



COMPENDIUM OF GLOBAL GOOD PRACTICES

Urban Solid Waste Management





AT SOURCE
SEGREGATION
COLLECTION &
SEGREGATION
REUSE & RECYCLE
RESOURCE
RECOVERY
PARTICIPATION
& SOCIAL
SUSTAINABILITY



an initiative of



First Published 2015

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PREFACE

The National Institute of Urban Affairs is the National Coordinator for the PEARL Initiative (Peer Experience and Reflective Learning). The PEARL program ensures capacity building through cross learning and effective sharing of knowledge related to planning, implementation, governance and sustainability of urban reforms and infrastructure projects – amongst cities that were supported under the JNNURM scheme.

The PEARL initiative provides a platform for deliberation and knowledge exchange for Indian cities and towns as well as professionals working in the urban domain. Sharing of good practices is one of the most important means of knowledge exchange and numerous innovative projects are available for reference on the PEARL website. “Knowledge Support for PEARL” is a program supported by Cities Alliance that aims to qualitatively further this initiative. One of its key components is to carry out a thematic and detailed documentation of good practices in various thematic areas related to planning, governance and service delivery.

In an effort to fill the critical knowledge gaps for efficient service delivery in Indian cities, a number of good practices from across the globe have been compiled to address specific issues in the areas of water supply, sanitation, solid waste management, urban mobility, and the incorporation of information & communication technology in service delivery processes. Each volume examines case specific processes, activities and results to garner ways of improving operational efficiency – integrated water management, increasing customer base, corporatization of supply, reducing NRW etc. for efficient *water supply*; waste water treatment programs, pro-poor sanitation policy formulation, reclamation & reuse initiatives and public private partnerships for better *sanitation*; comprehensive waste management strategies, at source reduction and segregation, municipal capacity building, recycling, reuse and resource recovery for effective *solid waste management*; integrated land transport systems, travel demand management, pedestrianisation for EcoMobility and integration of informal systems for enhanced *urban mobility*; and finally e-Government development models; GIS mapping for municipal functions and intelligent service delivery systems using *ICT*.

The compilations assemble good practices from countries like Burkina Faso, Senegal, Ireland, Japan, Cambodia, Bolivia, Brazil, Kenya, Netherlands and Mongolia (Water Supply); South Africa, Denmark, Singapore, Thailand, Indonesia, Pakistan, Uganda, Mauritius, Philippines (Sanitation); Australia, USA, Brazil, Bangladesh, Egypt (Solid Waste Management); Nigeria, Mexico, UK, South Korea, Colombia (Urban Mobility); Germany, China, Peru, UAE (ICT). Cases are examined from the perspective of increasing operational efficiency, enhancing systemic capacity, creating efficient public private partnerships and building long-term sustainability into urban management activities. Priority has been given to cases from developing countries in order to increase adaptability and replicability of key concepts and practices.

Jagan Shah
January 2015

ACKNOWLEDGEMENTS

The compendium of global good practices focusing on "Urban Solid Waste Management" is an outcome of a collective contribution of several individuals. NIUA acknowledges their contribution and thanks them for their support.

Firstly, we wish to sincerely thank the Cities Alliance and World Bank whose grant support and knowledge partnership for PEARL has made the documentation possible at a time when urban infrastructure development is one of the main agendas of the Government of India.

We would like to thank Deeksha Matta, Apurva Bajpai, Shoma Mathew and Shilpi Madnawat of the PEARL team, who have contributed in putting the compendium together; and Deep Pahwa and Kavita Rawat for designing and formatting the compendium.

This report would not have been complete without the coordination and editorial support of PEARL Team members Shabana Charaniya, A. Nanda Kishore, Yogita Lokhande, Siddharth Pandit and Sridipta Ghatak.

Special thanks are due to Ajay Suri, Regional Adviser-Asia, Cities Alliance and Prof. Jagan Shah, Director NIUA for their support, guidance and inputs. NIUA has been enriched by the experiences gained in this process and sincerely hope that the report will contribute towards strengthening solid waste management services in India in cities.

Dr. Debjani Ghosh
Project Coordinator



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INTRODUCTION

URBAN SOLID WASTE MANAGEMENT

Solid Waste management refers to all the activities associated with the handling of discarded solid material - from generation, prevention, characterization, monitoring, treatment, handling, reuse and ultimate residual disposition of solid wastes. (IWWG, 2014) These activities operate under a range of formal and informal actors at various scales in both developed and developing countries, with different levels of efficiency and organization depending upon the context. Despite the ongoing research on efficient waste handling systems and the vast and numerous SWM projects initiated world-wide, nearly 50-70 percent of solid waste generated, particularly in cities in developing countries, remains uncollected. Inefficiency in waste management and the urban issues associated with it (urban pollution and health hazards) greatly hinder not only economic and physical development but also social development in growing cities. As a result, sound and productive SWM remains one of the primary concerns of urban planners and policy-makers.

Urban areas in India, generate over 1,00,000 MT of waste per day. The collection, processing, transportation and disposal of this waste is the responsibility of Urban Local Bodies (ULB's). SWM in developing cities and towns deals with very diverse



categories of wastes including municipal (e.g., residential, institutional, commercial, light industrial), agricultural, and special (e.g., C&D, health care, household hazardous wastes, sewage sludge) (IWWG, 2014). Various responses have been formulated by national and city governments across the world for holistically and productively handling these categories of waste, with a constant effort towards being ecologically sensitive. The best practices compiled in this volume discuss some of these successful SWM innovations and solutions from a variety of global urban contexts. Through a perusal of SWM strategies in these diverse physical fabrics, socio-political set-ups and financial constraints, the possibility of adapting the underlying concepts



A Coimbatore Landfill: Contractor appointed to manage waste is non-compliant with guidelines regarding safe waste disposal

Source: The Hindu

to developing cities will be explored. The ultimate goals of the best practices are to achieve **equitable delivery of solid waste management**, ensure **urban cleanliness** and **lower negative environmental and health impacts**.

Key Application Areas

This documentation targets the limitations and challenges of contemporary solid waste management mechanisms in developing contexts, namely:

1. Low financial resources at municipal level for waste management and technological research;
2. Improper disposal of waste leading to extensive landfilling, littering in public places and choking of public infrastructure (drains, paths, gardens etc.);
3. Air, water and soil pollution due to release of GHG's & foul-smelling gases, stagnation of water bodies and leaching from landfills etc.;
4. Lack of a waste management culture and awareness amongst citizens.
5. Under-recognition of the role of the informal sector in waste management. The role of waste related activities in the marginalization of certain sections of society.

By studying a number of waste management initiatives in cities across the world, this document serves as a directory of relevant waste management solutions that aim at the reduction of waste generated; recycling/reuse/recovery of waste at all levels of handling – from home to landfill; better handling of residual waste particularly with the integration of modern technology; ecologically sound and socially just waste management. These initiatives have been discussed under the following thematic areas:

THEME 1- AT SOURCE SEGREGATION: The cases selected under this theme display the effective segregation of solid waste into recyclable, compostable and other categories, at source (schools, residences etc.) with the training and involvement of the participating community.

Ecosavers Project Marikina city, Philippines: This is an “innovative recycling scheme” initiated by the Marikina city Waste Management Office in co-ordination with the Department of Education to promote “ecological solid waste management” practices amongst youth.

Organics Pilot for Schools and Residences: The Department of Sanitation in New York offers curbside collection of organic waste for schools, residential areas/complexes and other institutional buildings that participate in the NYC Organics collection programme, segregating wastes in situ. This pilot programme is now codified into law.

THEME 2- COLLECTION & SEGREGATION: The initiatives described under this theme display the effective collection and segregation of solid waste by local authorities following the up-gradation of collection infrastructure and staff capacity building initiatives.

Material Recovery Facilities in Naga City: This case describes how Naga City in Manila manages to effectively reuse, recycle, and compost 60 tons of municipal waste generated in the city every day, at a five-hectare material recovery facility (MRF), known as Naga's Ecopark.

THEME 3- RECYCLE & REUSE: The cases under this theme discuss the ways in which non-organic MSW can be salvaged during waste collection and then recycled or reused. Redeeming recyclable materials from MSW considerably reduces waste transportation costs and landfill loads.

PET Bottle Recovery and Recycling – Extended producer responsibility In Mauritius: This case describes how popular commercial PET beverage bottles can be refilled and circulated in a systematic manner to save packaging costs and material.

Waste as Building Materials - The Loading Dock Reuse Program in Baltimore: A self-sufficient, nonprofit building materials reuse centre to provide low-cost building material for poor households.

THEME 4- RESOURCE RECOVERY: These cases discuss the extraction of the maximum practical benefits from MSW product so as to delay the consumption of virgin natural resources, and to generate the minimum amount of waste. Particularly relevant is the use of technology to transform waste to energy.

Plastic to Liquid Fuel conversion in Phitsanulok, Thailand: In Phitsanulok, plastic waste is segregated from MSW at a Mechanical Biological Treatment (MBT) facility and then converted into combustible fuel for vehicular propulsion.

Effective Landfill Site Management by Landfill Gas Recovery in Belo Horizonte: This case discusses the process of tapping methane rich landfill gases to be used as combustible fuel.

THEME 5- PARTICIPATION & SOCIAL SUSTAINABILITY: These cases discuss the importance of community participation in waste handling processes in order to instill ownership and responsibility amongst citizens. Practices like integrating informal waste handling arrangements with formal systems enhance the social sustainability of waste handling practices.

Informal Sector Integration - Waste pickers in Zabbaleen, Egypt:
Integration of Local Communities: Community Based Composting to Convert Organic Waste to Resource and Carbon Credit Generation in Dhaka, Bangladesh.

In September 2000, India framed its first Municipal Solid Waste (Management & Handling) Rules 2000 with the vision to guide all urban areas in the country towards Sustainable Municipal Solid Waste Management, adopting the aspects of waste minimization at source with an emphasis on the 3R principles of reduce, reuse and recycle; with proper systems of segregation, collection, transportation, processing, treatment and disposal in complete harmony with the environment.

New Concepts in Waste Management

New concepts in SWM like “integrated waste management systems”, “zero waste cities” and “low carbon cities” aim to streamline and organize the entire life-cycle of solid waste. In



Waste Hierarchy: Karuvadikuppam Dumpyard, Pondicherry

Source: Privatisation: A Formula for Provision or Perversion of Municipal Solid Waste Management?

WASTE HIERARCHY: RECYCLING TO LANDFILLING



WASTE HIERARCHY: AVOID, REUSE, RECYCLE, ENERGY GENERATION, LANDFILLING

THE WASTE HIERARCHY



Source: <http://www.northindiatimes.com/2013/05/28/haryana-to-introduce-community-solid-waste-management-in-villages/>

Source: Privatisation: A Formula for Provision or Perversion of Municipal Solid Waste Management?

these concepts, waste is seen not as superfluous but as a resource for new uses. The efficiency of such systems however requires firstly the existence of strong policy/legal framework to plan the waste management activities and bind actors in specific roles of the process. Secondly, it needs efficient technological support systems like GIS etc. to map and monitor needs and activities to ensure delivery. Such arrangements and extensive

pre-planning also require fiscal strength at the organizational level (which is usually the municipality). Due to these pre-requisites, it is currently difficult to implement holistic waste management systems in developing cities. However, with an entry point in capacity building initiatives and localized diagnostic studies, context specific versions can be formulated with active community participation.

COMPREHENSIVE WASTE MANAGEMENT, MUANGKLANG THAILAND

Location	Muangklang, Thailand
Region	South-East Asia
Agency	Muangklang Municipal Government

Project Aim

To create a comprehensive solid waste management strategy in order to make Muangklang a truly sustainable and livable city. By 2020, Muangklang aims to be a green, sustainable and a low carbon city with low levels of waste, high energy efficiency and sustainable levels of consumption.

Muangklang also aims to be a learning centre for Low Carbon Cities for other local governments within Thailand as well as the Greater Mekong region.

Some concrete aims include:

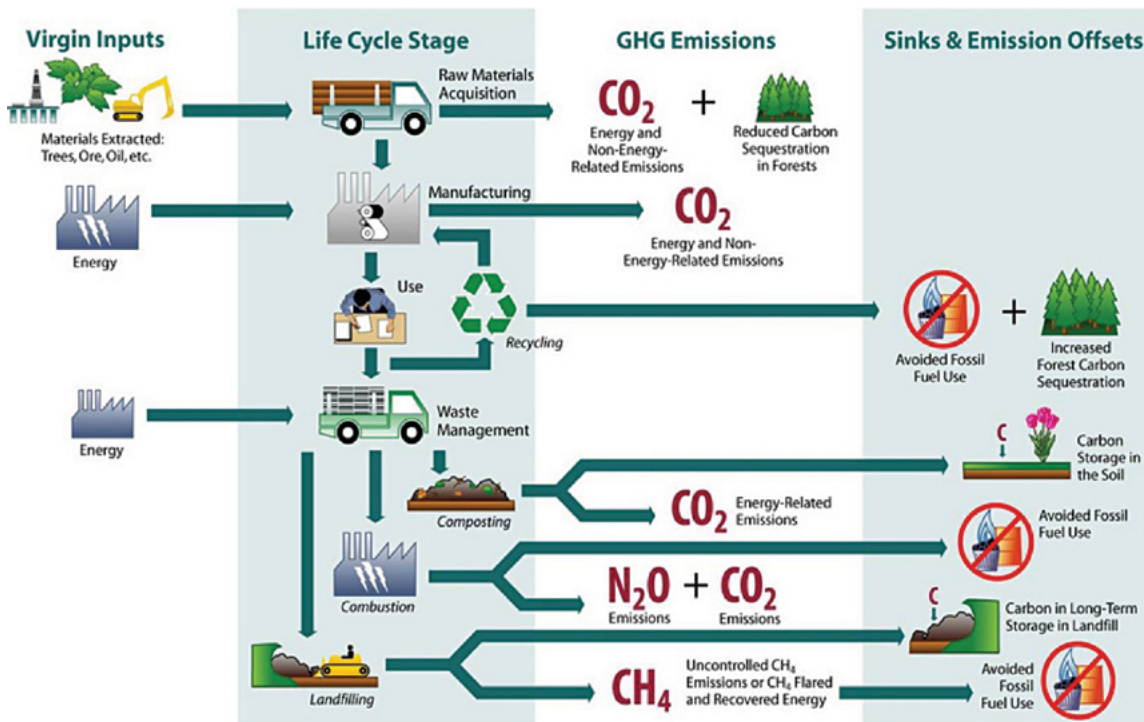
- Decrease waste generation to less than 1 kg per capita.
- Increase the pre-landfill wastesorting capacity by at least 20%
- Increase food production from utilizing locally produced compost by 10% and intensify the campaign for urban agriculture.

Muangklang is a Thai town located 269 kms south-east of Bangkok. With a sprawl of 14.5 sq. kms, it hosts 13 communities

INTEGRATED WASTE MANAGEMENT SYSTEMS

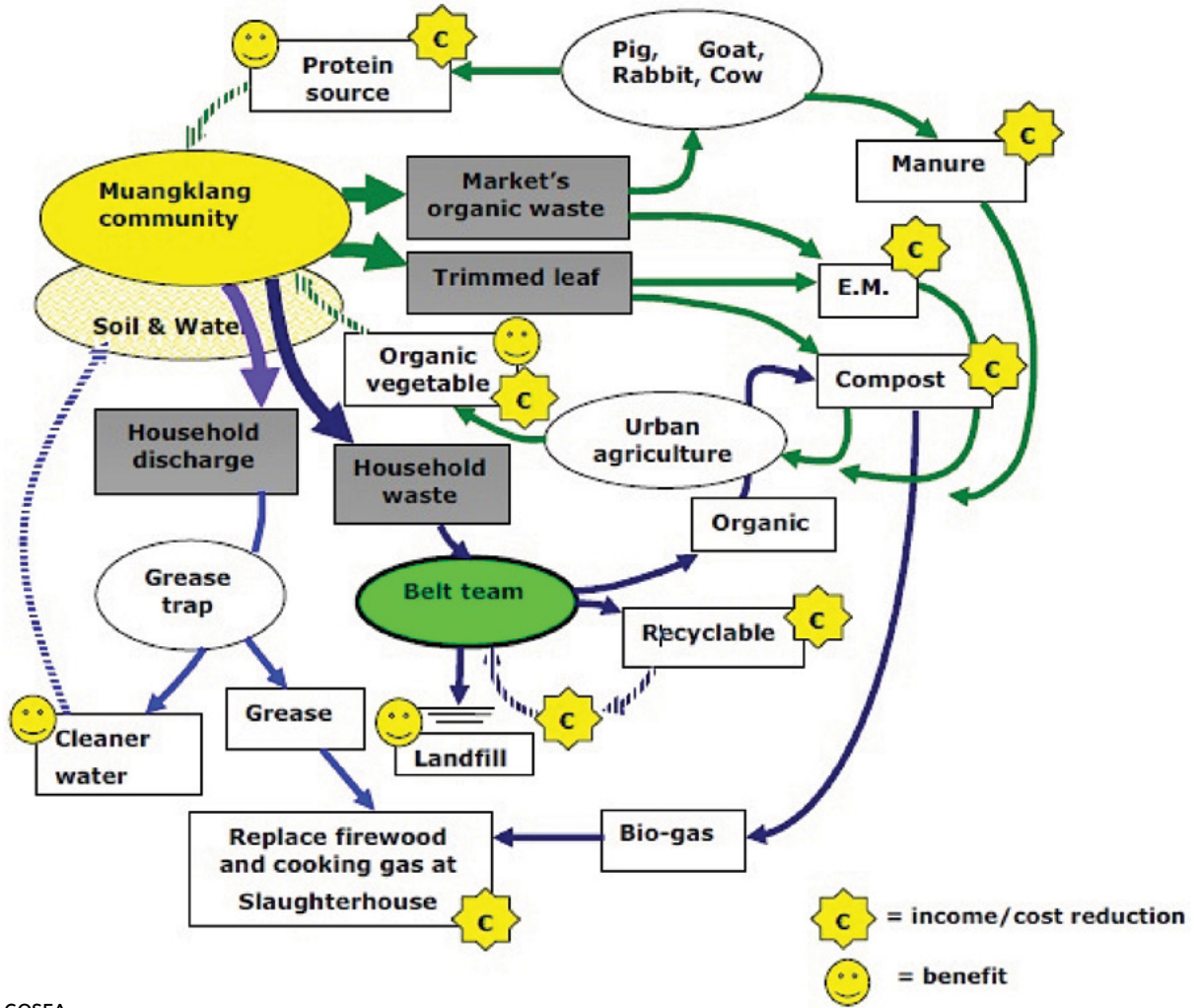
A modern integrated waste management policy is based on a combination of waste prevention and avoidance, maximized recycling of used goods, waste re-use, sorting and separate waste collection. (Craen & Velthoven) A strong IWMS combines several different technologies to offer specific waste processing options for all possible categories of waste. This combination of pre-processing, mechanical and organic recycling and power-generating technologies offers a synergy which would be unattainable if each technology was employed individually. (ibid)

MATERIAL MANAGEMENT FROM LIFE-CYCLE ANALYSIS



Source: <http://www.epa.gov/statelocalclimate/local/topics/waste-mgmt.html>

INTEGRATED WASTE MANAGEMENT SCHEMATIC REPRESENTATION



Source: DELGOSEA



with 3309 households and a population of 17,197 inhabitants. As with all ASEAN cities, problems relating to the efficient handling of organic waste were prevalent with most waste management practices concentrating on inorganic waste. Delivery of waste management services in Thai cities is essentially a municipal function with lack of co-ordination between local and national strategies for waste management (National MSW management strategy 1997). Additionally, regressive disposal practices like landfills and open dumps considerably deteriorated the physical and environmental fabric of Thai cities.

In order to make Muangklang self-sufficient, productive and a “truly liveable city” Mayor Somchai Chariyacharoen initiated the best practice model. Eventually Muangklang was selected as one of Thailand’s three Model Cities and is famous for its strong commitment to green city development. Among other achievements, Muangklang was the winner of Thailand Liveable City Award (2003) in the Tambon Municipality category, awarded by the Thailand’s Department of Environment Quality Promotion, Municipality League of Thailand, and Thailand Environment Institute (TEI). Muangklang is also the Coordinating Centre for the Eastern region of Thailand in the Urban and Environment Learning Network initiative promoted by UNDP, UN-Habitat and TEI.

Project Description

With a budget of only 1,000 Euro, the mayor launched a solid waste management program which led to a significant improvement in the living conditions of the local people and turned the city into a liveable environment. The project was essentially



financed by local government annual funds, with some financial and material contributions from private companies such as Apina Industry, National Starch and Chemical and the neighbouring area like the Rayong Province.

Project Implementation

Due to limited finances and keeping in mind the waste composition and social context of Thai cities, various innovations were made in the technology and implementation processes. An



Conveyer Belt for Manual Separation of Waste



Grease traps installed at households



Earthworm vermicomposting progress



Generation of methane/bio-gas in bio- digester



Trapped grease to be added to bio-digester



Open air composting with air vents and drainage pipes



adapted comprehensive waste management system was established.

- A low-tech incinerator was installed to dispose of non-recyclable and non-compostable waste.
- A simple out-door conveyer belt was installed to aid manual segregation of waste.
- A facility to collect and treat organic waste for producing compost.
- Natural gas powered buses were introduced, their tram-like appearance encouraging people to use public transport instead of cars, in the process, reducing fuel consumption.
- Effective Micro-organism (EM) concentrate was added at regular points in the municipal sewer. The EM concentrate was created with fruit and vegetable refuse.
- Grease traps were installed in houses and shops to reduce the river's organic load and for the collection of "fuel bars".

Key Results and Impacts

As a result of the comprehensive waste management strategies

including recycling and reuse, the number of trips made by garbage trucks to landfills reduced. This was economically and fuel-wise efficient and increased the life of landfills.

The compost for organic waste generates income and saves money for the town. Farming has increased in the municipality due to the availability of good manure and larger open areas. Methane gas has replaced conventional fuel sources in slaughter houses.

Due to the addition of EM concentrate at various points in the sewer, the water quality of Muangklang has improved, allowing the river to be used for recreational, transport and fishing purposes.

Increased use of public transport has reduced pressure on the town roads and also reduced vehicular exhausts, greatly improving local air quality.

Some key activities that involved citizens were as follows:

- Solid waste management—waste separation, conveyer belt, missing bins, school programs.
- Water quality improvement—E.M. production, grease trap



COMMUNITY INVOLVEMENT

Due to the short-term benefits of this program, citizens were keen to be involved in municipal government activities to implement the best practice model. Schools have joined the program and market vendors assist in collection of organic waste for energy production. Residents have voluntarily installed grease traps. Impressed by the mayor's endeavour, citizen's have elected him for a fresh term, giving him more time to complete the activities started under the comprehensive strategy for waste management.

promotion, annual feast on boat.

- Air quality improvement—NGV public bus, urban agriculture, green area promotion, traffic control.
- Educational program—school programs, volunteer trainers.
- Quality of life promotion—Restoration of traditional activities, new sports facility as a park, overall healthy environment.

Thus, the case of Muangklang displays how without large expenditures on infrastructure up-gradation and importing technology, substantial improvement in solid waste management practices can be achieved.

It also shows how the presence of a strong urban manager like mayor Chariyachoen at the local level, institutional will and capacity can be focused on deriving environmental, social and economic benefits from productive waste management.

Sustainability & Replication

The modest scale of the operation ensured self-reliance and sustainability, with the separation conveyer belt running independent of full-time supervision. Sale of compost, fuel, EM concentrate, recyclable material and locally grown vegetables



covers operation costs and workers incentives. Since the facility serves as a learning centre for waste management, an entry fee collected from visitors adds to revenue. As an off-shoot to this program, many schools have adopted educative SWM practices in order to train students in a hands-on manner. This imparts SWM knowledge to the next generation, ensuring sustainability.

Small-scale and low-cost initiatives like these can be replicated in the Indian context, due to the obvious monetary benefits of such programs and the relative ease of execution. Muangklang is a relatively small urban scale; this makes ensuring awareness and rallying

citizen support somewhat simpler than for larger more unmanageable scales like metropolises. However, mobilizing small urban clusters to implement self-sufficiency in waste management is a way of replicating Muangklang's success. Particularly in economically weaker urban communities, waste reduction means cost reduction and income generation. Moreover, such communities are commonly pre-initiated in informal waste handling practices offering a good opportunity to tap into local expertise. Thus enough incentive exists for the implementation of innovative waste management practices in Indian cities.

THEME 1

AT SOURCE SEGREGATION

Waste sorting refers to the process of separating household waste into its various constituent waste streams. *Segregation of waste* refers to the more specific act of separating dry waste, including wood, metal, glass etc. from wet waste comprising of organic refuse like food and garden waste. Segregating waste at source involves the separation of waste into these streams at the time of discarding. At source segregation is essential in order to:

1. Reduce municipal efforts and resources spent on the act of waste segregation post collection.
2. Avoid the soiling of recyclable materials with hazardous and wet waste due to haphazard clubbing during discarding.
3. Ensure the dignity and good health of waste collection workers.
4. Increase recyclability and reusability of waste and reduce land-filling.

At source segregation is mostly manual as it requires the involvement of the waste producing community in the act of segregation. Waste segregation methodology and scale varies according to the waste composition of the participating institutions and residences, and also the efficiency and organizational ability of the concerned municipality. While individual residences can collect dry and wet wastes separately to be handed to respective waste-recycling facilities, some institutions host 2 or 3 bin systems to segregate waste on a larger scale.

Initiatives in India

While some level of segregation of wet and dry waste does take place at the household level in Indian cities, much useful recyclable material like glass and plastic still ends up being transported

to landfills. To address this, formal household based systems for complete segregation of wet wastes have been initiated by the Brihan Mumbai Municipal Corporation.

The BMC, in collaboration with the Indian Centre for Plastics in the environment (ICPE) has initiated household waste collection programs at ward level, in order to ensure at source segregation of dry and wet wastes. For example, in the Cuffe Parade area, BMC has provided vans and staff for door-step collection of dry waste. A covered area within the ward is dedicated for the act of categorizing and segregating this waste into various streams like paper, plastic, metal etc. Local rag-pickers have been given identity badges to integrate them with the formal waste collection system. Wet wastes are also collected by the BMC but are transported to landfills. This initiative encourages residents to segregate waste into dry and wet waste streams at household level itself. Customary recycling traditions like “kabari” collection of newspaper and bulky wastes are also in effect in most Indian cities, keeping away a lot of dry waste from reaching landfills.



ECOSAVERS PROJECT MARIKINA CITY, PHILIPPINES

Location	Marikina, Thailand
Region	Southeast Asia
Year	2004
Agency	Waste Management Office Marikina & Department of Education (DepEd)

Project Aim

To promote a culture of discipline among the youth through ecological solid waste management. To establish good waste management practices through the empowerment of elementary pupils. To instill the realization of economic savings through a waste management program.

Context

Marikina city in Philippines, is a constituent city of Metro Manila, or the National Capital Region. With a population of 424,150 inhabitants, Marikina is known as the shoe capital of Philippines due to its notable shoe industry. As a result of having a strong local government, Marikina is now one of the most awarded city in the country.

In 2000, an Ecological Solid Waste Management Act was enacted to create a framework for managing growing solid waste issues in Philippines. This act emphasized on the role of Local Government Units (LGU's) in managing waste at a local level. Under this act, 103 of 109 cities in the Philippines set up a Solid Waste Management Board (SWMB) to produce a suitable Solid Waste Management Plan (SWMP) in accordance with the guidelines of the ESWM Act. In Marikina city, the Eco-Savers Program was envisioned out of this act, which required local governments to devise a waste segregation scheme to meet a waste diversion goal of 20%.

Project Description

Designed to be implemented as an educational awareness program, the Eco-Savers project focuses on propagating ecologically sound SWM practices at household, institutional and practitioner levels.

The program has the following objectives:

- To educate households in Marikina City to religiously practice waste segregation and recovery of recyclable household waste by enlisting public elementary students and teachers.
- To gradually realize the waste diversion target of 20% through recycling.
- To eventually reduce the cost being incurred by the city in its solid waste management program.
- To instill the value of environmental concern, preservation of health, consciousness on the amount and type of waste the target households produce, and the importance of savings.

The Eco-Savers program was partially funded by the UNDP for the printing of passbooks.

Project Implementation

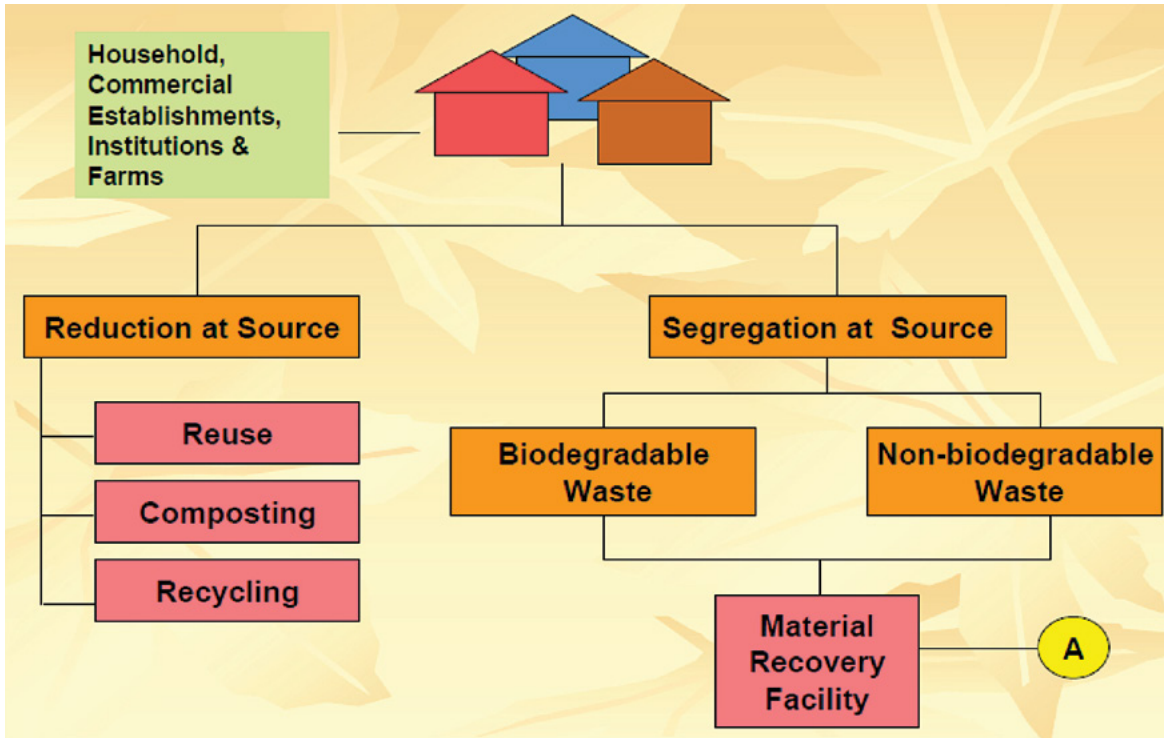
The project came under way by means of various strategies and activities:

Waste Management at Source: Tapping of elementary school student participation by city government as a way of penetrating individual households. Distribution of passbooks to students and teachers to keep tally of points scored by bringing in recyclable wastes on assigned Eco Days.

Promotion of economic benefits from recyclables: The points scored by students were valued at the rate of PhP 1 per point. These points were eventually exchangeable with everyday goods like sugar, cocoa powder, rice and educational material like books, stationary, toys etc. put on sale in an attractive "Eco-Savers" bus. The keeping of a cheque book greatly helped to incentivize students. Additionally, the program created ties between city governments and junkshops for recycle of collected waste.

Empowerment of elementary pupils in ecological solid waste management: Self-monitoring of household waste generation by students. The program empowered students to not only monitor the waste disposal process, but also reduce waste production.





Key Results and Impacts

Monetary Gains: The program has raised nearly PhP 1.3 million since inception and has reduced Marikina’s dependency on internal revenue. Expenditure on solid waste management was also minimized with junk shops now experiencing better and sustained business. Moreover, the Eco-Savers project subsidized educational supplies for students and instilled a savings culture in children.

Tangible Gains: The program serves to safeguard the city and community’s environment and health. Not only has landfilling reduced, but a genuine improvement in the air and water pollution levels has been observed due to decreased number of garbage trucks functioning everyday. Moreover, energy consumption in solid waste disposal has reduced.

Intangible Gains: Through its work in invoking public consciousness for sound waste management and a clean environment, the city government of Marikina has displayed strong political will for implementing and sustaining innovative waste management strategies. This process has built public trust in the municipal government.

Community Involvement

Looking at the program at a broader perspective showed that adopting a sound solid waste management at the household and community levels is a form of people empowerment. The community is given an opportunity in how they can best contrib-

ute to solve the perennial problem posed by garbage. The public school teachers were made aware of the existing environmental conditions, particularly the state of solid waste management. Hence, the natural outcome of the program is a strengthened working relationship between the city government, parents, students, and the business sector. On the whole, the Marikina waste segregation project has not only achieved its primary goal of reducing land-filling by the promotion of efficient recycling, it has also been able to empower a whole community in self-management of waste.

Replicability

Due to the simplicity of execution and the success of this program, it is slated for replication and implementation by other local bodies in the Philippines. The replication of the program is expected to inspire LGUs to come up with more new ideas for in-situ waste segregation. A strong benefit of this program is its scalability, since it can easily be adapted to different institutional capacities – both monetary and governance based. In the Indian context, there is tremendous scope for galvanizing community feeling for a mutually beneficial program like waste segregation and management.

The only aspect to be considered while replication is that the Marikina waste segregation project was a local government initiated strategy. Thus the presence of institutional will and motivation is essential for the success and sustenance of such projects.

ORGANICS PILOT FOR SCHOOLS AND RESIDENCES

Location	New York
Region	United States
Year	2012- present
Agency	Department of Sanitation (DSNY)& Department of Education (DOE)

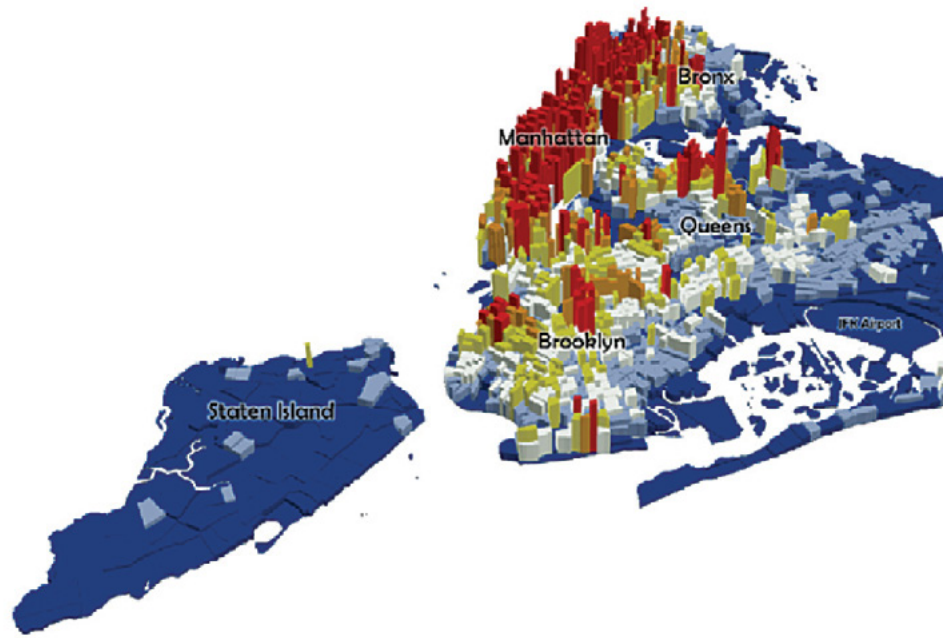
Project Aim

To engage communities in the separation of organic waste from the waste stream for easy curbside collection and subsequent composting.

Context

New York City is the most densely populated city in the United States with an average of nearly 28,000 persons per sq. mile. In this aspect it is one of the few developed cities that

compares to the density of Indian cities. Solid Waste Management has been structurally undertaken by the DSNY since the end of the 19th century, with initiatives like recycling, street sweeping and the maintenance of a uniformed staff body. But with growing density, simple disposal of waste has not remained feasible. With 10,500 tons of residential and institutional refuse, 1760 tons of recyclables a day and another 13,000 tons of wastes collected from private businesses daily, a comprehensive waste management strategy with a major in situ segregation focus was essential. As a result, the Organics Collection for schools and residences program was initiated along with several other pilot projects like “Recycle More”, “Waste Less” etc. in order to specifically address waste production and segregation. Organic waste accounts for about 31% of all waste generated by residents in New York City. By collecting and composting this waste, DSNY aims to produce fertilizer for public greens as well as provide renewable energy to power homes.



Project Description

In the fall of 2012, the Department of Sanitation (DSNY) began offering curbside collection of organic waste to select NYC schools, residences, and institutions. In 2013, the pilot program was codified into law by Local Law 77 of 2013, requiring DSNY to carry out the pilot through July 2015. The Organics Collection pilot program is operating in all five boroughs of New York. Currently the projects is carried out in association with 360 public schools, some private schools, 100,000 households and 50 large residential building.

Project Implementation

For schools, the DSNY made it necessary to have on campus at least one waste sorting station with:

- A bucket for excess liquids
- A metal/plastic/glass/carton recycling bin
- A landfill bin
- A brown organics bin

Posters were provided with each bin to help identify what goes in them. Everyone on campus was responsible for making sure the right kind of waste was put into these bins following which custodians placed the bins on the curb by 4 PM every weekday for collection. Additionally, recycling was made mandatory in NYC schools, with recycling bins placed in pre-assigned bins across the school. This ensured the collection of non-contaminated dry waste.

For residence, the Organics pilot project was voluntary, with residences and residential complexes exposed to literature and frequent advertisements encouraging them to join. Following this the DSNY delivered to each residence, a starter kit for the collection of organics:

- A 12 or 21 gallon brown organics bin
- Kitchen container for segregation of wet waste indoors
- An educational brochure
- Compostable liners

2006 Solid Waste Management Plan

- Sound business principles: Long term contract for processing recyclables
- Environmental concern: Intermodal transportation
- Environmental justice

Local Law 40 of 2010

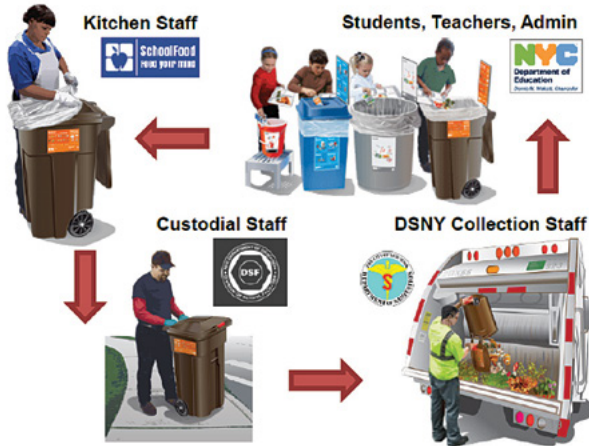
- Amendments to original LL19 of 1989
- By 2020
 - 25% diversion rate DSNY curbside & containerized
 - 33% diversion rate DSNY-managed

For high rise buildings with co-op boards, these boards were made responsible for collecting organic waste into brown bins and bringing it to the curb. For buildings with garbage chutes or common collection areas, either timings were stipulated for the disposal of organic waste bags or the management staff were made responsible for collecting brown bin bags from each floor. Signage was used profusely to encourage people to segregate waste at the household stage. The effort was to make it convenient even for unwilling residents to dispose organic waste separately. The waste is then collected by the municipality once or twice a week and taken to local and regional compost facilities.

Key Results and Impacts

Mandatory citywide recycling of rigid plastics had begun in New York in Fiscal 2014. As a result of this and the expanded pilot program of recycling organic material, the curbside and containerized recycling diversion rate increased slightly to 15.4 percent and the tonnage of recycling collected curbside increased three percent compared to Fiscal 2013.

A major reason for the success of the organics collections program were the "In-person interactions" that took place between



Replicability

Since a large portion of waste in developing cities in India is organic, a household organic waste segregation program would be hugely profitable, particularly since a large market for compost already exists in the country. However, a major reason for the success of the New York Organics for collection program is that regular waste collection and composting facilities were already in place and did not require any financing or setting up. In case such a model needs to be replicated in a context like India, collection facilities firstly need to service more of the population and with increased efficiency and reliability. Moreover, developing countries unable to invest heavily in collection apparatus like high quality bins and collection trucks, may need to devise alternative cost-effective waste handling methodology eg. scheduled re-use of bins on rotation basis. Approaching schools and institutions for a pilot project has once more been observed to be a successful starting point for mainstreaming segregation and recycling activity.



residents and community members. Local resident leaders championing the program provided further credibility and support.

Reduction in landfilling was observed due to an average 2% reduction in waste production per locality from Fiscal year 2013 to 2014. As a result, spending on transport and landfilling was also reduced.

THEME 2

COLLECTION & SEGREGATION

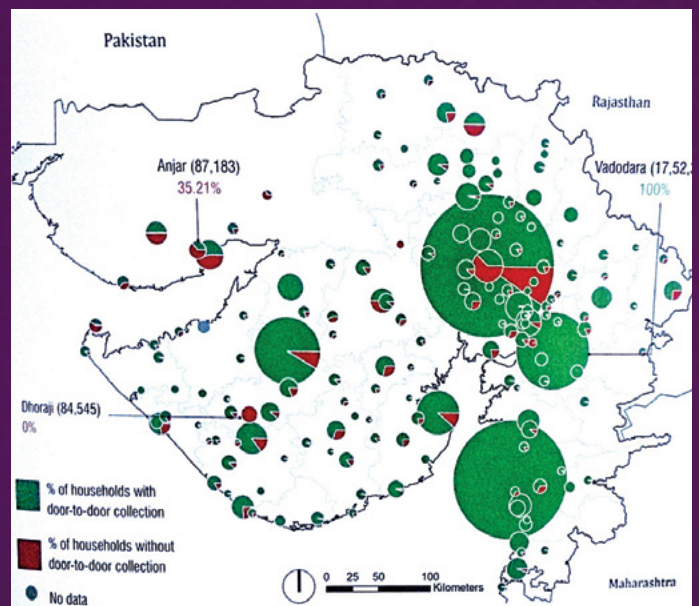
Waste collection and segregation refers to the transfer of solid waste from the point of use and disposal to the point of treatment or landfill. It includes the door to door or curbside collection of waste by municipal, private or informal waste collectors and the manual or mechanical/automated segregation of such waste at a waste handling facility in order to salvage material for re-circulation before landfilling. While waste segregation performed closest to the source is most advisable, with lack of established infrastructure and awareness among developing country communities, much of the collection and segregation responsibility falls upon waste management authorities. Hence, in these contexts, it is common for municipalities to spend nearly 20-50% of their available recurrent budget on solid waste management even though only close to 50% of the urban population is served.

It is therefore important to strategically plan solid waste management with special emphasis on capacity building of waste

collection authorities as well as the introduction of low-cost segregation technology to effectively increase material recovery and reduce land-filling.

Initiatives in India

Municipal door to door waste collection is provided by ULB's in most Indian cities to varying levels of comprehensiveness and efficiency. This service however remains limited to formalized localities, leaving informal settlements to formulate their own parallel waste handling systems. In the case of Gujarat, 32 ULB's have been found to provide 100% door-to-door collection services to all authorized settlements. Additionally, all municipal settlements other than Gandhinagar have 85% coverage for door-to-door waste collection services. Only three cities Patadi, Dhoraji and Anklav have close to nil door-to-door collection. Segregation and recovery activities however remain low at 5% and 31.2% coverage respectively.



MATERIAL RECOVERY FACILITY, NAGA CITY- PHILIPPINES

Location	Naga City, Cebu, Philippines
Region	Southeast Asia
Year	2002
Agency	Naga City Government - Solid Waste Management Office (SWMO)

Project Aim

To convert all operating landfill/dumping sites into material recovery facilities in accordance with the Philippines Solid Waste Management RA 9003.

Context

Naga city in the Cebu Metropolitan area of Philippines is a third tier city with a population of 101,571 people. The town hosts a large power station, a cement factory and a medium enterprise industrial park. The City Solid Waste Management Board created under City Ordinance No. 2001-073 followed by the organization of the Barangay Solid Waste Management Committee (BSWMC) is in place in compliance with Republic Act No. 9003. The Board's main task is to prepare and implement the SWM plans and programs while the BSWMC is tasked to prepare and implement a program supportive of the City's goal. BSWMC implements segregation at source, and recovery of recyclable materials at households and barangay level. The city allots PhP42 million per annum for its SWM programs, roughly 8% of its 2010 budget. Its investment on the Citywide MRF was PhP12 million, with annual labor cost of PhP3.7 for members of the Materials Recovery Facility (MRF) cooperative. The balance covers the maintenance and operating expenses of the city's waste disposal unit.

Project Description

The open dumpsite located at Barangay Balatas has long been utilized since 1960. A controlled engineered landfill was introduced in 2001 as an attempt to convert an uncontrollable dumpsite into a controlled one through:

- Strict monitoring of dumping activities;
- assignment of a permanent bulldozer to level newly-dumped garbage;
- weekly spraying of organic microbes called EM (Enhanced Microbes), used to enhance organic matter and to control leachate;
- banning of burning;
- banning scavengers - the city government instead organized the scavengers into a cooperative to regulate them and totally ban the children from scavenging;
- construction of a perimeter road inside the dumpsite to facilitate easy maneuver of trucks.

Eventually, the controlled landfill facility reached full capacity,

reinforcing the need for fresh waste management techniques. As a result an ordinance was passed to institutionalize material recovery as the preferred waste handling method in Naga city. Under this ordinance material recovery facilities were required to be created in all barangays of the metro, by local governments or with private sector collaboration. Previously scavenging waste pickers would be appointed as staff in these facilities and all residential waste would need to be segregated into recyclables and compostable organics.

Project Implementation

Naga city's entire waste diversion and segregation scheme is implemented as a combination of the work performed by "night workers" - or uniformed waste pickers who salvage recyclable goods from trash across their own communities and the more rigorous segregation performed at MRFs.

These small MRFs are common points in villages or places where residents bring their garbage and sort them out, separating the reusable or recyclable ones from the residual wastes which have no use anymore. A 'sorting crew' segregates the waste as it passes through the sorting facility on a conveyor belt. Naga has six functional MRFs in Barangays Sabang, Triangulo, Calauag, Mabolo, Bagumbayan Sur and public market.

These residual wastes are the ones that the garbage trucks pick up and take to Balatas Dump in Barangay Balatas on the outskirts, which is a large scale "dirty MRF" that accepts a mixed



THE 1ST INTEGRATED RESOURCE RECOVERY FACILITY IN CEBU
 Located in Pangdan, City of Naga, Cebu Province



waste stream of recyclables and organics creating soil fertilizer from about 40-50 tons of garbage daily.

Key Results and Impacts

As a result of the increased involvement of people in the waste segregation process at MRFs, daily garbage collections that amounted to nearly 140-160 tons in 2008-09 have now come down to 57.1 tons. Many food businesses have almost altogether

stopped using Styrofoam and plastic utensils, opting instead for washable plates, utensils and glasses.

Through the sale of fertilizer, the Balatas MRF earns USD 168,000 for Naga city and employs close to 155 families. Reduction in landfilling has improved air and water quality in the city opening out the Naga river for irrigation and navigation usage.

Replicability

Material Recovery Facilities provide an appropriate low-cost waste handling method for incorporating informal workers and achieving zero-waste generation status. Although the scale of Naga city is smaller than most problematic Indian cities, this case displays how inclusion of community members in waste sorting processes can help in firstly, reducing waste production and secondly the sorting of waste at source into recyclable and compostable. Not only will this address waste issues, it will also help in maintaining a sanitary environment for poorer communities while also providing them with a reliable source of livelihood.



THEME 3

REUSE & RECYCLE

Recycling is the process of converting waste materials into new products in order to achieve a set of goals:

- Prevent wastage of potentially useful materials
- Reduce the consumption of fresh raw materials
- Reduce energy usage,
- Reduce air pollution (from incineration) and
- Water pollution (from landfilling)
- Reduce space and cost associated with waste disposal (by reducing material sent to landfills).

These goals are achieved by reducing the need for “conventional” waste disposal and resorting instead to reusing and recycling; which form the second and third tier of the 3R hierarchy of waste disposal. Recyclable materials include various types of glass, paper, metal, plastic, textiles, and electronics. The composting or other reuse of biodegradable waste—such as food or garden waste—is also considered recycling. Innovations in the 3R’s lie not only in the efficiency of collecting and processing materials for reuse but also in the encouragement of people to take individual responsibility for their own rubbish.

Initiatives in India

E-Waste generation is a new and growing problem associated with advancement in technology which renders older electronic equipment obsolete. This e-waste contains valuable natural resources like rare earths, gold and leads which can be salvaged and reused. E-waste needs to be managed outside of landfills as this waste can release hazards which harm the environment. Moreover, recycling e-waste also has tremendous economic and social benefits as it generates employment opportunities.

E-Parisaraa is India’s first Government authorized E-waste recycler which started operations in 2005 in Bangalore. The objective of E-Parisaraa is to create an opportunity to transfer waste into socially and industrially beneficial raw materials like valuable metals, plastics and glass using simple, cost efficient, home grown, environmental friendly technologies suitable to Indian Conditions. E-Parisaraa offers services to IT majors, Public sectors, NGO’s etc. and is approved by both the Central Pollution Control Board and Karnataka State Pollution Control Board.



PET BOTTLE RECOVERY AND RECYCLING - EXTENDED PRODUCER RESPONSIBILITY IN MAURITIUS

Location	Mauritius
Region	Southeast Asia
Year	2001
Agency	Ministry of Environment, Mauritius Mauritius Bottler's Association

Project Aim

To address the growing problem of plastic waste by enforcing Extended Producer Responsibility via a deposit-refund scheme to encourage return of PET bottles.

Context

Mauritius is an island nation in the Indian Ocean located nearly 2000 kms off the south-east coast of Africa. Being an ecologically sensitive small developing country with a population of 1,259,838 persons, Mauritius faces inherent challenges in management of rising volumes of MSW due to scarcity of appropriate space for disposal and treatment facilities, financial constraints and lack of capacity. Further, due to the growth of tourism establishments and inflow of tourists, the generation of solid waste is expected to rise in the island. In developed countries, the recycling of plastic wastes is widely practiced, with polyethylene terephthalate (PET) flakes recirculated as material inputs for fibre/textiles, sheets, bottles and moulded products. However, such recycling methods are energy intensive and may incur high costs. Private sector involvement may be a mobilizing factor in such situations.

Project Description

In 2001 the Ministry of Environment in Mauritius began an extended producer responsibility initiative for PET bottles,



under the Environment Protection Regulation. As a part of this initiative, bottling companies had to establish a deposit-refund system to incentivize the return of the maximum number of PET bottles. They were also required to set up a collecting/compacting system for the collected PET bottles so that these could be recycled / exported.

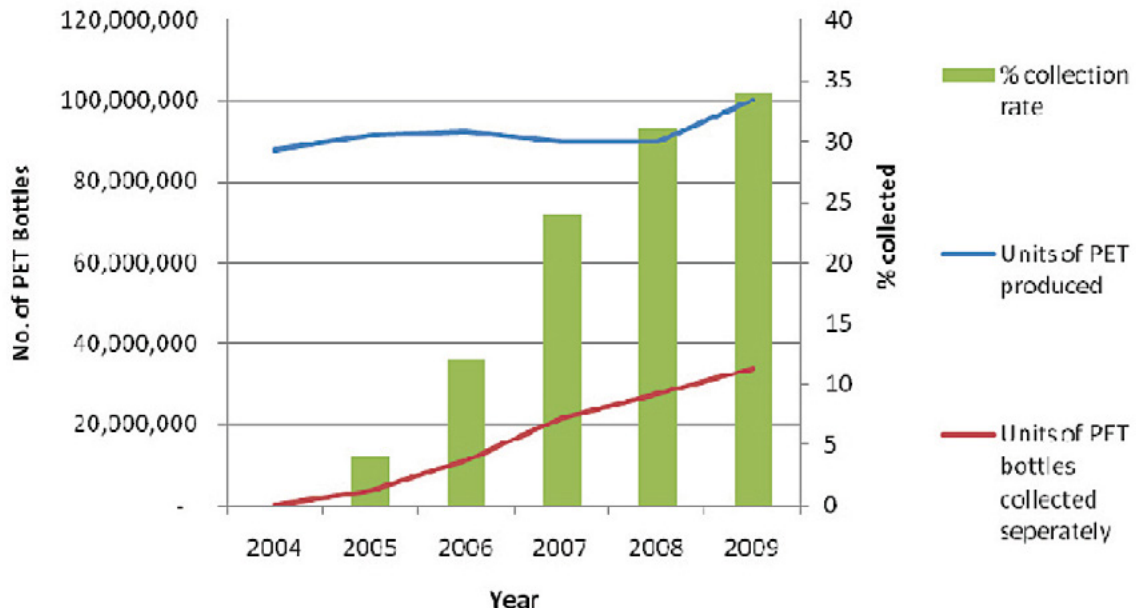
Project Implementation

In response to the regulation, the four big producers of soft drinks in Mauritius, Phoenix Camp Mineral, Quality Beverages Limited and Compagnie Industrielle des Pailles, regrouped themselves into the Mauritius Bottlers' Association and hired a firm, Steel Scrap Ltd., to initially set up a collection mechanism for used PET bottles based on a voluntary take-back system. As part of the collection system, fifty-nine special bins were placed at strategic spots (beaches, market places, hypermarkets, etc.) throughout the island. This initiative was supported by a sensitization campaign where consumers were invited to dispose their used PET bottles in these bins.

To improve collection rates, in 2005 the Bottlers' Association contracted the recycling and processing of PET bottles to a private company called Polypet Recyclers. This company buys PET bottles from individuals, NGO's, schools and other groups at the rate of Rs.7 per kg. The company has a recycling capacity of 1200 metric tonnes/day and charges the bottling companies at the rate of USD 396/ton.

The Ministry of Environment further promoted separation of waste in all primary and secondary schools. Four different bins were distributed and the school community was encouraged to separate their wastes into plastic bottles, paper, biodegradable waste and other wastes. The schools entered into an agreement with the private company for collection of used PET bottles.

FIGURE 5.8 INCREASE IN COLLECTION RATE OF PET BOTTLES



Source: Ministry of Environment Mauritius

The collected PET waste is then collected, baled and sorted out according to colour and specific number. The waste is washed, granulated, re-washed and dried in specially designed machines. They are then ground and fed into other machines which melt them under heat and pressure. The PET waste is finally processed into pellets for export to South Africa. The private recycling company is required to show the customs proof of the amount of PET exported.

Key Results and Impacts

Up to 34 per cent of the 3000 metric tonnes of PET used on the island (or about 80million bottles) are being successfully recycled.

The initiative created about 100 indirect jobs on the collection side and also hired more than 30 workers directly in the recycling company.

The Bottlers' Association also promotes community initiatives with NGOs to create an opportunity for local residents to get additional revenue obtained from reselling PET waste. As a result, a recycling culture was promoted amongst residents and more quantitatively, waste has become a source of livelihood for some under-mobilized sections of the community eg. even housewives of low income families organized themselves and went from house to house to nearby communities in order

to collect used PET bottles, since this gave them a fair source of income in return.

With the involvement of the private sector, the city authority was able to increase collection rates from 4% in 2005 to 34% in 2009.

Replicability

This model is easily replicable in developing contexts where industries intensively rely on plastics. PET bottle recycling has been found to be viable in cities with a local consumer base of over 200,000, a bracket that includes a large number of growing Indian cities

For recycling to be successfully implemented in cities, the process should be economically attractive. Privatization of recycling activity is another clause necessary for the success of such initiatives due to high infrastructure and running costs associated with the entire process of segregating plastics from the waste stream and processing for further use.

There is great scope for the involvement of informal waste handlers as well as consumers in such processes. City leaders can promote reuse and recycling of beverage containers by establishing deposit systems and/or imposing fees on one-way bottles.

WASTE AS BUILDING MATERIALS - THE LOADING DOCK REUSE PROGRAM IN BALTIMORE

Location	Baltimore, USA
Region	North America
Year	1984-present
Agency	Ministry of Environment, Mauritius Mauritius Bottler's Association
Awards	Presidential Award for Sustainable Development and the United Nations Habitat II "Building Communities of Opportunity" National Excellence Award

Project Aim

To increase the supply and use of affordable building materials for housing and community improvement by redirecting land-fill-bound, reusable materials into productive use.

Context

Baltimore is the 26th most populous city in the USA and the largest city in the north-west state of Maryland. With a population of 2,203,663, Baltimore is a prominent port city and medical service centre in the United States. Due to quick urbanization in the 1980s, a great and pressing need arose for the up-gradation of substandard housing in Maryland, with one out of every six housing units in the state declared substandard, and a majority of these substandard homes being occupied by poverty level households with annual incomes under \$10,000.

Project Description

When the combined resources of public, private and charitable sectors proved to be insufficient to meet the need for affordable housing, the Loading Dock, a 501(c) 3 nonprofit organization,

created a scheme to redistribute discarded and surplus building material. TLD operates out of a 42,000 sq. ft. warehouse in southeast Baltimore and serves as the state's central clearing-house for salvaged surplus building materials that are otherwise headed for landfills and redistributes them.

Project Implementation

TLD accepts all kinds of materials, including paint, lumber, plumbing fixtures, doors, cabinets, windows, caulks, moldings and just about anything reusable from the home building industry. Donors are contractors, distributors, manufacturers, and individual homeowners. It then creates and maintains an inventory of these items which are purchasable by customers and organizations at very subsidized rates.

Many times, products are new and unopened due to change in company stocks. However, it is hard to find items of exactly the required profile at all times, due to irregular supply.

Beginning from a small 7000 sq.ft.apartment, TLD has now expanded to acquire its own building and truck and the implementation of new services for both clients and donors, including the Do it Yourself Workshops, the Landfill Collection Program, and Community Collection Days.

Key Results and Impacts

TLD has rescued thousands of tons of building materials from landfills, assisted more than 8,500 individuals and groups and partnered with more than 400 manufacturers, distributors and contractors in the Mid-Atlantic region. Each year, TLD prevents approximately 24,000 gallons of paint and other toxic elements such as caulk, adhesives, stains and sealers from reaching landfills.

Low to moderate income housing and substandard housing are brought up to par. Neighborhoods are rejuvenated, which in turn prompts a healthier tax base in the city. Donors save dumping and storage fees; increase storage space by clearing unwanted and surplus items; gain a tax deduction for their contributions; earn LEEDs credits; and have the satisfaction of both helping the environment and underprivileged people.

The first non-profit program of its kind in the nation, TLD represents a successful marriage between nonprofit organizations and businesses that offers a creative way to tackle housing and environmental issues. It has inspired similar programs in other cities nationwide and has fielded requests for information from, and lent technical assistance to, more than 300 cities, some as far away as Tijuana, Mexico, St. Johns and St. Croix in the Caribbean, five countries on the west coast of Africa, Hungary and Germany.

Replicability

In India, out of 48 million tonnes of solid waste generated, construction and demolition waste makes up 25% annually. Nearly



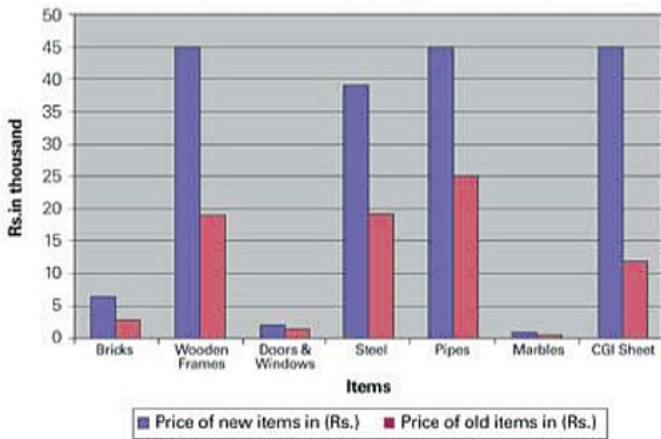


TABLE 1 : QUANTITY OF CONSTITUENT OF C & D WASTE GENERATED IN MILLION TONNES P.A.

Constituent	Quantity generated in million tonnes p.a.
Soil, sand and gravel	4.20 to 5.14
Bricks and masonry	3.60 to 4.40
Concrete	2.40 to 3.67
Metals	0.60 to 0.73
Bitumen	0.25 to 0.30 MT
Wood	0.25 to 0.30 MT
Others	0.10 to 0.15 MT

Source: Technology Information, Forecasting And assessment Council, Dept. Science and Technology,

50% of this C&D waste is landfilled, adding considerably to the already mounting issue of solid waste management. Analysis shows that reuse of construction waste can reduce the cost of low budget houses by approximately 30% to 35% without compromising the durability of the structure.

Hence is it very important for institutional provision and community initiative to co-exist for efficient recycling and reduction of C&D waste. Waste recycling plans should be developed for construction and demolition projects, prior to beginning construction activity. The plans should identify the wastes that will be generated and designate handling, recycling and disposal methods. A minimum of 4% of the total site area should be allocated and cordoned for storage and pre-treatment

*“You could build a house
With what people throw away”*

of the waste. Separation of C&D waste should be promoted at source and private or non-profit enterprises like The Loading Dock can be gainfully employed for the collection and transportation of the waste. Quality standards for the recycled or re-used products can be developed and monitored by Bureau of Indian Standards.

THEME 4

RESOURCE RECOVERY

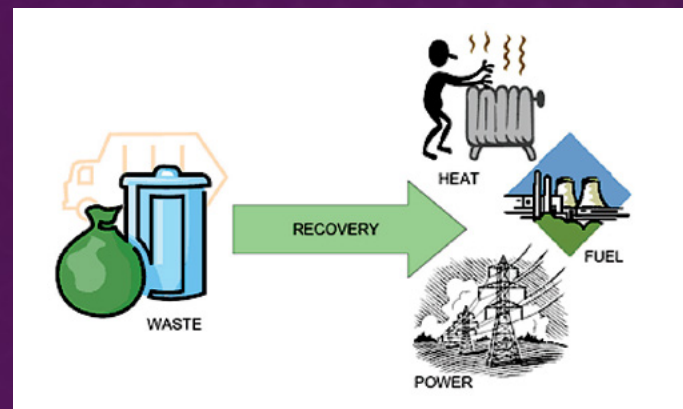
Resource recovery is the selective extraction of disposed materials for a specific next use, such as recycling, composting or energy generation. The aim of the resource recovery is to extract the maximum practical benefits from products, delay the consumption of virgin natural resources, and to generate the minimum amount of waste. Resource recovery differs from the management of waste by using life cycle analysis (LCA) to offer alternatives to landfill disposal of discarded materials. Some prevalent methods of recovering resource from waste are: capturing landfill gases to be used as a source of energy, converting waste material into combustible fuel and even recycling used material. Resource recovery is a key component in a business' ability to maintaining ISO14001 accreditation. Companies are encouraged to improve their environmental efficiencies each year. While the point of resource recovery is to reduce waste disposal in the first instance by resorting to other waste handling methods, energy production from waste is widely carried out as a last resort method of recovery.

Initiatives in India

According to the Ministry of New and Renewable Energy (MNRE), there exists a potential of about 1700 MW from urban waste (1500 from MSW and 225 MW from sewage) and about 1300 MW from industrial waste. The ministry is also actively promoting the generation of energy from waste, by providing subsidies and incentives for the projects. Indian Renewable Energy Development Agency (IREDA) estimates indicate that

India has so far realized only about 2% of its waste-to-energy potential. A market analysis from Frost and Sullivan predicts that the Indian municipal solid waste to energy market could be growing at a compound annual growth rate of 9.7% by 2013.

Energy can be recovered from the organic fraction of waste (biodegradable as well as non-biodegradable) through thermal, thermo-chemical, biochemical and electrochemical methods. Inorganic waste materials like plastic – which is generated at the rate of 56 lakh tonnes per year in India – can be processed with heat to produce fuel. With recent development of plastic processing technology at the Indian Institute of Petroleum, India can soon begin to convert plastic waste to gasoline, diesel or aromatics through the use of a combination of suitable catalysts.



PLASTIC TO LIQUID FUEL CONVERSION IN PHITSANULOK, THAILAND

Location	Thailand
Region	Southeast Asia
Year	2008
Agency	Phitsanulok Municipality & Ministry of Energy - Energy Policy and Planning Office (Eppo)
Award	Dubai International Award for Best Practice to Improve the Environment

Project Aim

To address the growing problem of plastic waste by initiating a refuse derived fuel (RDF) generation process for the conversion of waste plastics to oil.

Context

Phitsanulok Municipality is located in northern Thailand in the Muang district, 377 km away from Bangkok.

- 18.26 km² of municipal area
- 24,000 households
- 90,000 registered population
- 50,000-100,000 non-registered
- Waste generation in 2011 is about 76 tonnes/day
- Estimated waste composition is 40% organic, 40% recyclables, 20% others

Due to rapid increase in waste generation (upto 1.5kg/person/day) the municipality had to change dumping sites very often, each located further away from the city than the previous. As a result, an increase in urban sprawl and land prices was observed



along with increased social resistance by local communities where disposal sites were located.

Project Description

In order to address issues arising out of excess solid waste, Phitsanulok municipality adopted a municipal solid waste management scheme aiming towards zero waste landfill in 2007. This was a comprehensive waste management strategy including implementation of 3R, extended producer responsibility, raising community awareness and waste to energy conversion programs. A mechanical biological treatment (MBT) was performed on the organic rich waste of Phitsanulok in order to separate organic and plastic wastes. The plastics were then broken down by a pyrolysis process - a form of incineration that chemically decomposes organic materials by heat, in absence of oxygen.

Project Implementation

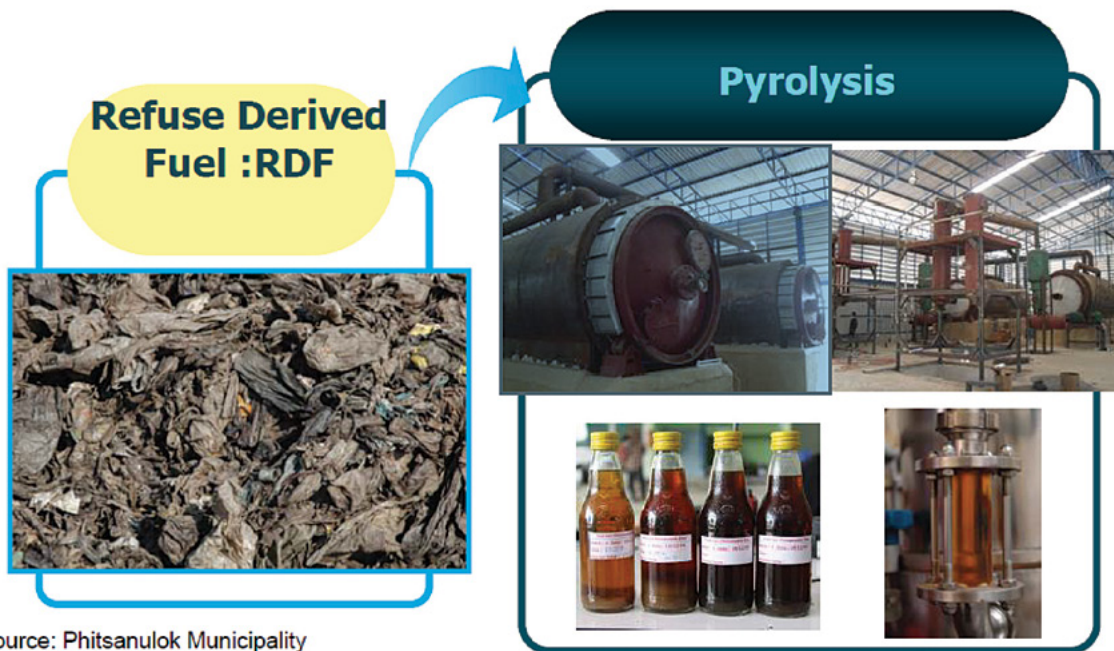
Phitsanulok in partnership with Muang Sa-Ard Co.Ltd., have constructed a waste plastic to liquid fuel facility to be fed with plastics from recent inputs at the MBT facility. Waste undergoes mechanical-biological treatment (MBT) and segregation of plastic from MBT (liquid fuel-diesel, gasoline) and finally a pyrolysis process. The plant has two reactors operating alternatively and in batches. 4 to 8 tons of plastics are fed per batch and each batch needs 24 hours for the plastics to be processed into oil (55-60% of the plastic weight), carbonaceous matter (5-10%), wax (5-10%) and flue gas (5-10%). The plant produces 2000l fuel per day. The liquid fuel is mixed (50:50) with diesel and it is used as fuel for trucks.

Key Results and Impacts

The negative impacts of waste plastics were addressed or minimized and plastics could be converted into a valuable resource. In this case, plastic recycling contributed to:

- Resource conservation, an important goal for most of the national and local governments, due to the current pressure on natural resources as a consequence of rapid industrialization and economic development.
- GHG emission reduction potential on two accounts; (a) making fuel from waste plastic can obviate an equivalent amount of fossil fuels, (b) co-disposal of waste plastic in landfills causes formation of pockets of anaerobic decomposition of organic waste which can be avoided.

Overall, Phitsanulok Municipality has gradually achieved the zero waste target through the 3Rs implementation, polluter pay principle, public participation, pre-treatment prior to landfill and pyrolysis. The remaining waste to landfill is approximately 5%. Phitsanulok Municipality may need advance technology such as incineration and ash recycling to achieve zero waste to landfill, however this technology is



Source: Phitsanulok Municipality

currently too expensive for developing countries.

Replicability

Industries and markets in India intensively rely on plastics. Plastic waste recycling, in most of the situations, could also be economically viable, as it generates resources which are in high demand. However, analysis of local conditions and consideration of the required initial capital investment are to be assessed.

Since the ban on light weight plastic objects made of film of

less than 20 microns has been unsuccessful in reducing plastic percentage in Indian solid waste, fuel production via pyrolysis is a plausible method of reducing plastic to landfill percentage.

Pilot projects like the plastic to waste process invented by Umesh and Alka Zadgaonkar have now been accepted by the Indian Oil Corporation and a 7.08 crore project for further developing the technology is in the pipeline. Mainstreaming this process is absolutely essential to address the 7000 tonnes of plastic waste produced in India daily.

EFFECTIVE LANDFILL SITE MANAGEMENT BY LANDFILL GAS RECOVERY IN BELO HORIZONTE

Location	Belo Horizonte
Region	South America
Year	2007
Agency	Municipal Department for Environment -Municipal Committee on Climate Change and Eco-Efficiency (CMMCE)

Project Aim

To implement effective landfill site management and GhG emission reduction by gas recovery and the generation of combustible natural gas.

Context

Sustainable development has been an important agenda in Belo Horizonte, the third largest city of Brazil. Belo Horizonte produces 3,580 tonnes of MSW and 28 tonnes of hospital waste every day. Waste management in Belo Horizonte falls under the jurisdiction of the Municipal Department of Urban Cleaning (Superintendência de Limpeza Urbana (SLU)).

Belo Horizonte has been pro-active in developing SWM practices through a series of activities, including an Integrated Solid Waste Management Model in 1993. Activities have included waste separation at sources, selective collection of recyclable waste (paper, plastic, metal and glass), and the creation of several organisations such as the Construction and Demolition Waste Recycling Programme, the Clean Urban Community Agents (organisation of workers, sweepers and collectors to improve their working conditions), and the Composting Programme and Programme for Tyre Collection. It has also piloted and operated a landfill gas capture scheme.

In 2006, the Municipal Department for Environment established the Municipal Committee on Climate Change and

Eco-Efficiency (CMMCE). The committee is composed of representatives from the municipal and the state government, civil society, non-governmental organisations, the private sector and academia. Related policies are reinforced by Law no. 10.175/11 introduced in May 2011. This law provides a Municipal Policy for Climate Change Mitigation. It includes a GHG reduction target of 20% by 2030 compared to 2007.

Project Description

The Belo Horizonte landfill has been active since 1972 when land for waste disposal was identified in the local government master-plan on highway BR 040. This site, named the Municipal Waste Treatment Centre (Centro de Tratamento de Resíduos Sólidos (CTRS)), operated for 14 years as a conventional landfill in accordance with the respective rules. In 1989, the first waste to energy project was implemented on trial basis by the Companhia de Gas de Minas Gerais (GASMIG), a subsidiary company of the state energy utility Companhia Energética de Minas Gerais (CEMIG). While it was initially successful in tapping biogas, the program eventually ran into losses as the existing collection technology was unable to cope with the increasingly inorganic waste composition that hindered biogas production in the landfill. After exploring various solutions for making the landfill environmentally and economically viable, the landfill site finally closed in December 2007, after being open for 32 years, to conventional operations. Towards the end of 2006, more than 17.4 million m³ of waste had been deposited in the landfill. The maximum landfill height was about 64 meters.

Project Implementation

A new waste-to-energy approach was identified for the site. In Brazil, most landfill sites currently use an open drainage system, where a flame burns the escaping biogas (i.e., flaring). In Belo Horizonte, the experts realised the potential to capture





the landfill gas with new technologies. In 2007, the local government launched a tender for a specialised company to capture the landfill biogas. One requirement was that it be linked with the certification and marketing of carbon credits under the Clean Development Mechanism (CDM), in accordance with the United Nations Framework Convention on Climate Change's Kyoto Protocol. The public process called upon national and international companies to present the most qualified and cost effective project to equip and manage the biogas production and utilisation centre.

The rights to use the biogas generated at CTRS was granted to the Italian company Asja Ambiente Italia Spa for a period of 15 years (2008-2023), while the biogas collection project proposal was designed for 10 years. Their project foresaw the creation and management of a plant with 1) biogas collection and transmission; 2) biogas suction and control; and 3) biogas treatment, electricity generation and flare combustion.

In December 2008, the project's infrastructure construction started and by the beginning of 2009, the first landfill gas collection wells were drilled. By the end of 2009, the landfill gas collection and flare combustion plant was installed. In 2010, the plant became fully operational. The project was given the authorisation to install and operate an energy plant of maximum 5 MW capacity, which equated to a maximum annual generation of 43,800 MWh.

An agreement was signed with the municipal authorities that the generated electricity would be directly sold to the energy utility (CEMIG) under a contract of four years, which would be distributed to consumers through the city's electricity network. The biogas capturing facility was also registered in 2011 under the CDM, thereby benefiting from carbon revenues through Certified Emission Reductions (CERs).

Key Results and Impacts

Additional energy generation: The dependency on energy generated from fossil fuels is reduced.

The energy produced by processing and burning biogas at the CTRS is commercialised through the local electricity utility provider CEMIG on a contract basis for four years for the installed capacity. In 2011, the plant had a gross electricity production of 30,400 MWh. The biogas plant consumed only 2,900 MWh in 2011 for maintenance and operation. Thus, around 28,000 MWh of electricity was supplied to the electricity grid. This corresponds to the electricity consumption of approximately 30,000-35,000 people. The exploitation of biogas in large treatment units also allowed for the negotiation of carbon credits in the international market.

Reduction of tonnes of CO₂ equivalent (tCO₂e): The community's carbon footprint from landfill sites is reduced.

The landfill site used to be among the largest single sources of GHG emissions in Belo Horizonte. GHGs from the landfill site have substantially reduced since 2009. Table 1 shows the projected scenarios for the amount of methane destroyed, CO₂e emission reductions and the net quantity of electricity supplied to the grid between during the CDM crediting period - 2010 and 2016 (the entire project period is mid 2009 until 2019).

Social achievements: Environmental and social conditions of the citizens living in the area are improved, as bad odours and poisonous emissions are reduced.

The project has had a positive impact on the local community. Complaints from residents, like bad smells, have receded and the risk of explosions and fire has significantly dropped. In addition, a highly-qualified team of engineers and operators were hired and trained to run the project.

Replicability

It has been estimated that collection of methane is only profitable in medium and large landfills (i.e. cities with over 100,000 inhabitants). By this argument, most Tier 1 and Tier 2 cities can host profitable landfill gas recovery projects. However, the feasibility of a waste-to-energy project also depends on other conditions. The waste of every nation, region and city has its own characteristics, e.g. the share of organic waste. A careful analysis of the physical and biological characteristics of the waste generated in a community or region as well as the design and the landfill operating conditions are fundamental for the success of a project. An investigation into the potential for capturing methane from a landfill site can go hand in hand with a wider investigation into the separating of organic waste towards organic digestion for energy production amongst others.

THEME 5

PARTICIPATION & SOCIAL SUSTAINABILITY

When designing solutions for waste handling issues it is important to acknowledge that waste generation is a cyclical and inescapable phenomenon. The effects of designed solutions hence need to be as sustained as waste generation itself. In contexts like India, where age old informal waste handling systems are collapsing under the stress of modern progress and urbanization, it is counter-productive to completely dismantle these systems to bring in new technologically sound versions. There may be multiple benefits of incorporating informal solid waste management infrastructure into new solutions eg. the regularization of informal waste pickers and participatory waste management. Such adaptations not only ensure social well-being and financial efficiency, they also ensure the creation of public ownership for urban environments amongst citizens by involving them in civic activity.

Initiatives in India

With a population of 3.5 million as per 2011 and a floating population of about three to four lakhs, Pune generates approximately 1400 metric tonnes of garbage each day.

In 1993, waste pickers and itinerant waste buyers in Pune came together to form Kagad Kach Patra Kashtakari Panchayat (KKPKP), a membership-based trade union; to establish, quantify and assert waste-pickers' contribution to society and safeguard

their livelihoods and dignity. Members were given I-cards and were recognized as formal waste-handling municipal staff. Today KKPKP has 9000 members out of which 80% are women.

In order to take advantage of the 2000 MSW policy rules to safeguard the interest of waste-pickers, the KKPKP in 2005 set-up SWaCH, a Pro-poor Public Private Partnership based cooperative to handle door-to-door waste collection activities. The initiative brought together two interests – the waste pickers' interest in upgrading their livelihood and the municipality's interest in sustainable SWM.



ZABBALEEN ENVIRONMENTAL AND DEVELOPMENT PROGRAM

Location	Cairo
Region	Middle-east
Year	1981-1998
Agency	Environmental Quality International (EQI)

Project Aim

To integrate informal waste handling systems with modern technologically robust processes in order to meet expanding waste processing needs in developing cities.

Context

Cairo has become one of the largest cities in the world, with a population of fifteen million and growing at a rate of almost one million every eight months. As a consequence, immense strain has been put on basic services, especially the collection and disposal of solid waste. Greater Cairo generates around 6000 tons of solid waste per day. Traditionally, two groups, the Wahis and the Zabbaleen, have worked together to collect and remove the city's trash; the Wahis control the routes and contract with homeowners, while the Zabbaleen collect the waste and transport it to their settlement, where it is sorted and recycled or used for animal fodder.

As the city grew and the amount of daily garbage skyrocketed, Cairo's trash collection needs began to overtake the Zabbaleen's capacity to provide services. The Zabbaleen were a marginalized and undervalued community with little or no organization or power. They lived in settlements with few basic services, and

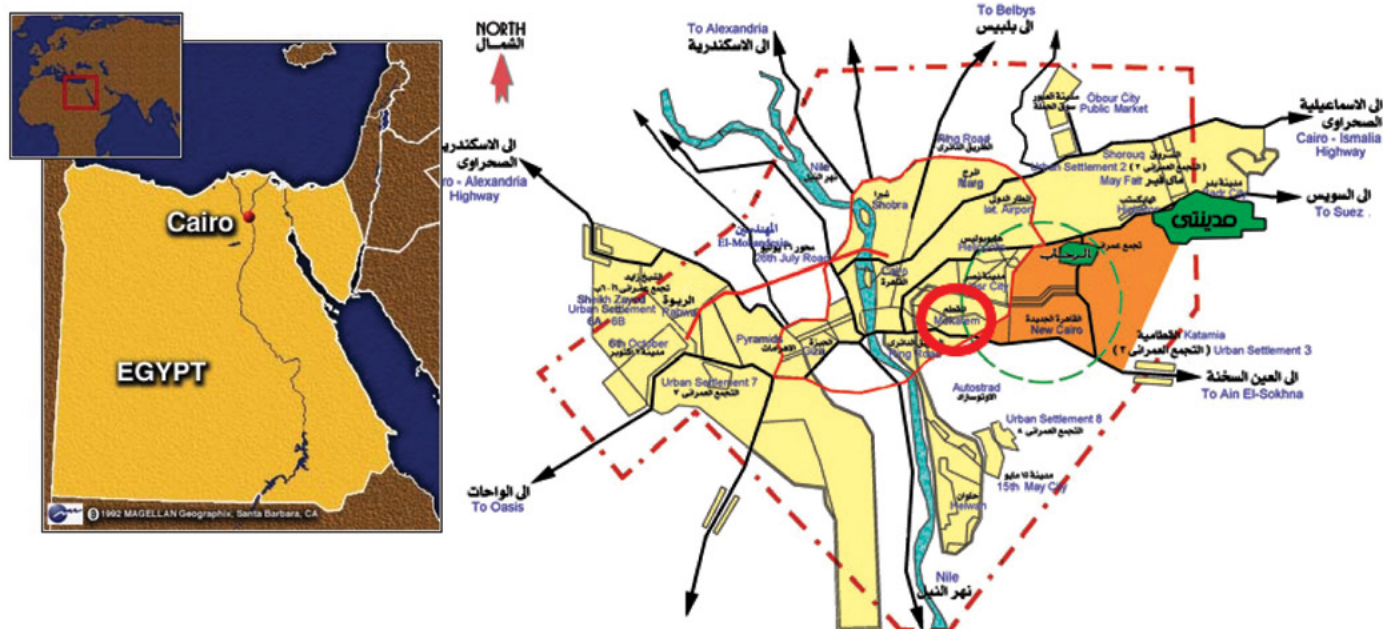
suffered from environmental devastation, little economic opportunity, lack of education, and a host of other problems endemic to urban slums. Even worse, with the government threatening to look elsewhere, to more "modern and efficient" systems, to meet the city's need for trash collection, the Zabbaleen faced the possible loss of their traditional livelihood.

Project Description

In response to these problems the Zabbaleen Environmental and Development Program was initiated in 1981. Founded on the premise that the Zabbaleen already provided a valuable service and filled a necessary niche in the infrastructure of greater Cairo, it sought to radically improve the living conditions and build the capacities of the Zabbaleen community in the Moqattam area, where over 50% of Cairo's garbage collectors live in deplorable environmental and sanitary conditions. A variety of partnerships involving local organizations, government, technical assistance groups, NGO's, and international funding and development organizations have resulted in a number of projects designed to extend services to Moqattam, create economic opportunity and generate income through the development of micro-enterprises, consolidate waste management, expand collection services, and build human resources. These projects have collectively worked to preserve the Zabbaleen's livelihood, begin the creation of more powerful community organizations, and legitimate their role as valuable service providers entitled to basic services.

Project Implementation

Following a receipt of a grant from the Ford Foundation, Oxfam



and Sour Emmanuelle Fund, Environmental Quality International (EQI) an NGO and later a community development association (CDO) began the Zabbaleen Environmental and Development Project in order to holistically improve the condition of workers in the garbage community. The program consisted of a number of exploratory and evolving projects initiated over a span of five years. These were:

- Area Upgrading and Infrastructure Extension Project
- The Internal Clean-up Project
- The Small Industries Project
- The Women-Headed Households Project
- The Animal Health and Production Project (Veterinary Centre)
- The Route Extension Project
- The Mechanization Project
- The Composting Plant
- Healthcare Projects

Out of these the internal clean-up project aimed at improving sanitation and cleanliness in the community's Moqattam neighbourhood. It organized Zabbaleen residents under the Gameya to remove rubbish from the locality. The Small Industries project aimed at creating income generating opportunities from the residents' existing trade, in the form of small community-based recycling industries to maximize waste value. The Route Extension Project aimed at incentivizing and extending waste collection routes of the Zabbaleen to previously under-served low-income areas with low value refuse generation. The residents were charged a small fee which went to provide a salary for the Zabbaleen workers.

In a drastic move, the mechanization project sought to ban donkey-drawn carts from plying the streets for garbage collection. The Zabbaleen were forced to mechanize to meet government standards for waste management and service delivery. This brought the Zabbaleens to forge ties with the Wahis – a previously estranged informal waste handling community - in order to harness their combined financial and human resources. This strategy provided the Zabbaleen community with the human and technological resourcebase to effectively respond to a major portion of Cairo's current and future waste management needs.

Key Results and Learnings

The effects of the Zabbaleen Environmental and Development Program stretch from tangible to intangible, with very visible benefits in the following areas:

Environmental: A general increase in sanitation and cleanliness levels within the locality as well as a reduction of the environmental and health related burden associated with the handling of large amounts of waste.

Economic: The Small Industries and Mechanization projects together succeeded in breaking the cycle of abject poverty that was unfolding generation after generation in the community. Income from recycling activities, small loans and the use of advanced infrastructure compounded the original income the community received from waste collection and disposal.



Capacity Building and Human Development: Taken together with the route extension project, the mechanization project has enjoyed high participation and success. It focused on linking environmental improvements with enterprise promotion, benefiting to the maximum possible extent from an understanding of the social structure and kinship relationships among the Zabbaleen. With the increased ease of work, lesser children were involved as child labour in waste collection, allowing them to attend school. The income generating project for female-headed households has been a source of empowerment for poor women who for various reasons had to support their families.

Overall, despite shortcomings like under-coordination, donor dependency, diffusion over time and uneven benefits for different parts of the community, the ZEDP was successful in bringing recognition and dignity to the Zabbaleens. Despite their status as outcasts, the Zabbaleen have proven themselves to be not only garbage recycling experts, but also excellent craftspeople with an exceptional eye for detail and art.

Replicability

For the purpose of replicating the social sustainability of this model in contexts like Indian cities, the following key elements need to be kept in mind:

Connecting Environmental Improvement to Enterprise Development: In Indian cities the relationship between produc-



tivity and quality of life is skewed, with large portions of the working community marginalized to the peripheries of cities. In order to benefit communities like rag-pickers and scavengers, it is first important to clearly understand and acknowledge the complementarity between the upgradation of work and housing environments of these communities and the institutionalization of their trades for maximum economic efficiency.

Recognizing Alternatives to New, High-Tech, Externally Imposed Solutions: Co-aligning of traditional waste management systems with new high-tech systems can reduce working costs considerably while also ensuring adaptability of external systems to local contexts.

Community Participation: For sustainability of a waste management system in Indian cities, it is important to engage local communities – which are often strong, vocal, already

mobilized and working constructively as a group at an informal level.

Partnership: Although dependency on aid and donor organizations is not entirely advisable for sustainability purposes, value-based partnerships with economically or strategically strong groups can provide the leverage and catalyst required to transform low-scale waste management initiatives to technologically efficient and highly viable projects that are able to expand with growing needs. As previously discussed in the case of BMC waste collection, ICPE’s support for segregation of plastics from the waste stream was mutually beneficial for both the waste collectors – who enjoyed a more dignified quality of life after their formalization – as well as ICPE – who’s research purposes were fulfilled. Moreover, it was a public learning initiative that took waste management knowledge down to the household level.

COMMUNITY BASED COMPOSTING TO CONVERT ORGANIC WASTE TO RESOURCE AND GENERATE CARBON CREDITS, DHAKA BANGLADESH

Location	Dhaka, Bangladesh
Region	South-Asia
Year	1998
Agency	Waste Concern

Project Aim

To address the growing problem of plastic waste by initiating a refuse derived fuel (RDF) generation process for the conversion of waste plastics to oil.

Context

Due to rapid economic development, population growth and increasingly urbanized lifestyles, city authorities of Bangladesh are confronted with the issue of managing rising quantities and diverse streams of MSW with limited urban infrastructure and capability. The capital city of Dhaka generates 3500 metric tonnes of MSW every day. The city's waste is transported to a sanitary landfill at the Matuail site in Dhaka. Uncontrolled landfilling has been a common practice in the city. The city lacks adequate facilities for treatment, recycling and disposal of hazardous waste.

A major portion (about 80 per cent) of MSW generated in the city is organic in nature with a moisture content ideal for recycling into compost. Waste Concern, a local research organization and non-governmental organization, works in close partnership with the government, private sector, international agencies and local communities to implement community-based composting.

Project Description

The centralized composting project in Dhaka has a capacity of 700 tons per day and processes organic waste from the city of Dhaka in three phases. The public-private partnership project has led to



many economic, social and environmental benefits such as new job opportunities to the communities and better livelihoods in the region.

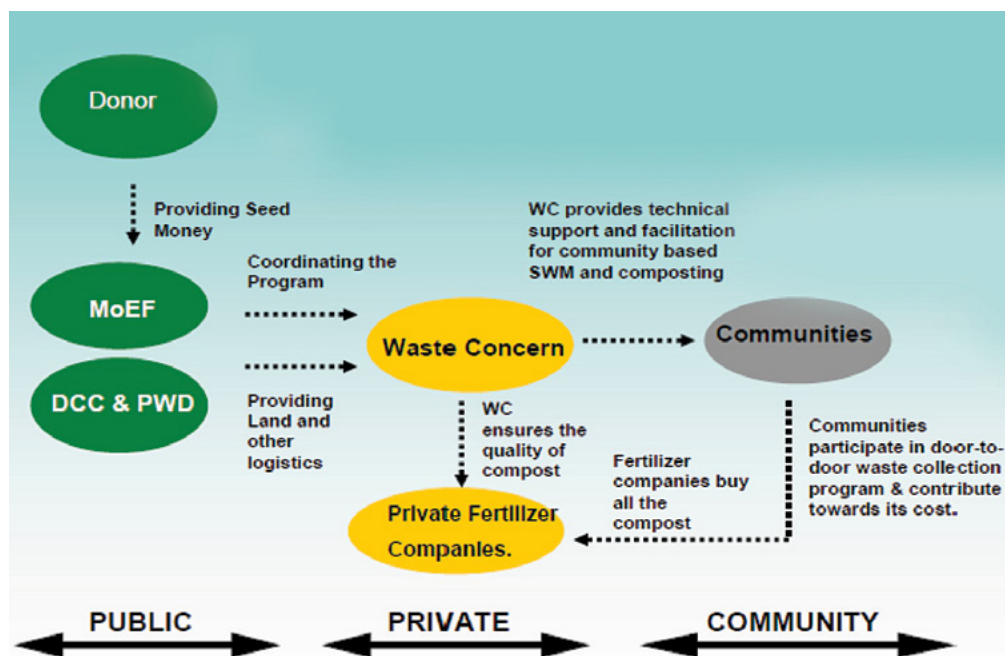
Project Implementation

The project included some interesting financial features which made it viable through community involvement and public private cooperation. The communities received door-to-door collection service and shared the cost of waste collection by paying a monthly fee based on their affordability. The private stakeholder had joint venture partners that included Waste Concern and its financial partners (banking institutions). The total investment required for the project was Euro 12 million. The mode of finance was 38 per cent equity, 45 per cent as soft loan and 17 per cent as loan from a local bank in Bangladesh.

A private sector company was involved to ensure the sale of compost by carrying out enrichment of the compost with nutrients and its subsequent distribution in the market. As a result, 75 per cent of the total revenue of the project came from sale of compost. The project was also successfully registered as a Clean Development Mechanism (CDM) project under United Nations Framework Convention on Climate Change (UNFCCC). A new methodology for accounting of emission reductions was developed by Waste Concern and its partners and was subsequently approved by the UNFCCC. Thus, the remaining 25 per cent of the project revenue came from community contributions in the form of a user fee and sale of certified emission reductions (CERs), making the project financially viable.

The main challenges to the project were the lack of a policy mechanism to create opportunities for developing public-private partnerships and absence of the practice of source separation of waste at the household level. The policy barrier was overcome by initiating public-private cooperation by convincing the city government to grant a concession agreement to a private fertilizer company to collect and process waste. The private stakeholder self-financed collection and processing activities, including





purchase of vehicle fleet and building the compost plant. Being a fertilizer company, the private stakeholder could also produce and sell quality compost to farmers.

Key Results and Learnings

- The project reduced the landfilling budget of the city
- Valuable resource was recovered from organic waste in the form of compost and the project also created assured revenue for 10 years through sale of compost and CERs.
- 800 jobs were created for poor urban residents
- 50,000 metric tonnes of compost is produced every year for more sustainable farming.
- The project avoids greenhouse gas emissions in the amount of 89,000 tonnes of CO₂-equivalent per year.
- The project resulted in behavioural changes in urban communities that were actively involved in the project as they became convinced about the resource value of waste.

An important aspect of the project was that it was not fully mechanized, due to which it could employ people from the informal

sector. Avoiding mechanization led to savings in capital cost. Consequently, workers could be provided with better salary rates, good working conditions, health insurance, day-care facility and free meals.

Replicability

Dhaka's centralized composting plant serves as a successful working model of how combined effort and partnership among public, private and civil sectors can lead to the successful implementation of 3R activities that have direct and far reaching benefits for the environment, community, government and small business.

The simple methodology formulated for measuring emission reduction can be useful for the Indian context, where similar CDM projects are already in execution under the National CDM Authority.

The scale of Dhaka as well as the scale of this project is particularly relevant to the Indian context. Hence funding and execution aspects of this PPP can give relevant input to similar models in India.



ANNEXURE

CONTACT DETAILS OF IMPLEMENTING AGENCIES FOR THE CASE STUDIES

Location	Source of Information	Agency's Contact
Muangklang, Thailand	<ul style="list-style-type: none"> • http://www.delgosea.eu/cms/Best-Practices/Introduction 	Partnership for Democratic Local Governance in Southeast-Asia (DELGOSEA) Cambridge Centre Bldg., 5th Floor, 108 Tordesillas, crn. Gallardo Sts., Makati City, Manila, Philippines Tel.: +63.2.4037697 Fax: +63.2.8936199 Email: Communications-Office@delgosea.eu
Theme 1: AT SOURCE		
Marikina City, Philippines	<ul style="list-style-type: none"> • http://www.delgosea.eu/cms/Best-Practices/Thematic-Area-3-Inclusive-Urban-Public-Services/12-Marikina-Eco-Savers-Project • http://www.marikina.gov.ph/ 	Address: Marikina City Hall, Shoe Avenue, Sta. Elena, Marikina City 1800 Trunkline : (632) 646 - 2360 / 70 Facsimile : (632) 646 - 5277
New York, USA	<ul style="list-style-type: none"> • http://www.nyc.gov/html/nycwasteless/html/home/home.shtml 	NYC Department of Sanitation Central Correspondence Unit 59 Maiden Lane, 5th Floor New York, NY 10038 http://www.nyc.gov/html/nycwasteless/html/contact/contact.shtml
Theme 2: COLLECTION & SEGREGATION		
Naga City, Philippines	<ul style="list-style-type: none"> • http://naga.gov.ph/sp-matters/ordinances/ordinance-no-2002-077/ • http://www.cityofnagacebu.gov.ph/the-countrys-best-zero-waste-management/ • http://pub.iges.or.jp/modules/envirolib/upload/2544/attach/iges_network_study_philippines.pdf 	Naga City People's Council Jesse M. Robredo coliseum Central Business District II Barangay Triangulo, Naga City +62 (54) 6214382 ncpcc_naga@yahoo.com
Theme 3: RECYCLY & REUSE		
Mauritius	<ul style="list-style-type: none"> • http://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=633&menu=35 	Division for Sustainable Development Department of Economic and Social Affairs United Nations Secretariat Building 405 East 42nd Street New York, NY 10017, USA Fax: + 1 212 963 4260

Location	Source of Information	Agency's Contact
Theme 4: RESOURCE RECOVERY		
Phitsanulok, Thailand	SUN-AREA Brochure accessed in July 2014: www.sun-area.net	Steinbeis-Transferzentrum Geoinformations- und Landmanagement Bachgasse 8, 97990 Weikersheim Tel: 0 79 34 . 99 288-8 Fax: 0 79 34 . 99 288-9 info@sun-area.net
Belo Horizonte, Brazil	"Using GIS technologies to help plan and build a sustainable city", by Derek Gliddon, Masdar City, accessed in July 2014: proceedings.esri.com/library/userconf/proc09/uc/papers/pap_1854.pdf	Masdar City Khalifa City 'A', Opposite Presidential Flight, P O Box 54115, Abu Dhabi, UAE Tel: +971 2 653 3333 Email: joinus@masdarcity.ae
Theme 5: PARTICIPATION & SOCIAL SUSTAINABILITY		
Cairo, Egypt	www.megacitiesproject.org/pdf/publications_pdf_mcp018d.pdf	Family Health International 1115 Burnett Street, Hatfield Square, Building 3, 4th Floor, Hatfield, Pretoria 0083, South Africa Tel: 27 12 762 4000 Email: BPP@fhi360.org
Dhaka, Bangladesh	• http://www.env.go.jp/recycle/3r/en/asia/02_03-3/06.pdf	Waste Concern House-21(Side B), Road-7, Block-G, Banani Model Town, Dhaka-1213, Bangladesh Telephone: +880-2-9873002, +880-2-9873067, +880-2-9873110 Fax: +880-2-9884774 Email: office@wasteconcern.org





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