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THE Hon'ble Prime Minister launched the Swachh Bharat Mission on 15 August 2014. The government is committed to take the Swachh Bharat Mission to the next level. 'The Swachh Bharat Mission has transformed one side of swacchata, now we will get latest technologies to transform Waste to Energy and Wealth in a major mission'. The PM-STIAC (Prime Minister's Science, Technology and Innovation Advisory Council) recommended establishing a Waste to Wealth Mission (W2W) which would identify real time major waste problems and sentinel sites across India and deploy latest technologies addressing waste across India. Consequently, the Office of the Principal Scientific Adviser to the Government of India set up a Waste to Wealth mission to test, validate and provide technological solutions for the management of waste. The 'Waste to Wealth' Mission aims to identify, test, and validate affordable decentralised technologies, adaptable to local requirements for waste management. Waste management in the developing world is critical for both climate change and global health; it is imperative that the very core of the climate change and global health is addressed. The solutions validated and demonstrated are exemplars which address waste management on site, in a decentralised manner, leading to decreased transport costs in waste handling, with a goal towards zero landfill.

Waste – The Challenge

In India, waste and waste management is a complex challenge with multiple components. The rough estimate of total waste generated every year is 1236 MT with no estimate of waste dumped into our water bodies. Some waste is unique to India such as pan masala, shampoo, etc. sachets, hair waste, animal / food / agri waste discarded without thought. And so, India has to find its own solution for managing this waste. Waste management is a universal issue affecting every single person in the world. Currently, about 2.01 billion

metric tons of Municipal Solid Waste (MSW) is produced annually worldwide. The World Bank estimates overall waste generation will increase to 3.40 billion metric tons by 2050. An estimated 13.5% of today's waste is recycled and 5.5% is composted, between one-third and 40% of waste generated worldwide is not managed properly and instead dumped or openly burned. Poorly managed waste is contaminating the world's oceans, clogging drains and causing flooding, transmitting diseases via breeding of vectors, increasing respiratory problems through airborne particles from burning of waste, harming animals that consume waste unknowingly, and affecting economic development such as through diminished tourism. Unmanaged and improperly managed waste from decades can create unimagined misery for generations to come. Therefore, investing in waste management is critical and a no-brainer. The Global Waste Management market is expected to grow from \$285 billion in 2016 to \$435 billion by 2023, growing at a compound annual growth rate (CAGR) of 6.2 %. The Global Waste Recycling revenue will grow exponentially, especially for plastic and electronic waste. The World Bank already has a record of investing in waste management infrastructure across the globe. It has moved more than \$4.7

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Burning, dumping or discharging a tonne of rubbish into waterways cost South Asian economies \$375 through pollution and disease, against \$ 50 – 100 required for basic systems to dispose of that same (one) tonne properly.

(McKinsey, 2016)



billion to more than 340 solid waste management programs since 2000.

The Waste Conundrum

Waste management is complex because of the multiple agencies and responsibilities:

1. Collection of waste

- Municipal Solid Waste – Civic/household
- Waste from water bodies
- Waste from soil (MLP, sachets and other plastic waste contaminating our top soil, etc.)
- Animal/cattle waste

2. Treatment of waste

- Legacy waste – about 80% waste in landfills like Ghazipur landfill is inert and cannot be used as Refuse Derived Fuel (RDF) and needs technology that can reuse the inert material constructively, such that it can be disposed off.
- Pyrolyse waste which is beyond reuse/recycle (toxic)
- Waste to Energy (electricity, biofuels, etc.)
- Waste to Value (recovering valuable material from waste)

3. Advanced technology for use of waste

- Torrefaction of biomass waste to bio-coal, use of the inert material for road construction, etc.

**For both collection and treatment of waste in the complex Indian conditions, decentralized, in-situ solutions need to be developed.)*

To add to the above complexities is the large number of stakeholders involved in the waste chain in India:

- Local urban bodies
- Municipal Corporation; different collection bodies for MSW, the water bodies in India, open drains have both MSW, dead animals, etc., have different collection system.
- State government
- Various Ministries of the central government (Ministry of Environment, Forest and Climate Change, Ministry of Drinking Water and Sanitation, Ministry of New and Renewable Energy, Ministry of Chemicals and Fertilizers, Ministry of Agriculture & Farmers' Welfare, Ministry of Power, etc.)

Decades of neglect, lack of foresight and complete absence of urban planning has left India staring at mountains of waste-landfills, waste-choked drains, water bodies and rivers. The cumulative consequence of decades of neglect has created “legacy waste”.

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Authorities in Morocco believe that \$300m they have invested in new sanitary landfills has already averted \$440m in environmental damage.

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Ref: “How the world should cope with its growing piles of rubbish”, The Economist, September 29, 2018 edition

There are about 48 recognised landfills across India, together covering nearly 5,000 acres of land, with a total land value of about Rs 100,000 crore. India generates about 275 million tonnes of waste per year. With current waste treatment rates of about 20 - 25 %, this leaves majority of waste untreated, in a heap, on landfills, and an equal amount in drains and river bodies. Drains and water bodies, emptying out into Indian rivers, also carry with them an unimaginable amount of waste. The Ganga is among the top 10 polluted rivers in the world, together accounting for 90% of the total ocean plastic pollution.

Municipalities need to have access to affordable technology which has been piloted and validated under Indian conditions. Today, most of the technology/equipment needed for waste management is imported, expensive and often not suited to our varied local situations. India needs affordable, decentralised, customised solutions for its land-constrained complex city matrix. For example, amphibian equipment to clean water bodies is imported; indigenisation of design and manufacturing of such equipment for smaller drains and water bodies is essential. Robotic long-hand scavenging machines to unclog drains, booms that filter and prevent waste in our drains entering a larger water body are some examples, where Atmanirbhar Bharat (self-reliant India) needs to kick in immediately. Entry to drains in India is choked with pan masala, shampoo sachets, chips/kurkure packets and so on, causing instant flooding of cities and towns during the monsoons.

Waste to Wealth Mission: Decentralised Solution

Waste collection and recycling is now a financially viable business. Plastic and electronic waste is premium uptake by the unorganized sector. The Municipal Solid Waste (MSW) continues to be a challenge with need for minimum land requirements and technology emergent.

The Waste to Wealth Mission in collaboration with the East Delhi Municipal Corporation (EDMC) has established a Decentralised Waste Management Technology Park at New Jaffrabad, East Delhi. The Technology Park is a pilot, providing end-to-end solutions for waste management, from semi-automated segregation of municipal solid waste to onsite compaction and treatment of the waste.

Municipal solid waste will be segregated onsite into combustibles fractions and non-combustible (compostable)



We are the future of your business

Zero waste, Zero energy, Zero landfill

- **Decentralized on-site waste processing**
- **Minimum land requirement**
- **Onsite waste treatment, processing, compaction, and possibility of conversion to energy**
- **Reducing secondary waste transportation cost**
- **Moving towards zero landfill**
- **Scaled up/replicated across various cities in India**

fractions. The combustible waste will then be processed on site, leaving less than 5% of inerts reaching landfill. In addition to incoming MSW, floating waste from adjacent 52-cusec drain will also be collected and processed on site.

This pilot will ensure Solid Waste Management Rules 2016 compliance of ULB's for reducing load on landfill sites, without procurement of new land for waste disposal. The area required for the pilot is 1100 sqmt of area (area currently utilized for open dumping or secondary collection site) with a waste processing of 10 tonnes per day.

Decentralised processing of waste is a step towards "Zero Landfill" with the added advantage of reduction in the transportation of the waste. The successful demonstration of this pilot will allow the model to be replicated in cities, towns and villages across India.

The Decentralized Waste Management Technology Park has piloted five technologies with integrated approach for one-stop solution for incoming fresh waste:

1. **'Xaper'** (by M/s E3 Waste Solutions, Punjab) – An indigenous semi-automated technology that segregates fresh mixed municipal solid waste into compostable, recyclable, combustible, and inert fractions. The local open dump site or dhalao is replaced by Xaper for onsite segregation and processing.
2. **'Plasma pyrolysis Unit'** (by IIT Delhi) - for thermal disintegration of carbonaceous material in an oxygen-starved environment into environment friendly components
3. **'Enviro-RISE R-A1100'** (by M/s DESMI India LLP) - technology from Denmark for removal of floating solid waste from the 52-cusec drain flowing adjacent to the technology park site.
4. **'Gasifier'** (by M/s GD Environmental Pvt. Ltd., Maharashtra) - A 150 kg/h plant for gasification of municipal solid waste (including COVID-19 waste) and possible conversion to energy.

Johkasou STP (by M/s Daiki Axis India Pvt. Ltd., Delhi) - A decentralized sewage treatment technology to meet the operational and nonpotable water requirement at the site through treatment, recycling and reuse of wastewater flowing in the 52-cusec drain.

COMMUNITY ENGAGEMENT: INTEGRAL TO WASTE MANAGEMENT

The Waste to Wealth Mission recognises that community or "Jan Bhagidari" engagement is the crux of successful waste management. Two very successful programmes have demonstrated the effectiveness of community engagement.

Swachhta Saarthi Fellowships: Initiated to empower citizens and individuals who are engaged in community work of waste management, waste awareness campaigns, waste surveys, etc. and provide them Swachhta Saarthi fellowship.

The fellowship was launched in 2021 to recognize students, community workers/self-help groups, and municipal / sanitary workers who are engaged in tackling the enormous challenge of waste management, scientifically and sustainably. The fellowship is aimed at amplifying the role of young students from schools and colleges, and citizens working in the community through Self Help Groups (SHGs), or in independent capacity in sensitizing the society towards waste management and offer innovative solutions for conversion of waste to value. The 2021 cohort had 344 Swachhta Saarthis consisting of high school students, college

Behaviour Change Solutions.

Decentralized waste-to-wealth

Approaches: Temple Waste to Gulaal, Dhoop, Gulkand, organic waste to Compost & Biogas Selecting the right unit for Community-Composting at Temples. Composting technologies for waste recycling options based on space/cost/maintenance efficiency. Final units selected were based on no requirement for electricity to run, affordability, small space in which the unit can be fitted, modularity in case it needed to be moved.



students, and community workers from across 27 States and 6 UTs that are currently making an impact through their efforts in waste management towards building a sustainable future.

Su-Dhara Programme:

Su-Dhara is a model for addressing urban waste by aligning science and technology with behavior change approaches. Communities can participate in enabling segregation and recycling to generate waste-to-wealth solutions. Vertiver, an NGO, oversees this programme. The methodology adopted was:

- Door-to-door research of 200 households on willingness to participate in decentralized solutions.
- Mapping of systems to assess waste streams, volumes and capacity to create local solutions for waste • Identification of decentralized technologies to address organic waste.
- Pilot installation of biodigester units at three temples and 1HH Biogas Plant.

Awareness, Outreach & Training

Several measures have been adopted to spread awareness about the concept and its various programmes.

Creation of community volunteer groups for addressing waste issues through “champions”.

- Extensive Community engagement through one-on-one interactions, communication materials, workshops, nukkad nataks, art competitions, murals, award ceremonies and ongoing feedback and reward systems for champions to generate buy-in and momentum for addressing waste at local levels
- Creation of SHGs to promote entrepreneurial models for products created from waste.

Efforts are also being made as part of the mission to train & build capacity among the various stakeholders to carry the movement forward. These include:

- Engaging with Ward Councillors and EDMC to help scale up activities in other wards • Training waste workers and communities on working together at Gali, Temple, Ward level to co-create solutions
- Training communities in making compost, gulal and managing biogas unit
- Training women to set up their own SHGs to sell products made from waste.

In addition, urgent attention is also needed in the development of skilled and trained professional personnel to operate and maintain the waste management chain, right from collection, operation and maintenance of wastehandling plants. Central, and integral to success, is design in the collection of centralised and decentralised waste treatment plants, and of the equipment used. Design of waste management should be the bedrock of a well-planned smart city, town or village.