. Gurgaun
49	UP	Meerut	1000	365000	10	Tender Finalized		(At present M/s Organic Re-cycling Systems)
50	Uttarakhand	Roorkee (Cluster of 18 ULBs)	2000	730000	25	Under Construction	Dec-17	BSR Green Powers Hyderabad Mr. Ajay Arora 9811169618 ajayarora@b sgreenpower .com, akarora@gm ail.com
	<b>Total</b>	<b>50</b>	<b>29966</b>	<b>10937590</b>	<b>398</b>			

Thus the five year roadmap this paper proposes is sorting out the issues involving MSW projects in these cities and towns with speed, scale and skill.

The implementation of the 18 recommendations through policy formulation and project implementation will bring in a sea change in the waste management sector in India, which can be model for other countries. The recent entry of NTPC, a Maharatna Public Sector power behemoth of INida into waste to energy space is a welcome sign. In September 2017, it has invited tenders for 100 MW capacities from waste to energy with latest technologies in a global tender. (Economic Times: NTPC invites developers to set up 100 waste-to-energy plants. BY PTI | SEP 17, 2017). As per Central Electricity Authority, India has harnessed 111.08 MW of WtE energy potential by August 2017. India awaits a long way to go.

To conclude, and given India's size, complexity and outreach to multiple stakeholders, the twenty first century policy makers in India will have to address eight major questions in the context of achieving both energy security and Swachh Bharat Mission:

- (a) How the waste to energy policy and Swachh Bharat Mission is integrated at federal, provincial and local levels and can have political and democratic grass root support for future sustainability?
- (b) How to translate that democratic support to fiscal and financial resource allocation for waste to energy projects and Swachh Bharat Mission in central and provincial and local budgets;
- (c) How to address the issues of land, labour, capital, technologies, research, and capacity building so that India can leapfrog into a zero waste future without repeating the mistakes of the pasts?
- (d) How India should be heading towards in the 21st century in this integrated field of "waste-energy-clean environment" taking the full benefit of various technological advancements?
- (e) How to cut down on bureaucratic red-tapism and create an ecosystem of ease of doing business, while promoting local technologies and make in India.
- (f) Addressing issues of resource security as critical underpinnings and factors for achieving the SDGs. Unlike the MDGs, SDGs are universal in nature aiming to bridge the gap between conventional approaches to economic development, poverty eradication, environmental sustainability and sustainable management of natural resources.
- (g) Focus on sustainability of waste management sector in India in particular and Asia Pacific in general, and dovetailing both in market framework, will largely depend on the supply security of natural resources, raw materials and minerals, freshwater resources, renewable energy sources.
- (h) Address issues of supply security of resources, keeping in view scale of introduction of circular economy which ultimately drives (3R) technological interventions. 3R technologies can linked to various themes at various levels with various domains - collection, sorting, resource recovery (including WtE), recycling, efficient material processing, industrial production, industrial symbiosis, eco- design, product sharing. The linkages to technology domains can be of 21<sup>st</sup> century technologies: such as nanotechnology, green chemistry, internet of things (IOT), ICT, and Industry 4.0 as a technological driver towards resource security and circular economic development as well as their spilling effects towards clean environment (land, water, air) and GHG reduction.

## End Notes

<sup>1</sup> Source: writing by Dr V.K.Jain, MNRE.

<sup>2</sup> Ghazipur Landfill, commissioned in 1984 had no certification since 2006. Height of the garbage mound was 50 meters, against the legally permitted 20 meters. It receives 3000 MTs of garbage daily, 30% of Delhi's waste generation. (The Indian Express, 2<sup>nd</sup> September, 2017. Page 5)

<sup>3</sup> The word cooperative implies partnerships among various stakeholders including private and corporate sector that ensures material security or supply of feed stock on a long-term and sustainable basis.

<sup>4</sup> Source: [http://planningcommission.nic.in/reports/genrep/rep\\_wte1205.pdf](http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf). Report of the Task Force on Waste to Energy “ We, the Members of the Task Force constituted to study technological aspects of Waste to Energy (W to E) projects and propose potentially sustainable models of Municipal Solid Waste (MSW) processing including energy recovery through integrated MSW management in the country, have carefully looked at the current situation of MSW management and various technologies that can be supported at a Decentralized and Centralized level on Public Private Partnership (PPP) mode to enhance resource recovery and deriving energy and nutrients from waste, after due deliberations have adopted the Report for Submission.” Dr. K. Kasturirangan Chairman Members 1. Secretary, MoUD 2. Secretary, DAE 3. Secretary, MoP 4. **Secretary, MNRE** 5. Secretary MoEF 6. Adviser to DCH, PC 7. Dr. Indrani Chandrasekharan 8. Prof. S. Dasappa 9. Prof. Emran Khan Expert Members 10. P. U. Asnani 11. Prof. Shyam R. Asolekar 12. Amit Kumar 13. Dr. Sharad P. Kale 14. Dr. A. Akolkar 15. Vijay Chaurasia Dr.A.K.Dhussa Peer Review Dr. Isher Judge Ahluwalia Dr M. Ramachandran Dr R.K. Pachuari Dr Sunita Naraiian.”

<sup>4</sup> [http://planningcommission.nic.in/reports/genrep/rep\\_wte1205.pdf](http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf)

<sup>6</sup> [http://planningcommission.nic.in/reports/genrep/rep\\_wte1205.pdf](http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf). PP iii.

<sup>7</sup> Draft Guidelines for maintaining Buffer Around waste Processing Plants and Disposal Facilities : [http://www.cpcb.nic.in/Draft\\_Guidelines\\_15.02.17.pdf](http://www.cpcb.nic.in/Draft_Guidelines_15.02.17.pdf)

<sup>8</sup> [http://planningcommission.nic.in/reports/genrep/rep\\_wte1205.pdf](http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf)

<sup>9</sup> EPW: Vol. 52, Issue No. 13, 01 Apr, 2017 » Waste-to-Energy and Recycling: Competing Systems of Waste Management in Urban India, Waste-to-Energy and Recycling, Vol. 52, Issue No. 13, 01 Apr, 2017, Special Articles by Aman Luthra.

<sup>10</sup> Written by Isher Judge Ahluwalia , Utkarsh Patel | Published: January 18, 2017: Indian Express  
C R Sasikumar.

<sup>10</sup> <http://www.uncrd.or.jp/>

<sup>12</sup> <https://www.google.co.in/imgres?imgurl=http://www.epa.nsw.gov.au/images/waste/waste-hierarchy.jpg&imgrefurl=http://www.epa.nsw.gov.au/wastestrategy/waste-hierarchy.htm>.

<sup>13</sup> The recent movie: Toilet A Love Story is an example of how the Swachha Bharat movement is capturing social psyche.

<sup>14</sup> <http://www.wtert.eu/default.asp?Menu=14&ShowDok=25>

<sup>15</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html>

<sup>16</sup> <http://academy.ourgreenerfuture.org/lesson/lesson-1-2>.

<sup>17</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy/targets/>

<sup>18</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-11-sustainable-cities-and-communities.html>

<sup>19</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-11-sustainable-cities-and-communities/targets/>

<sup>20</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-12-responsible-consumption-and-production.html>

<sup>21</sup> <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-12-responsible-consumption-and-production/targets/>

<sup>22</sup> <http://www.swachhbharaturban.in/sbm/home/#/SBM>

<sup>23</sup> [http://www.swachhbharaturban.in:8080/sbm/content/writereaddata/SBM\\_Guideline.pdf](http://www.swachhbharaturban.in:8080/sbm/content/writereaddata/SBM_Guideline.pdf). 30th June, 2017 & the Swachh Bharat Mission (Urban) guidelines, October 2014

<sup>24</sup> Sustainable development and happiness in nations, Energy, Volume 32, Issue 6, June 2007, pp. 891-897. Ivan, Vera, Opens, the author workspace. Author links open the author workspace. LucilleLanglois.

<sup>25</sup> Recently, the Government of India has launched a unique scheme to enable the citizens to access to the power supply throughout the county which will enhance energy consumption and access.



<sup>26</sup> The 'US Environmental Protection Agency' and the 'Institute for Local Self Reliance' estimated that 10,000 tons of materials create between 28 and 296 jobs for the reuse industry. The same volume of materials would create only 1 job at an incinerator and 6 jobs at a landfill.

<sup>27</sup> By reusing unwanted objects we can reduce the need for buying new products and, at the same time, save or even make money. For example: The University College London earned over £70,000 thanks to repurposing the 'Warp-it' software, which allows them to loan out assets and equipment they didn't use to other businesses. Reusing can also have a positive social impact. For example, a non-for-profit organisation, Reuseful UK, takes waste materials from businesses through its network of independent scrap stores, and makes them available to children. This rewarding social activity has not only beneficial and integrating impacts on the wider community, but also allows the younger generations to learn and be creative.

<sup>28</sup> <http://www.conserve-energy-future.com/reduce-reuse-recycle.php>

<sup>29</sup> <http://www.communitywoodrecycling.org.uk/learn-more/recycling-vs-reuse/>

<sup>30</sup> <http://www.wtert.eu/paper/3862/Municipal-solid-waste-management-in-India-challenges-and-potentials.html>.

The factors referred to under the quote are worth exploring separately.

<sup>31</sup> <https://www.changemakers.com/discussions/entries/industry-waste-trading-between-companies>

<sup>32</sup> <http://eaindustry.nic.in/cement/report1.asp>

<sup>33</sup> <http://www.hawa-project.org/services01.htm>

<sup>34</sup> <http://www.uncrd.or.jp/>

<sup>35</sup> 1. [http://searchdl.org/public/book\\_series/CES/1/28.pdf](http://searchdl.org/public/book_series/CES/1/28.pdf)

2. <http://wgbis.ces.iisc.ernet.in/energy/lake2006/programme/programme/proceedings/studentpapers/VIII/SadhanaFinal.pdf>

3. <http://www.ijaiem.org/volume3issue4/IJAIEM-2014-04-22-047.pdf>

4. [https://www.researchgate.net/publication/228852479\\_Studies\\_on\\_Municipal\\_Solid\\_Waste\\_Management\\_in\\_Mysore\\_City-A\\_case\\_study](https://www.researchgate.net/publication/228852479_Studies_on_Municipal_Solid_Waste_Management_in_Mysore_City-A_case_study)

5. <http://www.mysore.nic.in/SWM%20DPR.pdf>

<sup>36</sup>

1. <http://charlescorreafoundation.org/2014/03/08/187/waste> management report -Panaji

2. <http://timesofindia.indiatimes.com/city/goa/CCPs-waste-management-A-success-story/articleshow/18158293.cms>.

3. <http://www.downtoearth.org.in/coverage/waste-smart-cities-54119>.

4. [https://www.cleanindiajournal.com/pantowards\\_a\\_%E2%80%98bin-less%E2%80%99\\_city/](https://www.cleanindiajournal.com/pantowards_a_%E2%80%98bin-less%E2%80%99_city/)

5. <http://www.swachhbharaturban.in:8080/SBMULB/ulbadmin/documentManagement5>. Waste Management for Panaji Report prepared by Mr. Clinton Vaz.

6. World bank report on "Improving Municipal Solid waste Management in India"

<sup>37</sup>

1. <http://www.cseindia.org/userfiles/nirmala-bhavanam.pdf>

2. [https://www.iaeme.com/MasterAdmin/uploadfolder/IJCIET\\_08\\_01\\_028/IJCIET\\_08\\_01\\_028.pdf](https://www.iaeme.com/MasterAdmin/uploadfolder/IJCIET_08_01_028/IJCIET_08_01_028.pdf)

3. <http://www.sustainabilityoutlook.in/news/%E2%80%98clean-home-clean-city%E2%80%99-alappuzha-municipality-shows-way>.

4. <https://www.scoopwhoop.com/Keralas-Alappuzha-Has-Been-Picked-As-Indias-Cleanest-City-Heres-Why/#.oxpodojrv>.

5. <http://indianexpress.com/article/india/india-others/clean-home-clean-city-alappuzha-municipality-shows-the-way/>

<sup>38</sup> <http://www.satyamevjayate.in/Dont-Waste-Your-Garbage/EPISODE-3Article.aspx?uid=E3-Cities-A1>

2. <http://bobbili.cdma.ap.gov.in/en/bobbili-town-excels-smart-waste-management>

3. <http://timesofindia.indiatimes.com/city/visakhapatnam/Bobbili-town-An-inspiring-lesson-in-smart-waste-management/articleshow/53202971.cms>

4. <http://sac.ap.gov.in/sac/UserInterface/Downlaods/MSWMReports/bobbili%20DPR-%205.pdf>

5. <http://www.cseindia.org/userfiles/BOBBILI-SWM.kerala.pdf>

<sup>39</sup> 1. <http://research.ijcaonline.org/volume100/number10/pxc3898184.pdf>

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2. <https://pmc.gov.in/en/waste-management-overview>
  3. <http://www.thehindu.com/todays-paper/punes-waste-to-energy-project-pays-dividends/article3879613.ece>
  4. <http://www.moneylife.in/article/4-reasons-why-pune-scores-in-waste-management/47515.html>
  5. <http://www.hindustantimes.com/pune-news/pune-municipal-corporation-to-finally-set-up-garbage-plant-in-ramtekdi/story-jMUXNeXALipeIbIYW7qsLJ.html>

<sup>40</sup> Energy Efficiency Services Limited, A-13, IWAI Building, 4th Floor, Sector – 1, Noida – 201301, Uttar Pradesh, India, e-mail: [agdsm@eesl.co.in](mailto:agdsm@eesl.co.in), [www.eeslindia.org](http://www.eeslindia.org), Phone: +91 120 490 8000, Fax: +91 120 490809

<sup>41</sup> EESL home page. [https://eeslindia.org/User\\_Panel/CareersView.aspx](https://eeslindia.org/User_Panel/CareersView.aspx)

<sup>42</sup> [https://eeslindia.org/User\\_Panel/CareersView.aspx](https://eeslindia.org/User_Panel/CareersView.aspx)

<sup>43</sup> Hindu Business Lines 20<sup>th</sup> January 2016. Ventana, Ramky Environment partner to set up plastic-to-fuel plants

<sup>44</sup> “Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. Artificial Intelligence, Robots, Drones, Driverless Cars, 3D Printers, Internet of Things and The Revolution of Sensors, Decentralized Energy, DNA Engineering and the Rise of Bio-economy create a new landscape that will reshape manufacturing. It will also reshape waste management and recycling too, redefining the meaning of “waste”, creating new technologies, delivering robotic solutions and driverless collection patterns.” ISWA: <https://www.surveymonkey.com/r/4thindustrial>.

<sup>45</sup> The Times of India, September 22, 2017.

<sup>46</sup> Already there is case of a particular MSW plant in Delhi which was saved by Government’s prudent contribution of around INR 1200 Million so that the plant did not close down, holding the National Capital to hostage. The Company successfully made out a case that it could not just operate as per the tender terms it had bid and got the contract earlier. The only option for it was to close down its operations and go bankrupt.

<sup>47</sup> <http://www.epw.in/journal/2017/13/special-articles/waste-energy-and-recycling.html>

<sup>48</sup> Toxics Link, a New-Delhi based environmental NGO, classifies waste pickers into four categories: Those who carry sacks and collect anything of resale value from open drains, bins and dump sites; the kabadi or bhangar men on bicycles who collect from households and then segregate glass, paper, and bottles from plastics; those who ride tricycles and collect almost 50 kg of waste each day and travel long distances to sell them, and finally, those who work for scrap dealers.

<sup>49</sup> <http://mief.in/rag-pickers-in-india-not-painting-a-good-picture/Millennium> India Education Fund, 13 Community Centre East of Kailash, New Delhi-110065, India

<sup>50</sup> <http://www.indiaspend.com/contactus>

<sup>51</sup> Total waste volume was projected to spiral to 450 Million MTs annually by 2050 from current 62 Million MTs. Changing consumption pattern and consumer behaviour, along with globalization and e-commerce, per capita waste generation was going to go up.

<sup>52</sup> <http://www.indiaspend.com/contactus>

<sup>53</sup> <http://www.indiaspend.com/contactus>

<sup>54</sup> Darkness under the Lamps was a study undertaken by Harsh Mander and V Manikandan in 2011 at the Centre for Equity Studies in Madanpur Khadar, an urban village in south Delhi.

<sup>55</sup> <https://link.springer.com/article/10.1007/s00420-004-0564-8>.

<sup>56</sup> Currently 20 % of capital cost is given by Central Government as viability gap funding. Plus in the Tariff policy 2016, a Feed in Tariff window has been left for energy from waste and Regulators can determine the tariff. Plus Off Grid Mini grid operators have been given protection in operations even after the arrival of grid in the off grid areas where beforehand mini grids were in operation.

<sup>57</sup> The author has requested Mr Joan Marc Simon, Executive Director, Stichting Zero Waste Europe Rue de la Pépinière 10, Brussels 1000, Belgium to strive for opening a chapter in India.

<sup>58</sup> <https://www.forbes.com/sites/suparnadutt/2017/06/21/this-startup-is-making-indias-garbage-its-business/#1f592f2b5512>: The Ellen MacArthur Foundation has estimated that implementing circular opportunities in India could yield over \$624 billion per annum in material savings by 2050--equivalent to 30% of India’s current GDP.

<sup>59</sup> “What defines a “Zero Waste Municipality” is the firm and verifiable COMMITMENT to move towards Zero Waste and the RESULTS that it will deliver in the next years.” “Zero Waste is more a journey than a destination”

<sup>60</sup> <https://www.zerowasteurope.eu/zw-companies-2/>: Raw materials should be obtained, whenever possible, from recycled materials and not from new extraction. Any new extraction should be only justifiable when it

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comes from a regenerating source. A Zero Waste company will be diverting 90% from landfill and incineration. The linear system of production needs to be changed into a circular system in which the recycling potential can be maximised. Production processes should be redesigned in view of avoiding the generation of waste in and outside the plant. The consumption of energy and generation of waste of the product/machine should be included in the optimisation calculations. Apply eco-design and integrated product policy approach. Change the focus from labour productivity to resources productivity.”

<sup>61</sup> file:///C:/Users/Administrator/Downloads/Zero%20Waste%20Municipalities.pdf

<sup>62</sup> Effecorta in Italy is a shop with branches in the province of Lucca and Milan selling local, unpackaged products. It has won the Eco efficiency award in Italy. <http://www.zerowasteurope.eu/zw-companies-2/food-and-drink/>.

<sup>63</sup> <http://www.iswa.org/programmes/external-projects/>: Global Waste Management Outlook (GWMO): ISWA and UNEP have come to finish a successful cooperation on an ambitious project (2013-2015) to develop the first ever Global Waste Management Outlook. The GWMO aims to be a comprehensive, integrated and scientifically credible publication which provides an authoritative overview, analysis and recommendations for action of policy instruments and financing models for waste management around the world.

<sup>64</sup> <http://www.waste.ccacoalition.org/page/about-climate-and-clean-air-coalition-reduce-short-lived-climate-pollutants-ccac>. The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants is a partnership of governments, intergovernmental organizations, representatives of the private sector, the environmental community, and other members of civil society. The Coalition is government-led but is highly cooperative and voluntary. Its governance structure includes the following: a Working Group with representatives from the Partners oversees the cooperative actions of the Coalition. A High-Level Assembly of the Coalition Partners convenes to set policy, take stock of progress and initiate future efforts; a Scientific Advisory Panel is responsible for keeping the Coalition abreast of new science development on short-lived climate pollutants, answer specific questions of the Coalition and inform policy discussions; and a Secretariat is hosted by the United Nations Environment Programme (UN Environment) in Paris.

<sup>65</sup> <http://www.waste.ccacoalition.org/page/about-climate-and-clean-air-coalition-reduce-short-lived-climate-pollutants-ccac>

<sup>66</sup> MOUD, Government of India.