White Paper on National EPR Framework for E-Waste Management in India

Prepared by

The Energy and Resources Institute (TERI)

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Setting Up Innovative Value Chain for E-Waste Management

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List of Acronyms

ADF	Advance Disposal Fee
ARF	Advanced Recycling fee
ASSOCHAM	Associated Chambers of Commerce and Industry of India
BMZ	Federal Ministry of Economic Co-operation and Development
CAP	City Action Plan
CE	Circular Economy
CPCB	Central Pollution Control Board
CPR	Collective Producer Responsibility
CRM	Critical Raw Materials
CSO	Civil Society Organization
DRS	Deposit-Refund System
EEE	Electrical and Electronic Equipment
EoL	End-of-Life
ELV	End of Life Vehicles
EPR	Extended Producer Responsibility
EU	European Union
FICCI	Federation of Indian Chambers of Commerce & Industry
GGP	Green Public Procurement
GIZ GmbH	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICT	Information and Communications Technology
IPR	Individual Producer Responsibility
MeitY	Ministry of Electronics and Information Technology
MoEFCC	Ministry of Environment, Forest and Climate Change
MRF	Material Recovery Facility
MT	Metric Tonnes
MMT	Million Metric Tonne
NGO	Non-Governmental Organisation
NREP	National Resource Efficiency Policy
PCB	Polychlorinated Biphenyls
PRO	Producer Responsibility Organisations
PRS	Producer Responsibility Scheme
RLG	Reverse Logistics Group
RoHS	Reduction of Hazardous Substances
SCP	Sustainable Consumption Practices
SLAB	State Level Advisory Boards
SLCPs	Short-Lived Climate Pollutants
SPCB	State Level Pollution Control Board
SPV	Special Purpose Vehicle
TSDF	Treatment Storage and Disposal Facilities
ULB	Urban Local Bodies
UPTS	Upstream Combination Tax/Subsidy
WEEE	Waste Electrical and Electronic Equipment

Executive Summary

With the increasing usage and dependence on electronic equipment, humans have been generating e-waste at unprecedented rates. In 2019, the reported generation of e-waste was 53.6 million metric tonnes (MMT). E-waste problems are more severe in developing countries that use rudimentary processing technologies and improper e-waste handling and management to deal with their own e-waste and that of other developed countries. The recorded generation of e-waste in India was 1.02 MMT in 2019-2020, increasing at a rate of nearly (CPCB, 2020).

Electrical and Electronic Equipment (EEE) are intricate devices consisting of rare, valuable critical raw materials (CRM) which are difficult to extract. The rate of extraction of raw minerals for EEE production is significantly higher than the rate of their formation in nature. It is estimated that by 2050, the rate of consumption of resources would be three times higher than the rate at which earth can replenish and by 2060 the global consumption of materials such as metals and minerals would double (MeitY, 2021). Hence, it is essential to incorporate circularity in e-waste management – something which is missing from the current e-waste legislation in India as it majorly stresses on increasing the recycling rates rather than extending the life of EEE.

The current regulations on e-waste management in India are defined under E-Waste (Management) Rules, 2016. These rules lay down 21 types of EEE within their jurisdiction. They also introduced and mandated the concept of EPR for e-waste management, by defining the collection targets for brand owners and producers. The rules also state the proper channelization of e-waste right from generation till recycling/disposal. Despite releasing the rules and regulations for e-waste management, the current situation of e-waste management in India is still underwhelming, with majority of WEEE leaking into the informal sector unaccounted. The informal workers process e-waste in an unscientific manner, harming the environment and curtailing resource efficiency. Additionally, EPR is not being exercised properly due to lack of infrastructure and transparency within the e- waste value chain, along with limited responsibility sharing amongst the stakeholders.

The White Paper on National EPR framework looks at the entire value chain for e-waste management in India and aims to present an updated, circular and responsibility sharing roadmap incorporating the inputs of various stakeholders within the e-waste value chain.

Thekey recommendations of this white paper are presented below:

- **Introduction of Advanced Recycling Fee (ARF),** which is to be shared by waste generators and producers. ARF needs to be calculated by PROs, waste collectors and recyclers/dismantlers based on material handling and recycling costs.
- **Development of a digital database** to account for the CRMs utilized within the generated e-waste, rather than just the total mass of waste generated.
- CPCB and SPCBs are the nodal institutions for e-waste management. Introduction of

a **Task Force for e-waste management** to support CPCB/SPCBs in decision making, auditing of PROs, recyclers/dismantlers, etc. The task force can comprise of empaneled institutions and e-waste sector experts. Their other tasks may include:

- Quantify and monitor e-waste information received from SPCBs/CPCBs;
- Predict the incoming e-waste generation by studying the current EEE sale patterns;
- Oversee the activity of recyclers and dismantlers by audits and have the authority to imposefines and even cancel registrations if found guilty;
- Undertake capacity building and training exercises for all stakeholders;
- Suggest technology and infrastructural development based on hotspot analysis;

- **Setting standards and guidelines for recyclers, dismantlers and PROs** to distinguish compliant from non-compliant institutions and penalizing the latter.
- **Eco-designs of EEE** must be promoted and incentivized to reduce cost of recycling, encourage resource efficiency, and circular economy. Additionally, brand owners, producers, original equipment manufacturers (OEMs) must look for extending the life of materials and using secondary raw materials (SRM). Businesses must look toadopt a lease base model for acquiring their workstations. This will ensure proper EoL management and curtail the flow of e-waste into the informal sector.
- **Defining refurbisher as key stakeholders** in e-waste regulations and channelizing the flow of e-waste through them to recyclers/dismantlers, ensuring circularity within e-waste value chain.
- On account of shared responsibility, **ULBs to be incorporated as key stakeholders** in e-waste management since a major portion of e-waste generators are households.
- **Development of mechanisms for monitoring and reviewing collection** targets along with the legislations for e-waste management.

Building on the vision of shared responsibility, the success of the proposed framework requires cooperation from national, state, and city governments, brand owners, producers, and OEMs,industries and other waste generators, e-waste recyclers and dismantlers along with the informal sector. The concept of circularity and resource efficiency needs to be thoroughly embedded into the e-waste regulations in order to foster the implementation of the national framework. Finally, there is a requirement for regular, systematic monitoring of the action points along with the collection and analysis of data in the context to determine the efficacy, and the need for adjustment in the actions defining the framework.

Key Objectives and Goals of the White Paper

E-waste management policy, rules, and regulations are evolving in India and although the aim is to institute a robust take-back, recycling, and recovery system through effective implementation of Extended Producer Responsibility (EPR), very little has been achieved on ground. EPR is mandated under the E-Waste Management Rules, 2016 however, its collection and recycling process is not regulated or formalized. Also, despite the ban on transboundary movement of hazardous waste, most Waste Electrical and Electronic Equipment (WEEE) or e-waste generated from developed nations (about 75-80%) still illegally ends up in Asian and/or African countries (ILO, 2012). Here it is collected, traded, and recycled by the informal and semi-formal sector in a crude, unsafe manner.

To prevent leakages from the current e-waste management value chain, the policy with respect to EPR needs to be strengthened. A robust policy framework will encompass learningsfrom best practices globally, integrate key stakeholders involved, and get inputs from consultations and feedback of key experts along the value chain for effective implementationin India. Global best practices include institutional mechanisms such as effective take-back, collection, monitoring and reporting, financial mechanisms in the form of Advance Recycling/Disposal Fee (ARF/ADF) for consumers or a corpus fund for producers for collection, treatment, and safe disposal of e-waste, and social mechanisms for creating awareness and capacity building of stakeholders across the value chain to operationalize EPR. The inputs from stakeholder consultations across the e-waste value chain can help capture the roles andresponsibilities in context of implementation of EPR, determine the challenges including regulatory, financial, administrative, infrastructure, awareness and capacity gaps to be addressed, identify opportunities, and develop potential solutions for effective EPR implementation.

This White paper on National EPR Framework for E-Waste Management in India is based on inputs from global best practices and consultations of key experts with the objective of providing recommendations, policy advisory for e-waste management related issues of sustainable end-of-life (EoL) management of WEEE and promotion of circular economy and resource efficiency in the e-waste value chain. The outputs of this white paper can be used to strengthen policy framework for e-waste management and its local level implementation though targeted interventions. Thewhite paper is prepared as part of joint project of Reverse Logistics Group (RLG) India and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH under devloPPP.de program of Federal Ministry of Economic Co-operation and Development (BMZ), Government of Germany. Together GIZ and RLG are working towards Setting up InnovativeValue Chain for E-Waste Management to channelize e-waste for formal recycling with the involvement of the informal sector.

Background

Rapid modernization and technological advancements have made electronic appliances an integral part of our daily lives. Although their widespread usage and dependence have facilitated simpler lives and improved standard of living, this has resulted in widespread disposal of obsolete EEE at a global level, resulting in the generation of e-waste. Owing to the on-going swift progressions in the field of science and technology, major EEE manufacturers invest heavily in R&D of their products, in order to stay ahead of their competitors.However, these producers and manufacturers are yet to come up with innovative, scalable solutions to manage the e-waste generated and its impact during the disposal of products with relatively shorter life cycles remains a key challenge (Rautela, et al., 2021).

Improper handling and disposal of e-waste has severe impacts on human health and environment, since they contain several hazardous constituents such as cadmium, lead, chromium, mercury and precious metals like gold, silver and palladium. In developing countries like India, e-waste is majorly handled by the informal sector. In such informal settings, the valuable components of waste electronic equipment are extracted through manual dismantling and often recycled using primitive technologies such as burning, heating or basic chemical reactions. Primitive recycling mainly includes open burning of circuit boards wherein circuit boards are cooked over open flames, cables and plastics are burnt in open pits to recover copper and acid leaching is undertaken to extract gold and palladium (Ari, 2015). These basic processes harm the environment as various toxicants and particulate matter are emitted into the ambient air and leached into soil and water. Surface runoff during rainy season is a major environmental concern. Fine particles of black carbon generated during e-waste burning are a grave threat to the environment as these short-lived climate pollutants (SLCPs) have high global warming potential (World Health Organisation , 2015). Not just the e-waste workers, but the community at large, especially women and children, are directly exposed to a range of harmful toxic materials and chemical fumes from improper e- waste management (World Health Organisation , 2021). Improper management of e-waste can have adverse impacts on the environment and health; it is therefore essential to understand, monitor and quantify e-waste at regional and national levels and formalize its collection, treatment, and safe disposal processes.

The first step towards effective monitoring is defining e-waste including the components which constitute them. Globally, the E-Waste Statistics Guidelines describe a measurement framework to capture the dynamics of flows and stocks of EEEand e-waste. The categorization of WEEE is provided by United Nations University (UNU) and is referred as the UNU-KEYs, which group EEE productsinto six general categories (i) temperature exchange equipment, (ii) screens and monitors, (iii) lamps, (iv) large equipment, (v) small equipment and (vi) small IT and telecommunication equipment that correspond closely to waste management characteristics (Forti, Balde, Kuehr, & Bel, 2020).

In India, E-Waste (Management) Rules, 2016 define e-waste as ‘electrical and electronic

equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes.' Unlike the global categorization of 54 products, the Indian government identified only 21 components that fall under the jurisdiction of E-Waste (Management) Rules, 2016. These 21 components belong to 2 categories – (i) Information Technology and Telecommunication Equipment [16] and (ii) Consumer Electrical and Electronics [5] (MoEFCC, 2016). The categories under the E-Waste Management Rules are shown in Figure 1 below.

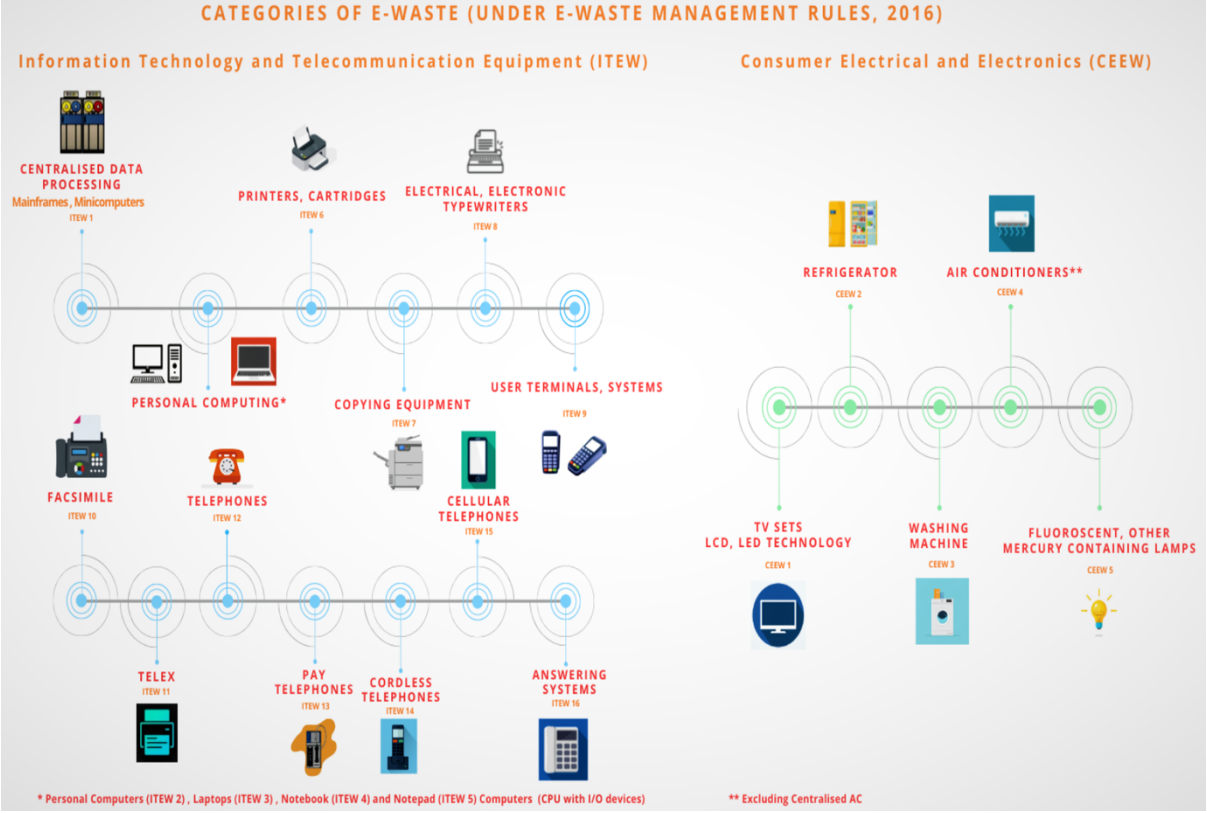

Figure 1: Different categories of e-waste under E-Waste (Management) Rules, 2016
Source: (MoEFCC, 2016)

The estimated e-waste generation in India was nearly 0.77 MMT in 2018-2019 and about 1.02 MMT in 2019-20 (CPCB, 2020). The processing rate of e-waste in India is increasingrapidly with several authorized e-waste recyclers and dismantlers appearing at regional and state levels. The installed capacity of e-waste recycling in India is 1.07 MMT, with a total of 400 authorized recyclers and dismantlers across all states and union territories (UTs). However, the values reported by CPCB are less than a third of the e-waste generation reportedby UN, which states India generated nearly 3.2 MMT of e-waste in 2020 (Forti, Balde, Kuehr, & Bel, 2020).Varied estimates for e-waste generation data for India in national and international reports may be due to the different categorization of e-waste (Biswas & Singh, 2020). Further, lack ofproper data collection and monitoring of recycling and recovery leads to discrepancies in dataon WEEE generation and treatment.

In India, the desired flow of e-waste is provided within the E-Waste (Management) Rules,

2016. According to the rules, the manufacturers of EEE (described within Schedule 1) are mandated to collect and channelize e-waste to CPCB authorized dismantlers either through Producer Responsibility Organization (PRO) or through a take back system by establishing independent collection centres. The channelization is to be done as per the categorization mentioned within Schedule 1 of E-Waste (Management) Rules, 2016. The e-waste is segregated at the collection centre and sent to CPCB authorized dismantlers. The dismantlers are required to maintain an inventory of the waste channelized to them and further abide to CPCB norms. From dismantlers, the e-waste is sent to either authorized recyclers or to a Treatment Storage and Disposal Facilities (TSDF) for hazardous waste and non-recyclables residues. The authorized recyclers are required to recycle the e-waste and send the non-recyclables to TSDF for final disposal. The useful products must be used for manufacturing newer electrical equipment (MoEFCC, 2016) (CPCB, 2016) (CPCB, 2018) (MoEFCC, 2018).In practice however, the management of e-waste in India is quite different from the desired flow. Despite the recent growth in formalized and authorized e-waste recycling and dismantling sector industries, the actual e-waste processed formally is still relatively low. Thisis primarily because more than 90% of India's e-waste is handled and processed by the unregulated informal sector (Heacock, et al., 2016) (NEC & ASSOCHAM, 2018). The informal sector often resorts to dangerous and non-scientific methods for resource extraction and disposes of the remnants irresponsibly, harming public health and the environment. The presence of informal sector challenges implementation of EPR. Inventory of e-waste generated is lacking due to improper monitoring and tracking of EoL management. Hence, majority of e-waste handled in India gets under reported due to the invisibility of the informal sector, resulting in leakages of recoverable valuables along the value chain (Sinha, 2020).

Import and illegal dumping of e-waste in India

India, being a member of the Basel Convention, has prohibited the import of e-waste into the country under Annex VIII A1180 (Basel Convention, 1989). The E-Waste Management Rules 2016 however state that EEE can be imported by producers that have EPR authorizations from CPCB. Despite having these strong legislations, the import of unauthorized e-waste takes place in India. The Hazardous Waste Management Rules, 2016 allows the import of used EEE for recycling, refurbishment and/or direct usage. This allows for leakage of e-waste into the nation as distinguishing between second-hand electronics and e-waste is difficult (Chatterjee, 2011). Lack of differentiation of second-hand goods from e-waste is a pressing issue of the Indian Trade Clarification based on Harmonized System (ITC-HS) codes stipulated by the Directorate General of Foreign Trade under Ministry of Commerce and Industry in importing products.

Actual data on import of e-waste is not currently available in India. According to Ministry of Commerce and Industry dataset, entire electrical machinery and equipment imports (denoted by HS 85) for the year 2021-22 corresponded to nearly ₹40,91,079 crores (Department of Commerce, 2022). However, it is impossible to track the flow of the incoming e-waste or second-hand goods under this data since they share the same HS code as new EEE imports (CSE, 2020).

According to the 2011 Rajya Sabha report *E-Waste in India*, nearly 50,000 tonnes of e-waste was imported to India in 2009 (Rajya Sabha Secretariat, 2011). This is perhaps the only official document

released which estimates the e-waste imported into India. More recently, 29 cases of illegal import of e-waste were detected by Central Board of Indirect Taxes & Customs (CIBC) in the last 3 years with Maharashtra and Tamil Nadu reporting the maximum cases (11 each), followed by Gujarat (3) and Uttar Pradesh and West Bengal (2 each) (PIB, 2022).

Estimating the imported e-waste into the current flow is challenging as they currently remain unaccounted in the inventorization process. Hence, in order to develop more comprehensive e-waste inventories, imported e-waste needs to be incorporated. However, with inadequate recycling facilities for proper e-waste management, import of second-hand electronic appliances needs to be reconsidered (Turaga, 2020).

The figure below describes the flow of e-waste in India:

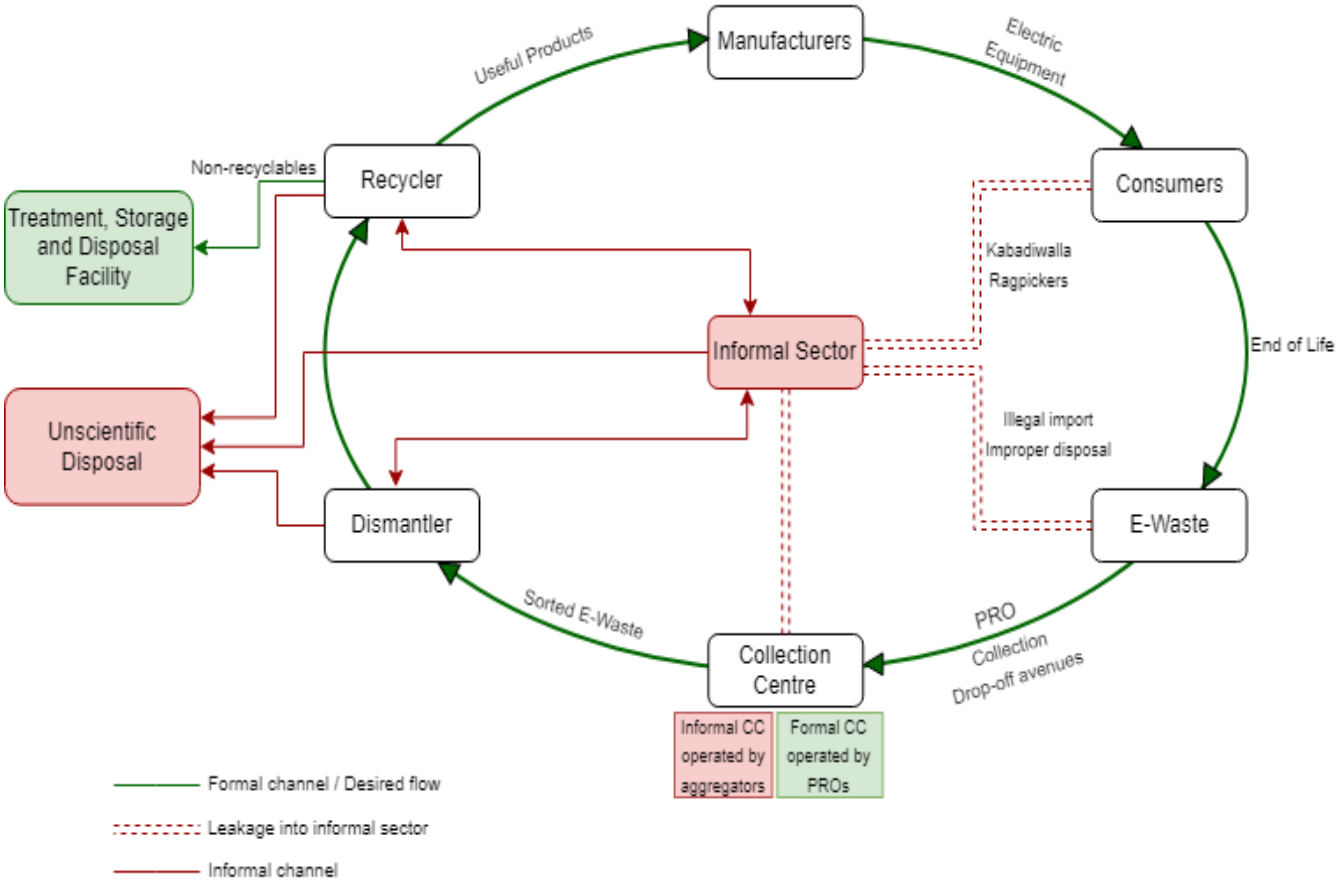

Figure 1: Flow of Indian e-waste [Teri analysis]

Existing Legislation for E-waste Management: Global and Indian Perspective

To effectively manage the increasing quantities of e-waste generated, several countries have come up with e-waste legislations. The rules and regulations around e-waste have an overarching aim of sustainable EoL management of WEEE through formal channels. The legal and regulatory framework can achieve this by defining the roles and responsibilities of all the stakeholders for proper use, safe collection, transport, dismantling, recycling, and disposal. Legislations and guidelines provide the basis of a framework to systematically tackle the problem of waste generation in a uniform manner, allowing for subsequent collection of e-waste data, monitoring, tracking, and evaluation. Analysis of global and national policies, rules, and regulations suggest that although two-thirds of the world's population is covered under e-waste legislation, the lack of uniformity in legislations across countries (apart from the EU – which follows the WEEE EU directive, makes it difficult to track, monitor, and evaluate e-waste generation and recycling on a global scale (Patil & Ramakrishna, 2020). Lack of strict enforcement, especially in Asian and African countries, is a major issue preventing countries from moving towards formal recycling. Due to lack of strict enforcement, there are negligible formal disposal and processing systems withpredominance of informal, crude e-waste recycling activities. Owing to the weak legislation and lax attitude, most developing countries face the issue of illegal dumping of e-waste imports from developed countries, which is also recycled through crude processing methods. Legislations instituted at global and national levels have tried to curtail the harmful management and illegal transport of e-waste which are described below.

Global Scenario

Globally, The Basel Convention aims to generate awareness and prevent transboundary movement of hazardous waste. At the Basel Convention (held at Basel, Switzerland) in 1989, 186 countries signed the treaty of Transboundary Movements of Hazardous Wastes and Their Disposal with the objective of environmental protection (Kummer, 2000) (Hackett, 1990). The treaty banned the trade of hazardous waste between member countries. Most of the members signed the treaty and enforced legislation prohibiting the import and/or export of hazardous waste in their respective countries. Major countries like the USA have not ratified this treaty and although transboundary movement of hazardous waste has reduced, the illegal export of e-waste from developed to developing countries persists.

At a regional level, the EU leads the way in setting the WEEE rules and regulations, as given in Table 1 below. The WEEE directive uniformly regulates e-waste management in its member nations including the process of separate collection and storage sites, treatment procedure requisites for specific materials and components, recycling, and recovery of resources that is reported and monitored by the National Enforcement Authority. The directive also encourages better upstream changes such as design-for-recycle and is based on the EPR principle, making producers responsible for recycling their EoLproducts.

Table 1: E-waste legislation in the EU and the UK

Country	Legislation (Policies, Rules & Regulations)	Year	About	References
European Union (EU)	Directive on the Restriction of Hazardous Substances (RoHS) (2011/65/EU)	2011 (latest revision is 2021)	Restriction of the use of certain hazardous substances; changing product designs (replacing them with environmentally friendly materials) and increasing recycling rates of waste electrical and electronic equipment.	(The European Parliament, 2011)
	Directives on waste electrical and electronic equipment (WEEE) (2012/19)	2012 (Amended in 2018; now known as WEEE 2)	To uniformly regulate the collection, recycling, and recovery of waste electrical and electronic equipment in the member nations from disposal to reuse.	(The European Parliament, 2012)
Germany	Governing the Sale, Return and Environmentally Sound Disposal of Electrical and Electronic Equipment (ElektroG)	2015	Implements the legal obligation of producers of electrical and electronic equipment to assume responsibility for the end of life of their products; Ensure disassembly-friendly production design.	(Federal Ministry for the Environment and Nuclear Safety, 2015)
Belgium	Waste Prevention and Management Ordinance (VLAREA)- Flanders (Flemish) Region	2004	Mandates the producer to finance the collection, treatment, recycling and recovery of waste electrical and electronic equipment and ensuring the collection andenvironmentally sound treatment and disposal of waste electrical and electronic equipment either collectively orindividually.	(Khetriwal & Jain, 2021)
	Producer Responsibility Decree – Wallonia Region	2005		
	Producer Responsibility Decree- Brussels Capital Region			

Country	Legislation (Policies, Rules & Regulations)	Year	About	References
Sweden	Ordinance (2014: 1075) on producer responsibility for electrical equipment	2014	Mandates producers to take responsibility for the problems that electrical waste gives rise to and give them incentives to take waste prevention measures.	(Poikela, et al., 2014)
	Ordinance on producer responsibility for batteries (SFS 2005: 209, 210 and SFS 2008: 834)	2008	Battery producers are obliged to collect all spent batteries through providing one or more suitable national collection systems.	
United Kingdom	The Waste Electrical and Electronic Equipment Regulations 2013 (SI 2013/3113)	2013	Minimized packaging requirement, restriction on dangerous substances (such as heavy metals). Obligates reduction in packaging for UK companies with > 2 million GBP turnover or with handling capacity of > 50 tons of packaging per year.	(The Waste Electrical and Electronic Equipment Regulations, 2013)

EU passed the WEEE Directive in 2012 which is a comprehensive document. It provides a basis for forming the e-wastelegislation in developing countries such as in Asia. Most populated countries with emerging economies such as China and India have adopted such regulations where the waste fraction is expected to increase multiple folds in the next few years. However, the existence of such legislation does not necessarily imply successful implementation or provision of proper e-waste management systems. Countries in Asia, in addition to being the largest e-waste generators are also a site for illegal dumping of e-waste imports. Asian countries are at different stages of economic development, which is reflected in their waste management systems. Robust national level, region specific legislation is needed across nations to prevent illegal import and export of e-waste, to sustainably manage e-waste generated within the country, and to uniformly monitor activities of e-waste management.

China being the largest producer of e-waste globally, has taken legislative steps toban illegal imports of e-waste. Legislations include prevention and control of pollution from WEEE, control of hazardous substances in e-waste and management through "3R– reduce, reuse, recycle" and "Polluter Pays" principles that focus on eco-design, enhanced formal collection, storage, and safe recycling with increased reutilization rates, and prevention of pollution from the EoL management activities. The Circular Economy Promotion Law, Administrative Rules on Prevention of Pollution by WEEE in 2008 put forward the EPR principle, which was formalized in 2012, requiring manufacturers to carry out environmentally safe management

of their products at the end of life.

In **Japan**, two main legislations control the management of e-waste. Under these rules, a recycling-based economic system is established in which home appliances are regulated. The rules define the responsibilities of stakeholders and determine waste collection points. The rules ensure that waste parts collected are reused, standards and minimum targets for recycling rate is set andnew measures to reduce waste and extend product life are introduced. The e-waste legislation in Japan and China is detailed below in Table 2 below.

Table 2: E-waste legislation in Japan and China

Country	Legislation (Policies, Rules & Regulations)	Year	About	References
Japan	Law for the Recycling of Specified Kinds of Home Appliances (LRHA).	1998 (Enforced in2001)	To create a recycling scheme to impose obligations on home appliance manufacturers and retailers to ensure proper waste treatment and efficient use of resources. LRHA outlines the regulations for specific home appliances {Rules on production of cathode ray tube television receivers, household air conditioners, washing machines, and refrigerators}. The responsibilities of waste generators, retailers, manufacturers, the Association for Electric Home Appliances, and city governments. The standards for recycling (including minimum recycling rate) and regulating the coupon system.	(Ministry of Economy, Trade and Industry, 2001)
	Law for the Promotion of Effective Utilization of Resources (LPUR)	2000 (Enforced in 2001)	Establish a recycling-based economic system by reusing parts of collected products, strengthening collection methods, and introducing new measures to reduce wastes and extending product life span.	(Ministry of Economy, Trade and Industry , 2015)
China	Catalogue for managing the import of wastes (MOC, MEP, NDRC, GAC, AQSIQ, 2009, No. 36)	2000	Banned the import of waste electrical and electronic equipment since2000	(Wong, 2018)

	Technical Policy on Pollution Prevention and Control of WEEE (MEP) (SEPA No. 115)	2006	Sets "3R" and "Polluter Pays" principles, stipulates eco-design, makes provisions for environmentally sound collection, reuse, recycling, and disposal of waste electrical and electronic equipment with aim to reduce the volume of e-waste and increase reutilization	(Wong, 2018)
	Requirements for Concentration limits for certain hazardous substances in electronic information products (SJ/T 11363-2006)	2006	Concentration limits to the six hazardous substances of electrical and electronic equipment; labelling and packaging requirements for controlled substances on recycling.	(Advancing the Business of Technology, 2006)
	Measures for the Control of Pollution from Electronic Information Products (MIIT, NDRC, MOFCOM, GAC, SAIX, AQSIQ, MEP)	2007	Restrictions on the use of six toxic and hazardous substances; requirements for eco-design; mandatory provision for producers to provide information on components, hazardous substances and recycling about their products.	(Lu, Zhang, & Zong, 2015)
	Management of Prevention and Control of Pollution from Electronic and Information Products China RoHS (MIIT No. 39)	2007	Sets requirements for eco-design, restrictions on use of hazardous substances and requirements for producers to provide information about their products.	(Wong, 2018)
	Administrative measures for the prevention andcontrol of environmental pollution by electronic waste (MEP)	2008	Focused on preventing pollution during disassembly, recycling and disposal of e-waste; provided a licensing scheme for e-waste recycling companies; undertake environmental impact assessment for e-waste dismantling, utilization and disposal projects; definition of responsibility of manufacturers, importers and retailers.	(Wong, 2018)

	Circular Economy Promotion Law, Administrative Rules on Preventionof pollution by WEEE	2008	To prevent pollution caused by the storage, transport, disassembly, recycling, and disposal of e-waste Put forward principles of EPR; Specifications of 3R -Reduction, Recycling and Reuse, To build incentive mechanisms, To control the total emissionsfrom enterprises.	(Chung & Zhang, 2011) (Lu, Zhang, & Zong, 2015)
	Regulations on the Management of the Recovery and Treatment of Waste Electronic and Electrical Products (China WEEE Regulation)	2009	Mandatory e-waste recycling, implementation of EPR, and establishment of a fund to subsidize e-waste recycling.	(Wong, 2018)
	Technical specifications of pollution control for processing waste electrical and electronic equipment(MEP)	2010	Technical requirements and contents of controls on collection, transport, storage, disassembly anddisposal of waste electrical and electronic equipment.	(Lu, Zhang, & Zong, 2015)
	Regulations on Recovery Processing of Waste Electrical and Electronic Products	2011	Implementation of EPR; establish of e-waste recycling fund; encourages partnerships in recycling of waste electrical and electronic equipment; Certification for second-hand electrical and electronic appliances.	(Wei & Yangsheng, 2012)
	Cleaner Production Promotion Law, The Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products	2002 (Amended in 2012)	Reduction of use of hazardous and toxic substances in electronic appliances and reduction of the pollution generated in the manufacturing, recycling and disposal of these products	(MoI & Liu, 2005)
	Extended Producer Responsibility (EPR) system	2012	Requires manufacturers to carry out environmentally safe management of their products after they are discarded.	(Chung & Zhang, 2011)

The Indian Perspective

In India, the Environmental Protection Act (EPA) passed in 1986 emphasized the prevention, control and abatement of all environmental pollutants. For regulation on WEEE, legislation was passed in 2011 with the E-Waste (Management and Handling) Rules. However, prior to this, the Ozone Depleting Substances (Regulation and Control) Rules in 2000 and the Hazardous Wastes Management, Handling and Transboundary Movement Rules, 2008 regulated the import and export of electronics, required registration of e-waste recyclers and banned import of hazardous e-waste for disposal. E-waste was included as part of Schedule IV of Hazardous Waste Rules, 2008 which mandated registry of e-waste recyclers. These rules however, did not make a clear distinction between other solid wastes and e-waste.

India has separate rules for management of spent batteries which are regulated by the Battery (Management andHandling) Rules, 2001. The objective of the battery rules is to channelize used lead acid batteries for recycling in an environmentally sound manner. The 2011 amendment to the rules has expanded the definition of bulk consumer, mandated selling of batteries to registered dealers, included registration of importers, and ensure availability of records with the SPCB for regular monitoring. The 2020 amendments have further expanded the battery chemistries covered under the rules to new lithium- ion and other similar batteries. They have mandated tracking through online records, safe formal recycling, data management, while providing clear outline of roles and responsibilities for the involved stakeholders. The rules have set up EPR collection targets along with framework for collection of spent batteries.

The E-Waste Management Rules, 2011 were formulated to regulate the management of e-waste during the complete life cycle of product including stakeholders from producers of EEE to recyclers. The rules (formulated like the EU WEEE directive) have implemented EPR, making producers responsible for EEE products at the end of life. This includes recycling of WEEE, setting up collection centres, implementing take back systems. 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 Deposit Refund System (DRS) were outlined and EPR collection targets also specified. In the 2018 amendment to the rules, the collection targets were revised, and PROs were mandated to register with CPCB for it to monitor and audit PROs activities through inspections. Such amendments to the original E-Waste Management Rules, 2011 aim to create an organized and legitimate industry for effective andimproved e-waste management in India. In 2022, the MoEFCC notified the E-waste Management Draft Rules limits the rules to four stakeholders including every producer, manufacturer, recycler and refurbisher and requires them to register on the centralized Central Pollution Control Board Online Portal before conducting of any activity. The draft rules in addition to defining the responsibilities of CPCB/SPCBs, manufactures, producers, refurbishers, bulk consumers, recyclers, state government, urban local bodies, port authorities also define the responsibilities of the Bureau of Indian Standards/MeitY that will issue standards on the refurbished products.

The legislations around e-waste and related management in India are given in Table 3 below.

Table 3: E-waste legislation in India

Legislation (Policies, Rules & Regulations)	Year	About	Reference
The Environmental Protection Act	1986	Emphasizes prevention, control, and abatement of environmental pollution.	(MoEF, 1986)
The Ozone Depleting Substances (Regulation and Control) Rules	2000	Regulates the export and import of EEE containing substances that can destroy ozone layer.	(MoEF, 2000)
The Hazardous Wastes Management, Handling and Transboundary Movement Rules	2008; re-notification in 2016	Requires companies/individuals receiving, treating, transporting, or storing hazardous waste have to seek permission from the relevant State Pollution Control Board; Mandatory registration of e-waste recycler with CPCB; Bans the import of hazardous waste for disposal or dumping of e-waste.	(MoEF, 2008)
Battery (Management and Handling) Rules	2001	The objective of channelizing used lead acid batteries for recycling in an environmentally sound manner.	(MoEF, 2010)
	(Amendment 2010)	The definition of bulk consumer was expanded to departments of central and state governments, boards and other agencies or companies who purchase hundred or more batteries per annum. The new batteries shall only be sold only to the registered dealers. The importers registered for 5 years and subsequent cancellations Make available records relating to receipt of used batteries, sources, quantities and metal yield to be submitted to the SPCB for inspection.	(MoEF, 2010)
	Draft notification in 2020	Types of batteries that are proposed to be brought under the purview include all primary (non-rechargeable) and secondary (chargeable) cells. Battery chemistry under the purview but not limited to include lead-acid battery, lithium-ion batteries, magnesium-ion battery, nickel cadmium and/or nickel-hydrogen battery, rechargeable alkaline and/or fuel battery, sodium-sulphur battery, sugar battery, super iron battery, ultra-battery.	(MoEFCC, 2020)

Legislation (Policies, Rules & Regulations)	Year	About	Reference
		To ensure tracking, safe and formalized recycling of batteries. Seek accountability to ensure proper recycling though formal channels. Tracking waste batteries through online records and data management. The amendment lays out responsibilities of the manufacturer, importer, assembler, re-conditioner, consumer, exporter, dismantler, collection centre and state/central pollution control board explicitly, stresses awareness on hazards of Lead, Cadmium and Mercury and safety measures associated with their handling. EPR Collection-targets stated along with framework for collection and channelization of waste batteries manufacturers to set up collection centres by themselves or jointly; ensure arrangements for safe transportation of old batteries; and to file annual record of sales and buy-back	
E-Waste (Management and Handling) Rules	2011	Rules to regulate the e-waste management at every level of EEE life span from producers to recyclers. All SPCBs/PCCs to grant consent to establish and to authorize the units for recycling of Waste EEE. Introduced the concept of EPR. EEE producer responsible for managing equipment at its EoL covering every producer, consumer/ bulk consumer, collection centre, recycler and dismantler. Producers also responsible to make consumers aware, to set up e-waste collection centres and establish take back systems. Restrict the use of hazardous substances such as lead, cadmium, mercury and brominates flame retardants.	(MoEF, 2011)
	(Amendment 2016)	Inclusion of more stakeholders including PRO. 2 possible instruments for EPR implementation by producers namely PRO and DRS.	

Legislation (Policies, Rules & Regulations)	Year	About	Reference
		Clear demarcation of roles and responsibilities applicable to producer, consumer or bulk consumer, collection center, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment. Simplification of authorization and registration process. Introduction of Collection EPR-Targets specified in Schedule III of the Rules as 30% of the quantity (either in number or weight) during first two years; 40% during third and fourth year, 50% during fifth and sixth years; and 70% during seventh year onwards.	
	(Amendment 2018)	Revision of collection targets under provision of EPR by way of revised targets and monitoring under the CPCB. As per the revised targets of e-waste collection, 10% quantity of waste generated collected during 2017-18; 10% increase every year until 2023. After 2023, the E-Waste collection target fixed at 70% of the quantity of waste generation. Separate collection targets introduced for new producers i.e. producers with sales operations lesser than the average life of their product. The PROs shall apply to CPCB for registration. The cost of Reduction of Hazardous Substances (RoHS) sampling and testing to be borne by government and in case of noncompliance the cost to be borne by the producers.	
	(Amendment 2022)	Mandates the manufactures, producers, recyclers and dismantlers to be registered on the centralized CPCB portal and not to engage with any unregistered manufacturers, producers, recyclers and refurbishers. Defines the responsibilities of Bureau of Indian Standards/ MeitY. Generation of EPR certificates through the portal in favour of registered recyclers and refurbishing certificates in the favour of registered refurbishers in the prescribed format.	(MoEFCC, 2022)

Legislation (Policies, Rules & Regulations)	Year	About	Reference
		Schedule III of the Rules, specifies E-waste recycling targets (weight) for the financial year 2022-23, 2023-24 and 202-25 onwards.	
Notification for draft E-Waste (Management and Handling) Rules	2022	Covers a wide range of EEE in six categories. Key stakeholders covered under the draft rules include manufacturers, producers, refurbishes, and recyclers. Leverage digital technology in the form of a centralized CPCB Online Portal for monitoring and tracking of e-waste movement through registered stakeholders. EPR for e-waste described with collection targets and EPR certificates to be traded like carbon credits. Penalty for violations described along with reimbursement system. Overall monitoring by Steering Committee described along with responsibilities of state governments and pollution control boards and urban local bodies.	MoEFCC, 2022

Circular Economy (CE) and E-waste: Benefits and Challenges

Electrical and Electronic Equipment (EEE) are intricate devices with components comprised of several precious metals and critical raw materials (CRM) – which are rare, difficult to extract, andvaluable. The rate of extraction of raw minerals is significantly higher than the rate of their formation in nature. In the past four decades, the metal requirement has increased by 87% (MeitY, 2021) estimations reveal that by 2050, the rate of consumption of resources would surpass the rate at which they are replenished by three folds and by 2060 the global consumption of materials would double.

Therefore, given the high rate of consumption of precious metals, moving towards circular economy (CE) and tapping into WEEE as a potential source of CRM as secondary raw material (SRM) is a necessary alternative to the current, highly extractive, and resource-intensive "Take-make-dispose" linear economy. CE aims at retaining the value of resources, products and materials by keeping them in use for as long as possible, simultaneously striving to minimize wastage at each life-cycle stage, and extracting the maximum value through reuse, repair, recover, remanufacture and regeneration of products and materials at the end of each service value.

The valuation of materials that could be recovered from e-waste generated in 2019 alone was calculated to approximately 57 billion USD by the Global E-Waste Monitor 2020 report (Forti, Balde, Kuehr, & Bel, 2020). With the current globally documented collection and recycling rate of 17.4%, raw materials worth 10 billion USD were recovered, preventing more than 15 MT of CO_2 equivalentemissions into the atmosphere and reinserting approximately 4 MT of raw material into the manufacturing line. The estimated value of various e-waste components, including CRM, are tabulated in Table 4 below:

Table 4: Prospective valuation of recoverable from e-waste in 2016

Material	Quantity (kilotons (kT))	Economic Valuation (Million €)
Iron	16,283	3,582
Copper	2,164	9,524
Aluminum	2,472	3,585
Silver	1.6	884
Gold	0.5	18,840
Palladium	0.2	3,369
Plastics	12,230	15,043

Source: (Arora, Hemkhaus, & Hinchliffe, 2020)

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remanufacture and regeneration of products and materials at the end of each service value. Moving towards CE for e-waste management provides opportunities ranging from economic aspects such as increasing profitability and enhancing resource security to various environmental aspects of mitigating degradation, abating loss of precious minerals along withreduced dumping of hazardous waste. The benefits have been discussed below:

Reducing environmental pressure and health effects:

The extraction of virgin raw material puts pressure on the limited resources available. From an industrial perspective, CE can enhance resource productivity, elongate product-life, and decrease dependency on virgin materials by recovering precious and critical materials from waste EEE. This will be done formally, in a safe manner thereby minimising occupational and health hazards associated with crude mining and recycling processes.

Improving resource efficiency through urban mining:

Curtailing the rate of supply of resources is a major constraint in the current production processes of EEE which results in the onset of chaotic economic conditions for e-waste. From the resource access and security perspective, moving towards CE tackles issues of material scarcity by recovering precious, critical, and other non-critical metals and supplying them as a 'secondary source of raw materials. E-waste acts like a concentrated ore with nearly 1.5 kg of recoverable gold available in one tonne ofmobile phone polychlorinated biphenyls (PCB). To put more perspective, one tonne of natural ore has an extractable reserve of a mere 1.4 grams of gold only (MeitY, 2021).

Increasing profits through enhancing recyclability and insulating from global shocks:

Urban mining from e-waste ensures business savings for producers allowing themto procure raw materials at far discounted rates, while establishing a secure and continuous supply chain. The FICCI Circular Economy Report justified the business possibility of commercial extraction of gold from e-waste with a scope of 0.7 to 1 billion USD (FICCI & Accenture, 2018).

Further, dependence on imports makes Indian manufacturing of EEE vulnerable to changes in global supply of raw materials and associated price instability. Urban mining can ensure a sustainable supply of raw materials at a pre-determined price range. For the Indian domestic electronic manufacturing sector to thrive, CE can help trap materials like copper, nickel, cobalt and others within the country, which is currently either imported despite having abundant reserves of iron ore and bauxite or exported in the form of waste PCB chips for high value metal extraction.

Although there are benefits to CE for e-waste management; its implementation can pose various challenges. As evident from the low e-waste recycling ratio of 17.4% in 2019, it is seen that there are shortfalls in the existent post-consumer e-waste management schemes (Forti,

Balde, Kuehr, & Bel, 2020). Challenges for proper implementation of CE in e-waste have been identified and discussed below:

Robust policy intervention in upstream management:

Most policies deal with downstream management of e-waste i.e. the EoL management of WEEE through collection, reuse, recycle and disposal, with little tono effective interventions in the upstream and midstream segment. Upstream measures for managing e-waste focus on improving the eco-design of products which include standardizing product design with emphasis on design-for-recycle. These challenges may be addressed by developing and further defining CE policies such as "3R" policy that strongly impose the concept of circularity amongst stakeholders, especially manufacturers for e-waste, mandating them to look at the full life cycle of the product from its inception stage. Additionally, lack of incentives for producers and manufacturers to shift from linear to circular methods is a key constraint in the upstream management of EEE.

Sustainable consumption and production (SCP) and green public procurement (GPP) in midstream management:

Midstream interventions in e-waste management like lean manufacturing and consumption can prevent large amounts of waste generation through sustainable production and consumption practices such as using products which have a longer life span, reusing refurbished products, extending product life span, using SRM in products that are non-hazardous. Current policies do not encourage sustainable consumption amongst bulk consumers. In addition to this there is a lack of large-scale green procurement marketplace to promote sustainable production andconsumption of EEE.

Enforcement in downstream management: Downstream management policies are crucial in the adoption and implementation ofCE. Current policies fail to enforce stringent monitoring and inventorization of e-wastegenerated, collected, treated, and disposed. This results in improper assumptions for the quantity of e-waste generated and leakages through the value chain. Unregulated leakages cause a shortage of e-waste reaching authorized recyclers who would extract and dispose EEE scientifically and avoid improper dumping. Inadequate authorization, monitoring, and enforcement results in the informal sector thriving, who process a major portion of unaccounted e-waste through unsafe techniques. The unregulated primitive methods used by the informal sector lead to low value recycling and cause irreversible environmental and health damages. Recently, regulators have started to inventorize e-waste generated. Such initiatives are needed for robust monitoring of tracking of e-waste.

Awareness and capacity building throughout the e-waste value chain:

Lack of awareness on proper e-waste management often reflects in the lax attitude of consumers who sell their WEEE to informal workers rather than returning it to a formal

setting. To overcome this, governments in coordination with the manufacturers and retailers should sensitize consumers and educate them, simultaneously setting up or upgrading the existing collection mechanisms. In addition to this, producers should provide the necessary skills to stakeholders including the informal recyclers. Through Key Person Interviews conducted as part of the study, it was determined recycling and dismantling operators are eager to upgrade their operations. The government has started various awareness generation programmes and a positive response is seen from MeitY's e-waste awareness program. This program had five major deliverables in the form of creation of content, organization of workshops, inventory study, mass awareness and e-learning content. Till date, this program has witnessed participation from close to 1.5 lakh people under awareness activities, and has also contributed towards developing manuals for bulk consumers, dealers, government, informal sector, manufacturers, refurbishers, RWAs along with school and college students (MeitY, 2022). Such programmes encourage the formation of many micro-industries which in turn would create enormous employment opportunities and enable social inclusion by creating safer work environments, especially for informal workers.

Role of Extended Producer Responsibility (EPR) for E-waste Management

The intensified volumes and complexity of waste generated at EoL stage exerts intolerable amount of stress on municipalities, governments, and taxpayers. Therefore, as we move towards circular economy (CE) for management of e-waste, it is important to have all stakeholders including the producers take shared responsibility. Implementation of a combination of environmental policies can be instituted to achieve CE in e-waste management. One of the strongest policies in doing so is the EPR which has become the established principle for implementing policies and waste management rules in many countries. EPR being one of the most essential and impactful tools for achieving CE in the domain of WEEE management, is given below and includes detailed challenges associated with EPR implementation and a possible framework for implementation.

EPR is a global environmental policy approach designed on Polluter-Pays Principle wherein the producer's responsibility of a manufactured product is extended to the post-consumer stage of the life cycle. There are two primary features of EPR policy – First, it shifts the physical and/or economical responsibility upstream to the producer, fully or partially away from the municipalities and taxpayers. In doing so, EPR shifts the responsibility of waste management from the government to the producers with the aim that they will internalize thecosts of the EoL management for their products. Second, it provides incentives to producers to incorporate environmental considerations while designing their products (OECD, 2001). This makes producers responsible for the environmental impacts of products throughout thevalue chain from product design, consumption, to EoL management.

Producers can fulfill their EPR obligation either by providing financial support and/or by taking over the operational and organizational obligationsof managing the post-consumer waste. When each producer independently assumes the liability of collecting and treating their own products or out-sources it to a third party, it is known as Individual Producer Responsibility (IPR). The advantage of IPR configuration is that it stays isolated therefore, the variations in the competitors' functioning fails to affect its own cost of e-waste management. On the other hand, owing to the lack of economies of scale and restricted market share, small scale producers find IPR unemployable. Thus, they commonly implement Collective Producer Responsibility (CPR), wherein several producers come together to take up the collection and recycling responsibilities. In view of the large economies of scale, collective schemes prove to be more cost-efficient. They are relatively easier to customize, administer and monitor for the producers as well as the regulators. CPRs typically embrace creation of a Producer Responsibility Organization (PRO) wherein the producers congregate forming a separate entity that enforces take-back and recycling for all producers' part of the PRO.

Financing of PRO collection systems for WEEE is mainly through a fixed-fee based model as opposed to a variable-fee model levied on packaging material. In a variable fee model, the

importers, producers or retailers pay a price with proportion to the product weight. A weight-based fee gives financial incentives to make products lighter or to opt for different material, however they do not stimulate other design for environment aspects such as the use of SRM. In a fixed fee model, a flat rate is applied for EoL management of products, which may be easier because with items such as mobile phones, the design and components are not standardized with various metals being used. Diversity in designs complicates implementation of variable fee. However, the fixed fee model is used for current waste management and is not applicable to waste generated in the future by products sold at present. This gives fewer incentives for design-for-environment (DSE) and for incorporating circularity in e-waste management (OECD , 2016). Finally, robust EPR schemes aim to make not only the material but also the financial flows transparent, allowing for a systematic, data-driven decision-making process. The producers may either directly or indirectly, through retailers and PROs developa financial model that is acceptable to the informal sector and engage with them during collection for WEEE. This may be through a fixed fee model or a variable fee model.

According to the OECD report, a few EPR models have been successfully adopted globally including:

- **Product Take-Back Mechanism:** Assigns responsibility for the EoL management of the products, where major retailers and producers partner with PROs for assistance.
- **Deposit-Refund System (DRS):** Payment is deposited while purchasing and is refunded whenthe product is returned to specified drop-off locations.
- **Advanced Disposal Fee (ADF):** Levied in advance during purchase based on estimated cost of collection and treatment. These fees can be used for financing post-consumer treatment and be transferred to municipalities or private waste management concessionaires.
- **Material Taxes:** Products that are difficult to recycle are taxed to promote the usage of less toxic materials. Furthermore, this EPR model also creates incentives for replacing materials which are difficult to recycle with recyclable materials in design phase.
- **Upstream Combination Tax/Subsidy (UPTS):** Tax paid by producers to subsidize waste management. Incentives such as tax reduction can be provided to producers for designing products for recyclability.

India too has implemented EPR, especially for managing plastic, packaging andewaste. In India, EPR is defined as '*policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturerof the product to various parts of the entire life cycle of the product, and especially the take-back, recycling and final disposal of the product*' (MoEFCC, 2020). The E-Waste Management Rules, 2011 introduced the EPR concept, however, the focus of EPR in India, is mainly on downstream collection of WEEE and not much on reuse, refurbishing, or formal recycling and recovery of materials.Also, implementation of upstream measures such as design for recycle (DFR) is not mandated inthe rules. As per the

rules, EPR implementation can be through various mechanisms such as establishing a PRO and/or DRS (CPCB, 2022) or e-waste exchange for collection and "buy-back" of products. Currently, there are 68 registered PROs for e-waste management and1765 EEE manufacturers have been granted EPR authorization in India (CPCB, 2022)

For EEE every producer is responsible for channeling e-waste to an accredited dismantler/recycler to ensure environmentally sound waste management. Allproducers of EEE covered by the E-Waste (Management) Rules, 2016 must acquire EPR authorization. This includes importers, e-retailers, on-line sellers, and others. A producer canimplement EPR through a take-back system, collection centres, or both to channel e- waste/end-of-life items to authorized dismantlers/recyclers. Producers must have agreements with authorized dismantlers and/or recyclers, either individually or collectively, through a PRO or an E-Waste Exchange system, as specified in their EPR Plan, which is approvedand authorized by the CPCB. Any producer that sells or places EEE on the market without first obtaining an EPR authorization is in violation of the rules (CPCB, 2016).

Producer Responsibility Organizations (PRO) and their role in waste management

The E-Waste (Management) Rules, 2016 defines PRO as, '*professional organization authorized orfinanced collectively or individually by producers, which can take the responsibility for collectionand channelization of e-waste generated from the 'end of-life' of their products to ensure environmentally sound management of such e-waste'* (MoEFCC , 2016).

PROs play a pivotal role in properly implementing EPR. PROs can help local level implementation of EPR where ULBs may lack expertise and help producers/ brand owners meet their EPR objectives andlegal requirements for the same. PROs must integrate and deal with a wide variety of stakeholders ranging from the government to brand owners, waste collectors and waste generators. Hence, they will help in the creation of a more transparent and robust system wherein accountabilities can be shared by various stakeholders. Since PRO is an individually run organization which will be seeking profits, they strive to make waste management a sustainable venture.

The PRO help producers achieve collection targets, make the process of collection and EoL management transparent, allowing for tracking of waste, and conduct awareness generation. In theIndian context, a typical PRO may provide the following services (Sinha, 2020)

1. Improve waste channelization and flow by developing methods for the collection of waste by integrating the informal sector.
2. Establish and operate waste collection centres and drop-off points and implement take back schemes.
3. Overseeing the waste value chain and traceability from waste collection from various points to waste storage and transportation.
4. Ensuring environmentally sound dismantling and recycling of e-waste.
5. Keeping inventory of waste handled and developing various compliance documentations.
6. Induce behavioral change via awareness programs at individual and bulk waste generators
7. Help producers with filing quarterly and annual returns.

Despite EPR being mandated in the E-Waste (Management) Rules, 2016 however, its implementation is not detailed. If properly executed, EPR can be highly beneficial for e-waste

management in incorporating circularity, resource efficiency through a shared responsibility structure. Benefits of adopting EPR for e-waste management can include:

1. **Awareness generation amongst stakeholders along the value chain** is a key benefit of EPR for E-waste management. Increased awareness generation will allow consumers to make responsible choices such as through SCP and GPP, dispose waste safely and further incentivize upstream packaging solutions. This can be achieved through eco-labelling and pamphlets on sustainable consumption and production. Furthermore, generating awareness amongst the consumers on self-repair of their products and providing them with the basic tools for the same can improve circularity through increased product life. Finally, increased awareness will enhance efficiency and transparency of the EPR collection and treatment system, while incentivizing eco-design upstream, and minimizing waste generation and landfill disposal.

2. Prevention of waste leakages from the value chain, reduction in inefficient recycling processes, and illegal disposal of e-waste**.** To adopt EPR in India, formal and informal sector may come together to manage e-waste and prevent leakages. A synergistic partnership will tap into the opportunities present in both the networks. The collection networks of informal sector are highly effective, but the processing techniques employed by them, and highly polluting leading to leakages and downcycling. On the other hand, formal operators can achieve higher processing efficiencies, but struggle to meet collection targets (Arora, Hemkhaus, & Hinchliffe, 2020)Integration of the informal sector (as part of EPR) not only provides social, financial security and safe working conditions for the workers but can also streamlines waste for higher value recycling through environmentally safe and efficient methods thereby creating a robust and sustainable e-waste management model.

3. Adopting EPR can give access to the EPR corpus fund raised collectively by manufacturers/producers. Funding for e-waste management such as setting up newer recycling institutions and technologies can come from this fund. This will allow for more raw materials to be extracted from e- waste, thereby improving circularity (Mahesh & Mukherjee, 2019). Funding could also be used to streamline waste materials from generators to recycling centres. Recovery of valuable materials, such as precious metals and reusable waste plastics, would ensure economic viability of the recycling business. Improved collection and recycling will ensure higher value materials available for operation, improvement of recovering yields by use of appropriate technology, and environmental safeguarding. Increasing automation in disassembly, repairing, and refurbishment processes will also allow for treating higher quantities of e-waste and yielding better quality materials. Use of EPR corpus fund for collection and high value recycling will strengthen the economic case for recycling and develop a robust, trustworthy second-hand marketplace for electronics. As for the societal benefits, improving technological interventions would ensure effective e-waste management in an acceptable, environment-friendly manner by minimising adverse health effects associated

with rudimentary recycling, decrease e-waste going to landfill and release negligible emissions to air, land, and water (Chatterjee, 2020).Proper implementation of EPR will allow for e-waste inventorization. The current estimations on the volume of e-waste flowing into the informal sector and the population engaged in e-waste management (directly or indirectly), is based on weak, inadequate, and inconsistent data. This inhibits the development of sound policies and legal frameworks, resulting in ineffective implementation mechanisms. All SPCBs are required to develop inventories of the generated e-waste in their concerned jurisdiction. However, with the current on-going practices in the domain of e-waste management, it is particularly troublesome to maintain the flow, let alone formulate an inventory. Hence, channelization of waste for data inventory can be effectively undertaken with the intervention of PROs working under EPR. Properly channelized e-waste makes it easier to monitor and report the generated waste data against what is collected, treated, and disposed. Inadequacy of data has been a grave concern in managing e-waste in India (Sinha, 2020).

4. Proper implementation of EPR will allow for e-waste inventorization. The current estimations on the volume of e-waste flowing into the informal sector and the population engaged in e-waste management (directly or indirectly), is based on weak, inadequate, and inconsistent data. This inhibits the development of sound policies and legal frameworks, resulting in ineffective implementation mechanisms. All SPCBs are required to develop inventories of the generated e-waste in their concerned jurisdiction. However, with the current on-going practices in the domain of e-waste management, it is particularly troublesome to maintain the flow, let alone formulate an inventory. Hence, channelization of waste for data inventory can be effectively undertaken with the intervention of PROs working under EPR. Properly channelized e-waste makes it easier to monitor and report the generated waste data against what is collected, treated, and disposed. Inadequacy of data has been a grave concern in managing e-waste in India (Sinha, 2020).Recently some cities like Delhi have started the inventorization process facilitated by the Delhi Pollution Control Committee. Such best practices should be scaled to a pan India level. Effective EPR framework will focus on the full life cycle of the product with the goal of waste minimization. This includes incorporating eco-design standards with the primary aim at facilitating recycling and reuse of materials at EoL (Torres, et al., 2016) .Upstream measures such as guidelines on eco-design and raw material extraction, including SRM usage encourage manufacturers to streamline their approach in selecting the manufacturing processes and designing their equipment to promote recyclability. Additional design strategies like designing for adaptability and reparability which include ease of disassembly, repair, refurbishment, and upgradation of existing consumer electronics like phones and laptops can be effectively adopted with thehelp of proper EPR.

5. Recently some cities like Delhi have started the inventorization process facilitated by the Delhi Pollution Control Committee. Such best practices should be scaled to a pan India level. Effective EPR framework will focus on the full life cycle of the product with the goal

of waste minimization. This includes incorporating eco-design standards with the primary aim at facilitating recycling and reuse of materials at EoL (Torres, et al., 2016). Upstream measures such as guidelines on eco-design and raw material extraction, including SRM usage encourage manufacturers to streamline their approach in selecting the manufacturing processes and designing their equipment to promote recyclability. Additional design strategies like designing for adaptability and reparability which include ease of disassembly, repair, refurbishment, and upgradation of existing consumer electronics like phones and laptops can be effectively adopted with the help of proper EPR.

Policy instruments for implementation of EPR for e-waste across the value chain

Globally, EPR has been widely welcomed for managing e-waste. One study state that EPRis highly utilized in managing EEE, with the most common global policy being take-back mechanism, which constitutes nearly 70% of all the EPR policieswhich have been successful (OECD, 2013). According to another study, globally EPR has facilitated better recycling rates for e-waste which has led to higher product recovery rates (Deloitte, 2014).

EPR is a performance-based regulation in which specific outcomes and objectives are defined including the roles and responsibilities of stakeholders involved. However, the way EPR is practiced or implemented for achieving specific the specific outcomes and objectives is not always bound by legislation and usually depends on the stakeholders. Overall, EPR schemes are more than just a fundingmechanism for collection and treatment of WEEE with an aim to impose accountability on theproduct's full life cycle, starting from the product design to bring about better, cleaner production. Objectives as part of EPR can be achieved through various policy measures in the upstream, midstream, and downstream stages of the value chain as described below.

Upstream measures for managing e-waste include better eco-design of products with emphasis on design-for-recycle. Harmonizing environmentally sensitive designs in the upstream stage such as through standardized product development will ensure sufficient volumes are collected for standardized recycling measures downstream. Producers in the upstream stage can instill innovation to use less virgin material in products and procure recycled materials or SRM instead, especially for the plastic component of EEE. Policy measures such as mandating minimum recycled content standards, use of SRM and ban on use of hazardous substances will ensure eco design of products. Upstream measures are not limited to products and sustainable sourcing of raw materials but are also extended to sustainable packaging solutions for increasing downstream recycling.

Midstream measures include creating demand for sustainable products. This can be achieved through a combination of policy, economic, and social instruments. Awareness generation on sustainable consumption is key to creating demand forthe same. This may be achieved through mandatory product labelling, brochures on instructions for safe use and disposal of materials, and environmental information labelling. Economic instruments such as green public

procurement (GPP) to further create a market for sustainable products (such as use of lesser hazardous materials, energy efficient, design-for recycle) which can be implemented as best practices to be scaled and replicated.

Downstream measures for EoL management of WEEE are to be strengthened by ensuring management within formal channels, without leakages into the informal systems. Policy instruments for the same include standardized recycling procedures to ensure recycling in bulk. Economic instruments including ADF and DRS must be instituted to prevent leakage and ensure "take back" of WEEE through formal channels. Further social instruments including training and capacity building for urban local bodies and waste pickers on standardized dismantling and recycling and further integration into formal channels must be incorporated.

There are various policy, economic and social instruments which can be used to encourage producers to accept greater responsibility and effectively implement EPR. The tools that can be used are summarized in Table 6 below:

Table 6: Policy, economic, and social instruments for implementation of EPR for WEEE

Policy	Economics	Social
1. Minimum collection targets mandating take-back 2. Minimum recycled content standards 3. Use of secondary materials 4. Ban on use of hazardous substances – Restrictions on use of heavy metals like lead 5. Restrictions on unscientific disposal of certain materials	1. Advance Disposal Fee (ADF) 2. Material taxes and removal of subsidy (Tax on virgin materials; Tax rebate for use of recycled components) 3. Deposit Refund Scheme (DRS) 4. Green Procurement 5. Landfill tax	1. Product labelling 2. Brochure on instructions on safe use and disposal of materials 3. Environmental information labelling 4. Training of waste pickers, the informal sector, and integration

Source: TERI analysis based on literature review

Figure 2 below describes the workings of e-waste flows and implementation of EPR in India through various policy measures. The solid lines indicate the formal flows of WEEE and dashed lines indicate flows by the informal and semiformal sector. The producers, manufacturers, importers of electronics can supply their products either directly or through retailers and via formal channels implement take backs and buy backs or implement DRS or ADFs. Here producers also play a key role in awareness generation amongst consumers on proper use and disposal of products for which they may use a combination of social instruments through labelling, brochures etc. The producers are responsible (either independently or through PROs) to set up collection centres for WEEE or have e-waste exchange platforms for proper collection mechanisms. From here, WEEE should be sent to CPCB authorized dismantling and recycling centres (but is mostly taken up by the informal

and semi-formal sector, undertaking crude dismantling and recycling methods that lead to environmental pollution. The raw materials extracted during this process are sold in the informal material exchange market like Seelampur in Delhi). The WEEE flow is to be regulated and monitored by the CPCB and SPCB. The PROs are to be registered by the CPCB and their workings such as annual waste exchange, authorized collection and dismantling/recycling are to be closely monitored by the SPCBs.

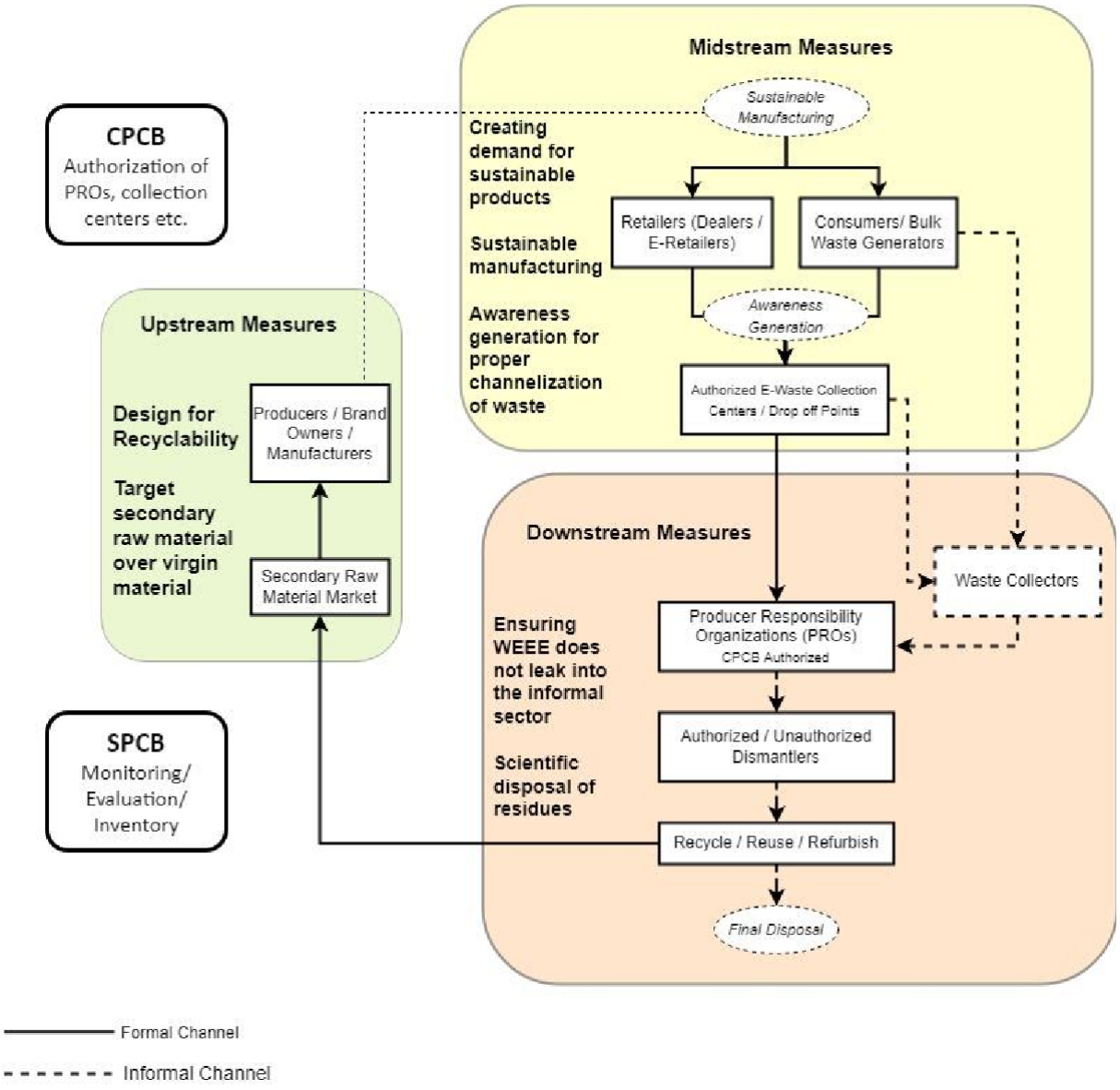

Figure 2: Mechanism of EPR implementation in India through various policy measures [Source: TERI Analysis]

Challenges in Implementation of EPR for E-Waste

In theory, EPR manifests itself as a solution that can tackle the escalating nuisance of e-waste on its own and facilitate circularity however in reality the actual implementation of EPR face many challenges, and few of the key ones have been discussed in this section.

Global Scenario

The most common yet the most crucial challenge to immaculate enforcement of EPR is the lack of information. At present, this sector in general remains a black box lacking transparency, accountability and legitimacy. Though this opacity is unintentional, however, for the smooth operation of the EPR initiatives, transparency is a must and can be solely achieved through creating open lines of communication between the participating stakeholders that deal with upstream, midstream and downstream EEE.

Several issues that threaten the good functioning of EPR are lack of enforcement mechanisms, which require permanent monitoring and control by public authorities. These issues include free-riding, competition concerns, illegal landfilling, exports of waste and usedproducts, lack of transparency on costs and of traceability for certain products (OECD, 2014). In cases where the governing bodies lack the requisite enforcement and means necessary to guarantee compliance, approaches like revoking licenses could be used as a tool.

Since the scope of EPR goes beyond the EoL and it addresses various aspects over the entire value chain of a product, they may also have broader impacts on national as well as international markets. EPR being a multi-stakeholder venture with private entities holding its ownership makes the system potentially vulnerable to trade and competition. The dispute over the allocation of costs between the producer, municipalities and the partners of PROs proves to be a resistance in the establishment and working of the EPR schemes.

Despite the enormous volumes of e-waste generated, the EPR schemes fail to capture a huge portion of devices reaching the EoL stage. This leakage of post-consumer equipment occurs through both legal and illegal channels. Refurbished or repaired equipment or even second-hand products have a huge market in developing and under-developed countries and thus, these goods with embedded valuable recoverable materials find a way out of the country legally. Illegal leakage occurs due to the activities of informal recyclers or through illegal export of waste to the third world countries. Unauthorised facilities and informal recyclers do not comply with any norms, and they employ rudimentary and unsafe waste management systems with sub-standard technologies which make them more profitable but rendering severe environmental problems.

The global context has significantly evolved since the development of the first EPR policy and thus new and unusual challenges are emerging. Since the establishment of online markets, there has been an exponential rise in internet sales worldwide. These products sold online frequently ride free of EPR systems owing to their intractability. This puts national producers

who are contributing to EPR schemes at a competitive disadvantage.

Indian Perspective

Most of the concerns identified on a global scale are faced, at least to some extent, at country level in India as well. The biggest challenge that EPR systems targeting e-waste in India face is inadequate information about the quantum as well as the flows of the post-consumer equipment. Unclear and diverse tracking and reporting modalities along with varied calculation methods do not present a clear picture of the current scenario and associated waste flow estimates, which is needed to effectively plan and implement EPR.

Only 21 categories of e-waste devices or components have been identified in India as opposed to 54 categories in the developed nations around the world. This also presents a challenge in calculating estimates and shows the lack of awareness in fully capturing the e-waste issue. Awareness among the citizens is also missing which can be blamed both on the municipalities as well as the producers who fail to educate the users of responsible EoL disposal methods and do not communicate effectively about the collection systems.

Lack of necessary administrative and institutional capacity required to adequately deal with waste and to ensure evolvement and enforcement of EPR policies support the growth of EPR system in Indian cities. Scarcity of technology and non-availability of indigenous e-waste processing centres – leaving very limited power with recyclers makes it difficult for responsible PRO to ensure realrecycling.

Unsatisfactory regulatory design and enforcement mechanisms create unclear and overlapping roles and responsibilities, deficiency of quality data across all the stakeholders and different understanding of recycling. This also allows the producers to transfer the liability to the customers or other partners from the PROs. Additionally, the lack of influence and control over all the material value chain entities tolerates emergence and build-up of problems in the collection and processing of e-waste equipment, which leaks into informal channels. Such a grievous scenario is an outcome of the legislation which has no stringent penalties for producers and can act as a deterrent for not adhering to the regulations (The Hindu, 2014).

The formal players face stiff competition from the informal sector as the former bears tremendous costs in terms of collection, recycling technology, pollution control and safety which the latter completely neglects. Such leakages of valuable material into the informal sector are not held accountable by authorities and are demotivating for the maturation of EPR systems in India.

Global Practice on EPR for E-Waste

EPR is becoming more widely recognized across the world as an effective waste management strategy that helps in recycling and reducing landfilling of products and materials. The fundamental aspect of EPR is that manufacturers accept responsibility for managing the waste created by the items they sell. EPR programs and policies are now in place in many developed countries and many emerging economies as well. In several emerging nations of Asia, Africa, and South America, such programs are in the inception stages. Nonetheless, the specific features and outcomes of these measures vary significantly across regions, countries and industries (OECD, 2014).

At the European Union (EU) level, all Member States have implemented EPR schemes on the four waste streams for which EU Directives recommend the use of EPR policies (packaging, batteries, End-of-Life Vehicles (ELVs) and Electrical and Electronic Equipment (EEE)). Under various EU Directives and their Member States' national implementing laws, the consumers can return any e-waste, packaging, or batteries to a municipal collection point or to a retail outlet free of charge. Producers are then responsible for financing collection, recycling, and recovery from collection points onward. Producers do not necessarily have to organize the collection and recycling directly; they are responsible for paying costs. EU EPR directives set minimum requirements for all Member States but allow flexibility for national regulations to go further. As a consequence, national EPR legislation and enforcement can differ substantially between Member States.

EPR programs in North America encompass a wide range of goods and are generally planned and implemented at the sub-national level, by states and provinces. Although the United States of America lacks national law on e-waste management, 25 states and the District of Columbia have adopted legislation (Forti, Balde, Kuehr, & Bel, 2020). The extent and impact ofstate regulations varies, as does the prohibition on consumers from disposing of electronics in landfills. Between 1991 and 2011, the US enacted more than 70 EPR laws generally requiring manufacturers to implement EPR programmes, but without specifying recycling targets. In parallel, producers themselves have implemented voluntary and stewardship programmes for the collection and recycling of their products. In Canada, the 2009 Canada- wide action plan for EPR emphasizes on a harmonised, outcome-driven model that has resulted in developing systems where producers discharge their responsibilities collectively with oversight by provincial governments.

In Latin America only a few countries have managed to establish e-waste laws. Apart from Mexico, Costa Rica, Colombia, and Peru, only Brazil and Chile are establishing the bases from which to start with the implementation of a formal regulatory framework for e-waste. Chile's "Framework Law on Waste Management, Extended Producer Responsibility, and Promotion of Recycling" 2016, is working on the specific e-waste regulation, which will include collection and recycling targets and set the guidelines for the implementation of formal collection systems (OECD, 2014).

The South Asian region on the other hand has begun to recognise the importance of proper e-waste management. China has national legislation in force that regulates the collection and treatment of fourteen types of e-waste (i.e., five types, initially, and nine more were later added). The regulated fourteen types of e-waste are: televisions, refrigerators, washing machines, air conditioners, personal computers, range hoods, electric water-heaters, gas water heaters, fax machines, mobile phones, single-machine telephones, printers, copiers, and monitors. Other countries in East Asia, such as Japan and the Republic of Korea, have advanced e-waste regulation. In Japan, most EEE products are collected and recycled under the 'Act on Recycling of Specified Kinds of Home Appliances' and the 'Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment'. Japan was one of the first countries globally to implement an EPR-based system for e-waste (Forti, Balde, Kuehr, & Bel, 2020).

In Africa, EPR and waste management strategies in general are still in their infancy. Informal recyclers serve a vital role in several nations, particularly for valuable waste fractions. Few nations, like South Africa, Morocco, Egypt, Namibia, and Rwanda, have some e-waste recycling facilities in place, although they coexist with the presence of a substantial informal industry. 'Technical Guidelines on Environmentally Sound E-Waste Management for Collectors, Collection Centers, Transporters, Treatment Facilities, and Final Disposal' have been established and are now being implemented in Ghana. In Nigeria, the EPR initiative began with the creation of the 'E-waste Producer Responsibility Organisation of Nigeria' (EPRON), a non-profit organization founded by Nigerian electrical and electronic manufacturers. EPRON is Nigeria's first Producer Responsibility Organization (PRO) for electronic trash, having been established in March 2018 with contributions from HP, Dell, Phillips, Microsoft, and Deloitte. In South Africa, comprehensive waste management legislation was enacted in 2009, giving the environment minister the authority to enforce EPR measures on a product-by-product basis. Despite the fact that EPR projects in South Africa have mainly been initiated by industry, the government has enacted regulations to ensure enforcement of some of these initiatives, for example an industry-led tyres recycling initiative (OECD , 2016).

E-waste management in Switzerland:

Switzerland generated 201 kT of e-waste in 2019, out of which the e-waste documented to be collected and recycled was 123 kt. In Switzerland the e-waste management is undertaken by EPR where the financing of collection, utilisation and disposal is carried out by charging advanced contributions from customers when buying EEE, called as advanced recycling fee (ARF). The fee is included in the purchase price. Producers/importers can join a producer responsibility organisation (PRO) that collects and manages the charges, but it is also possible to have an individual take-back system. PRO takes on the collection, take-back logistics and reporting obligations for member companies and reports volumes put-on-market based on which fees are calculated. It fixes treatment standards for recyclers and awards contracts to recyclers in a competitive process. Treatment providers/ recyclers are paid based on an index-system which ensures fairness and stability of the system. In terms of collection, retailer and municipal collection points offer free drop-off and take-back. PROs have additional collection points as well (e.g. at train stations). Commercial consumers can request for paid pick-up. Manufacturer and importers pay for collection, treatment, recovery and environmentally sound disposal of WEEE at the point the product is put-on market.
Source: (Khetriwal & Jain, 2021)

E-Waste Management in Singapore:

Every year, Singapore creates more than 60,000 tonnes of electrical and electronic trash (e-waste), and the pace of e-waste creation is projected to rise in parallel with economic growth and the popularity of electrical and electronic equipment (EEE) among consumers and companies. In light of the foregoing, the National Environment Agency (NEA) established a regulated e-waste management system to ensure appropriate e-waste collection and disposal. The regulated e-waste management system is based on EPR concept, in which manufacturers are responsible for collecting and disposing of their goods when they reach the end of their life. The Resource Sustainability Act (RSA), which is managed by the NEA, is used to execute this EPR system. Furthermore, ALBA E-waste Smart Recycling Pte Ltd has been designated as the Producer Responsibility Scheme (PRS) Operator for a five-year period, from 1 July 2021 to 30 June 2026, to collect regulated consumer electrical and electronic waste across Singapore on pro-bono purposes. The product scope in e-waste management includes Solar photovoltaic panels; Information and Communications Technology (ICT) equipment; Large appliances; Batteries; and Lamps. Regulated consumer products are collected by the PRS Operator. Licensed waste collectors and licensed e-waste recyclers are responsible for the disposal of e-waste. Regulated consumer products are collected by the PRS operators and regulated non-consumer products are collected by the producers of these items at no extra fee. Retailers of regulated consumer products are to provide 1-for-1 takeback of products or provide in-store collection of e-waste. In terms of monitoring, annual reporting to NEA is done by producers on parameters like quantity and types of e-waste collected, recycled and disposed.
Source:(NEA, 2022)

E-Waste Management in Canada:

In Canada, the provincial governments are responsible for developing, monitoring and administering regulations for the treatment of WEEE. These governments set performance targets for the designated materials, review and approve industry stewardship plans, monitor and oversee the programs' operations, and provide the compliance and enforcement measures. The regulations require manufacturers of covered electronic devices to participate in approved electronic product stewardship programs. The programs allow consumers and businesses to drop off eligible electronic devices for recycling, free of charge, at numerous depots throughout the Province. In 2009, the Canadian Council of Ministers of the Environment (CCME) – an intergovernmental forum, officially recognized EPR and provided support by preparing the Canada-wide Action Plan (CAP) for Extended Producer Responsibility (EPR) listing the post-consumer products for management. The goal of the CAP is to increase the waste diversion and recycling of waste through harmonization of provincial EPR Programs. Phase 1 of the CAP focusses on the implementation of EPR programs for electrical and electronic products since 2015. Electronic producers comply with the provincial EPR obligations by joining a producer responsibility organisation. The Canada-wide Electronic Products Recycling Association (EPRA) is the PRO responsible for representing obligated stewards selling electronic products covered by EPR regulations in a given province. On behalf of obligated stewards, EPRA is responsible for developing, implementing, promoting, financing, and operating province-wide programs for the safe and effective management of WEEE.
Source: (OECD , 2016)

E-waste Management in Japan:

Japan has a population of 126 million and per capita e-waste generation is 20.4 kg. It has one of the most advanced e-waste legislations in Asia. Japan was one of the first countries globally to implement the EPR-based system for e-waste. Most e-waste is collected and recycled under the Act on Recycling of specified kinds of home appliances (2001) and the Act of Promotion of Recycling of Small EEE (2013). The laws for specified kinds of home appliances promote environmentally sound management of e-waste and efficient use of recyclable sources. It covers air conditioners, refrigerators and freezers, all kinds of televisions, washing machines and clothes dryers. The Act on Promotion of Recycling of Small EEE extends the coverage of home appliances recycling law to other electronics as well. In terms of collection, manufacturers can contract with other organisations such as the Association for Electric Home Appliances (AEHA), to provide collection services on their behalf. In rural areas, collection is provided by local government or the AEHA if the retailer cannot cover. Consumers are responsible for delivering end-of-life products to the nearest collection point, retailers are responsible for proper channelization and manufacturers are encouraged to use recycled materials in their products. Consumer pays for the collection, transport, and recycling of targeted products. Manufacturers are obligated to finance the recycling of their own products. In terms of monitoring mechanism they have manifest system where special receipt is provided to end users from retailers helping them trace how the collected products are treated.
Source: (OECD , 2016)

Key Stakeholders for Enabling an Effective and Comprehensive Framework of EPR for E-Waste

E-waste management in India is multi stakeholder engagement process including producers, bulk consumers, waste collectors, dismantlers, recyclers, regulatory agencies and pollution control boards. The key stakeholders involved across different stages of e-waste value chain are e-waste producers, consumers, and waste managers. They are supported by stakeholders such as industry associations, waste management companies, transporters, and importers/exporters. The common stakeholders across the value chain of e-waste include: civil society organizations (CSOs), and regional, national, and international governmental and non- governmental institutions. The government has stakeholders across the central, state, and municipal levels, thus including the Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Electronics and Information Technology (MeitY) and CPCB as part of primary national-level stakeholders; SPCBs, State Health, Urban & Environment Departments as part of primary state-level stakeholders; and ULBs, Municipal Corporations and Nagar Parishads as part of primary city-level stakeholders. Among these different stakeholders: households, government offices, public and private sector establishments, educational institutes, business and corporate offices are chiefly responsible for the generation of e-waste. They generate e-waste and pass it to the waste taskforce comprising of waste pickers, scrap dealers, whole sellers, recyclers, dismantlers for waste management purposes. In the informal sector, the stakeholders responsible for managing e-waste primarily carry out operations such as collection, segregation, dissembling and dismantling.

The figure below includes the key stakeholders:

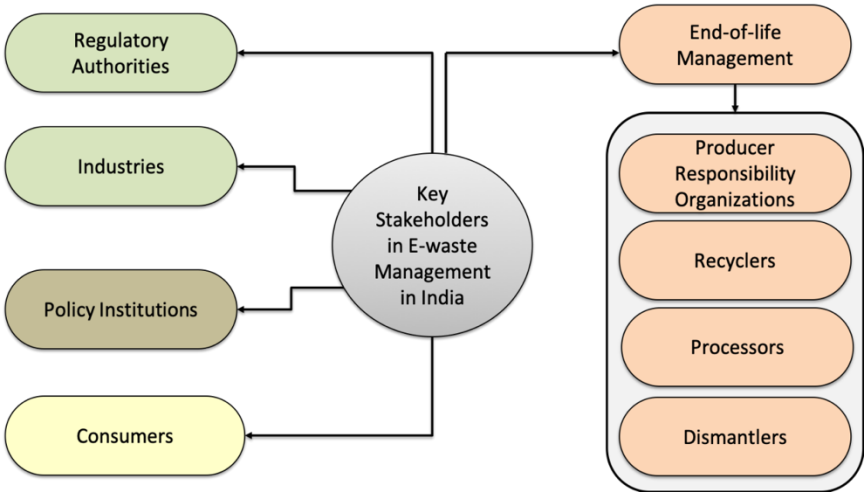

Figure 3: Key Stakeholders in E-waste Management in India

- Regulatory Authorities: MoEFCC, MeitY, CPCB; SPCBs/PCCs; ULBs; Port authorities
- Industries: EEE Manufactures, Brand Owners, Producers, Retailers
- Policy Institutions: NGOs, CSOs, Think Tanks, research organizations
- Consumers: Individuals, households; Bulk consumers
- End-of-life Management: Producer Responsibility Organizations (PROs), waste collectors, informal sector and aggregators, Recyclers/ dismantlers, E-Waste Processors

Stakeholders Mapping

The stakeholders are mapped based on the waste management delivery chain present at the country level starting from source waste collection to disposal of waste. The mapped stakeholders, along with their roles and responsibilities, are listed in Table 7 below. In line with stakeholder discussions conducted and a review of secondary literature, Table 7 maps out the concerns and challenges experienced by various stakeholders, as well as offers potential solutions and possibilities to enable the effective implementation of EPR. Concerns and challenges faced by various stakeholders are categorized into major aspects such as regulatory, financial, administrative, infrastructure, education, and awareness, skills and capacity.

Table 7: Role of key stakeholders for e-waste management in India

Stakeholder Category	Role & Responsibility	Challenge Category	Description of Challenges faced	Potential Solutions / Opportunities
Government: Ministries and Regulatory Authorities	Provide policy framework at national and state levels including regulations, market-based instruments, information and voluntary tools; Facilitate capacity building activities; Monitor and ensure compliance	Regulatory	Unavailability of sound, legislation enforcing eco-designs; coherent state-wise EPR implementation of rules; No role of state pollution control board in framing rules for e-waste; Ineffective implementation of existing regulations and legislation; Lack of state-wise monitoring and incomplete enforcement chain within states.	- Stringent monitoring and enforcement of the provisions of the E-Waste (Management) Rules to meet EPR targets and independent information on where the collected waste is recycled. - For monitoring, action needs logical conclusion and enforcement within the state. This is not done as the non-compliance is reported to CPCB instead of designated SPCBs. - State boards should be brought in confidence before CPCB on issues of EPR authorization. Currently, State Board is empowered to give authorization only to

Stakeholder Category	Role & Responsibility	Challenge Category	Description of Challenges faced	Potential Solutions / Opportunities
				dismantlers, refurbishers and recyclers. While issuing any EPR authorization – the location of the collection centre should be verified; - Incentive mechanisms for consumers / households to be taken into consideration while framing or amending rules. Incentivize households for collection of e-waste back such as in New DMC and other municipalities in Delhi. - Inventory to be established for products rather than raw material inventory.
Local government	Provide city level e-waste roadmap; Create byelaws; Implement waste management activities; Engage with private players supporting waste management activities.	Administrative/ Financial	Lack of on-ground compliance and implementation of waste management activities	- Dedicated collection depots or formal recycling centres where consumers can voluntarily drop-off the e-waste. - Create e-waste inventory. - Determine price range for e-waste raw materials through integration of the informal waste traders and recyclers.
Producers/ Manufacturers/Brand Owners/ Retailers	Organize, finance and operate e-waste take back system, either individually or collectively, through PROs.	Infrastructure/ Financial/Awareness	Lack of proper infrastructure to operate e-waste take back system; Major producers, manufacturers who introduce electronic goods in the market are in more than one state and	- Create verification mechanisms of e-waste flow systems that are proposed by producers in their EPR plans (Biswas & Singh, 2020).

Stakeholder Category	Role & Responsibility	Challenge Category	Description of Challenges faced	Potential Solutions / Opportunities
			lack knowledge on how to implement EPR in different states.	
Producer Responsibility Organisations (PROs)	Operate e-waste take-back systems on behalf of producers and ensure collected e-waste is transported to appropriate treatment centres and is properly treated.	Regulatory Infrastructure/ Awareness/	Lack of regulatory compliance on transparency; providing limited public information on economic data and on the costs faced by producers, recyclers and municipalities.	- Determine the appropriate level of public information to be required from PROs and producers to have compliance on ground (OECD, 2014).
Waste collectors & Aggregators	Ensure proper streamlined waste collection and safe storage of collected waste.	Infrastructure/ Awareness/ Skill and capacity	Mostly done by informal sector; Collection centres not in compliance with CPCB guidelines; lack of skill up gradation inhibits their participation in dismantling and recycling processes.	- Formalisation of the existing informal sector with the formal sector following environmentally friendly and scientific methods of managing e-waste.
Consumers including bulk consumers	Ensure to return the used electronic products to the collection centres or to the retailer.	Education/ Awareness//Capacity/ Infrastructure	Unwillingness of consumers and enterprises to hand out their obsolete EEE or pay for WEEE recycling; lack of awareness among the consumers regarding the nature of e-waste and the associated regulations and a narrow focus on compliance on the part of the producers.	- Consumers to ensure that they do not throw e-waste in the municipal bin but hand it over (in a properly packed form) through takeback system / Collection and channelization system of producer or to a collection centre of an authorised recycler who is part of producer channelization system.

Stakeholder Category	Role & Responsibility	Challenge Category	Description of Challenges faced	Potential Solutions / Opportunities
E-Waste Processors	Responsible for material recovery, recycling, disposal of waste	Infrastructure Education/ Awareness/ Skills and Capacity.	Limited processing capacities; focused more on metal recovery and less on the glass, plastics, and ceramics that comprise a significant proportion of e-waste	- The processing should be carried out in an environmentally safe manner to protect the health of the workers and of the environment overall.
Recyclers and Dismantlers	Carry out pre-processing and material recycling.	Infrastructure/Awareness / Skills and Capacity.	Absence of appropriate infrastructure for dismantling and high value recycling facilities; rudimentary recycling techniques are detrimental to the environment and health of the workers	- The unloading of EoL product should be carried out in such a way that there should not be any damage to health, environment and to the product itself; Ensure monitoring of health and environmental conditions of informal e-waste centres; and integration of informal sector with the formal.
Non-Governmental Organization / Civil Society Organizations	Influence all parts of the e-waste value chain (i.e. production, consumption, and EoL) through different measures like research and development; capacity building; raise awareness and initiatives on local issues; support policy making and compliance at national, state, and at local levels	Financial/ Infrastructure	Lack of data to determine e-waste flows and support policy making; lack of financial capacity and infrastructure to support nation-wide awareness generation and skill development activities.	- Establishment of e-waste collection, exchange and recycling centres should be encouraged in partnership with governments, NGOs and manufacturers.

Source: TERI Analysis based on stakeholder discussions and secondary literature review done as part of the project

Key Recommendations: Shared Responsibility Framework for Effective Implementation of EPR

Shared responsibility among key stakeholders along the value chain is needed for effectively developing and implementing EPR policy for e-waste management that considers the environmental and social costs, follows the waste hierarchy, and incorporates the principles of circularity. Stakeholder engagements allow for development of an overall communication strategy to keep policy makers, regulators, producers, retailers, consumers, dismantlers, recyclers, and other stakeholders informed, understand gaps in the current scenario, determine roles and responsibilities of stakeholders involved, and have theirbuy-in for effective implementation.

The EPR policy developed should be in line with related national, regional, and international policies and framework related to waste management. In 2019, The National Resource Efficiency Policy (NREP) outlined the electrical and electronic equipment sector as a priority sector with the need to develop EPR and strengthen its compliance to enhance access to secondary materials by way of collection targets and gradual implementation of penalty for non-compliance. Internationally, the Basel Convention aims at managing the issue of trade and illegal movement of e-waste. The EPR policy should be in line with these related policies which may be achieved through stakeholder consultations with key experts and policy makers. More recently, the Indian finance minister Ms. Nirmala Sitaraman outlined in her Budget Speech for 2022, the need to transition towards circular economy in order to enhance productivity while creating jobs and businesses for the same. She mentioned that action plans, including one for e-waste, are ready and that "*the focus now will be on addressing important cross cutting issues of infrastructure, reverse logistics, technology upgradation and integration with informal sector, which will be supported by public policies and regulations, extended producers' responsibilities framework and innovation facilitation* (GoI, 2022)." Therefore, a shared responsibility EPR framework will advance the circular economy (CE) agenda in WEEE and include upstream measures such asdesign for recycle and banning hazardous components in product design. For downstream management, it is required to have minimum collection targets, recycled content, and recovery targets which may be achieved with the help of integrated informal sector. A life- cycle approach in designing the EPR policy should ensure environmental costs are minimized and not transferred to another phase of product life or added to other waste streams. It is important to note that EPR is a national policy; however, e-waste generation andcollection are local issues. Translation of EPR policy objectives and associated collection targets to local level implementation is necessary. This may be achieved through shared responsibility whereby the policy makers at national level interact with local governments and with implementing agencies including recyclers to understand their needs and gaps in the current scenario. Regular interactions between key stakeholders will allow for development of EPR policy that is embedded in the local context with local adaptation such as integration of the informal sector, development of collection infrastructure at city level,

associated recycling facilities and/or creation of treatment clusters, and a robust secondary raw materials market.

To begin with, the EPR policy should ***define the scope of materials*** that are to be covered comprehensively. Currently in India, there are only 21 components under the 2 categories of Information Technology and Telecommunication Equipment [16] and Consumer Electrical and Electronics [5]. Interaction with sector experts, as part of the project, suggests that the current scope of defined materials is not comprehensive and should be revised to include more components as part of EEE – globally 54 items are included under WEEE, whereas 21 products are listed within e-waste framework by the Indian legislation. The Indian legislations misses prominent EEE such as dishwashers, microwaves, GPS monitoring devices, internet routers, etc. which need to be included. In addition to that, plastic materials that make up a major component of EEE products are not covered under EPR for e-waste. EPR should mandate collection of plastics under the E-Waste Management rules. Unlike general plastic products, the plastics used in EEE products have flame retardants and therefore need segregated collection.

Define the objectives, scope of activities, along with time-bound targets on collection of e-waste. This is necessary to direct stakeholders towards funding for certain activities and outcomes which are to be delivered. Currently, the objective and scope of activities focus on achieving collection targets for e-waste. Interviews with key experts, as part of the project, suggest that the objective and scope should be expanded to include recycling and recovery targets. This can enable development of high value recycling and matured material recovery. There are also no standards or certifications for reuse and refurbished products, which is an important objective for development of secondary raw material market.

Roles and responsibilities of stakeholders involved in terms of financial and operational responsibilities include manufacturers, producers, dealers/retailers, refurbishers, consumers/ bulk consumers, PROs, municipalities, dismantlers, recyclers, the informal sector, and reporting and monitoring bodies such as the CPCB, SPCBs and ULBs. Here, it is important to define ***who owns waste materials*** and is responsible for the materials during different steps of the EoL management process.

Implementation of EPR as given in the E-Waste Rules maybe through PRO and/or Deposit-Refund System (DRS) to enhance collection. Such collection mechanisms increase collection rates and channelize e-waste in a streamline manner. However, PROs are currently facing infrastructure related challenges for safely disposing the waste products. This is mainly due to the fact that despite having nearly 300 formal e-waste recyclers authorized by CPCB in the country, WEEE is still found leaking into the informal sector, making accountability and traceability of e-waste a challenge for all relevant stakeholders.

Producers, with the help of municipalities, can set up collection centres in compliance with government regulations and have ***centralized recycling and recovery mechanism*** through eco-***parks*** or ***micro-factories*** in India that transform e-waste into reusable material. This maybe

through different business models based on public-private partnerships.

Lack of concentrated volume of WEEE is a deterrent to implementing high-cost recycling technologies. ***Eco-parks*** will counter this by ensuring that the required volume of WEEE is consolidated, which is currently scattered in informal settings, for the application of better technologies. Informal sector can also be formalized within these eco-parks with robust health and safety measures in place. Here high value metals like gold, silver, copper and palladium in e-waste can be separated and resold in a safe manner and plastic can be collected and recycled or directed towards proper recycling centres. Uptake of standardized and described technology for efficient, high value recycling as opposed to crude recycling should be encouraged in recycling parks. For example, the eco-park could include processing capacities like 1000kg PCB/day and a 100kg PCB/batch process plants to manage different quantities of waste.

Informal sector integration is needed to enhance collection efficiency while preventing crude recycling and transitioning to safe recycling and recovery of materials. E-waste recycling already happens informally in a few clusters in India in Delhi (Seelampur) and in Moradabad and Meerut in Uttar Pradesh. These clusters are also informal markets for secondary raw materials. These informal clusters may be transformed to semi-formal/ formal e-waste management clusters that integrate the informal sector and also benefit from tapping into the existing robust network and ecosystem developed by them. Conversely, eco-parks may also be co-located in or near industrial, manufacturing areas for effective reuse, refurbishing, recycling, and uptake of secondary raw materials. Recycling in a centralized manner in clusters and eco-parks can create an ecosystem for the informal sector to integrate to semi-formal functioning allowing for recycling of materials in a designated setting along with data collection and tracking. In such a setting, regulators can also enforce rules systematically while ensuring closure of illegal, informal recycling points.

Robust mechanisms for ***data collection and tracking, transparent reporting, monitoring, and enforcement*** to prevent free-rider issue, to evaluate EPR performance and associated targets and make modifications to achieve higher efficiency of recycling and recovery targets are required. Data collected should include EoL e-waste data on waste generation and collection and midstreamdata provided by producers pertaining to their sales in order to forecast the upcoming e-waste generation trends. Irrespective of the volume of waste generated, it is essential to monitor thequantity of e-waste for evaluating the developments over a certain time period and for setting targets and assessing them. Furthermore, development of policies, regulations and legal instruments require coherent data for public access and detailed quantification of generated e-waste. Additionally, data availability in the public domain will eventually lead to transparency in generation rates, e-waste flow channels, methods of handling and technologies for disposing potentially hazardous e-waste (International Telecommunications Union , 2021)For tracking, monitoring agencies may be set up at state level as part of the State Level Pollution Control Board (SPCB), collection data from localbodies and reporting to the CPCB annually.

S.No	EEE Code	Categories (All parts included)	Rate/Kg*
1	ITEW1	Mainframe/Server	85
2	ITEW2	PC	40
3	ITEW3/4/5	Laptop/Notebook Computer/Notepad Computer	100
4	ITEW6	Printer	30
5	ITEW7	Copying Equipment	30
6	ITEW8	Electrical and Electronic Typewriter	15
7	ITEW9	User Terminal and System	15
8	ITEW10	Facsimile	15
9	ITEW11	Telex	15
10	ITEW12	Telephones	15
11	ITEW13	Pay Telephones	15
12	ITEW14	Cordless Telephones	15
13	ITEW15	Cellular/Smartphone	100
14	ITEW16	Answering System	15
15	CEEW1	TV	12
16	CEEW2	Refrigerator	35
17	CEEW3	Washing Machine	30
18	CEEW4	Air Conditioner	80
19	CEEW5	Fluorescent and Other mercury Lamp	Negative Charge
20	Others	E-Waste Mixed with Plastic	Starting from Rs. 7/Kg
		E-Waste Mixed with Metal	Starting from Rs. 22/Kg
		Printed Circuit Boards	Starting from Rs.6/Kg
		Lithium Ion Battery	Starting from Rs. 35/Kg
		Solar Panel	11/Kg
		Solar Panel (Thin film)	Negative Charge
		Electrical Equipment	Starting from Rs. 6/Kg
	*The final and no-regret offer will be shared after inspection of the material by the below dismantlers/recyclers		

Figure 4: Tentative rate card for e-waste collection drive by RSPCB (Oct 2021)

Integration of the informal sector with the government including the urban local bodies (ULBs) can be seen in the form of successful e-waste collection drives started in various parts of the country. ULBs as key stakeholder facilitate e-waste collection mechanism in the form of collection drives. The collection drives are based on a tentative Rate-Card system created in association with the informal sector including dismantlers and recyclers who set a price per kilogram of different categories of EEE (ITEW and CEEW) items to be collected.

The ULBs also incentivize households for collection of e-waste back providing this collection mechanism in the form of collection drives along with a tentative rate card indicating the price for each material. This can be seen in done in New DMC and other municipalities in Delhi and Rajasthan.

Effective financing of EPR for e-waste to be formulated with the help of government in order to determine how EPR may be managed sustainably, create a constant supply of raw materials, overcome price volatility and supply constraints of virgin raw materials, and leakage into the informal sector.

The funding under ***mandatory fee-based EPR schemes*** will provide support for proper e-waste management techniques. The financial support under EPR must be timely reviewed and updated depending upon waste generation, market conditions, and technology. Financing of EPR by producers/importer/brand owners (PIBOs) via a mandatory fee-based model may be done as suggested in PWM rules through a corpus fund at the central or state level. The contribution may be via an escrow account managed by a Special Purpose Vehicle (SPV). The fee paid by producers may be based on normative cost depending on waste generation, collection schemes, and recycling and recovery targets.

A ***modulated fixed-fee model based*** on pre-determined price range for e-waste management may be better. However, this fee-based model might not be implemented effectively at local level as ULBs and SPCBs may not have the expertise or resources to design, implement and manage effective e-waste management programs within their jurisdictions to incorporate the modulated fee structure. In this case a PRO may be instituted for the same.

State-Level Advisory Board (SLAB) and Special Task Force may be constituted for proper implementation of E-Waste Management Rules and EPR. The SLABs may constitute key stakeholders along the EEE and e-waste value chain and provide basis for implementation of shared responsibility as part of EPR.

The SLABs may comprise of the following members: secretary or joint secretary from department of urban and rural development or local self-government department of the state or a representative of Panchayats. Representatives should also be from the revenue department, CPCB, SPCB or PCC, town planner or district magistrate, from urban local bodies, from an NGO/CSO associated along with the informal sector representation for collection and/or recycling, representative of waste recycling industry, researchers, and key experts in WEEE sectors should be part of SLAB and including industry body representative.

The SLAB should be responsible for ensuring proper implementation of e-waste rules, EPR, along with monitoring and managing associated disbursement of funds to local level municipality, recyclers for implementation of EoL waste management including related awareness generation and IEC activity. The SLAB may meet biannually to review the implementation of EPR and associated funds, forecast the upcoming e-waste generation based on current sales and product life and update EPR collection targets accordingly, provide recommendations, and give updates to SPCBs.

SLAB may also ensure EPR schemes in terms of incentives are provided to producers for sustainable product designs and stimulate innovation considering the life cycle of the product. EPR schemes should clearly define responsibilities for use of funds and include policy instruments such as tax on virgin components vs. tax-rebate for reusing materials to be implemented.

Continuous ***stakeholder engagement and consultation*** during the entire process of EPR design and implementation is needed from key EPR experts, ULBs, pollution control boards, businesses, organizations including PROs, and the informal sector to ensure acceptability, transparency in flows, monitoring waste, high recycling efficiency, overall effectiveness, and regular refinement of the EPR schemes. This may be achieved through the constitution of SLAB. In addition to stakeholder engagements, ***capacity building*** of local level implementing agencies, ULBs, recyclers, informal sector, and consumers is necessary for uptake of shared responsibility for sound e-waste management across the value chain.

Awareness generation leading to behavior change is essential in effective implementation of EPR. At the national level, producers and regulators can work together to create awareness on e-waste management issues. For example, in 2015, the Ministry of Electronics and Information Technology (MeitY), as part of Digital India, initiated awareness generation with the help of industry partnerships amongst consumers on hazards of improper recycling and on best practices for e-waste disposal. Awareness on sustainable consumption and technical know- how of e-waste management including high-value recycling is needed to prevent leakages of e-waste and have effective EPR implementation. At the local level, SLAB can

ensure capacity building with stakeholders and measure associated behavior change through monitoring key parameters such as decrease in waste generation, increase in collection rates, and improved recovery rates from products.

Finally, the EPR framework for e-waste should be in line with other EPR schemes such as for plastic waste management. For plastic waste management, the Government of India has taken several steps to reduce single use plastics and implement EPR framework at local level through inclusion of EPR implementation guidelines, rules, and regulations in the City Action Plan (CAP) and institution of Special Task Force at state level for monitoring (The Hindu, 2021). E-waste management at city-level will be strengthened only through similar measures, which are incorporated in the byelaws and CAP state modalities of EPR implementation, responsibilities of local level stakeholders, monitoring, and appropriate enforcement mechanisms and sanctions developed such as penalties for offences and non-compliance.

In order to achieve this, white paper key recommendations and shared responsibility structure for EPR in e-waste management has been developed through extensive consultations and key person interviews. Stakeholder inputs have been an important aspect of this white paper to understand how aspects of circularity and shared responsibility can be incorporated as part of the EPR for e-waste management. A detailed list of key stakeholders interviewed as part of developing this white paper is given in Table 9 in Appendix. Based on key interviews with stakeholders from across the value chain, elements of the framework have been prepared that give the challenges and the associated action points to implement in Table 8 below.

Table 8: National EPR Framework for fostering effective e-waste management in India (based on Minutes of Meeting)

Elements	Description	Challenges	Action Points
Monitoring and tracking the implementation of regulations	Monitoring the implementation of EPR framework including the associated E-Waste Management Rules, Plastic Waste Rules, Battery Rules, Hazardous Waste Management, Handling and Transboundary Movement Rules	- Lack of data due to fragmented data collection and inventorization; - Lack of coherence in E-waste, plastic waste, hazardous waste management rules and regulations; - Timeline and implementation lag between when waste management rules and regulations comeinto effect and their on-ground implementation; - Lack of awareness with local bodies on implementation, monitoring, and tracking of rules; - Increased paper trading in the form of invoices and paper trails show e-waste movement and recycling however, this is not supported by on-ground formal recycling efforts; - Reported rates for collection and recycling are not audited for authentication; - Lack of tracking and inventorying leads to double counting of materials	- Development of a digital platform for transparent material flow from producer to end of life management tracking of e-waste along with proper inventorization. - Two-way tracking of EEE products produced upstream and WEEE received downstream at collection centres. - Streams of waste i.e. quantity and items dismantled into and sold to respective recyclers, who report the materials received from collection centresand outputs of final recycled materials including any residual hazardous waste generated from recycling activity. - The government should create a comprehensive list of EEEproducts as part of the regulations. The current list of 21WEEE items is not comprehensive and does not adequately represent the e-waste burden. - Forecast future e-waste generation depending on the sales of each category of EEE mentioned in e-waste rules. To be used to set collection and reuse targets. - Recyclers, refurbishers, dismantlers and PROs should also keep a record of e-waste collected, secondary raw materials sold, recycled and final disposed quantities to match the data of e-waste collected from different collection centres.

Elements	Description	Challenges	Action Points
		when shifting from one stakeholder to the other in the value chain; - Informal secondary raw materials (SRM) market and second-hand usage and market for IT in electric and electronics makes it harder to account for e-waste generated; - Waste collection mechanisms like drop-off centres are not in compliance with or supported by CPCB guidelines. There are no separate guidelines in place.	- For a robust enforcement chain, state board to be brought into confidence before CPCB issues ofEPR authorization. There is a lack of authority with SPCBs for complete logical enforcement. Once state boards issue complaint, regulatory action is taken by the central body (CPCB), which can take time and lead to delays in enforcement. - SPCBs to play a role along with CPCB in framing rules for e-waste and implementation of the same. - Setting up criteria for establishing and guidelines for operating PROs and collection centres.
Financial costs	Compliance, dedicated budget for EPR fund to include collection and treatment costs, support to start-ups and entrepreneurs.	- Financial flows not tracked through collection and end of life management; - Estimates to be established for cost of recycling, treatment, and final disposal; - Producers do not have a robust mechanism to channel their funds towards treatment of waste; - Lack of credit system to be used to offset waste generated.	- Financial mechanisms should be transparent and quantity, value, and weight of e-waste collected at centres and sold to recyclers to be recorded and matched with the data given by PROs. - The data on financial and material costs of collection, recycling, reuse of secondary raw materials, and final disposal should be used to determine the estimate EPR corpus fund and its allocation.

Elements	Description	Challenges	Action Points
Economic instruments	These may be in the form of tax incentives, penalties, upfront charges like the Advanced Recycling Fee (ARF)	- Market rate for raw materials is decidedby the informal sector. - Price volatility ofsecondary raw materials from e-waste makes it difficult to plan for future recycling and treatment infrastructure and predict availability of recycled materials.	- PROs should come out with a fixed price for different materials processing incorporating the cost of recyclers/ dismantlers and convey it to the brand owners through the government. This can be added in the price of the product as ARF. - ARF can be shared between consumer and brand owner as they both are equally responsible for generating the waste. The rate of ARF to be developed as per the standard rate of valuables and theirextraction cost, which needs to be centralized and not left on the will of the brand owners. - The penalties for not meeting collection targets need to be clearly mentioned and strictly monitored by CPCB and SPCBs.
Upstream focus	Upstream focus to include design changes – design-for-recycle and targets for use of secondary raw materials in electronics.	- EPR in India unlike European countries is focused on downstream end of life management as opposed to encouraging upstream changes; - Current e-waste rules focus on recycling instead of refurbishing and reuse of secondary raw materials. Reuse targets should be favoured over recycling to foster circular economy in WEEE.	- Brand owners to provide information of the materials used in EEE for improving recyclability. - Strictly promote eco-design concept and modular design concepts such as- (a) Items should be non-soldered to eliminate use of heavy metals like lead and mercury which inhibits recyclability. (b) Develop eco-friendly recovery methods. (c) Value addition to non-precious items like plastic from e-waste extraction to promote circularity and reduce virgin product consumption.

Elements	Description	Challenges	Action Points
			- Establishing refurbishers as key stakeholders, channelizing WEEE to them before recyclers, and setting primary targets for brand owners to refurbish materials under EPR regulations. - For improving resource efficiency, modular designs need to be encouraged and recyclables to be channelized for high value, upcycling to promote circularity and reduce consumption of virgin polymers. - Modular, eco-design will reduce costs of recycling by making the process standardized, which should be mandated.
Incentivizing stakeholders	Incentivize recyclers and waste collectors to ensure e-waste is not leaked into the informal sector and reasonable profits are measured for MSMEs involved.	- The quality of raw materials used in EEE products is decreasing to reduce the overall cost of appliances. This subsequently makes recycling of e-waste less profitable.	- Incentives such as tax rebates can be given for product manufacturers to adhere to eco-design concepts and use recycled materials over virgin materials. - Incentivize brand owners for extending product life and include schemes such as sharing of electronics for bulk consumers and providing cheaper, refurbished products. - Incentivize households to handover e-waste for collection. - New DMC and other municipalities in Delhi and Rajasthan have provided collection mechanism in the form of collection drives along with a tentative rate card indicating the price for each material.

Elements	Description	Challenges	Action Points
Digital technology and infrastructure	This includes collection centres, MRFs for dismantling e-waste, associated recycling facilities and/or creation of treatment clusters, eco parks, and market for secondary raw materials	- Formalized recyclers rely on the informal sector for collection of e-waste and sometimes also on informal recyclers for different recycling methods. - There is a lack of strict distinction between the formal and informal recyclers. Many formal recyclers are operating in crude informal manner. - Often formalized recyclers do not have the adequate infrastructure to process complex EEE and use unscientific techniques similar to the informal sector.	- Development of a centralized, digital online platform for transparent material flow from producer to end of life management,tracking of e-waste along with proper inventorization. - Fund research organizations for developing recycling technologies within India. - Centre of Excellence (CoE) for e-waste recycling to be developed where new start-ups can approach them for guidance and overall awareness generation. They also can help in funding and enable smaller companies to scale up. - The knowledge of this CoE on Centre for Materials for Electronics Technology (C-MET), Hyderabad is not widely spread, which is a challenge for companies looking to set up newer e-waste recycling units.
Standards/ Certifications on recycling methods OHS safety	Includes standardized dismantling and recycling procedures and use of secondary raw materials.	- Lack of standards or certifications for reuse and refurbished markets for development of secondary raw material and recycled products market. - Lack of standard protocols for safe handling at end-of-life management stage.	- An association of recyclers needs to provide with recycling SOPs and guidelinesfor various components to standardize the recycling processes. - Standards and SOPs for recyclers, dismantlers and PROs to help distinguish compliant fromnon-compliant dismantling and recycling and penalise the latter. - Standards to be in place for reuse of secondary raw materials to ensure quality assurance and checks.

Elements	Description	Challenges	Action Points
Knowledge and Awareness on e-waste management	Awareness on sustainable consumption and technical know-how of e-waste management.	- Understanding and awareness around toxicity of e-waste amongst stakeholders is low, especially at user, collector, recycler and dismantler levels along the value chain. - Unwillingness of consumers and enterprises to hand out obsolete EEE or pay for WEEE recycling.	- Generate awareness amongst consumers, bulk waste generators on e-waste management including hazards associated with improper waste management etc. - Encourage consumers to adopt contractual models (lease/subscription model) from producers rather than purchasing them to encourage electronics in circulation for reuse, recycling.
Capacity building and integration of informal sector	- Targeting specific consumers with measurable behaviour change. - Integration of informal sector in collection and preliminary preparation such as dismantling for recycling.	- E-waste formally collected still leaks into informal channels for crude recycling done without OHS compliance	- Informal sector needs to be incorporated as major stakeholders in e-waste management as brands and PROs cannot compete with the existing collection network of the informal sector. They need to be recognized and held accountable in case of non-compliance. - Formalisation of the existing informal sector will be based on following environmentally friendly and scientific methods for managing e-waste in collection and preliminary preparation such as dismantling for recycling.

Formalized collection	Including avenues for drop offs, scheduled collection drives and ad-hoc door-step collection services	- Cannot return WEEE at electronic stores - as the stores will then incur a disposal fee. - Brands do not have a robust "buy back"scheme in India. - In India, people consider e-waste as an asset and are keener to sell it to informal, kabadiwalas rather than handing it over to PROs or producers, which results in leakage of waste to informal sector	- Urban local bodies to be key stakeholder in e-waste management. They could facilitate e-waste collection mechanisms in the form of e-waste collection drives. -Thecollection drives should be based on a tentative Rate- Card system created in association with the informal sector including dismantlers and recyclers to set a priceper kg of different categories of EEE (ITEW and CEEW)items to be collected. - Dedicated collection depots or formal recycling centres where consumers can voluntarily drop-off e-waste. - The reported collection and processing targets should be mentioned in terms of tonnes of material and types rather than tonnes of waste. To help in segragate and channelization of materials and reduce waste disposal. - Tonnes of material and types to be reported by PROs on e-waste collected, by collection centres one-waste received and soldto different recyclers, and also by recyclers on e-waste collected from different centres, materials refurbished, recycled, and residual waste generated. Different buy back systems are appearing in actionplans submitted for EPR authorization to the CPCB however, those actions plans need to be verified andaudited for determining effectiveness of on-ground implementation.

Elements	Description	Challenges	Action Points
Institutional Strengthening	Clearing house/coordination body, Steering committee associations such as (SLAB or Special Task Force), Institutions to be responsible for scientific and technological development, overseeing the data collection and monitoring	- Lack of an overseeing body for development of a comprehensive framework and its implementation with goal and target setting; - Currently, stakeholders are working in silos without an overarching framework that clearly identifies the roles and responsibilities of each stakeholder towards the other stakeholders – creating broken value chain with leakages and lack of data collection,monitoring, and tracking.	- CPCB and SPCBs should empanel institutions/companies through an agency or government body such as NIELIT for audits on recyclers, dismantlers and PROs. Those doing voluntary audits should be given preference by the SPCBs. -An e-waste task force needs to be formed under CPCB/SPCBs that monitors and quantifies e-waste from various stakeholders, particularly recyclers, dismantlers and disposers as they are the priority stakeholders in terms of environment, circularity and resource efficiency. - Task force should be formed containing e-waste experts with the sole purpose of e-waste management: (1) Their roles must include quantifying and monitoring e-waste by compiling information from SPCBs and CPCBs; (2) Predict e-waste generation by understanding sales of electronics by various brands; (3) Oversee recyclers and dismantlers activity by audits and have authority to impose fines and even cancel registrations for non-compliance; (4) Undertake capacity building and training exercises for all stakeholders involved; - Suggest technology and infrastructural development by identifying hotspots.

Source: TERI Analysis based on minutes of meetings from stakeholder discussions and secondary literature review done as part of the project

In Conclusion

To develop a comprehensive structure for effective EPR implementation of e-waste management in India, few steps have been outlined in accordance with the stakeholder discussions conducted as part of this project and review of secondary literature.

- *Regulatory Enforcement*: There should be stringent monitoring and enforcement of the provisions of E-Waste (Management) Rules so that EPR targets are met and there is independent information on where the collected waste is recycled. SPCBs and CPCB are required to monitor and enforce compliance with the standards specified for collection centres, dismantlers, recyclers and PROs. Regulatory actions such as authorizations and their conditions, data on inspections of registered facilities and compliance status of inspected facilities should all be made publicly available for scrutiny. These practices should be institutionalized as part of the regulations across the country. Developing a regularly updated and publicly available inventory of district-wise generation of e-waste quantities by e-waste type (e.g., computers, mobiles, and appliances), waste composition and flows will play an important role in enforcement.
- *Strengthen Role of Consumers & Bulk Consumers:* For effective implementation of EPR, there is a need to bring consumers to the core of e-waste management. There should be ease of participation among the consumers for managing e-waste which could be enhanced by setting up wide collection networks across the country. Increased consumer awareness is required to ensure that they do not throw e-waste in the municipal bin, instead, hand them over to take back system/collection and channelization system of producer or to a collection centres of an authorized recycler who is part of producer channelization system. In addition to this, specific instructions in the form of guidance to bulk consumers should be made available where they are mandated to give away e-waste only to PROs so that collection mechanisms set up on behalf of producers are strengthened. Unlike the European countries, a fair portion of household consumers in India lack environmental consciousness and hence often do not participate in dropping e-waste for free at collection points without availing any monetary returns or other incentives. Despite awareness and engagement programmes, responsible PROs are unable to collect considerable amounts of e-waste from individuals. Under various EU Directives and their Member States' national implementing laws, the consumers can return any e-waste, packaging, or batteries to a municipal collection point or to a retail outlet free of charge. Similarly, in Japan, consumers are responsible for delivering end-of-life products to the nearest collection point, retailers are responsible for proper channelization and manufacturers are encouraged to use recycled materials in their products. Consumer pays for the collection, transport, and recycling of targeted products (OECD , 2016).
- PRO's operate e-waste take-back systems on behalf of producers and ensure collected e-waste is transported to appropriate treatment centres for proper treatment. For this to work effectively there is a need to determine the appropriate level of public information

to be required from PROs and producers to have compliance on ground. Change in tendering conditions for e-waste needed to make PROs and other aspects of e-waste management competitive and prevent collusion. For example, in Switzerland, PRO takes on the collection, take-back logistics and reporting obligations for member companies and reports volumes put-on-market based on which fees are calculated. It fixes treatment standards for recyclers and awards contracts to recyclers in a competitive process. (Khetriwal & Jain, 2021)

- *Data Transparency:* As discussed in depth throughout this document, unavailability of data is a key constraint for proper e-waste management in India. Despite the E-Waste Management Rules mandating several stakeholders to file their returns, there is little to no data. In order to overcome this, PROs need to play a crucial role in recording the formalized e-waste collection. Also, brand owners need to engage with think tanks to forecast their e-waste generated and tally it with the collection rates in order to cross check. However, informal sector needs to be integrated for improving current data monitoring scenario in India's e-waste sector as the amount of e-waste currently leaking into the informal sector is unaccounted for.
- *Capacity Building and Awareness Generation:* Continuous capacity building and awareness initiatives targeting specific consumers associated with measurable behavior change is required for effective implementation of EPR. These awareness efforts should be geared towards not only achieving safe handling of e-waste but also to reduce long term usage of electronic products. Overall, the public awareness generation initiatives should be based on partnerships and collaboration among various stakeholders.
- There is a need to develop a *module for impact assessment for EPR implemented*. Such a module to be based on formal systematic data collection and analysis, determine the quantity of e-waste diverted to formal channels, increase rate of recycling, diversion of waste from landfills/dumpsites, and estimate the diversion of financial burden from municipalities/ tax payers to producers. This will be beneficial in analyzing the performance of EPR, and will also quickly help in identifying the shortcomings, if any in the existing mechanism.
- EPR framework for e-waste management should be in line with other EPR frameworks in the country such as for Plastic Waste Management where Government of India has taken several steps to reduce single use plastics and implement EPR framework at local level by including EPR implementation guidelines, rules, and regulations in the City Action Plan (CAP).

Way forward

The EPR policies and framework for e-waste management in India are still evolving. As part of this project, additional stakeholders and key experts along the value chain were also consulted for inputs on key recommendations. A National Level Workshop on EPR Framework for E-waste Management in India was held on 26th April 2022 to disseminate the findings of the framework and further obtain comments for the same. The agenda for the same is given in the Appendix section below. At the national level workshop, the current e-waste management scenario was discussed along with the role of PROs and moving forward the draft notification on E-waste management and its impact on stakeholders.

Although this *White Paper on National EPR Framework for E-Waste Management in India* was prepared prior to the draft notifications for E-Waste Management rules 2022 (which came out on 19th May 2022), the shared responsibility framework presented in the document encompasses elements also introduced in the draft notifications such as the centralized CPCB online portal. This document is prepared for policy makers in the field to implement a robust EPR framework at national, regional, state and local levels and our inputs on the draft E-Waste Management Rules 2022 is also included below.

Draft E-Waste Management rules 2022

The recent notification for draft E-Waste Management rules 2022 came out on 19th May 2022. The notification aims to comprehensively cover the topic of EEE and e-waste management. The E-Waste Management Rules 2016 currently only include EEE under two categories (i) Information technology and telecommunication equipment (ITEW) and (ii) Consumer Electrical and Electronics and Photovoltaic Panels (CEEW), which in the new draft notification will be increased to six categories to include (iii) Large and Small Electrical and Electronic Equipment (LSEEW), (iv) Electrical and Electronic Tools (With the exception of large- Scale Stationary Industrial Tools) (EETW), (v) Toys, Leisure and Sports Equipment (EETW), and (vi) Medical Devices (With the Exception of All Implanted and Infected Products) (MDW).

Unlike the current rules, the notification only covers the following four stakeholders manufacturers, producers, recyclers, and refurbishers of the e-waste value chain. The notification does not mention the involvement of PROs and instead directly makes the producers responsible for carrying out their EPR responsibilities. Similarly, dismantlers are also not included along with the recyclers and the latter is responsible for the maintaining a record of material collected dismantled, recycled and sent to registered recycler on the online portal. Although currently the majority of the e-waste is managed or leaks into the informal sector, there is no mention of the informal sector and its integration in the formal ecosystem described in the notification. Limiting or deregulating the rules to only five stakeholders mentioned in the notification can make the monitoring process easier however, it may also put undue pressure on the recyclers only to maintain record of e-waste collected, dismantled, recycled and sent to registered recycler. Further not considering the parallel, informal sector as key stakeholders may inhibit their integration into the formal ecosystem. Further, the importer of used EEE is not mentioned as a key stakeholder but is to follow 100% of the EPR obligation. The notification, however mentions the involvement of the port authority whose responsibility is to verify import and export related activity, inform the CPCB of illegal activities and take action against the importer for violations.

The notification includes refurbisher as a key stakeholder who are to refurbish equipment as per the guidelines of Compulsory Registration Scheme (CRS) presented by MeitY/BIS and send any e-waste generated in the process to registered recyclers. Including refurbishers as key stakeholders is a step towards achieving a circular economy in EEE.

Further in line with circular economy principles, the EPR Implementation, recycling and trading is detailed. The EPR is described to include collection targets where producers obtain EPR target and implement the same. Manufacturers and producers are to ensure at least 60% of their e-waste is collected and recycled by 2023 and 70% and 80% by 2024 and 2025, respectively. EPR certificates are included and will certify the quantity of e-waste collected and recycled in a year. These are to be traded like carbon credits helping bridge shortfalls, where surplus quantities may be sold to another company to help meet its target. Finally, to carry of the reverse logistics the producers are to set up e-waste exchange facilities for collection and recycling.

The current notification leverages digital technology in the form of a digital Online Portal to track EEE. Key stakeholders mentioned; manufacturers, producers, refurbishes, and recyclers are to register on the Online Portal to specify annual production and e-waste collection targets, implement EPR (as per Schedule III), and file returns. The portal will be used to monitor and track e-waste management from collection to its final disposal. The overall implementation will be overseen by the Steering Committee with CPCB representative as its chairman, key stakeholders, and representatives from key ministries. State pollution control boards are to inventorize, monitor compliance of EPR. The state governments are to allocate industrial space for e-waste dismantling and recycling, capacity development, and ensuring health and safety of workers. Finally, the urban local bodies ensure facilitation of segregated e-waste collection and disposal systems.

Unlike the current rules which do not describe penalties, the recent notification enforces the rules and make stakeholders accountable through penalties levied for those who do not meet the annual targets. Although, the exact penalty quantum is not specified but if the target of recycling is met with a year's delay they will be refunded 85% of the fine and up to 60% and 30% reimbursement if the delay is two and three years respectively in meeting target. In addition to this, any false information (above 5% of actual e-waste) disclosed over generation of EPR certificates will result on revocation of registration and may be prosecuted in addition to the EC levied.

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Appendix-1

Table 9: List of stakeholders interviewed from the organizations along the E-waste management value chain

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
1	RLG, India	PROs	RLG is operationalizing what is written in policy documents for E-waste management onground by liaising with producers and implementing rules with dismantlers and recyclers thereby also helping them formalized. Currently have a network of 30+ recyclers.	- RLG helping formalize the value chain by operationalizing what is written in policy documents, Rules and EPR for E-waste management on ground by stakeholders. - RLG starting reverse management of stock keeping unit (SKU) and organizing RE-Commerce seminars - Producers now mandate dot take responsibility of EoL Management and allocatefunds for the same. This will help in formatting the value chain. - Producers to incorporate cost of EoL Management in addition to design for environment in the cost structure of product. - Regulatory gaps - rules don't provide for definitions of mandates, are not up to datewith current machinery and recycling capacity calculated should be beyond land areaand should include type of machinery used.
2	Suritex	Dismantlers/ Recyclers	- Started in 2012 in Nagpur a developing city, Tier II city. Are authorized recyclers that recycle all types of E-waste as we are majorly into the PCBs board which are in almost everyelectronic product. - Suritex recyclers ensure full recycling of materials as have tie ups with other recycler for processing of different types of E-waste Hyderabad, Pune, Ahmedabad. Suritex does some steps and then sends remaining waste toother recyclers for further processing including to Japan such as Mitsubishi.	- E-waste flows to Delhi, Chennai, Mumbai, Kolkata, Hyderabad through robustchannels by informal sector - Processing over 100% capacity due to waste collection from informal sector howevercannot report this as rules don't allow for integration of informal sector. - Experienced paper trading by informal sector and PROs. PROs are not transparent/traceable may show one recycler authorized work on paper for other producers and generators. - When purchasing scrap prices vary as metal rates fluctuate a lot therefore need specific rates from government or a range of rates. Governments have given deprivation rate of 10% per year, but government has no rates or range of rates forscrap.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
3	Saahas	PROs	Saahas managing Plastic, electronic, and Solid waste. Saahas is a CPCB approved PRO connecting and working between producer and recycler.	- Audit mechanism needed to determine physical trail of material for EoL management. Physically show/ report stock at downstream vendor. When we get incoming material - dispatch of end-product. - Producers of raw materials like copper to show how much raw material recycled or how much recycled material they have used. - EPR implementation Should not only focus on EoL management of products but to start from upstream manufacturing stages (as done so In other countries) and to be tracked throughout products life. Make stakeholder Responsibility circular instead of linear by showing reuse of material and can track material for example on a central platform. - Build an ethical and traceable supply chain and buyers and sellers of materials and waste materials to report the same.
4	Center for Sustainable Development (CSD)	CSOs/NGOs	Centre for Sustainable development (CSD) is based in Nagpur. We have been engaging with Swach Survekshan ranking for Nagpur. Awareness partners since 2014 for Nagpur Municipality. Conducting segregation of waste and programmers in 200 schools in Nagpur. Working in slums on source segregation and composting workshops. Also conduct programs in RWA and housing colonies - zero waste management. Currently, working in three colonies, created a women group, give composting kit - encourage them to segregate waste - linking to dry recyclers and set up Material Recycling Facility (MRF) within colony. Have put in compost bins in all colonies - 5 women in all colonies do training. Also conducting Awareness on e-waste and tied up local waste recycling in Nagpur.	- Need to integrate waste pickers but waste pickers to come up with self-sustaining model where ULB gives them space and recognition. Emulate Bangalore's waste picking group. - Entrepreneurial model for waste pickers as opposed to being salaried employed - Need awareness generation for E-waste management. Awareness generation on what is E-waste and value of each item, its effect on environment and health issues associated. - EPR framework Should give the waste pickers the right to the waste while giving them training for safe handling.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
5	SWaCH	CSOs/NGOs	- Recycling and livelihood projects on plastics and paper are done by SWaCH which is India's first Co-Op of waste pickers. Formed out of a labor movement. SWaCH was organized in early 90s, integrated SWM of cities with door to door collection. Partnership with PMC, Pune for formal waste management system - working with PMC to manage Pune's MSW - SWaCH waste pickers cover 90% of the city. - Integration of informal sector provides job security. SWaCH works on a lighthouse model - scrap shops owned by waste pickers - weighing the waste and charging fairly and giving it back to waste pickers who still making a profit. Plastics - collect MLP and this model has been on for 3 years - brand owners pay for gap funding with minimum assured price. This model has so far diverted over 1000 MT of MLP from landfill.	- SWaCH is India's first Co-Op of waste pickers. It works on a lighthouse model whereby scrap owned by waste pickers. - E-waste purchase by weight or monthly basis. Can set per KG rate - based on market rate. SWaCH sells e-waste once a month about 0.5-1Tonne per month - EPR frameworks - for e-waste and plastics but a lot is left out of PWM rules including E-waste and Sanitary waste. Scope should be expanded to include plastics in E-waste and Sanitary waste to have enhanced collection of the same. - Need new guidelines for each waste to reduce plastic use and increase use of other materials. Mining guidelines needed for plastic - various items, plastics, metals etc. - Waste that is non-recyclables onus on producers to invest in R&D and reduce or substitute such material. Waste that is recyclable, onus on Coops like SWaCH to invest in traceable EoL management. Waste recyclable but unviable, onus on producers to set artificial price tallow for its collection create increased demand and invest in better recycling. - For more robust EPR framework, models to determine tracking and monitoring that is currently left to CPCB. Ensure old and new rules are not conflicting and create cohesion of frameworks. Need to lay out exactly what should be done, need clarity on when and how rules to be actually played out.
6	Founder, Electronic Waste India, Saharanpur, UP	Dismantlers/ Recyclers	Currently work as a CPCB authorized recycler/dismantler in Saharanpur. E-waste is provided to Electronic Waste India by RLG from consumers and vendors like Philips, Vodafone and Voltas. Currently have treatment capacity of 25 TPD and undertake processing for large appliances like fridge, TV, AC and washing machines. Do not recycle small IT electronics like mobiles and laptops.	- In order for EPR to thrive in India, materials and recyclables should be easily available to recyclers, who can process e-waste in a scientific manner. - For ensuring recyclers are undertaking proper measures, CPCB has mandated all recyclers to submit quarterly returns to the concerned SPCB with the details of technology used, amount of e-waste received, processed, dismantled and disposed. - Currently, at grassroots level, e-waste recycling technologies are nascent and they need to be upgraded with the help of brand owners in order to properly undertake e-waste management.
7	CSE	CSOs/NGOs	CSE is a research organization headquartered in Delhi and works extensively in e-waste management along with other waste streams. Recently, they released e-waste management	- Increase electronic equipment list to comprehensively address all items instead of limiting to the 21 types

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
			report highlighting the issues and way forward for improving e-waste management in India	- Data collection on waste generation actual quantum to be collected and shared on public domain, including list of recyclers. - Circularity to be incorporated by extending life of product through various business models of refurbished items, design changes, and availability of spare parts - Limit informal sectors role to collection and channelization with proper integration of Informal sector - Increase role and responsibilities of municipalities and panchayats in integrating informal sector, increasing awareness of consumers, and overall enhancing collection and channelization of brand and orphaned e-waste - Consumers to be incentivized to return product after use through incorporation of Advance Recycling Fee (ARF) - For robust value chain to move from transactional system to contractual system
8	UMICORE	Dismantlers/ Recyclers	Umicore is a precious refining company - extracting precious metals from complex precious metals which is operational in several countries. The main plant in Belgium processes 500-1000 TPD of e-waste. More than 200 types of materials processed.	- Centralized e-waste recycling is better in terms of maximizing resource efficiency and resource recovery as it used the best available technologies and the companies specializing in recycling the specific WEEE can undertake its recycling. - Decentralized e-waste recycling is good for critical raw material extraction, but it may not be effective from resource efficiency and environmental perspectives as the formal recyclers may not possess the right technologies for dealing with intricate e-waste. - One of the major challenges in proper e-waste management in India is that the majority of e-waste is falling into the hands of informal sector, or formalized recyclers that do not have the right technology to handle e-waste. To tackle this, the government of India should allow exporting of e-waste to developed countries where the processing technologies are readily available. - Lack of proper monitoring of e-waste quantities falling into the hands of formal and informal recyclers is a major issue in India. Proper quantification of e-waste flow will clearly illustrate which sector requires immediate technological intervention. - For properly implementing EPR in India, collection and processing chain needs to be formalized. Additionally, proper transparency needs to be provided as to what happens to the collected e-waste under EPR mandate. India has set EPR collection targets but there is no strict monitoring as to whether brands are actually doing it and how this collected waste is being treated.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
9	E-Parisara Hindupur	Dismantlers/ Recyclers	- One of the first companies to start e-waste recycling (first to get government approvals from Karnataka Pollution Control Board and from CPCB in 2004). Operating from Bangalore (capacity 9200TPA) and have another facility in AP (capacity 6000TPA). Operating from Bangalore (capacity 9200TPA) and have another facility in AP (capacity 6000TPA). Currently operating under capacity at only 10-20TPM - only doing laptop and mobile phone batteries. After recycling, other electronics: Steel is sold to steel repressor to make construction steel. Cu, Al is also sold to recyclers. After dismantling sell plastic to authorized plastic recycler. Have been working with RLG working since inception of RLG in India. Together, they recycle IT products from informal sector and bulk waste generators.	- Recycling consumer electronics like fridge and AC is not feasible for recyclers as there are a lot of costs involved like treating and processing hazardous waste. Also, the price for recycling is high and the profit is not sufficient to make it sustainable. - The quality of EEE has reduced over time to make the electrical equipment more affordable. This has reduced the value of recoverables for recyclers – since the materials used in manufacturing are not as valuable as the ones initially used. - As per the regulations, subsidies are to be provided to recyclers. However, the current subsidies received by recyclers from producers are not sufficient enough to make the recycling of e-waste a sustainable business. - The EPR framework needs to account for the liabilities and also make strict regulations for the producers who are unable to meet their EPR collection targets. Currently, this is a major gap in Indian EPR legislation.
10	HP	Brand Owners		- The e-waste rules and EPR framework needs to be reworked. Currently, the majority of it has been taken from EU (where the collection and waste infrastructure is different) and does not account for Indian scenario. i. Informal sector needs to be incorporated as major stakeholders in e-waste management as brands and PROs cannot compete with the existing collection network of informal sector. They need to be recognized and also held accountable in case of non-compliance. ii. Recycling standards need to be defined and monitoring mechanism need to be developed under e-waste rules and regulations so that the PROs and brand owners can hold recyclers accountable for not following environmentally sound techniques. iii. Need holistic framework where CE is incorporated and all the other regulations should also be designed in accordance to circularity. - One major issue with the current Indian EPR framework is that the collection targets for brand owners are increasing every year, but the recycling capacity is not increasing

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
				in accordance to it. In case recycling is not available in India, transboundary movement should be allowed for properly processing CRM and valuables for resource efficiency and circularity.
11	TERI	Bulk Waste Generators		- One way of achieving circularity and strictly ensuring EPR gets applied is by allowing brand owners to rent or lease their systems to bulk waste generators like institutions and large organizations. This way the brand owners can ensure whether a product requires disposal, or can be refurbished and used again. The bigger brands may use the newer electronics whereas the businesses with budget constraints can use the refurbished ones at cheaper rates. - The e-waste management rules need to lay down the rates for electronic scrap such as computers, televisions, etc. and also consider laying down the cost of extracted material throughout the value chain. Currently recyclers and aggregators are charging unjustified amounts, which sometimes results in unsound disposal or e-waste by bulk generators.
12	NEERI	Bulk Waste Generators		- E-waste rules need to incorporate more appliances into WEEE category to avoid under reporting and correctly identify the status quo. Also, CFL and mercury bulbs need to consider as e-waste since under hazardous waste category, it is not handled efficiently from the households. - Laws need to be developed practically considering the Indian scenario and not be adopted from EU or other developed countries. Informal sector needs to be included and not considered an outcast while developing rules. Synergy needs to be developed between brand owners, recyclers and the ministries for designing laws and updating the EPR targets. - E-waste monitoring is a major constraint and it requires additional institutions to look after the governance rather than just CPCB and SPCBs. An e-waste task force can be formed that monitors and quantifies e-waste from various stakeholders, particularly recyclers, dismantlers and disposers as they are the priority stakeholders in terms of environment, circularity and resource efficiency. - For improving resource efficiency, modular designs need to be encouraged and the non-valuable recyclables need to be channelized for upcycling to promote circularity by reducing the consumption of virgin polymers.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
				- Under EPR, Advanced recycling fee (ARF) should be mandated in India as nobody is willing to pay beyond the EoL. ARF can be shared between consumer and brand owner as they both are equally responsible for generating the waste. The rate of ARF needs to be developed as per the standard rate of valuables and their extraction cost, which needs to be centralized and not left on the will of the brand owners
13	IIT -K		Environmental engineering program, school of environmental science and reengineering and affiliated with renewable energy. Research on waste management in general - wastewater and waste management. Working in the field and developing courses on line of waste management and e-waste management, integrated waste management on YouTube. This is a GOI funded program. Also done work with SmART cities in Guwahati, Kolkata, resource recovery and determined how to keep waste away from landfill, how we can make value added products. Course on e-waste, did a small study on environmental risk, improper e-waste management, MEITY (Dr. Sandeep Chatterjee) had a panel/ group working with different stakeholders on a policy paper titled Circular Economy in Electronics and Electrical sector published in May/June 2021. The paper looks at the entire value chain, goal to extract maximum value with focus on EOL and replacement of certain material in e-waste - high toxic material replaced with low toxic material. Critical metals/ minerals, rare earth metal extraction of iron and copper. Secondary	- India is the third largest e-waste producer in the world. Only 10% gets collected from formal sector and we need to improve collection and management. - Improve collection by integration of the informal sector- training, capacity bustling of safe handling of waste. - Limiting informal sector work to robust/ efficient collection and safe dismantling of waste, this should then be taken up by formal recyclers. - User should pay for recycling of WEEE and this disposal (EoL) fee should be charged as a percentage (as done so with GST) at the beginning when the consumer is buying the electronic product.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
			raw material from e-waste, mining from sustainability point of view.	
14	MeitY	Government Departments / Agencies nodal officials (DPCC, CPCB, MoEFCC)		- Targets reported to pollution control boards are not audited and have leakages of materials, which can be overcome through tracking of material for which CPCB can come out with a software system to check the mass balance. - Manufacturers should in detail report product composition - raw materials used including hazardous materials. - Tracking may be done with manufacturers reporting quantity of material collected and percentage of that material collected which is plastic, metal, rare earth metals, etc. The dismantler to also report how much waste received out of which how much percentage is plastic, metal etc. - There is a EPR compliance cost. Currently, collection and recycling of e-waste cost playing havoc (because materials are not processed). Materials still leak into the informal sector for processing. PROs should come out with a certain price for different materials - giving synergy among PROs. - Need an association for recyclers (before standardizing recycling methods etc.) need an association and forum as is there for producers to set up common SOPs, dos and don'ts etc. Make entire chain committed and dedicated to the job. Subsequently also need to come out with compliance optimum costs. - Auditing of recyclers, PROs, dismantlers should be mandatory by SPCBs or CPCBs which may be done through an agency or government body such as NIELIT. Those doing voluntary audits should be given preference by state solution control boards. - Targets should not only be for collection. Collection targets for manufacturers, recycling target to be set for refurbisher not manufacturing this is to encourage circular economy and refurbishing instead of increasing WEEE for recycling only. Refurbishing to be encouraged before recycling.
15	Karo Sambhav	CSOs/NGOs	Karo Sambhav does not outsource waste collection from informal sector, bulk consumers etc. Karo Sambhav is the only organisation from India to be a part of WEEE forum.	- Government should intensify on the PROs and every PRO should declare at what cost they are operating and brands to share their cost of compliance in order to end corrupt practices across the country. - Talk to aggregators informally and existing PROs to understand what and how PROs are doing on ground. There is compliance on paper but the same lacks on ground.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
				- Deep thorough financial audits like CAG audits can work towards auditing, data collection and data study for effective EPR implementation. - In India 54 PROs are working but there is no auditing. - EPR was envisaged as having more level playing field, more and more producers and will become compliant, the intent to do good work will increase, consumers and bulk consumers will give waste, India could experience best technology for treatment, there will be fair trade practices, PRO's will not be competing on getting the client but to show the highest level of compliance. If we assess these parameters then we have failed on the parameters because of lack of enforcement which can be overcome by capacity building or outsourcing. - Challenge in existing EPR implementation is that collection targets are defined but recovery percentage is not defined - EPR systems around the world such as in Germany and UK are collapsing because of excessive corruption. If this is not tackled then we may see the collapse of EPR in the country. In order to move in the right direction there needs to be sound understanding of the cost and acknowledging the cost. - Technology plays an effective role in channelizing waste but has its own limitations. Technology platform cannot just be a trading platform but will need on-ground audits for the same.
16	Central University of Gujarat			- India lacks official estimated quantity of e-waste generated. Recent estimates suggest that India may have generated around 1.5 million tonnes of e -waste. - Effective implementation of policies should be there to curb the mismanagement of e-waste. In addition to this, in context of stakeholders functional linkages should be there. - Need of IEC and awareness generation for E-waste management to involve more people and capacity building. *Provisions should be there to make producers and manufacturers responsible for their waste. Also, there has to be some provision to go the same retailers in order to return the product that is not in use anymore. - Stakeholders is directly from producer to scrap dealers. In between lies the individual households, educational institutions and government and private establishments from where the e-waste generates. The main player is the scrap dealers and it is important to include them formally. Most of them are from unorganized sector. They should be

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
				made like municipalities having a formal structure. We can have a type of scenario of keeping 3 dustbins for solid, liquid and e-waste and some formal structure to deal with this. The problem lies when the scrap dealers throw the waste. Model of 3 bins in every household could curb the e-waste mismanagement.
17	Toxics Link	CSOs/NGOs		- Post 2016, there has been a change due to target based EPR. Have some sort of compliance but only on paper. Compliance mechanism to check EPR performance is being done in the last few years after waste Management 2016 rules - but shows paper trading that is compliance on paper but not much on-ground action. - EPR framework used globally for various waste streams, framework meant to see changes across life cycle and not just waste management aspect. The framework and waste management aspects to be linked with upstream changes as well. - There are no upstream changes that EPR is expected to bring in and incentives, producers to take action on that account. - One key element to improve overall EPR is to roll out on ground implementation by introducing elements of transparency mechanism needed for material value chain and financial and creating capacity, awareness generation.
18	Sofies	CSOs/NGOs	Sofies undertakes external audits for checking compliance of recyclers/dismantlers.	- Paper trading is an issue - Need external validation through checks to ensure technical standards and safeguards for recycling are being followed. Standards can be coded for authorization that downstream is genuine. - Regulations to be reviewed every 2-5 years regularly along with stakeholder mechanism built in this. This happens in Europe etc. - States should have clarity of definition of roles and responsibilities. Each state officercan interpret the EPR in their own way. it is not rule based - Guidelines issued by CPCB, - Material balance is required as per the composition of e-waste, in order to assure thereare no duplicate entries. - There is no barrier of entry to PROs - Kenya's EPR legislation is better as it gives criteria for setting up a PRO which can be monitored and reviewed. - Need EPR targets reporting framework

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
19	PRO India	PROs	In plastic waste, PRO India is trying to do work of a PRO but not like a waste management company. It works with waste management companies but not creating separate channel of plastic waste, 60% of plastic waste is non-recyclable and is co-mingled. Waste pickers do not remove it through the municipal path to landfill. Once the waste reaches the factory of the waste management companies- PRO India helps segregate this waste, able to handle the bulk, not create a separate channel for waste which is also waste. PRO India also reaching out for lease of uniform framework.	- EPR for E-waste management more mature than for plastic waste management and includes involvement of ULB and PROs. - PROs can come forward helping brands meeting EPR requirements including informal sector integration as part of EPR framework. - Need commonality in entire EPR structure and better policy coordination for different EPRs for e-waste and plastic waste so plastics in EOL vehicle waste and e-waste is also treated through proper channels. - Propose a common framework in the form of a pyramid structure where EPR is at top under which we have different categories, instead of management of waste independently. EPR applicable to all industry and to all products – should have broken down category wise and those categories should come under EPR rules and regulations for each applicable. - Electronic companies not mandated to treat plastics in electronics. With 6-7 waste streams for products, companies should suggest how they will deal with each waste stream (like plastic) and meet their product responsibilities. - Lack of awareness under which bucket of EPR does our product fall and where plastics fall - Timeline and lag between one implementation and the other - waste rules coming out in different years - EPR is a costly exercise. It has to be based on polluter pays principle instead of producer pays principle. EPR is a cost negative exercise- brands are forced to do this and looped and because its cost negative, infrastructure will not be built. These cost negative proposals will be implemented only through viability gap funding, together with brand and government through PPP models.

	Organization	Stakeholder Category	Background/ Introduction/ Brief	Key Points
20	Delhi Pollution Control Committee (DPCC)	Government Departments / Agencies nodal officials	Delhi Pollution Control Committee (DPCC) is the nodal pollution control authority in the UT of Delhi	- Collection centres not in compliance with CPCB guidelines - The role of state pollution control board is very minimal. Currently, there is no role of SPCBs in formulating or commenting on e-waste regulations. As per the e-waste rules, CPCB is the competent authority to issue EPR authorization. State Board is empowered to give authorization only to dismantlers, refurbishers and recyclers - E-waste at very nascent stage because of scarce human resources for monitoring for state - Many players in e-waste sectors - producers, refurbisher, and dismantlers - formal numbers very low and don't reflect real scenario. For monitoring action need of logical conclusion and enforcement but cannot do this because the non-compliance is reported to CPCB - Major producers, manufactures who introduce electronic goods in the market are not in the bracket because they do their business in more than one state. They are pan-India / trans national firms doing business in different places. The crux of e-waste rules is to introduce responsibility to producers but those manufacturers are outside where state boards such as DPCC cannot tighten the rope on them - Incomplete enforcement chain has led to lack of interest in state pollution control board for complete logical enforcement - E-waste enforcement very tiny priority compared to other pollution sources like air pollution, water pollution, industrial pollution hogs a large section of priorities in government and SPCBs but next with one year will have major actors will be brought under the umbrella

Appendix-2

National level workshop for EPR Framework for E-waste Management in India
Minutes of Meeting held on 26.04.2022 at 11 am to 4 pm

The Agenda for the National Level Workshop for EPR Framework for E-waste Management in India is presented below

National Level Workshop on the National EPR Framework for E-Waste Management in India

Date: 26th April 2022 (Tuesday) | 10:00 to 16:30 (IST)
Venue: The Oberoi, Dr. Zakir Hussain Marg, New Delhi

Draft Agenda		
Time	**Topic**	**Tentative Speakers**
10.00-10.10	Welcome address	Dr. Shailendra Dwivedi, Team Leader, Climate Change and Circular Economy, GIZ India;
10.10-10.20	Introductory Remarks	Ms. Radhika Kalia, Managing Director, RLG Systems India Pvt. Ltd.
10.20-10:30	Special Address	Dr. Sandip Chatterjee, Director and Scientist F, Ministry of Electronics, and Information Technology (MeitY), GOI;
10.30-10:40	Inaugural Address	Shri Anand Kumar, Scientist F & Divisional Head, Central Pollution Control Board (CPCB), GOI
10:40-10:50	Brief overview of the project	Mr. Jai Kumar Gaurav, Senior Advisor, Climate Change and Circular Economy, GIZ India;
10:50-11:00	Brief overview of the project	Mr Tanveer Alam, Assistant Manager, Compliance and Risk Management, RLG Systems India Pvt. Ltd.
11:00-11:15	Tea Break	
11:15-12:30	Presentation of the White Paper Draft	Mr. Abdullah Atiq, Research Associate, TERI; Ms Shweta Gautam, Research Associate, TERI
12:30-13:00	Q&A Session	TERI, GIZ, RLG
13:00-14:00	Lunch Break	
14:00-15:50	Discussion & Deliberations for *The Proposed EPR framework & way forward: Brand Owner's perspective*	Ms. Mehar Kaur, Associate Fellow & Area Convenor, TERI
15.50-16.00	Vote of Thanks	Ms. Shweta Gautam, Research Associate, TERI
16:00-16:30	Snacks/High Tea	

List of Participants:

1. Mr. Jai Kumar Gaurav, Senior Advisor, GIZ
2. Ms. Divya Bawa, Junior Technical Expert, GIZ
3. Ms. Radhika Kalia, Managing Director, RLG Systems India Pvt. Ltd.
4. Mr. Tanveer Alam, RLG Systems India Pvt. Ltd.
5. Mr. Agam Babbar, Senior Executive, RLG Systems India Pvt. Ltd.
6. Ms. Sakhshi Tekriwal, Senior Executive,RLG Systems India Pvt. Ltd.
7. Ms. Anuroop Banerjee, RLG Systems India Pvt. Ltd.
8. Ms. Mehar Kaur, Associate Fellow, TERI
9. Mr. Abdullah Atiq, Research Associate, TERI
10. Ms. Shweta Gautam, Research Associate,TERI
11. Dr. Sandip Chatterjee, Director and Scientist F, MeitY
12. Ms. Priti Mahesh, Chief Program Coordinator, Toxics Link
13. Mr. Sahil, Toxics Link
14. Ms. Deepali Sinha Khetriwal, Managing Director, Sofies
15. Mr. Sushant Vasisht, Consultant, Sofies
16. Mr. Srinivasu, Senior General Manager, Bluestar
17. Mr. Vivek Khare, DGM, Bluestar
18. Mr. Saurabh Garg, Voltas
19. Mr. Hari Shankar, E-Parisara Hindupur
20. Mr. Vaibhav Adhyaru, Senior Executive, Umicore
21. Mr. Pranav Piyush, AGM, SIDBI
22. Mr. Pawan Kumar Bharti, Manager, SIDBI
23. Ms. Ritika, Manager, The Wired Hub
24. Mr. Rishi Vyas
25. Ms. Vaishnavi Chaturvedi, Business Manager
26. Mr. Pranay Kumar, Hayat E-Recyclers Pvt. Ltd.
27. Mr. Prakhar Pandey

Key Points discussed:

- Awareness generation among key stakeholders is needed, especially for bulk consumers as they do not see/differentiate between authorized or informal sector players and instead need to ask for certification, return filed by buyer against waste sold.
- For stakeholders need to improve skill set, provide technology, and create clusters (can handhold them) for end processing unit to integrate the informal sector. Informal sector needs handholding, and they need to be used as an opportunity to create a robust system.
- Responsibilities of central and state pollution control boards, state governments, urban local bodies to be well defined to prevent e-waste leakages. This includes transparency such as through third party audit of recyclers.
- Leakages from waste aggregators, informal sector to be prevented such as through:
    - Economic incentives from producers (EPR) to citizens;
    - Financial modelling could include direct incentive to consumer - credit points given to consumer for return of old products.
    - Real time monitoring (using block chain technology) or online portal to track e-waste value chain and build reverse logistics.
- Lack of accountability for amount of waste collected and actually recycled, which may be addressed through penalties and reimbursements for corrective actions.
- EPR is focused on waste management and does not include upstream measures such as design change toward sustainability through use of secondary raw materials (SRM) and increased product – shelf life. Circular economy for EPR should include talks about choice of raw material and design as well. The design of a product can determine how much will be reused and how much will go for recycling.
- To track e-waste there is a need for registration of appliances for transfer - difficult to register every user for each product but for most problematic electronics need register and track for accountability. Producers manage consumers by informing them regarding the hazards linked to products.
    - Registration is good for the informal sector as then regulations can be imposed.
- Moving forward there is need to make available technology such as for high value recycling and recovery for managing e-waste, and standardization and benchmarking for the same. Brands along with BIS need to set up standards and benchmarks.
- BRSR SEBI sustainability reporting standards do not consider waste management part.
- Market for use of secondary raw materials and refurbished goods to be created for which capital infusion in the system is needed. Consumers may be charged in the form of ADF for proper disposal.
- Globally, PRO is supported by producer and funded by producer. In the Indian context, PRO is not supported much, is an independent entity, hence role of PRO needs to be defined or systematically be subsumed under the producers responsibility.
- Need to have transparent online mechanism to account for collection of e-waste. To track and monitor the e-waste flows right from the enforcement authority, one nodal point of contact is desired for each stage along inventorization of the data on an online portal.

- Producers want to make profit, however the reverse supply chain is costly, so all stakeholders should ensure that revenue logistics is being served. Reverse Logistics comes with various challenges including:
    - Buy back, multiple pick-up location come at a cost, distribution centre – all need to have a system on board.
    - Cities can be involved for collection drive.
    - Availability of material, pricing, paperwork, categorization of product are all challenges.
- Consumer can go to a nearby shop to sell the old product instead of giving it to the informal sector, this kind of a model, has been implemented at various places in India.
- For recyclers the major challenge is paperwork and uploading the same online for tracking purposes.
- Safe disposal of hazardous waste: from recyclers, after salvage of materials, where is the components gone/ residual waste to be sent? - whether it is sent to TSDF or co-processing, the clarity on the same to be defined.
- New draft notification for E-waste rules 2022–
    - Need to consider - SMEs, bulk consumer, collection centre and PRO. If we change rules, disruption will happen. The new framework disrupts the entire e-waste flow and value chain with no mention of PROs or its role.
    - Without PROs, producers will need to assign other 3rd party systems who will not be audited. How will this be transparent?
    - It only is beneficial for big recyclers but does not take into account the smaller SMEs like dismantlers, recyclers, etc.
    - Producer will be charged higher from recycling
    - The new rules do not state any importance to informal collectors or their integration which can disrupt the shared responsibility framework for e-waste management.
    - who would do secondary recycling if recyclers are involved so much
    - System is not steady, which will make the investors wary of investment
    - Recyclers do not have obligation for type of e-waste, they may pick any type of waste and say that they have done their part. The e-waste being recycled by recyclers to be monitored.
    - The rules should be to facilitate ecosystem to promote green industries.

About TERI

A dynamic and flexible organization with a global vision and a local focus, TERI was established in 1974, with initial focus on documentation and information dissemination. Research activities, initiated towards the end of 1982, were rooted in TERI's firm conviction that efficient utilization of energy and sustainable use of natural resources would propel the process of development.

All activities in TERI, the largest developing-country institution working towards sustainability, move from formulating local and national-level strategies to shaping global solutions to critical issues.

Buoyed by more than 43 years of excellence in research and innovation, TERI is now poised for future growth, driven by a global vision and outreach, with a philosophy that assigns primacy to enterprise in government, industry, and individual actions.

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