Office of the Principal Scientific Adviser to the Government of India

Smart City
MISSION TRANSFORM-NATION

Ministry of Housing and Urban Affairs
Government of India


## ADVISORY NO. 23 ON:

# E-WASTE MANAGEMENT IN SMART CITIES

MARCH 2023

# List of Abbreviations

| Abbreviation | Description |
|---|---|
| BIS | Bureau of Indian Standards |
| BARC | Bhabha Atomic Research Centre |
| CCTV | Closed-Circuit Television |
| CFC | Chloro Fluoro Carbon |
| CFL | Compact Fluorescent Lamp |
| CIPET | Central Institute of Plastics Engineering & Technology |
| CNG | Compressed Natural Gas |
| CPCB | Central Pollution Control Board |
| CRT | Cathode Ray Tube |
| C-MET | Centre for Materials for Electronics Technology |
| D2D | Door to Door |
| DRS | Deposit Refund System |
| EDMC | East Delhi Municipal Corporation |
| E-waste | Electronic waste |
| EEE | Electrical and Electronic Equipment |
| EoL | End-of-Life |
| EPA | Environment (Protection) Act |
| EU | European Union |
| EPR | Extended Producer Responsibility |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH |
| GoI | Government of India |
| GST | Goods and Services Tax |
| HCFC | Hydro Chloro Fluoro Carbon |
| IEC | Information, Education, and Communication |
| IIM | Indian Institute of Management |
| IoT | Internet of Things |
| LCD | Liquid Crystal Displays |
| MeitY | Ministry of Electronics and Information Technology |

| Abbreviation | Description |
|---|---|
| MoEF&CC | Ministry of Environment, Forest and Climate Change |
| MoHUA | Ministry of Housing and Urban Affairs |
| MRF | Material Recovery Facility |
| MSME | Ministry of Micro, Small and Medium Enterprises |
| NEERI | National Environmental Engineering Research Institute |
| NML | National Metallurgical Laboratory |
| NGO | Non-Governmental Organisation |
| MRF | Material Recovery Facility |
| PCB | Printed Circuit Board |
| PCC | Pollution Control Committees |
| PRO | Producer Responsibility Organisation |
| PSA | Principal Scientific Adviser |
| PV | Photo Voltaic |
| PVC | Polyvinyl Chloride |
| RLG | Reverse Logistics Group |
| ROKA | Residents Of Kasturba Nagar Association |
| RWA | Resident Welfare Associations |
| SDG | Sustainable Development Goals |
| SHG | Self-Help Group |
| SPCB | State Pollution Control Board |
| TSDF | Treatment Storage and Disposal Facilities |
| ULB | Urban Local Bodies |
| UN | United Nations |
| UNITAR | United Nations Institute for Training and Research |
| UNU | United Nations University |
| WEEE | Waste from Electronic and Electrical Equipment |
| XLRI | Xavier School of Management |

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# 1 Introduction to E-Waste

## 1.1. Definition of E-Waste

Advances in electronics, communication, information technologies, and increased consumers' affordability have made EEE indispensable in modern societies. The waste arising from end-of-life electronic and electric products, referred to as WEEE or simply e-waste, is one of the fastest-growing waste streams in the world today[2].

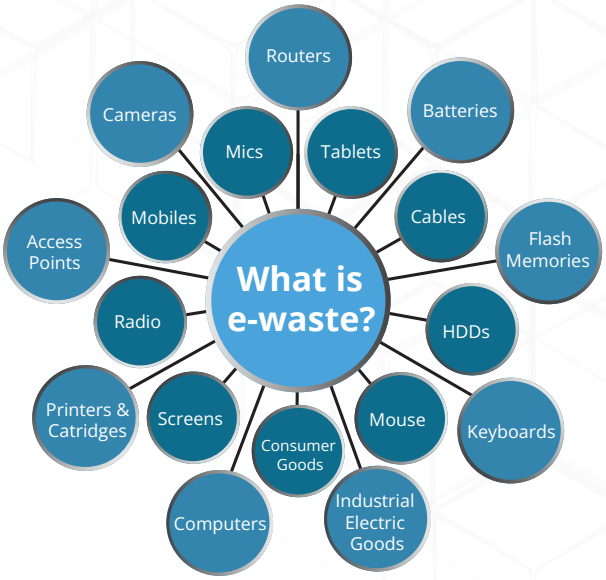


**Figure 1: What is e-waste?[1]**

According to the E-Waste Management Rules 2022[3], 'e-waste' means electrical and electronic equipment (including solar PV modules/panels/cells), discarded as waste, and rejected from manufacturing, refurbishment, and repair processes.

According to UNITAR's Global E-Waste Monitor 2020[4], EEE becomes e-waste once its owner has discarded it as waste without the intent of reuse. The E-waste Statistics Guidelines[5] divide EEE into 54 different product-centric categories. The categorisation is referred to as the UNU-Keys.

## 1.2. Potential Risk to Environment and Public Health

The processing of e-waste is dominated by the informal sector and most of India's e-waste is managed by the informal sector and under hazardous conditions. The workers in the informal sector carry out most of the processes without wearing protective equipment like gloves or masks, exposing them to acidic gases, toxic smoke laden with heavy metals, and contaminated ashes. Informal units operate in the backyards of residential areas, extending the risk to families, especially children and elderly people. Improper recycling techniques adopted by these workers are resource inefficient and pose a threat to occupational health and safety of the people involved. Thus, the informal sector workers are exposed to highly toxic, poisonous, and carcinogenic elements. For example, mercury is toxic to the brain, kidneys, central nervous system, cardiovascular system, and lungs. Child labour is also prevalent in low-skilled operations.

The air and soil pollution caused due to these unsafe practices and dumping of hazardous parts of WEEE in landfills are also grave environmental concerns. Since e-waste contains a significant amount of hazardous and toxic substances, even a small volume of e-waste entering other waste streams releases toxic and halogenated substances.

[1]Image source: https://www.giz.de/en/downloads_els/Business%20Model%20Toolbox%20for%20Setting%20up%20E-Waste%20Recycling%20Facility%20in%20India.pdf
[2]https://www.who.int/news/item/28-06-2020-global-e-waste-surging-up-21-per-cent-in-5-years#:~:text=This%20makes%20e%2Dwaste%20the,waste%20was%20collected%20and%20recycled.
[3]https://moef.gov.in/wp-content/uploads/2022/05/Draft-E-Waste-Management-Rule.pdf
[4]https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf
[5]https://www.itu.int/en/ITU-D/Environment/Pages/Toolbox/Guidelines.aspx

According to a plea[6] submitted to the National Green Tribunal in July 2018, electronic waste accounted for **40%** of lead and **70%** of heavy metals found in landfills.

Image for representational purposes only; Photo credit: Shutterstock

**Figure 2: An e-waste landfill**

While this crude form of e-waste management provides livelihood to people engaged in this activity, the current methods of dismantling and extraction followed by dumping are associated with higher social and environmental costs.

## 1.3. Challenges and Opportunities in E-Waste Management for Cities

There is a strong economic case for better e-waste management in cities, from a perspective of rare earth materials and revenue proposition for cities. Recycled metals are also 2 to 10 times more energy-efficient than metals smelted from virgin ore. According to the Global E-Waste Monitor 2017, India generates about 2 million tonnes (MT) of e-waste annually and ranks fifth among e-waste producing countries, after the US, China, Japan, and Germany. In 2016-17, India treated only 0.036 MT of its e-waste. E-waste is growing at a compound annual growth rate (CAGR) of about 30 per cent in the country.

### 1.3.1. Challenges

Despite the EPR legislation in India, for almost a decade, the role of the informal sector in collection, dismantling, and recycling of e-waste remains high rendering the formal collection and recycling infrastructure both underutilised and limited. High prevalence of the Informal Sector and the lack of access to clean recycling technologies are the daunting challenges of the e-waste management ecosystem.

As per CPCB 2022[7], there are **472** registered dismantlers and recyclers in India, having an installed capacity of 1426685.22 metric tonnes per annum.

Image for representational purposes only; Photo credit: Shutterstock

**Figure 3: A dismantler at an e-waste management unit**

[6]https://greentribunal.gov.in/sites/default/files/news_updates/Report%20of%20Oversight%20Committee%20in%20OA%20No.%20512%20of%202018%20(Shailesh%20Singh%20Vs.%20State%20of%20UP%20&%20Ors.)_compressed.pdf
[7]https://cpcb.nic.in/uploads/Projects/E-Waste/List_of_E-waste_Recycler.pdf

There are leakages from the formal sector to the informal sector leading to inefficient and hazardous processing of the e-waste. A report by the Union Environment Ministry in 2018[8] found that many of India's e-waste recyclers weren't recycling waste at all. While some were storing it in hazardous conditions, many didn't even have the capacity to handle such waste.

The informal e-waste trade chain consists of a widespread network of unauthorised collectors, iterant buyers, dismantlers, recyclers, and other intermediaries. It is characterised by an entrepreneurial SME infrastructure that permits profitability in operations. Unauthorised facilities and informal recyclers do not comply with any norms employ rudimentary and unsafe waste management systems with sub-standard technologies that pose huge risks. The informal collector network chain effectively achieves high collection rates for the various categories of e-waste, including high-value WEEE like computers, laptops, televisions, and mobiles from households. During the dismantling and recycling stages, the focus is on recovering parts for sale as second-hand parts, repairing them using old parts and recoverable materials such as plastic, copper, gold, and other valuable metals. The dismantling and recycling operations performed by the informal sector are extremely crude and exposes the person engaged to hazardous chemicals and environmental damages due to leachates and emission.

What makes recycling e-waste challenging? The metals and compounds that constitute e-waste do not exist in a pure state, making isolation difficult and ecologically sound processing a costly affair. Most of these metals and compounds are potent toxins concentrated in circuit boards, plastics, batteries, LCDs, etc., and potentially hazardous to the health of workers when not processed with caution. E-waste contains a wide range of heavy metals like lead, cadmium, and mercury. Circuit boards, one of the most valuable parts, contain lead and cadmium, both of which are valuable. Other examples include CRT monitors which have lead oxide and cadmium; mercury in the flat screen monitors and switches; cadmium in computer batteries; organic compounds such as brominate flame retardants in PCBs, plastic casings, cables, and PVC cable insulations.

### 1.3.2. Opportunities

**According to the Global E-waste Monitor 2020[9], the estimated value of recoverable materials from e-waste generated in 2019 was approximately 57 billion USD**

When managed responsibly, e-waste can serve as an important source of secondary raw materials. The secondary raw materials can then be utilised for manufacturing, reducing the burden on virgin resources. These materials are constituted of up to 69 elements from the periodic table including ferrous, non-ferrous, precious metals (e.g., gold, silver, copper, platinum, palladium, ruthenium, rhodium, iridium, and osmium), speciality metals, critical raw material (e.g., cobalt, palladium, indium, germanium, bismuth, and antimony), and non-critical metals, such as aluminium and iron.

The informal sector's contribution to product life extension through repairs, refurbishment, and improving old scrap collection rates is significant. Also, the manual dismantling operations performed by the informal sector workers, lead to higher value-added products entering the recycling process in contrast to mechanised operations leading to higher complex fractions requiring more energy-intensive operations.

[8]https://www.thehindu.com/news/national/e-waste-recycling-has-doubled-says-centre/article30983383.ece#:~:text=A%20report%20by%20the%20Union,capacity%20to%20handle%20such%20waste.
[9]https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_july1_low.pdf

## 1.4. E-Waste Management: The Sustainability Dimension

E-waste management should be considered in the broader sustainability context and not in isolation. E-waste management, recycling, refurbishing, and circular economy in manufacturing (e.g., using recycled materials in manufacturing) are all interconnected sustainability practices. The smart cities should align the policies and approaches targeted at promoting e-waste recycling and sync with those formulated to promote a circular economy in electronics and other sectors.

The life cycle of any electronic product may be considered in three phases: pre-consumption, consumption, and post-consumption.

**Electronic Product Life Cycle**


Figure 4: Electronic product life cycle[10]

Recycling comes under the post-consumption phase. However, the nature and scope of recycling are intrinsically linked to activities under the other two phases. For example, by designing products for circularity, waste production can be minimised at the manufacturing stage (*pre-consumption phase*), and the ease and scope of recycling can be increased during the post-consumption phase. Sustainable design (*pre-consumption phase*) can lead to easier dismantling of electronic products and higher rates of material recovery from collected e-waste (*post-consumption phase*), thus making the recycling business more feasible and viable for recyclers. But, as of now there exists a disconnect between the '*Pre-consumption*', '*Consumption*', and '*Post-consumption*' phases for most electronic products.

Technological advancements in electronic products' manufacturing have happened rapidly in the last decade and a half. This is especially visible in the changing material composition of electronic products every few months. At present, there is hardly any communication or a platform to discuss relevant ideas between those who design and manufacture these complex electronic products (producers) and those who refurbish and recycle these products when they turn 'waste'. It is, therefore, not surprising that even the most developed regions of the world are grappling with numerous challenges in managing the ever-increasing volumes of e-waste. If left unchecked, the volume of e-waste generated will keep growing, as will the complexities underlying technology and material composition, making it difficult to manage and recycle e-waste.

[10]Source: Author's compilation

Smart cities should develop a practical approach to encourage 'Re-engineering', 'Repairs', and 'Refurbishments' technologies at the manufacturing centres or in the manufacturing sector so that 'circular economy' is implementable and economically viable. This will create more entrepreneurship opportunities in the MSME sector, especially among the women.

## 1.5. Legislations on E-Waste

As per E-Waste (Management) Rules, 2022, Rule 17, Schedule - V the responsibilities of Urban Local Bodies are defined as follows:

(1) To ensure that e-waste if found to be mixed with Municipal Solid Waste is properly segregated, collected and is channelised to registered recycler or refurbisher.
(2) To ensure that e-waste pertaining to orphan products is collected and channelized to registered recycler or refurbisher.
(3) To facilitate setting up e-waste collection, segregation, and disposal systems.
(4) Conducting training sessions to develop capacities of the urban and rural local bodies.

In India, the Environment (Protection) Act[11] passed in 1986 emphasised the prevention, control, and abatement of all environmental pollutants. For regulation on WEEE, legislation was passed as the E-Waste (Management and Handling) Rules, 2011[12]. India has separate rules for managing spent batteries, the Battery Waste Management Rules 2022, released on 24th August 2022, the objective of which is to recycle used lead-acid batteries in an ecologically sound manner.

The E-Waste (Management & Handling) Rules, 2011 were formulated to regulate the management of e-waste during a product's life cycle, with participation of stakeholders from producers of EEE to recyclers. The 2016 Amendment to the rules added more stakeholders such as PROs and outlined their roles and responsibilities. The manner of EPR implementation through PRO and DRS were outlined, and EPR collection targets were also specified. In the 2018 Amendment, the collection targets were revised, and PROs were mandated to register with the CPCB for the latter to monitor and audit PRO activities through inspections.

In 2022, the MoEFCC notified the E-waste Management Rules[14] which delimits the rules to four stakeholders, including every producer, manufacturer, recycler and refurbisher, and requires them to register on the centralised CPCB online portal before undertaking any activity. The rules, in addition to defining the responsibilities of CPCB/SPCBs, manufacturers, producers, refurbishers, bulk consumers, recyclers, state government, urban local bodies, and port authorities, also define the responsibilities of the BIS and MeitY who will issue standards on refurbished products.

[11]https://www.indiacode.nic.in/bitstream/123456789/16614/1/epa_1986.pdf
[12]https://www.meity.gov.in/writereaddata/files/1035e_eng.pdf
[13]http://www.mppcb.nic.in/proc/Batteries%20(Management%20and%20Handling)%20Rules,%202001.pdf
[14]https://moef.gov.in/wp-content/uploads/2022/05/Draft-E-Waste-Management-Rule.pdf

## 1.6. Techno-Economic Feasibility of Recycling Business

The lack of affordable infrastructure and recycling facilities has made e-waste recycling a bigger challenge. Primitive recycling techniques used by the vast informal sector to extract precious metals cause inefficient extraction and loss of valuable resources. The rudimentary recycling process and lack of state-of-art facilities lead to materials leakages, and prevailing issues in reserve logistics make this business less productive and disorganised. Smart cities should scout their local R&D ecosystem, start-ups, and MSMEs for getting access to affordable indigenous technologies that could be an effective solution for the society. Special programmes can be organised, for hand-holding the vast informal sector in each of the smart cities, with deployment of these technologies creating clusters in states that will, in turn, provide the desired recycling infrastructures for e-waste processing, and generate employment among the lower strata of the population.

Indian R&D laboratories have developed several such technologies for printed circuit boards, lithium-ion batteries, spent magnets, WEEE plastics, etc., suitable for the Indian e-waste management scenario to extract precious metals, including gold, silver, copper, palladium, and valuable plastics. It will be desirable to have the support of ministries like MeitY and MSME for skill development, technology upgradation, assistance to submit project proposals, and stabilising plant operations once the machinery is procured.

### Suggested steps for enhancing the techno-economic feasibility of e-waste recycling business in Smart Cities

#### a) Creation of a database of electronics repair shops in the city

A database of electronic repair shops, including refurbishers, should be set up in the smart cities. These shops should be asked to maintain a material flow accounting of e-waste and e-waste components. Suppose a repair shop is selling any e-waste or recovered material to any other individual or entity in the e-waste management value chain. In that case, that data must be recorded in a material flow accounting book. This database will also help prepare an inventory of e-waste (e-waste inventorisation) that can facilitate compliance with e-waste management regulations and help attract e-waste recyclers to smart cities.

#### b) Creation of electronic hubs in the city

It is recommended that smart cities develop electronic hubs. The entire spectrum of sales, services, repairs, and recycling can be offered by electronic hubs. These hubs should house shops selling electronic products, providing maintenance and repair services, and shops that trade in e-waste and components. These hubs can also contain dedicated points for collecting and buying e-waste from the consumers. These electronic hubs will essentially be 'phygital' (physical + digital) hubs complemented by digital electronic hubs (websites and apps for connecting citizens of smart cities with electronic hubs near their locations). Existing electronic sales and repair shops outside the phygital hubs will be encouraged to tie up with shops located in the electronic hubs. Information about these electronic repair and recycling shops, e-waste deposit and purchase points, should be prominently displayed in these sales outlets through display messages, banners or QR codes for consumers.

## c) Integration of the informal sector

A number of entities in the informal sector remain in the informal sector because they choose to. It is recommended that smart cities devise plans to convert the current informal sector hubs in each city should be converted to 'Micro Enterprise Clusters', and in-situ development should be the strategy/approach, rather than shifting or relocation of the hubs. Individuals and entities in the informal sector should be encouraged to either own a shop or connect with others in the electronic hubs. Periodic information dissemination, training sessions, and workshops can be organised for the informal sector entrepreneurs and workers.

These platforms can also engage other key stakeholders (e.g., developmental organisations, NGOs, producers, and industry associations, recyclers etc.) with the informal sector. These forums should also be used to facilitate cross-sector partnerships enabling the informal and formal sectors (producers and recyclers) to collaborate in a manner ensuring the informal sector's focus on aspects of e-waste management that they are more efficient and effective in (e.g., collection, sorting, dismantling, minor repairs, recovery of materials like plastics, copper, and glass, etc.). In contrast, the formal sector can focus on capital and technology-intensive aspects (e.g., recovery of materials like rare earth metals, refurbishing including major repairs, recycling, etc.).

## d) Creation of a knowledge bank

As the smart cities are technologically more mature, they should utilise their existing IT infrastructure to create a knowledge bank. There should be proper documentation and knowledge management systems to create a knowledge base of systems, practices, and approaches to manage e-waste. By sharing knowledge, best practices can emerge that make it easier for other smart cities to adopt specific measures. Administrators of smart cities should have online access to this knowledge base extendable to researchers who, in turn, can analyse the data to suggest necessary modifications as and when required.

## e) Public engagement

Smart cities should employ a multi-pronged approach for public engagement with e-waste management and recycling. To begin with, awareness campaigns can be organised across cities to sensitise the public about e-waste management. In addition, any one day of a month can be dedicated to e-waste management across all smart cities through collection drives at schools, colleges, commercial establishments, etc. This will help in educating the public about the significance of e-waste management and different e-waste disposal options available for consumers. Incentives for public could include consumers' access to repair and maintenance services at a preferential rate (at the local government level).

## f) Linking with the producers of electronic items

One of the lacunae with waste management in India is the lack of sufficient engagement of producers with key stakeholders, especially the informal sector, formal recyclers, and local governments. Under the EPR framework of the e-waste management rules, different e-waste flow responsibilities are entrusted to these stakeholders. By reaping the benefits of the steps mentioned above, producers can be nudged or incentivised to engage with the smart city's recyclers and administrators and help meet specific EPR responsibilities. A 'right to repair', similar to the 'right to repair' rule of the EU is expected to be introduced in India. A database of electronic repair shops, phygital electronic hubs, an integrated informal sector, and the presence of a knowledge bank can facilitate the involvement of producers with the recyclers and smart city administrators.

# 2 Role of Smart Cities in E-waste Management

As per the extant rules, the manufacturers of EEE are mandated to collect and channelise e-waste to CPCB authorised dismantlers either through a PRO or through a take-back system by establishing independent collection centres. In the cities, the collected e-waste is segregated at the collection centre and sent to CPCB-authorised dismantlers. The dismantlers are required to maintain an inventory of the waste and abide by CPCB norms. From dismantlers, the e-waste is sent to either authorised recyclers or TSDF for hazardous waste and non-recyclable residues. The authorised recyclers have to recycle the e-waste and send the non-recyclables to TSDF for final disposal. It is also expected from the cities' e-waste management mechanism that the extracted useful products should feed into the production line and must be used to manufacture new products. Below is an indicative figure that mentions the e-waste value chain, different steps, stakeholders and processes:

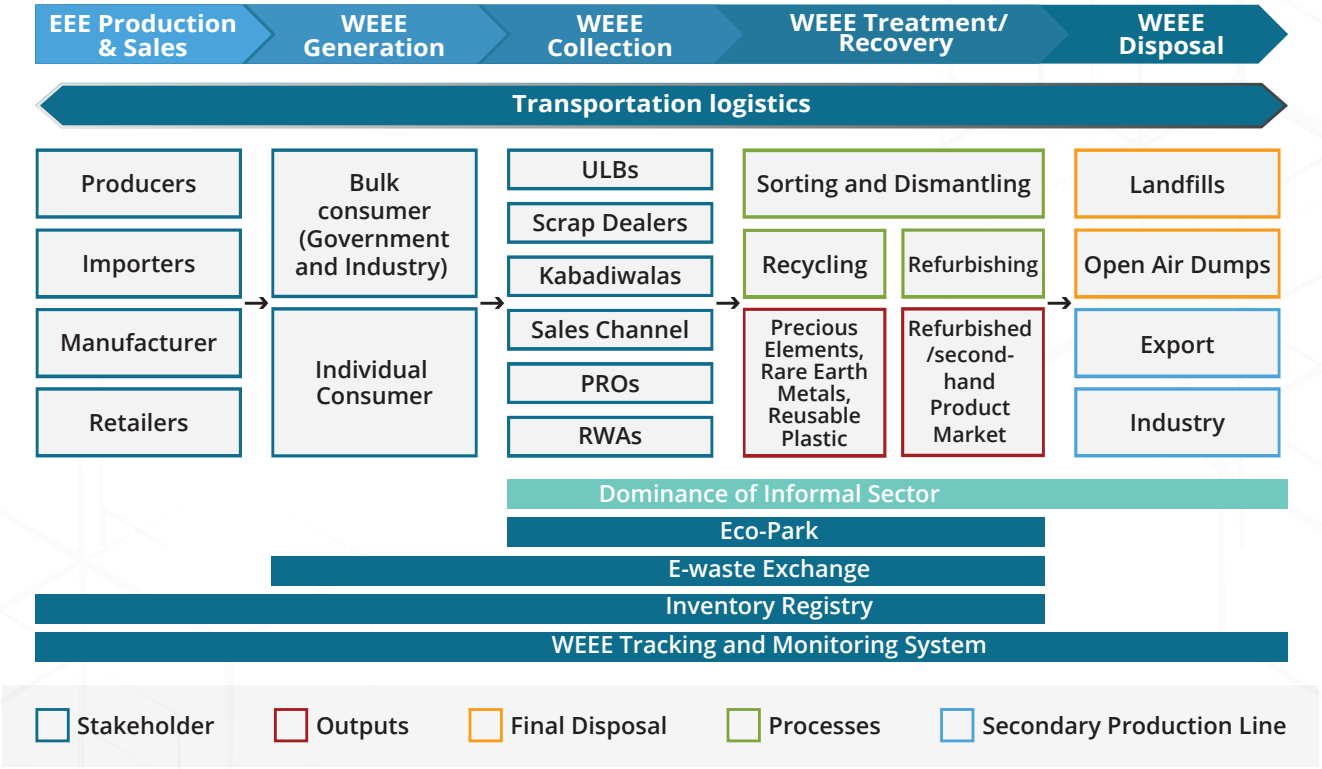


**Figure 5: E-waste value chain[15]**

In practice, however, the management of e-waste in India is quite different from the desired flow. Despite the recent growth in formalised and authorised e-waste recycling and dismantling sector industries, the actual e-waste processed formally is still relatively low. Below is an indicative diagram demonstrating the e-waste flow as it occurs actually. It is therefore important for the smart cities to be cognizant of the existing practices in e-waste management. Many of the existing mechanisms can be suitably tweaked and along with the use of their smart infrastructure, cities can manage their e-waste much more efficiently.

[15]Source: Authors compilation
[16]Image source: Unreleased paper on EPR framework on e-waste management in India, TERI, 2022

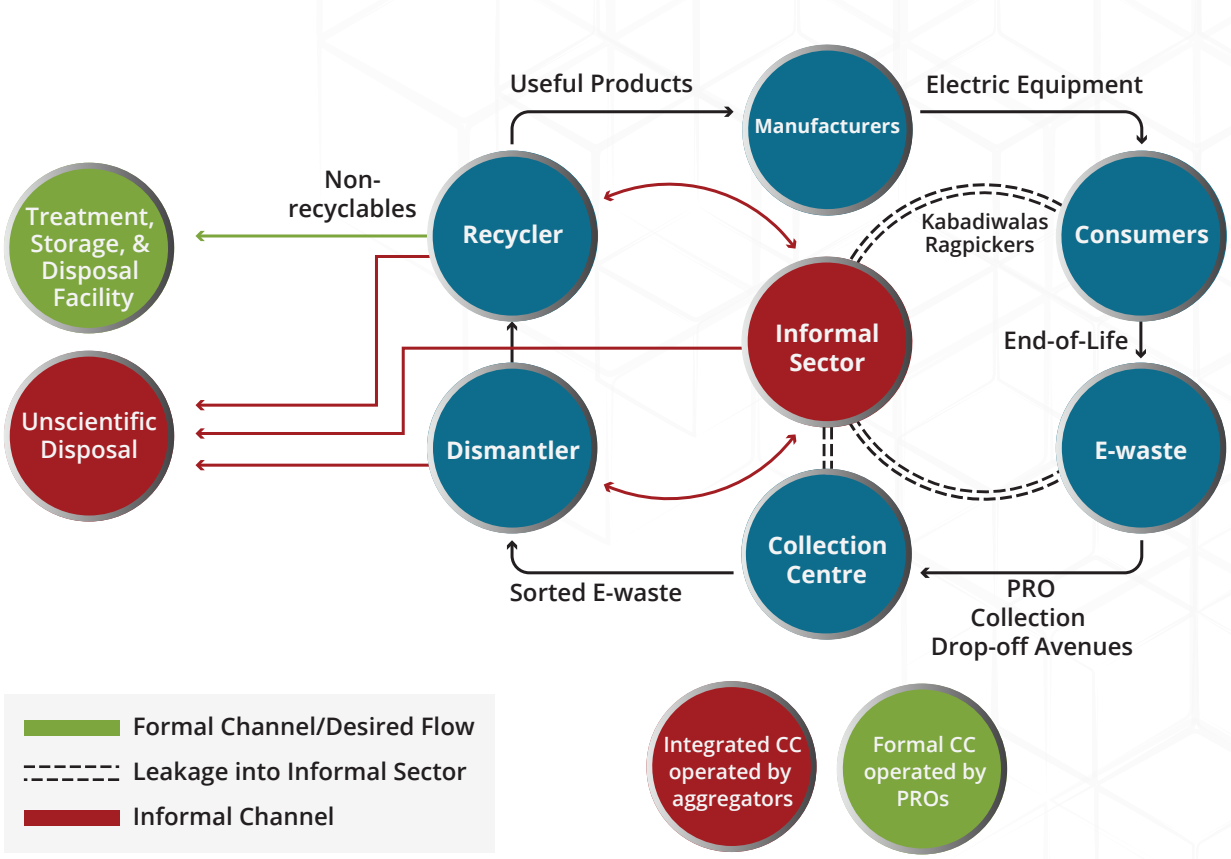


**Figure 6: E-waste flow[16]**

The value chain of e-waste management can be categorised into e-waste generation, collection, storage and transport, segregation and dismantling, treatment, and final disposal. Each of these steps with relevant stakeholders in the context of smart cities is discussed in detail in the below sections.

## 2.1. Waste Generation

The generation of WEEE is the first step of the complex value chain of its management.

### 2.1.1. Stakeholders involved

E-waste is generated by manufacturers, retailers, bulk consumers such as central/state government departments, public sector undertakings, banks, educational institutions, multinational organisations, international agencies, industries and health care facilities,

### 2.1.2. How can smart cities manage e-waste generation?

Waste generators have the responsibility of sensible disposal of e-waste. In partnership with PROs, the smart city administrations can set up a mechanism for data collection at each point in the e-waste flow and digitise the same. All SPCBs must develop inventories of the generated e-waste in their jurisdiction. This process can be streamlined and harmonised for data collection and maintenance of the inventory.

To encourage responsible behaviour of consumers (for reuse, repair and proper disposal of EEE), awareness campaigns can be designed to engage different stakeholders based on their responsibilities and to trigger action. It can also be organised with the support of PROs or producers, including door-to-door campaigns and collection drives.

## 2.2. Collection of E-Waste

The collection is of fundamental importance for all WEEE collection groups as it determines the amount of WEEE that enters the recycling chain. The technology requirements are low at

### 2.2.1. Stakeholders involved

The responsibility of collecting e-waste is with the producers as per the EPR. This is done by establishing a take-back system, setting up collection centres, or both. Typical means for collection includes specific collection points, designated companies specialised in the collection, and the informal sector engaged in waste picking.

The roles of ULBs and the city administration have been described under the E-Waste (Management) Rules 2022 as follows:

- To ensure that e-waste if found to be mixed with Municipal Solid Waste, is properly segregated, collected, and channelised to a registered recycler or refurbisher.
- To ensure that e-waste pertaining to orphan products is collected, and channelised to registered recycler or refurbisher.
- To facilitate setting up e-waste collection, segregation, and disposal systems.
- Conducting training sessions to develop the capacities of ULBs.

### 2.2.2. How can smart cities manage e-waste collection?

With support from producers and PROs, the smart cities can set up collection centres in the areas under their jurisdiction. The collection centres may collect and store e-waste on behalf of producer/dismantler/recycler/refurbisher and transfer the same to authorised dismantlers/recyclers. The producers are expected to have arrangements with authorised dismantlers/recyclers either individually or collectively to mobilise e-waste/end-of-life products to authorised dismantlers/recyclers.

The collection points/bins can be placed at designated places where e-waste can be collected from residential areas, office complexes, commercial complexes, retail outlets, customer care stores, educational and research institutions, and RWAs. The collection centres should facilitate the disposal process through a mobile app and a call centre. The consumers should be able to raise a request (preferably on the website of the collection centre) mentioning details of the item(s) they need to dispose of and request a pick-up. The smart cities can also use mobile collection vans can be used for door-to-door collection of e-waste from institutions/individuals/small enterprises. Such vans could be linked to collection centres and shall be part of their EPR plan if provided by producers.

Some cities can work as regional nodes for maintaining a large collection facility. The existing infrastructure of smart cities, such as sensor-based bins, smart collection vans, and waste sorting machinery can be repurposed for e-waste generated in that city.

It is important to ensure that the material from collection centres should only be sent to the authorised dismantlers and recyclers. In case of waste, where no recyclers are available, the material can be sent to treatment, storage, and disposal facilities.

## 2.3 Storage and Transport

WEEE should be safely separated from other waste and sorted in collection groups. The transportation of e-waste is an important aspect and depends on the collection group. Separated components should be transported safely to avoid the release of hazardous substances. Therefore, smart cities should ensure the use of containers that reduce the risk to the health of human and the environment while meeting the requirements of downstream processors. The technological maturity of cities should be leveraged to design transport solutions to protect WEEE from breakage and to keep it secure and protected during storage and transit. Correct handling of the containers is also crucial to ensure safety and prevent leakage.

### 2.3.1. Stakeholders involved

Under the current rules, the producers and PROs are responsible for the transportation and storage of the e-waste after collection. The responsibility of storage lies with producers, collection centres, dealer dismantlers, recyclers, and refurbishers, and they must follow the CPCB's guidelines for collecting and storing e-waste. Only authorised transporters should be contracted for transporting the e-waste, the list of which should be available with the city administration.

### 2.3.2. How can smart cities manage e-waste storage and transportation?

It is recommended that the Smart Cities should take adequate steps to ensure the safe transportation of e-waste, as many components can be hazardous. Before transportation, the WEEE should be packed in an environmentally sound way while also reducing risk to the people handling it. Documentation and maintenance of records along with proper labelling of the cargo are crucial for the items being transported. The storage capacity of any collection centre should be commensurate with the volume of operations (weight and numbers) and category of e-waste. The city administration should make available adequate facilities for managing leakage of compressor oils, coolant/refrigerant gases such as CFCs/HCFCs, and mercury from end-of-life lamps. Loading, transportation, unloading and storage of e-waste/ end-of-life products should be carried out in such a way that its end use, such as reuse after

## 2.4. Segregation and Dismantling

Dismantling operation comprises of physical separation and segregation after opening the electrical and electronic equipment into the component by manual operations. E-waste must be separated from other kinds of waste. Many components of e-waste are hazardous to health and the environment; hence, proper care must be taken while dismantling them.

### 2.4.1. Stakeholders involved

An individual, organisation, a registered society, a designated agency, a company or an association can engage in dismantling of e-waste into their components by obtaining authorisation from the respective SPCBs/PCCs. The informal sector also undertakes the activities of segregation and dismantling.

### 2.4.2. How can smart cities manage e-waste segregation and dismantling?

The premise for dismantling operation should have waterproof roofing and impermeable surfaces. There should be ample space for storage of disassembled spare parts and separate storage containers for special items like batteries, capacitors containing polychlorinated biphenyls, or polychlorinated terphenyls.

Dismantlers may use simple equipment like the screwdrivers, wrenches, pliers, wire cutters, tongs, hammers, etc. for dismantling. As the workforce involved in dismantling operations is at a certain amount of risk, it is suggested to the smart cities that the administration should tie up with the PROs to provide appropriate personal protective equipment such as goggles, masks, gloves, helmets, and gumboots, while dismantling e-waste. The cities should also recognise and empower the authorised refurbishers. The directly usable components, after dismantling, should be sent to an authorised refurbisher. The other parts can be sent to authorised recyclers depending upon the nature of the e-waste component. For instance, dismantled and segregated plastic from e-waste should be sent to registered plastic recyclers.

## 2.5. Recycling of E-Waste

The recycling output for WEEE depends on the amount collected, the efficiency of the pre-processing steps, and the final refining steps. The material recovery efficiency of the entire recycling chain depends on the efficiency of each step and on how well the interfaces between these interdependent steps are managed. After manual dismantling, mechanical processing may serve as pre-processing followed by refining, which usually has high technological requirements, such as that of large integrated smelters, etc.

### 2.5.1. Stakeholders involved

Authorised recyclers who work independently or are ideally a part of the producer's channelization system are the major stakeholders. Any individual or enterprise who is engaged in recycling and reprocessing of e-waste assemblies or their components and having such facilities should ensure that no damage is caused to the health and environment during storage, transportation, dismantling, and recycling of e-waste.

### 2.5.2. How can smart cities manage e-waste recycling?

Smart cities should have a detailed account of the authorised recycling facilities in the city and their capabilities. The cities should use a cloud-based system to maintain a record of e-waste collected, dismantled, recycled, and sent for final disposal. The recyclers should ensure that the fractions or materials not recycled in its facility are sent to the other authorised recyclers and the residue generated during the recycling process is disposed of in an authorised treatment storage disposal facility.

A schematic representation of the processes involved in e-waste recovery is shown in the figure below:

A schematic representation of the processes involved in e-waste recovery is shown in the figure below:

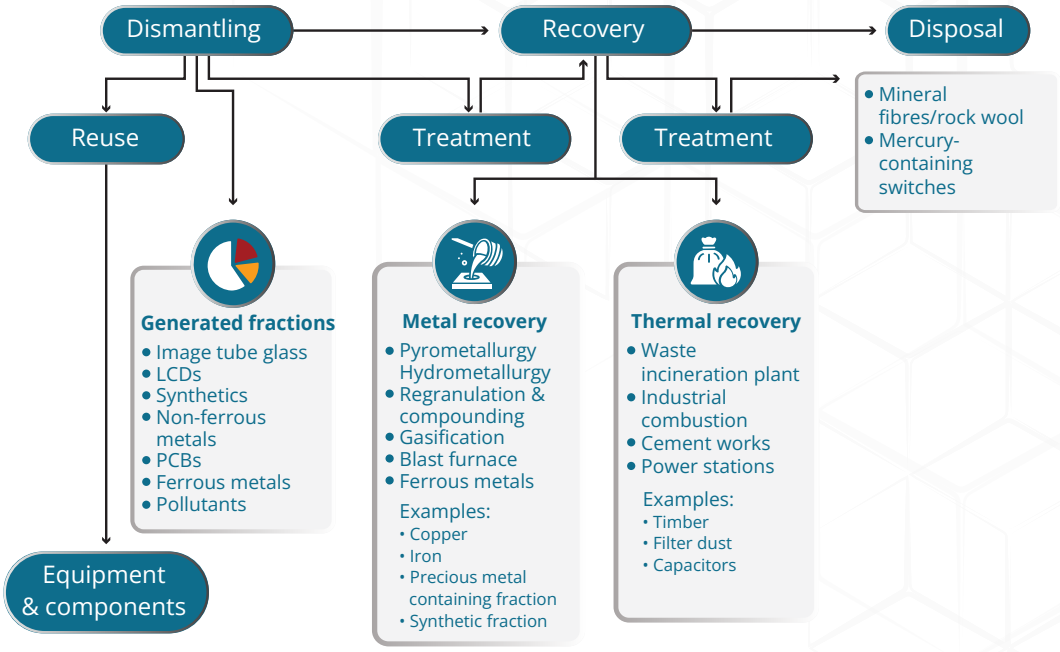


**Figure 7: Schematic representation of the processes involved in e-waste recovery**

Currently many of these processes are not optimized for maximum outputs. However, technology can provide efficient, economical, and easy-to-implement solutions for e-waste management and therefore play an important role in this ecosystem. E-waste comprises of multiple components including structural metals, plastics, and also valuable parts such as PCBs, Li-ion batteries, rare earth materials such as neodymium magnets and phosphors, among others. Smart cities should leverage the indigenous STI ecosystem (public R&D labs, industry, start-ups, etc.) to scout for technologies that may be useful for e-waste management. Technologies developed and demonstrated at an industrial scale by Indian R&D organisations on recycling of PCBs, plastics, lithium ion, rare earth metal recovery can be taken up by authorised recycling enterprises for reclamation of e-waste. A snapshot of the technologies that are developed by India's public R&D

## 2.6. Final Disposal

All fractions of WEEE cannot be recovered pertaining to their design and usage of non-recoverable materials. Such fractions, or hazardous waste fractions need to be disposed in hazardous waste treatment facilities. The two options that are used are landfills and incineration.

Landfilling is one of the most widely used methods of waste disposal. It is also a big challenge for the urban areas as the landfills often do not fulfill the highest standards, and as a result there are possible leakages from waste into the subsurface. The cities should aim at minimising the hazardous environmental impacts from landfilling by conditioning hazardous materials from e-waste separately, and by landfilling only those fractions for which there are no further recycling possibilities. The cities should ensure that there are state-of-the-art landfills that respect ecologically sound technical standards.

Incineration is the process of destroying waste by burning at high temperatures. Since e-waste is composed of a variety of substances, incineration is associated with a major risk of generating and dispersing contaminants and toxic substances. Cities should avoid open incineration at all costs and appropriate incinerators should be used only when absolutely necessary.

[17]Source: https://journals.sagepub.com/doi/pdf/10.1177/0256090919880655

# 3 Managing E-Waste: The Way Forward

## 3.1. E-waste Management Eco-Park

E-waste management ecological park or 'eco-park' is an integrated facility where scientific and environmentally safe processing of e-waste is done by accommodating stakeholders like dismantlers, recyclers, refurbishers, plastic waste processors, and others. Such parks create resource-efficient and cost-effective e-waste recycling ecosystems that are more competitive, attractive for investment, and risk resilient. Collaboration between stakeholders—such as companies, government agencies, local informal recycling communities, financial institutions, service providers, and R&D institutions—has a crucial role to play in this approach.

Smart cities have the technological maturity to develop such technology parks for end-to-end processing of e-waste aiming towards zero-waste to landfill. A group of cities can collectively develop a centralised park, where e-waste from all partnering cities can be processed. The parks should also host authorised refurbishing units as well as sale units for the extracted materials (base metals, rare earth metals, engineered plastics, glass, etc.). Several activities that can be undertaken by such parks are mentioned below:

- The park shall engage informal operators to leverage their knowledge base in collection network. Cooperation with the informal sector will help to ensure availability of waste for processing in the formal sector and contribute to making the formal units economically viable.
- The park shall have an authorised refurbishing market as a secondary product sale market for electronic goods, batteries, chargers, laptops, personal computers, and mobiles.
- There can be mutually agreed rate contracts, in consultation with producers and retailers for buy back of used electronic goods. The electronic components may also be sold to the refurbishers operating outside the park.
- Base metals like copper and aluminum, precious metals like gold and silver, and rare-earth metals like platinium, palladium, etc. and reusable plastic extracted in the park can be transferred to the mainstream production line. Manufacturers can be regular buyers.

Since this is a capital intensive effort, the land can be provided by the state government and the infrastructure can be developed in the PPP mode. The central and state governments can extend their support to eco-parks, till they become financially viable. These eco-parks can centralize informal operators in one place and monitor their activities for regulatory purposes. The formal and informal sectors can work together in such settings for seeking better revenue from the collected WEEE.

The long-term goal of the park should be to develop a national EEE manufacturing/importing registry which has linkage and traceability up to final zero-waste disposal.

## 3.2. Digitalisation of Processes and Operations and Use of Emerging Technologies through ICCCs

Under the ICCCs setup in Smart Cities, solid waste tracking of waste bins, waste fleet, and waste processing facilities is already undertaken and data on waste movement is available. Cities may enhance ICCC capabilities for monitoring and levying charges on the e-waste generation. This can be most efficiently done for De Novo e-waste generation. The city ICCCs can also support creation of Extended Producer Responsibility (EPR) Certificates as proposed in the E-Waste Rules 2022. The ICCC capabilities can allow creation of "e-waste registries" for de novo sales of electronic goods within a particular city's boundaries, and these registries may be extended to CPCB to support revenue generation from "EPR Certificates". Cities may explore revenue generation models for data sharing on e-waste.

The smart infrastructure of the cities such as smart waste collection solutions that track waste levels and provide route optimisation and operational analytics, smart bins supported by sensors, IoT waste monitoring system, and several such technologies can be explored for managing the e-waste of smart cities. These solutions are efficient and can help the municipalities meet sustainability goals such as zero waste, improve services for residents, and reduce operational costs. A smart bin is a waste or recycling bin outfitted with a sensor that can detect bin fill level, collection events, fire, tilt, and temperature. A separate smart bin, for e-waste, can be placed along with other waste bins across the cities.

IoT e-waste monitoring system can provide an efficient solution to electronics waste collection and generation of data. The loads on disposal units might change according to the day, week, and season. The "smart" dumpsters may then provide waste collectors with real-time, fill-level information. The IoT solution can determine the best paths for garbage collectors to take in order to prioritize regions in need of a clean-up while avoiding disposal units that still have space. This results in a more efficient pickup operation that doesn't take into account empty garbage containers, saving both fuel and manpower. A representation of digitalisation of processes and operations is shown below:

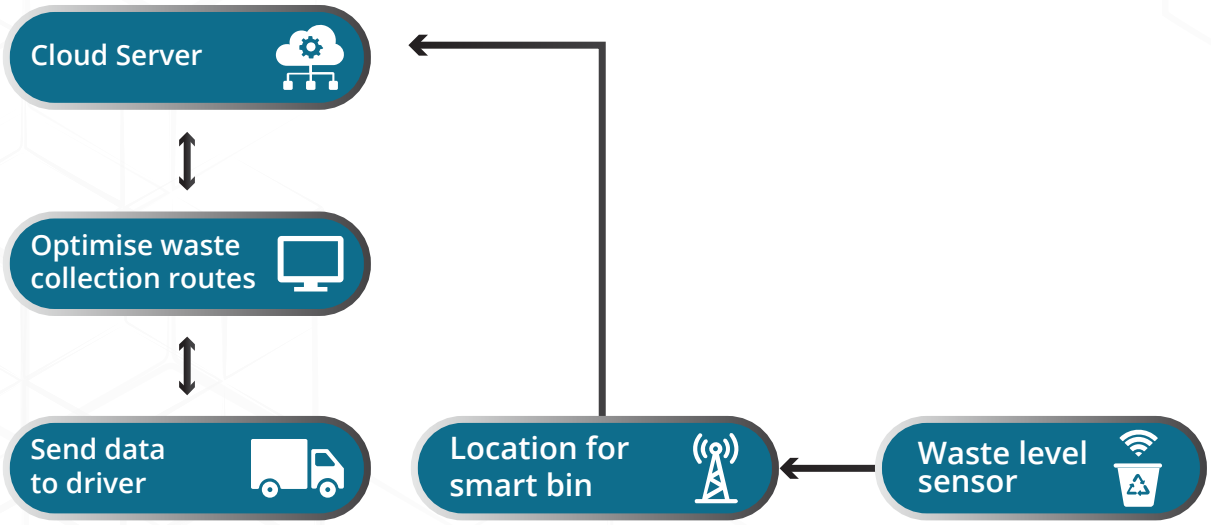


Figure 8: Digitalisation of processes and operations

## 3.3 National E-waste Inventory

A national e-waste inventory will enhance recycling, remanufacturing, reuse, and repair of e-waste which is essential for the development of sustainable smart cities in India. E-waste inventory system can be a cloud-based framework for keeping record of electronics item sales data primarily from the e-commerce sector as well as from offline sales. The sales data of electronic items can be retrieved from database of e-commerce websites and offline sales can be tracked from the GST fillings. The cloud architecture can gather necessary information and use that to create an appropriate framework for e-waste inventory. This will help the municipalities and other stakeholders like recyclers to strategize in advance for a better collection efficiency and increased e-waste recycling.

## 3.4. Adoption of Technologies for E-Waste Management

Technology can provide efficient, cost-effective, and simple-to-implement solutions, making it a crucial component of e-waste management. However, the current e-waste management ecosystem has little place for technologies. As a result the processes are highly inefficient. The recovery of metals from PCBs, for example, using rudimentary techniques is dangerous and the variety of precious metal resources, such as gold, silver, palladium, and copper, in PCBs must be recovered in an environmentally appropriate recycling method. Only a fraction is currently recovered in India, the valuable components requiring high-end technology are being exported to foreign smelters. Some Indian recyclers have attempted to import expensive foreign technologies and plant machinery but could not sustain due to a high running cost, low volume of input materials, and the inability of the technologies to address local needs.

A number of R&D projects have been initiated at national institutions in India. Public R&D labs such as CMET, NML, BARC, CIPET, NEERI, and several others have developed technologies for processing of PCBs, Li-ion batteries, EoL-CFLs, silicon solar cells, hard disk drive magnet/NdFeB magnetic scrap, knocked off plastic from e-waste and many other components of WEEE. These technologies on recycling of PCBs, plastics, lithium ion, rare earth metal recovery should be made available to the entrepreneurs in the formal sector to create a sustainable ecosystem of recycling businesses.

Based on previous interactions of the PSA Office with the technology developers, an indicative list of technologies is presented below. This is by no means a comprehensive representation of the technological prowess of the R&D institutes. Individual institutes can be contacted for obtaining more details on the technologies mentioned above.

| Name of Technology | Technology Developer | Input Material | Output Material | Possible Uses of Outputs |
|---|---|---|---|---|
| Selective metal recovery from active cathode material of spent Li-ion batteries using solvent extraction | C-MET | Li-ion battery | Cobalt and nickel suphate, lithium carbonate | Storage batteries, nickel plating, dry cell batteries fungicide, algaecide, medicinal uses, catalyst, etc. |
| Extraction of valuable metals from cathode material of spent Li-ion batteries using pyrometallurgy process | C-MET | Li-ion battery | Pure Co-Ni alloy | Hydraulic tubing, seawater cooling and firewater systems, heat exchangers, condensers, piping, etc. |

| Name of Technology | Technology Developer | Input Material | Output Material | Possible Uses of Outputs |
|---|---|---|---|---|
| Recovery of valuable materials from end-of-life silicon solar cells | C-MET | EoL silicon solar cells | Glass pieces, copper ribbons, PVF, EVA, silicon | Ornamental and decorative items, wiring and cables, adhesives used in packaging, bookbinding, bonding plastic films, pipes, sliding windows and doors, and packaging |
| Recovery metals and other materials from printed circuit boards (PCBs) | CIPET | PCBs | Organic epoxy resin, nonmetal glass fibers, metals | Paver blocks for flooring, metal plating, construction elements, and connectors |
| Recovery of precious metals from waste PCB, gold and silver of 99.5% purity | NML | PCBs | Gold, silver | Jewelry, adornments, medicine and dentistry, mirrors, electrical contacts, and batteries |
| Integrated metal (Cu, Ag, Ni, Zn, Pb, Au and others) recovery from solid waste | DRIIV | PCBs | Copper, nickel, etc. | Respective industries |
| Technology for recovery of rare earths and removal of hazardous mercury from end-of-life CFLs | BARC | EoL CFLs | Mercuric sulfide, lanthanum oxide, Yttrium oxide, etc. | Pigments, optical glasses, electrodes, conducting ceramics refractories, stains, photonics, transistor devices, etc. |
| Recovery of waste wires and cables | | Plastics from EEE | Flexible PVC seals and strips | Flooring of train compartments, garage floor covering, industrial flooring, basement, workshop, and firehouses |
| 3-D filament from Waste Electrical & Electronic Equipments (WEEE) plastics | CIPET | Plastics from EEE | 3D printer filament | 3-D printing and other industrial uses |
| Process for the recovery of neodymium from waste hard disk of PC | NML | Waste hard disks of PCs | Neodymium fluoride | Water insoluble neodymium source-use in oxygen-sensitive applications, such as metal production |

**Table 1: Snapshot of indigenous technologies developed for e-waste recovery**

# 4 Framing and Implementing E-Waste Action Plan

E-waste management is a humongous challenge for developing countries such as India. It has a major public health and environment degradation issue and is exponentially increasing by the day. E-waste management is an evolving sector in terms of both technology and policy landscape. As described in the sections above, successful management of e-waste requires an all-inclusive approach for overcoming challenges across the value chain, process optimization at all levels, deployment of indigenous technologies, for waste reduction, value retention, increasing life expectancy of a product, and its ability to be repaired, reused, and recycled. Based on the below principles, cities are advised to create and implement their e-waste action plans:

1. Increasing information campaigns, capacity building, and awareness are critical to promoting environment-friendly e-waste management programs.
2. Reducing the number of hazardous substances in EEE can be done in collaboration with the industry. Some examples of on-ground implementation of innovative processes and technologies is briefly captured in the annexure.
3. Cities may consider extending the Solid Waste Management collection techniques and networks to collect e-waste in separate bins, carefully leveraging a mixed approach of conventional and modern technologies.
4. It is strongly recommended that smart city administrators should analyse the best practices of e-waste management being followed in their localities as well as globally and contextualise them to suit their on-ground requirements.

Thus, Cities are advised to take steps as provided in section 2 & 3 to manage their e-waste efficiently. The policy instruments in the city action plan should be designed by factoring all the life stages of EOL products and e-waste, and by careful consideration of the economic aspirations, social benefits, and environmental challenges of the cities and country at large.

# 5 E-Waste Management Advisory for Smart Cities: A Snapshot

## Technology infusion in e-waste management ecosystem

- Collaborate with the regional STI ecosystem for indigenous technologies for managing e-waste.
- Collectively develop a centralised e-waste management park, with state-of-art technologies, for end-to-end processing of e-waste.
- Create a cloud-based inventory system for recording the sales data of electronic items.

## E-waste awareness and information drives

- Campaigns, workshops, street plays etc. can be organised.
- Organise discussion between manufacturers, refurbishers, and recyclers for better understanding of the complexities of e-waste management.
- Develop a centralised Knowledge Management System/repository of systems, practices, and approaches for managing e-waste in smart cities.

## Repair/reuse/refurbish

- Encourage 'Re-engineering', 'Repairs', and 'Refurbishments' technologies at manufacturing centres and build formal channels for the sale of refurbished items.
- Create electronic hubs in the city for the entire spectrum of sales, services, repairs, and recycling.
- Create a database of electronic repair shops, including refurbishers, and maintain a material flow accounting for e-waste and e-waste components.

## Integration of the informal sector

- Encourage and connect the informal sector with electronic hubs.
- Periodically organise workshops for information dissemination among informal sector entrepreneurs and workers.
- Collaborate with PROs for providing appropriate personal protective equipment to dismantlers.

## E-waste collection drives

- Dedicate a day in a month for organising city-wide e-waste collection drives.
- A separate smart bin for e-waste can be placed along with other waste bins across the city.
- Mobile collection vans can be used for door-to-door collection.
- Create a mobile/web application for registering e-waste pickup requests.

# Annexure: Some On-Ground Solutions for E-Waste Management

Several entities are part of the e-waste management value chain. This advisory is supported by certain examples which are operational in the real locations. Based on the workshop conducted jointly by the PSA Office and the Smart Cities Mission for deliberating on the challenges and probable solutions for e-waste management, a few cases of e-waste management have been presented here. The following section is the compilation of inputs submitted by different stakeholders who participated in the workshop. These submissions are made by authorised recyclers, PROs, RWAs, and development organisations. The information provided below can be revisited on their respective websites.

## A1.1. Recycling on Wheels: SmartER by Eco Recycling Ltd. (Ecoreco)

Eco Recycling Ltd. (Ecoreco) started formal recycling of e-waste in India in 2005 to address the increasing quantum of e-waste and find solutions to regenerate commodities to save natural resources.

Ecoreco noted the following through their experience of working in the sector over the years:

1. Almost everyone wants that their e-waste to be collected from their doorstep.
2. The majority of the generators want cash for end-of-life devices.
3. Most people do not know that their e-waste contains hazardous elements. They also do not know that e-waste increases pollution and, in turn, increases medical expenses.
4. MSMEs, large corporations, producers, and others noted are not so inclined to change their old practices until there is no direction from the head of the organisation or by the Board of Directors or no strict legal compulsion.

Keeping the above in mind, the Ecoreco Group developed Recycling on Wheels Facility SmartER. Salient points of SmartER are as below:

1. As a moving facility, it acts as a perpetual method of developing awareness.
2. Environment-friendly dismantling and on-site shredding activities familiarises generators to distinguish between formal and informal way of recycling.
3. Conducts D2D collection from each household which is an important requirement of EPR obligation.
4. On-site shredding of devices plugs off leakage of e-waste going to the informal channel.
5. Documentary evidence and CCTV footage of the activities inside the vehicle help meet the regulatory requirement to issue a Certificate of Recycling.
6. Shredded e-waste is then sent for onward processing and recovery of contents as per the extant rules.
7. Ecoreco deploys small CNG-driven vehicles with trained staff for collection from every address.
8. The accumulated e-waste is pre-processed in **Recycling on Wheels** Facility before further processing at recycling facilities.
9. Ecoreco provides its user with the digital **Certificate of Appreciation** for following an environment-friendly approach.


Figure 9: Seamless collection to compliance

**Eco-Bin:** This is another initiative of Ecoreco. The Eco-Bins were created to facilitate effortless e-waste collection in a network across the nation, and they enable the organised recycling of e-waste from individuals and small generators while also creating awareness.


Figure 10: An Eco-Bin

The above information has been provided by Ecoreco. To know more, you may visit https://ecoreco.com/.

## A1.2. E-waste Initiatives by a Resident Welfare Association in Chennai, Residents Of Kasturba Nagar Association (ROKA)

ROKA is a resident welfare association (RWA) based in Chennai which, for the past four years, has been actively involved in solid waste management (source segregation of waste, collection, and processing) and environment-related activities directly or indirectly to mitigate climate change.

ROKA's primary focus and motive is to spread awareness with action-oriented initiatives, not limited to the area under its realm but also broadening its base across Chennai and other cities, helping organisations, associations, volunteers, and communities with various projects in environment, mitigating climate change and global warming.

### ROKA's role in e-waste management in the city of Chennai:


Figure 11: E-waste initiatives by a Resident Welfare Association in Chennai, Residents Of Kasturba Nagar Association (ROKA)

#### Problem

ROKA has identified the absence of a regular collection system for e-waste, even where there is source segregation and door-to-door collection of waste, as a problem area in e-waste management.

## Solution

ROKA focuses on organising collection drives in Chennai city, which do not come under the normal collection system, especially e-waste. They started with a bi-annual collection drive for e-waste, open across Chennai. At the end of the drive, the collected items are handed over to registered, and licensed e-waste recyclers for recycling and refurbishing.

So far, ROKA has carried out five collection drives in the last four years for e-waste and other materials and collected close to 13 metric tonnes of e-waste. ROKA has inspired many to take collection drives as an active medium in solid waste management to divert materials from landfills and send it for processing. Citizens across the city walk in during the collection drive to deposit their e-waste, collected over years with great confidence with ROKA.

## Challenges

1. Finding a suitable place for the public to come and deposit had been challenging, as ROKA, being an RWA, does not have a permanent place to store the e-waste.
2. Cost of logistics and identifying a holistic recycler.
3. The cost of the e-waste even for the non-working material and the subsequent dilemma among residents to deposit it during collection drives such as lack of monetary compensation versus handing over to the *kabadiwalla* for money not realising the unscientific way in which it may be processed.

## Suggestions

The following were suggested by ROKA:

1. Mass awareness programs on e-waste can be organised by the corporations/ municipalities/villages on the hazardous nature of e-waste when disposed into the landfill with the help of RWAs, volunteers, NGOs, etc.
2. A weekly or monthly collection of e-waste from the residents wherever D2D collection is in place. A day in the week can be exclusively for e-waste only.
3. An e-waste kiosk can be placed at every ward or zone level for people to come and deposit as and when they want. The kiosk must be under constant supervision, and the items should be handed over to recyclers periodically and not let overflow.
4. MRF in the cities can have a specific protected, safe area for e-waste collected by the conservancy workers from D2D.
5. Encouraging and supporting RWAs and volunteers involved in solid waste management with space to conduct such awareness and collection drives periodically.

The above information has been provided by ROKA.

## A1.3. 'Deposit Refund System' and 'Smartskan' by Recykal

DRS is a mechanism for collecting large volumes of dry waste generated by used products, containers, packaging, e-waste, etc. and channelising them into recycling streams. DRS will be an effective, efficient, and traceable method to handle dry waste, including e-waste generated. The case study showcased here is for plastic containers; however, it can be adopted for e-waste more effectively.

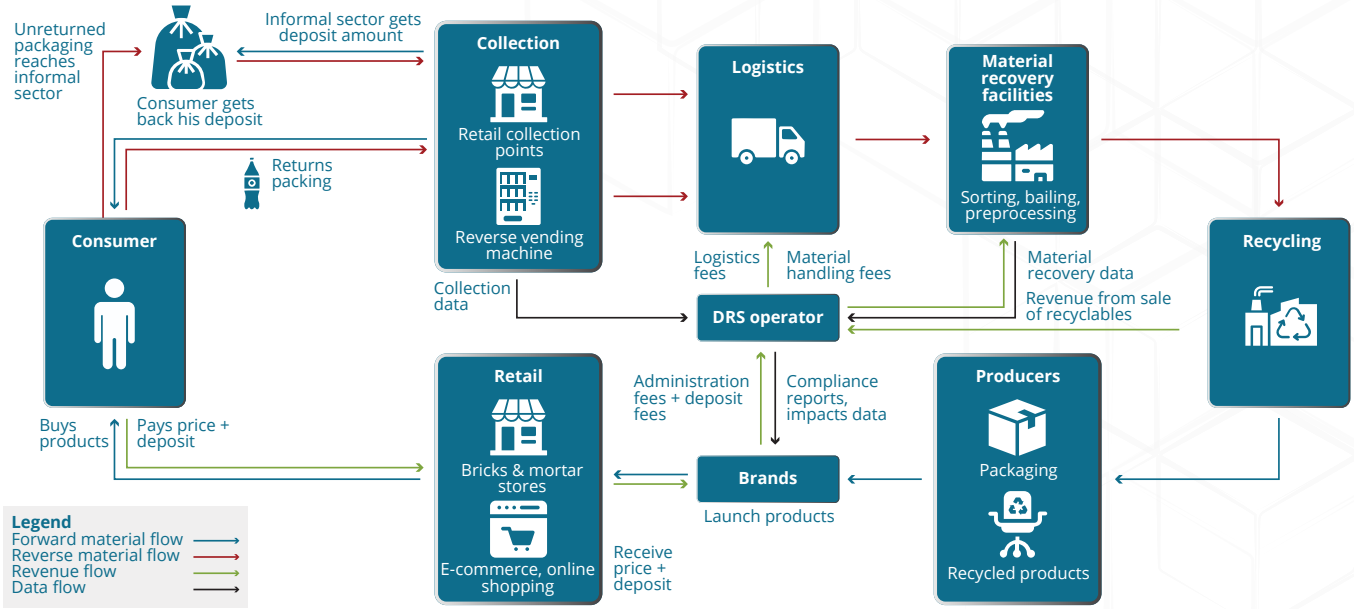


**Figure 12: Smartskan by Recykal**

The scheme can be under the purview of the respective state governments and enable the following key benefits:

- Improved the quality of recyclables
- Reduces waste by bringing clean, non-contaminated post-consumer plastic waste for recycling
- Creates a sense of responsibility and behavioural changes among the consumers
- Enhances the recycling/build-up of facilities
- Enables large cost savings by reducing clean-up costs and the tonnage of material needing to be collected through roadside collection programs
- Formalises the informal sector stakeholders

Not only do DRS rollouts create more jobs in processing centres and recycling facilities, given better supply-side consistency of material jobs, but they also allow them to avail the deposit amount for non-redeemed items.

**Case study**

The ever-increasing plastic pollution problem in Kedarnath (close to 10,000 kg of solid waste generated every day) has slowly altered the area's ecosystem. With the help of the district administration, Recykal was able to distribute and ensure the usage of scannable QR stickers to all shops en route to the Kedarnath trek. Shop vendors pasted these stickers onto consumer goods packaged in plastic and collected a nominal deposit fee from the consumer, which was then refunded once the discarded plastic was returned to the DRS. This system can be adopted for e-waste, with brands providing QR code based scanning options to track product destination and refund in the case of returns.

| | |
|---|---|
| **Start date** | : May 18, 2022 |
| **Number of shops registered** | : 65 |
| **QR code distribution to shops** | : 10,450 |
| **Amount collected from QR sale** | : 1,04,500 |
| **Number of bottles collected from customers** | : 2,895 |

## Smartskan

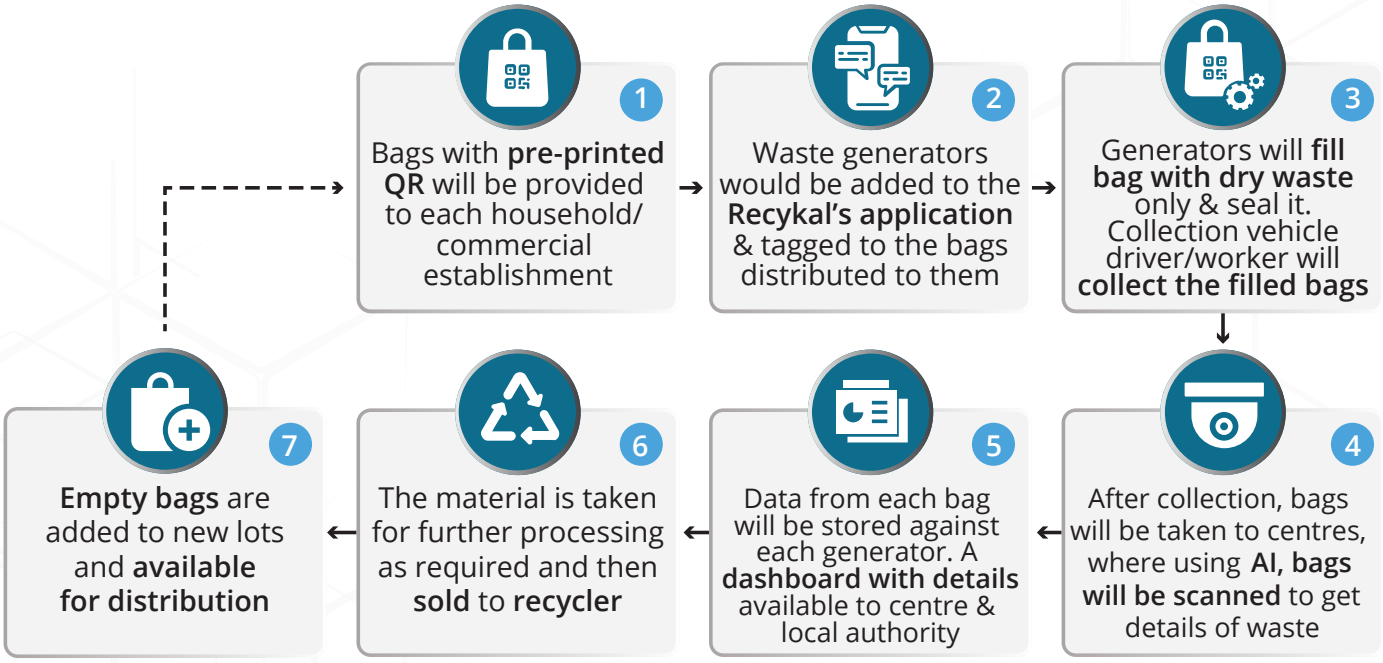


**Figure 13: Smartskan process flow**

Smartskan is a scanning technology that enables segregation at source by enabling the tracing of garbage generators. Smartskan works by tracing the waste generators through QR code enabled bags and/or products (uniquely identifiable by QR codes) given to them (households) to store and collect segregated waste and e-waste. This results in household level targeted communications and IEC programs for effective implementation of waste management. Smartskan is administered at the ULB level.

## Why Smartskan?

- Improving segregation at source and identifying non-compliant households
- Improving the efficiency of segregation centres to reclaim recyclable materials
- Higher realisation of processed waste through a digital marketplace
- Better targeting of IEC to the generators/households who need to improve their waste segregation and disposal process.

## Summary of implementation

| **Place** | **: Latur, Maharashtra** |
|---|---|
| a. Duration | : October 2021 to June 2022 |
| b. Total customers | : 11,587 |
| c. Households | : 10,100 |
| d. Shops | : 1,487 |
| e. Total customers (total weight collected in kg) | : 32,518 |
| f. Average weight collected (kg) | : 3.06 |
| g. Households (total weight collected in kg) | : 4,323 |
| h. Average weight collected (kg) | : 5.99 |
| i. Shops (total weight collected in kg) | : 28,195 |
| j. Average weight collected (kg) | : 2.85 |
| k. Contaminated bags (number) | : 189 |

| **Place** | **: Nathuawala, Dehradun** |
|---|---|
| a. Start date | : June 23, 2022 |
| b. Households registered | : 1,501 |
| c. Commercial registered | : 8 |
| d. Collection done | : 69 |

The above information has been provided by Recykal. To know more, you may visit https://recykal.com/.

## A1.4. CLEAN e-INDIA: Joint Initiative by Attero Recycling Pvt. Ltd. and EDMC

Attero is a sustainability-focused company developing processes and technologies to fuel the circular economy by recycling e-waste and lithium-ion batteries. Clean e-India is an initiative where Attero works with municipalities to provide e-waste management solutions.

### EDMC's e-waste and Attero:

The EDMC area, with a population of ~4.5 million (2018), covers 105 km in Delhi's North and South Shahdara zones. The EDMC consists of 64 municipal wards spread in two zones.

The EDMC decided to provide a comprehensive solution to manage its e-waste and selected Attero from several agencies that had offered their solutions. Attero has a Level 3 facility for mechanical recycling, precious metal recovery, logistical and customer support solutions, and required licenses and approvals.

### About CLEAN e-INDIA:

Attero started an initiative called CLEAN e-INDIA in March 2021 at six major Indian cities under which individual consumers can get e-waste picked from their homes. Attero ensures that e-waste is recycled responsibly, taking care of the environment, social impact, and data privacy.

Consumers get additional benefits by being rewarded in cash for all the e-waste that is picked up from them. To achieve this, Attero established the following:

1. Awareness of consumers through social media, self-help groups, collection drives, and branded vehicles.
2. Dedicated toll-free numbers for consumers to call for doorstep pick up.
3. Collecting waste and rewarding consumers fairly through digital payments.

### CLEAN e-INDIA and East Delhi Municipal Corporation Association:

Attero has undertaken several initiatives jointly with the EDMC since August 2021. The project objectives were also aligned with the Swachh Bharat Mission (Urban). The key objectives of the project are as follows:

- Modern and scientific e-waste management, handling, and disposal as per E-Waste (Management) Rules 2016 and E-Waste (Management) Amendment Rules, 2018.
- Generate awareness about sanitation and its linkage with public health.
- Capacity augmentation of EDMC in the desired sectors.

### Activities undertaken:

- Several awareness drives and e-waste pick-up drives have been undertaken in the residential, commercial, institutional, and industrial areas under EDMC.
- There has been a significant effort to jointly engage with the RWA, SHG, market associations, and other social groups like NGOs.
- Regular joint monitoring and review of the monthly collections, awareness activities, and overall acceptability of the initiative.

## Current progress:

Under this initiative, residents of the EDMC and across other cities of India have provided e-waste to Attero across 16 categories.

## Learnings:

Most consumers find it difficult to accept the prices offered for end-of-life items like mobile phones and laptops considering the cost paid at the time of purchasing, especially if these are in working condition even though they are completely obsolete. Several consumers are more comfortable dealing with their local kabadiwallas. The RWAs take time to realise the importance of this initiative, but once they understand it, they are fully supportive.

## Way forward:

Attero aims to create awareness about e-waste among 1 million people in the EDMC and 50 million people across India while assisting communities in recycling e-waste responsibly.

## Awareness building activities:

### 1 Branded vehicles along with e-captains


Figure 14: Branded vehicles along with e-captains

## 2 Hoardings in public places


Figure 15: Hoardings in public places

## 3 E-waste awareness posters at apartment entries


Figure 16: E-waste awareness posters at apartment entries

## 4 Collection drives in apartments


Figure 17: Collection drives in apartments

## 5 Social media campaigns


Figure 18: Social media campaigns

The above information has been provided by Attero. To know more, you may visit https://www.attero.in/.

## A1.5. E-Safai by GIZ

Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, a federally owned enterprise on behalf of the German Government, and RLG Systems India, part of Munich-headquartered RLG, a leading global service provider of comprehensive reverse logistics solutions, are jointly implementing a three-year-long Development Public Private Partnership Project titled "Setting Up Innovative Value Chain for e-waste management" also known as "E-Safai" initiative.

The project has helped establish four collection centers (two in each city of Delhi and Hyderabad), per guidelines by CPCB. These collection centers are working with daily inventorisation and stock checks. Safe storage and transportation of electronic waste are assured. Collections are done as per the defined best plan of collection vehicles, and movement of e-waste is done to authorised recyclers within 30 days.

The total collected e-waste through collection drives is 120.81266 MT for reporting period duration from 10/09/2020 to 10/03/2022.

**Figure 19: Images of collection centres and collection vehicles under e-Safai initiative**

### Clean to Green Portal:

- Clean to Green Portal is being used to incentivise students across educational institutions. **Student Portal:** https://www.letya.online/cleanlogin/greenescout/
- Collection Portal for Individuals/Dealers Retailers and Bulk Consumers is used to track

### Take Back Portal:

https://myholycrm.com/bulk/green/public/login

### C2G Website:

https://cleantogreen.in/, https://cleantogreen.in/collection-point/

## Placement of Eco-Bins:

The collection points/bins can be at designated places where e-waste can be collected from residential areas, office complexes, commercial complexes, retail outlets, customer care stores, educational and research institutions, and RWAs. These collection points have to be part of the producer's collection and channelisation plan. Mobile collection vans can be used for door-to-door collection of e-waste from institutions/individuals/small enterprises. Such vans shall be linked to collection centres and, if provided by producers, shall be part of their EPR plan.

As part of the project 30 Eco-Bins have been placed for e-waste collection in two cities. Sixty more Eco-Bins will be procured and two bins are proposed to be placed in the German embassy. The sole purpose of placing the Eco-Bins is to extend the reach of our collection points for effectively collecting e-waste in an environmentally safe manner.


**Figure 20: Eco-Bins placed at GIZ-India office**

The above information has been provided by GIZ.

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