E-Waste Training for Policymakers and Regulators

Facilitator's Manual

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
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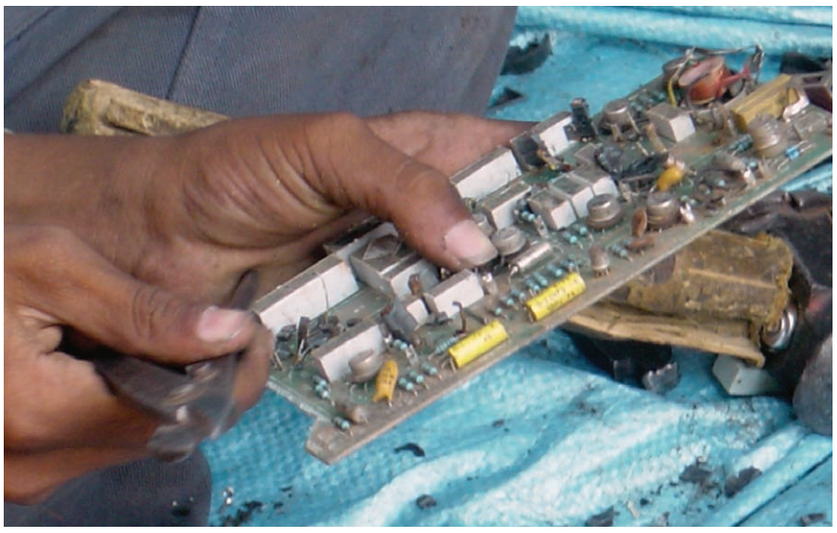
General Introduction

The introduction to this training reader will familiarize the trainers with the project background, the set-up of this manual, and provide helpful suggestions on how to use this document for providing training on one of the various topics. The content of this training is aimed at regulators (mainly State Pollution Control Boards or Committees (SPCBs / PCCs)) who are responsible for implementing the Indian E-Waste (Management & Handling Rules) 2011 (Indian Ministry of Environment and Forests 2011).

This training reader has been developed under the capacity building work package of the WEEE Recycle project in cooperation with the Centre for Science and Environment (CSE). This manual is the guideline for the “Policy Course” to support the implementation of e-waste (Management and Handling) Rules, 2011. These courses are targeted at the trainers who are planning to conduct the training of the regulators, decision makers and recyclers to support implementation and compliance to the Rules.

Project Background

The GIZ-ASEM programme has been working on e-waste management initiatives in India since 2004 with the support of Indian and European partners. GIZ-ASEM has initiated a European Commission funded SWITCH Asia project in January 2010 for establishing e-waste channels to enhance environment friendly recycling (WEEE Recycle). The training for the State Pollution Control Boards (SPCBs) is carried out within the framework of this project. The manual is based on the training course which has been given to SPCBs in May 2013 in Delhi. This training course and manual has been developed jointly with the Centre for Science and Environment (CSE).



The objective of the WEEE Recycle project is to reduce the pollution due to recycling of e-waste in the unorganized sector in four urban areas in India. This goal is to be achieved by encouraging

environmentally sound recycling through a collective effort of all relevant stakeholders in the value chain. The project will initiate dialogue among stakeholders, promote industry and government views, strengthen linkages between formal and informal economies, promote technology cooperation, provide state-of-the art information on WEEE techniques and enhance local capacities on assessing environmental situations. The project involves the establishment of an association of informal dismantlers and recyclers which are on the path of formalization. The formalized entities of the informal sector workers will be ready to take up environmentally safe management practices and implementation of cooperation models between the informal and formal sector for environmentally sound management of e-waste.

Capacity Building within the Framework of the Project

The objective of the capacity building part of this project is to strengthen the general capacity in the informal recycling sector SMEs, as well as that of formal recyclers, producers of electrical and electronic equipment (EEE), bulk generators of e-waste and other relevant e-waste stakeholders in India.

This specific trainings course aims at regulators and policy-makers. It informs them about the current situation in the e-waste recycling sector in India, the background of e-waste management and recycling as well as the legal provisions regarding and the responsibilities of the regulators. This shall support the regulators in their duty to effectively implement the Rules.

Basic Course Structure

The training for SPCBs and other regulating authorities is given in a week-long course. It contains eleven elements which resemble the eleven training sections found in this manual. These eleven elements are

1. Introduction and Overview
2. Background on E-Waste
3. Hazardous Substances in E-Waste
4. E-Waste Management & Handling Rules
5. Inventorization
6. Efficient E-Waste Collection Mechanisms
7. Best Practices on Dismantling and Recycling
8. Extended Producer Responsibility
9. Compliance Mechanisms on E-Waste
10. IEC Activities
11. Developing an Action Plan

All elements of this five-day course are included in this manual. The structure of the training, including information on which session is to be held on which day, can be found in the figure below. Of course, the structure of the sessions can be altered as per the requirements of the target group. It is possible to only present on those topics relevant for the respective target groups. The duration of the training course of one week also originates from the inclusion of site visits to formal and informal recyclers in the original training course. Resulting from this training's experience it is highly advisable to include site visits as it showcases the training participants the reality of e-waste recycling on the ground.

By following the numbering system 1 - 11 you can easily navigate through the training reader and access each training session. These numbers will be your guide through this manual.

Day 1	Day 2	Day 3	Day 4	Day 5
• Introduction and Overview • Background on E-Waste • Hazardous Substances in E-Waste	• E-Waste Management & Handling Rules • Inventorization • *Site visit*	• Efficient E-Waste Collection Mechanism • Best Practices on Dismantling and Recycling • Extended Producer Responsibility	• Compliance Mechanisms on E-Waste • IEC Activities • Site visit	• Developing an Action Plan

Table 1: Tentative training course structure

How to Use This Manual

In this last part of the general introduction the kind reader will receive an introduction on how to use this manual. As mentioned in the previous subsection there are eleven elements in this policy course, labeled 1 - 11. Element 1 “Introduction & Overview” will be the first section covered in the subsequent chapter 1. Element 2 will be covered in Chapter 2 and so forth.

Each chapter contains the guidelines on the presentation of the respective session. The chapter opens with a general summary of the session, followed by a structure of the session content in bullet points and the objectives of the session. This allows you to get a quick idea on what the training session is about.

The rest of each chapter follows the outline and chronology of the presentation. This enables you as the trainer to use this manual together with the PowerPoint slides to prepare yourself and give the presentation.

At certain points in the manual you will find boxes labeled “trainer’s note”. These boxes directly address you as the trainer and remind you of an important point, or some other task to be carried out before giving the respective part of the presentation. An example would be the reminder to provide enough worksheets for your trainees in order to do an exercise. An example of such a box is shown below:

Trainer’s note
The trainer may show the pictures in the slides to familiarize the participants with the PPEs. It is important to stress the need for proper equipment. For example, any clothing material cannot be used as mask as it will not prevent the exposure and hence it is essential to use the right kind of mask.

A last point to be made refers to exercises in the training course. If there is an exercise it is labeled as such. Some exercises require the use of worksheets. Those can be found in the annex of this manual.

1 Introduction & Overview

1.1 Introduction to This Session

In the session on Introduction & Overview, the concept of the training course is presented to the participants. They will be introduced to the agenda and the objectives of the training session will be made clear. Additionally, participants will be able to voice their expectations.

1.1.1 Objectives of This Session

At the end of this session the participants should be able to:

- Understand the general objectives of the training course
- Know about the expected outcomes of the training course
- Formulate their own expectations regarding the training
- Know about the structure of the training course

1.1.2 Overview of This Session

- General Objectives
- **Expected** Outcomes
- Participants' Expectations
- Training Course Outline

The following sections contain the actual training contents.

1.2 General Objectives

General objectives of the training are to

- **Inform participants about e-waste** and associated issues such as quantification, collection, value chain, hazardous substances, etc.
- Assess the relevance of these issues for SPCB staff
- **Review participants responsibilities** as SPCB officers as per the E-Waste (Management & Handling) Rules 2011
- **Define further steps to be taken** by the participants for the successful implementation of the Rules
- **Encourage participants to clearly define actions** for implementing the Rules and improving the management of e-waste in their state
- Expose participants to the reality of e-waste recycling and management

1.3 Expected Outcomes

Expected outcomes of the training are

- Making participants **understand the basics of e-waste** such as flow models, the value chain, e-waste management steps and treatment options
- Transmitting a clear **understanding of participants' responsibilities** for implementing the Rules
- Inform about participants about the **key challenges of e-waste management** from a regulator's perspective and offer several **options on how to address them**
- Supporting participants in developing an **action plans** containing detailed steps and activities on how to proceed with the proper implementation of the Rules

1.4 Participants' Expectations

In this slide, the participants should be asked about their expectations regarding the content of the training course.

Trainer's note
For memorising the expectations of the participants these can be collected on a notepad or on cards. These can be used at the end of the workshop to compare the results of the workshop with the expectations that had been voiced by the participants in the beginning.

1.5 Training Course Outline

For the outline of the training course, each day should have a separate slide. A possible structure of day 1 of the workshop could look like this:

Time	Session Title
10:30 – 10:55	About training programme
10:55 – 11:15	Course outline
11:15 - 11:45	Tea
11:45 – 12:30	Understanding e-waste
12:30 – 1:30	E-waste value chain
1:30 – 2:30	Lunch
2:30 – 2:45	Movie on e-waste
2:45 – 3:30	Hazardous substances in e-waste
3:30 - 3:45	Tea
3:45 – 5:15	Environmental & OHS + E-Waste QUIZ

Table 2: Example of training outline

2

Background on E-Waste

2.1 Introduction to This Session

In this session the participants are introduced to the issues associated with the generation, management and disposal of E-Waste. It is discussed what e-waste is composed of, how much e-waste is generated and by whom as well as where, how e-waste flows through the e-waste recycling and management system and what the average life time of e-waste products is.

2.1.1 Objectives of This Session

At the end of this session the participants should:

- Have a basic understanding on the problems associated with e-waste management
- Know what e-waste is composed of
- Know where e-waste is produced and in what quantities
- Understand the flows of e-waste
- Be familiar with the concepts for estimating the average life-time of EEE

2.1.2 Overview of This Session

- What is e-waste
- Composition of e-waste
- Generation of e-waste
- State and city wise e-waste in India
- Mechanism of e-waste flow
- Average life of electronic goods

The following sections contain the actual training contents.

2.2 What is E-Waste?

Electronic waste or E-waste is any waste that comprises of all types of electrical and electronic equipment that has or could enter the waste stream. It includes TVs, computers, mobile phones, white wares (refrigerators, air conditioners, washing machines, stoves, etc.), toys, toasters or any household or business item with circuitry or electrical components with power or battery supply. Growth of Information and Communication Technology Sector has enhanced the usage of the electronic equipment exponentially. Today electronic waste is one of the fastest growing waste streams in the country with a

growth rate of 10% per annum[1] (Chatterjee 2011). There is no comprehensive and recent inventory of e-waste in the country however as per Central Pollution Control Board's (CPCB) preliminary estimates the e-waste generation in India has been estimated to be 0.8 million tonnes by 2012. Also according to a report by United Nations (UN) the world wide generation of e-waste is estimated around 30-50 million tonnes per annum[2] (Indian Central Pollution Control Board 2011).

In developed countries E-waste equals 1% of total solid waste on an average. In USA it accounts for 1% - 3% of the total municipal solid waste generation. In European Union, Waste Electrical and Electronic Equipment (WEEE) or e-waste increases by 16-28% every year which is three times faster than the average annual municipal solid waste generation. In India and China although the per capita generation is less than 1 kg it is growing at an exponential pace. The increasing "market penetration" in developing countries, "replacement market" in developed countries and "high obsolescence rate" make WEEE/E-waste one of the fastest waste streams[3] (UNEP 2007a).

E-Waste can be defined by the following characteristics:

- Electronic waste or e -waste is any broken or unwanted electrical or electronic appliance.
- E-waste includes computers, consumer electronics, phones, medical equipments, toys and other items that have been discarded by their original users.
- E-Waste also include waste which is generated during manufacturing or assembling of such equipments

Others define e-waste the following way:

- **WEEE Directive (EU 2002)**

  Electrical or electronic equipment which is waste including all components, sub-assemblies and consumables, which are part of the product at the time of discarding.

- **Basel Action Network (Puckett et al. 2002)**

  E-waste encompasses a board and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users.

- **OECD (2001)**

  E-waste is defined as "any appliance with an electric power supply that has reached its end of life."

2.2.1 Exercise: What is E-Waste?

Ask the participants what they think e-waste is comprised of.

As a solution, the WEEE Directive's definition of EEE is presented from which e-waste is generated as well as the definition from the E-Waste (M&H) Rules

EEE in ten categories (**WEEE Directive**)

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment

1 http://mit.gov.in/sites/upload_files/dit/files/EWaste_Sep11_892011.pdf

2 http://cpcb.nic.in/ImplementationOfE-WasteRules.pdf

3 http://www.unep.or.jp/ietc/Publications/spc/EWasteManual_Vol1.pdf

5. Lighting equipment
6. Electrical and electronic tools (with the exception of large -scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

Table 3: Categories and products of electrical and electronic equipment

S. No.	Category	Products
1.	Large household appliances	Large cooling appliances, Refrigerators, Freezers, Other large appliances used for refrigeration, conservation and storage of food, Washing machines, Clothes dryers, Dish washing machines, Cooking Electric hot plates, Microwaves, Other large appliances used for cooking and other processing of food, Electric heating appliances, Electric radiators, Other fanning, exhaust ventilation and conditioning equipment
2.	Small household appliances	Cleaners, Carpet sweepers, Other appliances for cleaning, Appliances used for sewing, knitting, weaving and other processing for textiles, Iron and other appliances for ironing, mangling and other care of clothing, Toasters, Fryers, Grinders, coffee machines and equipment for opening or sealing containers or packages, Electric knives, Appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and body care appliances, Clocks, watches and equipment for the purpose of measuring indicating or registering time Scales.
3.	IT and telecommunications equipment.	Centralized data processing, Mainframes, Minicomputers, Printer units, Personal computing, Personal computers (CPU, mouse, screen and keyboard included), Laptop computer (CPU, mouse, screen and keyboard included), Notebook computers, Notepad computers, Printers, Copying equipment, Electrical and electronic typewriters, Pocket and desk calculators and other products and equipment for the collection, storage, processing, presentation or communication of information by electronic means, User terminals and systems, Facsimile, Telex, Telephones, Pay telephones, Cordless telephones, Cellular telephones, Answering systems, And other products or equipment of transmitting sound, images or other information by telecommunications.
4.	Consumer equipment.	Radio sets, Television sets, Video cameras, Video recorders, Hi-fi recorders, Audio amplifiers, Musical instruments, Other products or equipment for the purpose of recording or reproducing sound or image, including signals or other technologies for the distribution of sound and image than by telecommunications.

5.	Lighting equipment	Luminaries for fluorescent lamps with the exception of luminaries in households, Straight fluorescent lamps, Compact fluorescent lamps, High intensity discharge lamps, including pressure sodium lamps and metal lamps, Low pressure sodium lamps, Other lighting or equipment for the purpose of spreading or controlling light with the exception of filament bulbs.
6.	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	Drills, Saws, Sewing machines, Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making, holes, punching, folding, bending or similar processing of wood, metal and other materials, Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses, Tools for welding, soldering or similar use, Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means, Tools for mowing or other gardening activities.
7.	Toys, leisure and sports equipment	Electric trains or car racing sets, Hand-held video game consoles, Video games, Computers for biking, diving, running, rowing, etc., Sports equipment with electric or electronic components, Coin slot machines.
8.	Medical devices (with the exception of all implanted and infected products)	Radiotherapy equipment, Cardiology, Dialysis, Pulmonary ventilators, Nuclear medicine, Laboratory equipment for in-vitro diagnosis, Analyzers, Freezers, Fertilization tests, Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability.
9.	Monitoring and control instruments	Smoke detector, Heating regulators, Thermostats, Measuring, weighing or adjusting appliances for household or as laboratory Equipment, Other monitoring and control instruments used in industrial installations (e.g.in control panels).
10.	Automatic dispensers	Automatic dispensers for hot drinks, Automatic dispensers for hot or cold bottles or cans, Automatic dispensers for solid products, Automatic dispensers for money, All appliances which deliver automatically all kind of products[4] (UNEP 2007a)

4 http://www.unep.or.jp/ietc/Publications/spc/EWasteManual_Vol1.pdf

EEE in the E-waste (M&H) Rules

S. No.	E-Waste Categories
i.	IT and telecommunication equipments: Centralized data processing: Mainframe, Minicomputers Personal computers: Personal computers (CPU with input and output devices), Laptop, Notebook, notepad etc. Printer including cartridge, Copying equipments Electrical & electronic typewriters, Pocket and desk calculators, Other products and equipments for collection, storage, processing, presentation or communication of information by electronics means, User terminal & systems, Facsimile, Telex, telephones (cellular, cordless, pay phones) answering machines, And other products or equipments of transmitting sound, images or other information by telecommunication
ii.	Consumer electrical & electronics:- Television sets (including LCD & LED), refrigerators, washing machines, air-conditioners

Figure 1: E-Waste categories as per the E-Waste (M&H) Rules

2.3 Composition of E-Waste

The composition of e-waste is very diverse and contains products across different categories. A typical electronic and electrical item consists of more than 1000 different substances which can fall under hazardous and non-hazardous categories. The major constituents are ferrous and non-ferrous metals, plastics, glass and plywood, printed circuit boards, concrete and ceramics, rubber and other items. Iron and steel constitutes about 50% of the WEEE followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium etc. Table 4 given below shows the average weight and composition of some selected electronic and electrical appliances. The presence of elements like lead, mercury, arsenic, cadmium, selenium, and hexavalent chromium and flame retardants beyond threshold quantities in WEEE / E-waste classifies them as hazardous waste.

Table 4: Percentage weight of different materials in e-waste[5] (UNEP 2007a)

Appliances	Average weight (kg)	Iron (Fe) % weight	Non Fe-metal % weight	Glass % weight	Plastic % weight	Electronic components % weight	Others % weight
Refrigerators and freezers	48	64.4	6	1.5	13		15.1
Washing Machine	40-47	59.8	4.6	2.6	1.5		31.5
Personal computer	29.6	53.3	8.4	15	23.3	17.3	0.7
TV sets	36.2	5.3	5.4	62	22.9	0.9	3.5
Cellular telephones	0.08-0.100	8	20	10.6	59.6		1.8

The selected appliances in Table 4 are the most commonly used electronics and electrical that constitutes bulk quantities of WEEE/E-waste in developing countries.

5 http://www.unep.or.jp/ietc/Publications/spc/EWasteManual_Vol1.pdf

WEEE/ E-waste dismantling or incineration is considered toxic. Therefore, they are targeted for reuse, recovery or hazardous waste disposal. The recovery of metals is a profitable business, which results in local, trans-boundary and global trade. The presence of elements of economic value in E-waste and their recovery potential makes it a source of secondary raw material and a tradable commodity. It can be understood from the tables given below the recoverable quantities of elements in some common household electronics which can be reused for other purposes.

Table 5: Recoverable quantities of elements in a TV (Cambodian Ministry of Environment 2009)

Elements	Percentage	ppm	Recoverable Weight of element (Kg)
Aluminum	1.2		0.4344
Copper	3.4		1.2308
Lead	0.2		0.0724
Zinc	0.3		0.1086
Nickel	0.038		0.013756
Iron	12		4.344
Plastic	26		9.412
Glass	53		19.186
Silver		20	0.000724
Gold		10	0.000362

Table 6: Recoverable quantities of elements in a refrigerator

Material Type	Percentage
CFCs	0.20
Oil	0.32
Ferrous metals	46.61
Non Ferrous metals	4.97
Plastics	13.84
Compressors	23.80
Cables/Plugs	0.55
Spend PurfFoam	7.60
Glass	0.81
Mixed Waste	1.31
Total	**100**
Materials disposed of to incinerator	0.20
Materials disposed of to landfill	8.90
Materials sent for recycling	90.90

Table 7: Recoverable quantities of elements in a PC (Cambodian Ministry of Environment 2009)

Elements	Content (% to total weight)	Content (kg)	Recycling efficiency (%)	Recoverable weight of element (kg)
Plastics	23	6.25	20%	1.25069408
Lead	6	1.71	5%	0.08566368
Aluminum	14	3.85	80%	3.08389248
Germanium	0.0016	0.00	0%	0
Gallium	0.0013	0.00	0%	0
Iron	20	5.57	80%	4.45453312
Tin	1	0.27	70%	0.19188512
Copper	7	1.88	90%	1.69614576
Barium	0.0315	0.01	0%	0
Nickel	0.8503	0.23	0%	0
Zinc	2	0.60	60%	0.35979072
Tanialum	0.0157	0.00	0%	0
Indium	0.0016	0.00	60%	0.00026112
Vanadium	0.0002	0.00	0%	0
Terbium	0	0.00	0%	0
Beryllium	0.0157	0.00	0%	0
Gold	0.0016	0.00	99%	0.000430848
Europium	0.0002	0.00	0%	0
Tritium	0.0157	0.00	0%	0

Elements	Content (% to total weight)	Content (kg)	Recycling efficiency (%)	Recoverable weight of element (kg)
Ruthenium	0.0016	0.00	80%	0.00034816
Cobalt	0.0157	0.00	85%	0.00362984
Palladium	0.0003	0.00	95%	0.00007752
Manganese	0.0315	0.01	0%	0
Silver	0.189	0.01	98%	0.005037984
Antinomy	0.0094	0.00	0%	0
Bismuth	0.0063	0.00	0%	0
Chromium	0.0063	0.00	0%	0
Cadmium	0.0094	0.00	0%	0
Selenium	0.0016	0.00	70%	0.00030464
Niobium	0.0002	0.00	0%	0
Yttrium	0.0002	0.00	0%	0
Rhodium	0	0.00	50%	0
Mercury	0.0022	0.00	0%	0
Arsenic	0.0013	0.00	0%	0
Silica	24.8803	6.77	0%	0

The recyclable potential of WEEE is specific for each appliance. The parts, materials found in it can be broadly classified into six categories.

- Iron and steel, used for casings and frames
- Non-ferrous metals, especially copper used in cables, aluminum and gold.
- Glass
- Plastic
- Electronic components
- Others (rubber, wood, ceramic etc.)

2.4 Generation of E-Waste

Waste Electrical and Electronic Equipment (WEEE) or E-waste is one of the fastest growing waste streams in the world. In developed countries, it equals 1% of total solid waste on an average. It is expected to grow to 2% by 2010. In USA, it accounts for 1% to 3% of the total municipal waste generation. In EU, historically, WEEE increases by 16-28% every five years, which is three times faster than average annual municipal solid waste generation. A recent source estimates that total amount of WEEE generation in EU ranges from 5 to 7 million tons per annum or about 14 to 15 kg per capita and is expected to grow at a rate of 3% to 5% per year (UNEP 2007a). The amount of E-waste in the EU was estimated between 8.3 and 9.1 million tonnes in 2005 and expected to reach some 12.3 million tonnes in 2020 (Huisman et al. 2007). All in all, the global amount of e-waste generated per annum is estimated between 20 and 50 million tonnes and solely obsolete computers have contributed between 1994 and 2004, approximately 2.872.000 tonnes of plastic, 718.000 tonness of lead, 1.363 tonnes of cadmium and 287 tonnes of Mercury all adding to the environmental burden (Nischalke 2008).

In developing countries the share of e-waste ranges from 0.01% to 1% of total municipal solid waste. In countries like China and India, though annual generation per capita is less than 1 kg, it is growing at an exponential pace. The increasing “market penetration” in developing countries, “replacement market” in developed countries and “high obsolescence rate” make WEEE/E-waste one of the fastest waste streams.

In South Africa and China by 2020 e-waste from old computers will have jumped by 200 – 400 % from 2007 levels and by 500% in India (Schluep et al. 2009).

By that same year in China, e-waste from discarded mobile phones will be about 7 times higher than 2007 levels and, in India, 18 times higher. By 2020, e-waste from televisions will be 1.5 to 2 times higher in China and India while in India e-waste from discarded refrigerators will double or triple.

China already produces about 2.3 million tonnes (2010 estimate) domestically, second only to the United States with about 3 million tonnes. And, despite having banned e-waste imports, China remains a major e-waste dumping ground for developed countries.

In the European Union (EU), the total generation of e-waste in 2005 was estimated to be 9.3 million tonnes which included 40 million personal computers and 32 million televisions. The same scenario applies to mobile phones and other hand held electronic items used in the present society. Each year over 130 million mobile phones in the United States and over 105 million mobile phones in Europe reach their end-of-life and are thrown away.

A recent review of European legislation on e-waste, known as the "Waste Electrical Electronic Equipment (WEEE)" Directive (mentioned earlier), highlights that in 2005 in Europe alone, there were between 8.3 and 9.1 million tonnes of e-waste, tendency rising. In Australia, with an average of 22 electrical items per household, the Australian Bureau of Statistics has estimated that in the next two years, most of the 9 million computers, 5 million printers and 2 million scanners in Australian homes will be replaced. In the US the Environment Protection Agency (EPA) has reported that the US generated 1.9 to 2.2 million tonnes of e-waste in 2005, with only 12.5% collected for recycling (Step Initiative n.d.).

E Waste Generation
Global quantity: approx 20-50 million tonnes (UNEP).
Mobile phones: 700 million units (2005)
Europe: 8.3–9.1 million tonnes annually
US: 2.6 million tonnes annually (2005 - US EPA).
India: 0.33 million tonnes (2007, Mobiles and computers).
Rates of increase: 3-5% globally, 10-12% India.

Agarwal 2012

Between 2000 and 2005, the Organization for Economic Co-operation and Development (OECD) notes a 22% growth in Information and Communications Technology (ICT) in China. Furthermore, China was the 6th largest ICT market in 2006, after the US, Japan, Germany, UK and France. This is astounding when one considers that just ten years ago, less than 1% of China's population owned a computer. Computers are only one part of the e-waste stream though, as we see that in the EU in 2005, fridges and other cooling and freezing appliances, combined with large household appliances, accounted for 44% of total e-waste; according to UNU's Study supporting the 2008 Review of the Waste Electrical and Electronic Equipment (WEEE) Directive (Step Initiative n.d.).

2.5 Generation of E-Waste in India

Indian economy has witnessed significant growth in the last two decades. The IT sector has contributed significantly to the overall economic growth. In recent years, the electronic industry has been growing very rapidly. India's low manufacturing costs, skilled labor, raw materials, availability of engineering skills and opportunity to meet demand in the populous Indian market have contributed significantly to facilitate the growth of the electronics industry. Besides, India's, large and growing middle class of 320-340 million has disposable income for consumer goods.

In India, among top ten cities, Mumbai ranks first in generating e-waste followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. The 65 cities generate more than 60% of the total generated e-waste, whereas, 10 states generate 70% of the total e-waste.

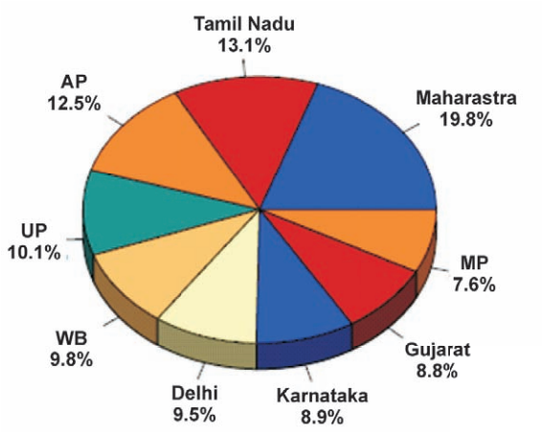


Figure 2: State wise E-Waste generation in India

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste. An Indian market Research Bureau (IMRB) survey of 'E-waste generation at Source' in 2009 found that out of the total e-waste volume in India, televisions and desktops including servers comprised 68 per cent and 27 per cent respectively. Imports and mobile phones comprised of 2 per cent and 1 per cent respectively (Rajya Sabha Secretariat 2011).

2.6 E-Waste Flow

The lifecycle of e-waste can be broadly represented in three steps:

1. Material flow
2. Life cycle
3. Geographical boundary

The following flowchart gives an understanding of material flow along the life cycle of electrical and electronic equipment, its conversion into an obsolete item and transformation into a new material.

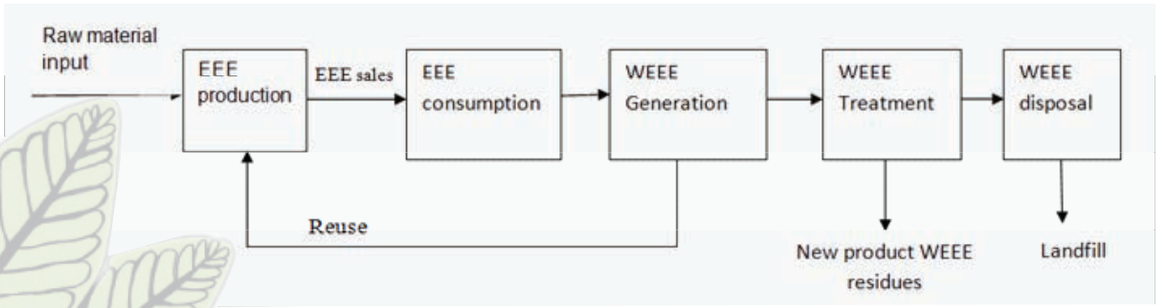


Figure 3: Flowchart of E-Waste

The establishment of material flow within a geographical boundary assists in identifying, networks / chain connecting different phases of life cycle of electrical and electronic equipment and associated stakeholders. Once the chain gets established, "material flow balance" ex. Input/ output balances in each phase forms the basis of quantification of WEEE/ E-waste in the life cycle analysis of electrical and electronic equipment. The WEEE/ E-waste material flow model developed by "European Topic Centre

on Waste" has been described below and shown in Figure (UNEP 2007b), to develop a conceptual understanding of WEEE/ material flow. The salient features of this model are given below.

1. The model is based on the 'unit process approach', where a unit process represents processes or activities.
2. The material flow model considers all unit processes and flows within a defined boundary. Arrows indicating the flow of material link the unit processes.
3. There are two different kinds of unit process.
   Type 1 receives material without any alteration, where there are no conversions. Therefore, input is equal to output ex. use and collection of electrical and electronic equipment. In Type 2, a conversion of materials takes place, thus creating new materials (products, waste, etc.) ex. treatment of WEEE/ E-waste including dismantling/ incineration/ smelting etc.
4. The boundary is the interface between the existing system and the external environment or other systems

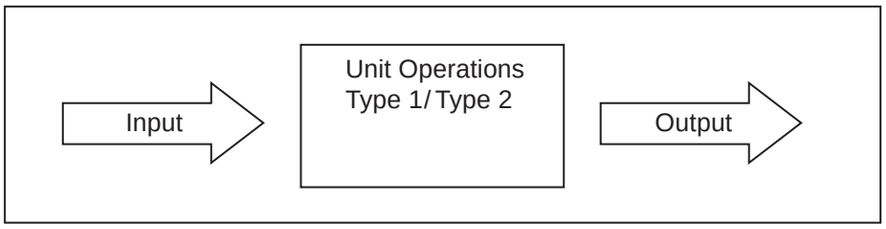


Figure 4: Conceptual e-waste flow model

The material flow model, when applied to "life cycle" of electrical and electronic equipment leads to evolution of the 'Four-Phase-Model', where each phase describes respective unit operations and different stakeholders.

Phase I:

Unit Operations/ Processes/ Activities: Production and sales of electrical and electronic equipment including import, export, and input of equipment for re-use from repair of WEEE/ E-waste.

Stakeholders: Manufacturers, importers, exporters, and retailers (brand new/ second hand)

Phase II:

Unit Operations/ Processes/ Activities: Consumption of electrical and electronic equipment, use of electrical and electronic equipment in households, offices and industry.

Stakeholders: Consumers like households, commercial places like offices and industry

Phase III:

Unit Operations/ Processes/ Activities: Collection of end-of-life electrical and electronic equipment, including transfer to treatment/disposal sites, import/export.

Stakeholders: Consumers, importers, exporters, collectors, traders, dismantlers, waste treatment operators

Phase IV:

Unit Operations/ Processes/ Activities: Treatment/disposal alternatives for WEEE/ E-waste ex. repair, decontaminating, dismantling, shredding, landfill and incineration.

The input/output material balances explaining the mathematical relationship has been described in the table below

Table 8: Four-Phases-Model

Phase 1 – Production / Sales	
Mass or number of equipment sold to consumers within a specified time period (t) is the basic parameter to design this system. It is assumed that no losses occur and no conversion of material takes place in this phase. Therefore Input = Output	Input/Output for Sales: Input (t) = Productior (t) + Import (t) + re-used of collected WEEE (t) – Treatment/Disposal of non-saleable EEE (t) Output (t) = Consumption (t) + Export (t)
Phase II – Consumption	
The design of the model of phase II requires mass/number of pieces of equipment bought and used by the consumers. After a certain time span (average life time t) the end-of-life goods are passed on for collection. It is assumed that in the consumption period no losses occur and no conversion of material takes place. The model will not consider the servicing of the equipment, the replacement of parts etc. Therefore Input = Output	Input/Output for Consumption: Input (t) = Output Sales (t) – export (t) Output (t) = WEEE generated (t)
Phase III – Collection	
The design of the model in phase III requires mass or number of goods collected after the consumption period. It is assumed that in the collection period no losses occur and no conversion of material takes place. In addition the import WEEE / E-waste has to be considered. The transport itself and its need for energy are not considered. Therefore Input = Output	Input/Output for Collection: Input (t) =WEEE generated after consumption (t) + import of end-of-life EEE (t) Output (t) = end-of life goods transferred to disposal/ treatment/reuse [possibilities 1…n (t)] + export (t)
Phase IV – Treatment / Disposal	
The design of the model in phase IV requires mass or number of WEEE/E-waste collected and transferred to the different treatment disposal activities. During this phase, a conversion or transition of WEEE/E-waste takes place, thus creating new materials (fractions, components, dangerous substances). In phase IV the model has to be designed for each specific type of treatment/disposal, taking into account the material input and the conversion of the material. Output depends on conversion/ transition of the material and will lead to specific transfer factors.	Note: Treatment/disposal comprises one, two or even successive steps with different technologies used. The formula for this phase can be developed depending on the level of treatment and disposal.

It may be noted that all the mathematical formulations in this model are functions of time. Therefore, these formulations require following data for a particular geographical region/city/ country with respect to time.

1. Production and import data for electrical and electronic equipment
2. Sales and export data for electrical and electronic equipment
3. Local WEEE/ E-waste generation data
4. Imported WEEE/ E-waste data
5. WEEE/ E-waste data transferred for disposal/ treatment/ reuse

The key time dependent functions related to WEEE/ E-waste in this model are “Local E-waste Generation” and “Imported E-waste”. The time factor in “Local E-waste Generation” function is defined in terms of “Average Life Time/Obsolescence Rate” of E-waste and is an indicator of “Consumer Behavior.” “Imported E-waste” is a function of time of implementation of regulations controlling import and export of E-waste in a geographical region/ city/ country.

2.7 Average Life of EEE

Average life cycle/ obsolescence rate is the time span after which the electrical and electronic item comes to its “end of life”. It can be defined in terms of ‘active life”, ‘passive life” and storage”.

Average life cycle/ Obsolescence rate = Active Life + Passive Life + Storage

The number of years, a machine can be effectively used is called its active life. After active life, it can be refurbished or reused for certain time period. This time period constitutes passive life. Storage includes storage time before disposal and storage at repair shops before dismantling.

In developed countries, average life cycle of electrical and electronic equipment is generally equivalent to “Active Life”, while in developing countries, it is a sum of active life, passive life and storage. Therefore, in developing countries, a second hand market exists for WEEE/ E-waste after its active life. All the three parameters vary in different geographical regions. Therefore, average life cycle/ obsolescence rate varies in each geographical region and leads to different WEEE/ E-waste inventory.

The material flow analysis (MFA) described in the above section helps to establish WEEE/ E-waste trade value chain. This trade value chain describes unit operations/processes/ activities carried out by different stakeholders in a geographical region. In developed countries, where WEEE/ E-waste management system is in operation, the entire trade value chain occurs in organized/ formal sector. In developing countries, a part of the trade occurs in unorganized/ informal sector. An example of generic E-waste trade value chain based on MFA in a developing country is shown in the figure below (UNEP 2007b).

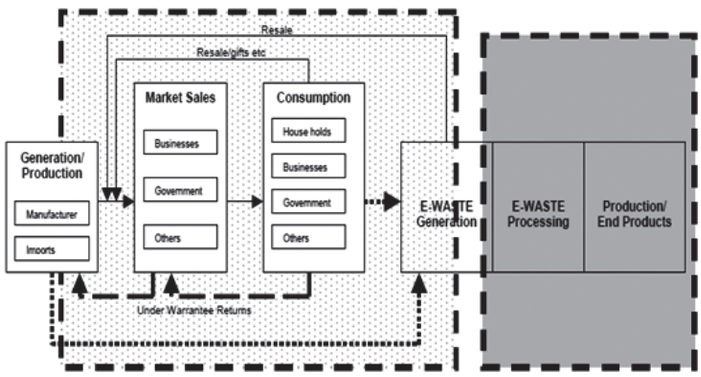


Figure 5: E-waste trade value chain

In majority of developing countries, the informal sector engagement starts from the point of collection and continues till the last stage in some capacity. However, other steps/unit operations like E-waste processing, production/ end products may be present or absent in a country.

2.8 Exercise: E-Waste Quiz

At the end of the first day, participants are asked to take a short quiz on e-waste. The quiz brings up several of the issues that have been presented in the previous sessions.

There are three sets of supporting document for the quiz:

- A questionnaire containing the 15 questions
- An answer sheet with the correct answers
- A presentation with the answers; the presentations also allows you to present the results of quiz

The questionnaire and answer sheets can be found in the annex.

Trainer's note
Make sure to prepare the Worksheets for the participants.

3

Hazardous Substances in E-Waste

3.1 Introduction to This Session

Hazardous substances found in e-waste pose threats to human health and the environment if they are not properly treated in the collection, dismantling and recycling process. In this session the most important hazardous substances found in e-waste are presented as well as the risks associated with them and options on how to treat the ensuring that the hazardous substances are not released.

3.1.1 Objectives of This Session

At the end of this session the participants should be able to:

- Name the most hazardous substances found in e-waste
- Understand the risks associated with these substances
- Know about options on how to prevent the hazards resulting from these substances

3.1.2 Overview of This Session

- Hazardous Substances in E-Waste
- E-Waste Processing Risks to Health and Environment
- Case Studies on Hazards of E-Waste
- Restriction of Hazardous Substances
- Green EEE without Hazardous Substances

The following sections contain the actual training contents.

3.2 Hazardous Substance in E-Waste

E-waste is also known to contain a wide variety of toxic or otherwise hazardous components that may constitute a serious risk for human health and the environment if they are released during processing, recycling or disposal. For example, e-waste contains a wide range of heavy metals, such as lead, cadmium and mercury, and also persistent organic compounds, such as brominated flame retardants (BFRs) and phthalates. Some of the possible hazardous elements contained in E-waste are listed in the table below.

Table 9: Possible hazardous substances in WEEE/E-waste Components (Indian Central Pollution Control Board 2008)

Component	Possible Hazardous Content
Metal	
Motor \ Compressor	
Cooling	ODS
Plastic	Phthalate plasticize, BFR
Insulation	Insulation ODS in foam, asbestos, refractory ceramic fiber
Glass	
CRT	Lead, Antimony, Mercury, Phosphors
LCD	Mercury
Rubber	Phthalate plasticizer, BFR
Wiring / Electrical	Phthalate plasticizer, Lead, BFR
Concrete	
Transformer	
Circuit Board	Lead, Beryllium, Antimony, BFR
Fluorescent Lamp	Mercury, Phosphorus, Flame Retardants
Incandescent Lamp	
Heating Element	
Thermostat	Mercury
BFR – containing plastic	BFRs
Batteries	Lead, Lithium, Cadmium, Mercury
CFC, HCFC, HFC, HC	Ozone depleting substances
External electric cables	BFRs, plasticizers
Electrolyte Capacitors (over L/D 25mm)	Glycol, other unknown substances

Among the substances mentioned in the table above, of most concern are the heavy metals such as lead, mercury, cadmium and chromium (VI), halogenated substances (e.g. CFCs), polychlorinated biphenyls, plastics and circuit boards that contain brominated flame retardants (BFRs). BFR can give rise to dioxins and furans during incineration. Other materials and substances that can be present are arsenic, asbestos, nickel and copper. These substances may act as a catalyst to increase the formation of dioxins during incineration.

However, many of these pollutants are not present as pure compounds in the e-waste, but are constituents of complex materials, e.g. flame retardants in plastics, or are hidden inside electrical components, such as mercury in switches, and are therefore difficult to isolate and separate from the other components. These facts make the recycling of e-waste complicated and costly, but is necessary from an environmental point of view. To avoid serious environmental pollution and human exposure, adequate treatment of e-waste is crucial, particularly considering the huge amounts of e-waste we are producing globally[1] (Swedish Environmental Protection Agency 2011).

1 http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6417-4.pdf

Pollutants or toxins in E-waste are concentrated in circuit boards, plastics, batteries and LCDs (Liquid crystal displays). Some of the common pollutants occurring in waste electrical and electronic equipment are given in the table below. This table closely resembles table 9. Only the table below is given in the presentation:

Table 10: Pollutants and their occurrence in WEEE (Rajya Sabha Secretariat 2011)

Pollutant	Occurrence
Arsenic	Semiconductors, diodes, microwaves, LEDs (Light emitting diodes), solar cells
Barium	Electron tubes, filler for plastic and rubber, lubricant additives
Brominated flame-proofing agent	Casing, circuit boards (plastic), cables and PVC cables
Cadmium	Batteries, pigments, solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRTs)
Chrome	Dyes/pigments, switches, solar
Cobalt	Insulators
Copper	Conducted in cables, copper ribbons, coils, circuitry, pigments
Lead	Lead rechargeable batteries, solar, transistors, lithium batteries, PVC (polyvinyl chloride) stabilizers, lasers, LEDs, thermoelectric elements, circuit boards
Liquid crystal	Displays
Lithium	Mobile telephones, photographic equipment, video equipment (batteries)
Mercury	Components in copper machines and steam irons; batteries in clocks and pocket calculators, switches, LCDs
Nickel	Alloys, batteries, relays, semiconductors, pigments
PCBs (Polychlorinated biphenyls)	Transformers, capacitors, softening agents for paint, glue, plastic
Selenium	Photoelectric cells, pigments, photocopiers, fax machines
Silver	Capacitors, switches (contacts), batteries, resistors
Zinc	Steel, brass, alloys, disposable and rechargeable batteries, luminous substances

The waste from electronic products include toxic substances such as cadmium and lead in the circuit boards; lead oxide and cadmium in monitor cathode ray tubes (CRTs); mercury in switches and flat screen monitors; cadmium in computer batteries; polychlorinated biphenyls in older capacitors and transformers; and brominated flame retardants on printed circuit boards, plastic casings, cables and PVC cable insulation that releases highly toxic dioxins and furans when burned to retrieve copper from the wires. Many of these substances are toxic and carcinogenic. The materials are complex and have been found to be difficult to recycle in an environmentally sustainable manner even in developed countries.

The major hazards associated with the harmful elements in the composition of WEEE are listed in the table below.

Table 11: Hazards from e-waste substances

Metal	Danger
Lead	A neurotoxin that affects the kidneys and the reproductive system. High quantities can be fatal. It affects mental development in children. Mechanical breaking of CRTs (cathode ray tubes) and removing solder from microchips release lead as powder and fumes.
Plastics	Found in circuit boards, cabinets and cables, they contain carcinogens. BFRs or brominated flame retardants give out carcinogenic brominated dioxins and furans. Dioxins can harm reproductive and immune systems. Burning PVC, a component of plastics, also produces dioxins. BFR can leach into landfills. Even the dust on computer cabinets contains BFR.
Chromium	Used to protect metal housings and plates in a computer from corrosion. Inhaling hexavalent chromium or chromium 6 can damage liver and kidneys and cause bronchial maladies including asthmatic bronchitis and lung cancer.
Mercury	Affects the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk. It is released while breaking and burning of circuit boards and switches. Mercury in water bodies can form methylated mercury through microbial activity. Methylated mercury is toxic and can enter the human food chain through aquatic.
Beryllium	Found in switch boards and printed circuit boards. It is carcinogenic and causes lung diseases.
Cadmium	A carcinogen. Long-term exposure causes Itai-Itai disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones. Cadmium is released into the environment as powder while crushing and milling of plastics, CRTs and circuit boards. Cadmium may be released with dust, entering surface water and groundwater.
Acid	Sulphuric and hydrochloric acids are used to separate metals from circuit boards. Fumes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.

E-waste typically contains complex combinations of materials and components down to microscopic levels. The wastes are broken down not just for recycling but for the recoverable materials such as plastic, iron, aluminum, copper and gold. However, since e-waste also contains significant concentration of substances that are hazardous to human health and the environment, even a small amount of E-waste entering the residual waste will introduce relatively high amount of heavy metals and halogenated substances. Such harmful substances leach into the surrounding soil, water and air during waste treatment or when they are dumped in landfills or left to lie around near it. Sooner or later, they would adversely affect human health and ecology.

Typical pathways for the release of pollutants from e-waste are:

Heavy metals	Dioxins and Furans	Acids
• Dust generated during mechnical treatment, for example, the dismantling and crushing of WEEE. • Flue gas released during thermal treatment, for example, the release of metals from compounds during the incineration of plastic. • Vaporization wherein metals are released from compounds in an acid bath	• Dioxins and furans are emitted during the thermal treatment of WEEE, for example during - • The combustion of cable insulation containing PVC in order to recycle copper wiring • The incineration of epoxy resin containing flame retardant from circuit boards in order to recycle the metal they contain	• Released in the form of vapour when metals are released from compounds. May also get distributed throughout the surrounding area in the following ways • Factory air and dust being blown into the vicinity • Leaching through waste water and seepage • Release of flue gas into the atmosphere as a result of open incineration of furnace combustion

Figure 6: Pathways of pollutants

Unless suitable safety measures are taken, these toxic substances can critically affect the health of employees and others in the vicinity – who manually sort and treat the waste – by entering their body:

- through respiratory tracts,
- through the skin, or
- through the mucous membrane of the mouth and the
- digestive tract

The health impact of e-waste is evident. This impact is found to be worse in developing countries like India where people engaged in recycling e-waste are mostly in the unorganized sector, living in close proximity to dumps or landfills of untreated e-waste and working without any protection or safeguards. Many workers engaged in these recycling operations are the urban poor and unaware of the hazards associated with them. For instance, such recycling activities lead to the deterioration of local drinking water which can result in serious illnesses. It was found that a river water sample from the Lianjiang River near a Chinese “recycling village” had lead levels that were 2400 times higher than the World Health Organization Drinking Water Guidelines thereby involving a serious health hazard.

The generation of huge quantity of electronic waste presents an enormous environmental and health hazard to any community. This is best indicated by the table below which shows the amount of waste that 500 million computers can create.

Table 12: Waste of 500 million PCs (Rajya Sabha Secretariat 2011)

Resource	Weight in pounds
Plastic	6.23 Billion
Lead	1.58 Billion
Cadmium	3 Million
Chromium	1.9 Million
Mercury	632,0000

The above table shows the magnitude of problem that the piling heaps of E-waste poses. However, the table depicts only the waste generated from 500 million computers, so we can envisage the quantities of waste generated by other electronics.

There are basically four ways of treating E-waste. The most common one has been storing e-wastes in landfills, but it is replete with all the dangers of leaching described earlier. The hazardous effects are far worse in the older or less stringently maintained landfills or dumpsites. In the US, about 70 per cent of heavy metals (including mercury and cadmium) found in landfills come from electronic discards. Because of its hazardous nature, dumping in landfills have been banned in most of the states in the US and European Union.

Another method commonly used has been to incinerate or burn the goods concerned, but this process releases heavy metals such as lead, cadmium and mercury into the atmosphere. Municipal incinerators have been some of the largest point sources for dioxins in the US and Canadian environments and of heavy metal contamination of the atmosphere.

Reusing and recycling are the other ways of dealing with e-wastes. They have been preferable because they increase the lifespan of the products and therefore imply less waste over time. Re-use constitutes direct second hand use, or use after slight modifications are made to the original functioning equipment like memory upgrades, etc. However, they end up as waste eventually as they have limited life span. The reuse of second-hand electronic goods in the developing world including India falls in this category, where the waste ends up locally and where there is no adequate facility and competence to deal with them appropriately.

While recycling appears to be a safe method to utilize or dispose e-wastes, it can be a misleading characterization of disparate practices including dismantling, shredding, burning, exporting, etc. which are mostly unregulated and often create additional hazards itself. “Recycling” of hazardous wastes, even under the best of circumstances, has little environment benefit as it simply moves the hazards into secondary products that eventually have to be disposed of. One view says that unless the goal is to redesign the product to use nonhazardous materials, recycling may be a false solution. However, it is also true that recycling is good not only for the environment but also a good business practice. Recycling is therefore an important solution, especially if we consider that e-waste contains many valuable and rare materials.

3.3 E-Waste Processing Risks to Health and Environment

Collection risk: release of hazardous substances during breakage; release of Hg: breakage of light sources, switches

Dismantling risk: Emission of lead and barium oxide from crushing of CRT glass, risk of explosion because of vacuum in CRT

Shredding risk: Emission to air (e.g. plastic will give rise to various organic compounds as well as metals; evidence shows that Cd and Pb levels PBDE levels, and PBDD levels among workers in TV recycling facility are very high)

Pyro-metallurgical process risk: Fly ash has high amount of metal and PCDD/PBDD

Hydro-metallurgical process risk: Irritation of skin, eyes, respiratory tract kidney central nerve system, pollution of groundwater & environment

Landfilling risk: Leachate and evaporation of hazardous substance

Incineration risk: Emission to air and generation of ash; emissions may cause respiratory problem, lung problem, affect reproductive system

Plastics recycling risks: BFR turn into brominated dioxins

3.4 Case Studies on Hazards of E-Waste

The following case study demonstrates the hazards of e-waste recycling to human health and the environment:

Case study 1: Taizhou of Zhejiang province, China

- UK exports 1,00,000 tonnes of e-waste every year: majority goes to China
- Process adopted in China is rudimentary, with minimum emphasis on technology and health aspects
- Study was conducted in Taizhou of Zhejiang province (60,000 people and 2 million tonne of e-waste to recycle metal)
- Air samples were collected in the downstream and workers health check were conducted
- Release of POP and heavy metals: accumulated in body due to inhalation
- Test were conducted: Pollutants level were in the workers blood
- High probability of DNA damage which can induce cancer
- **Recommendation:** Primitive dismantling technology should be banned

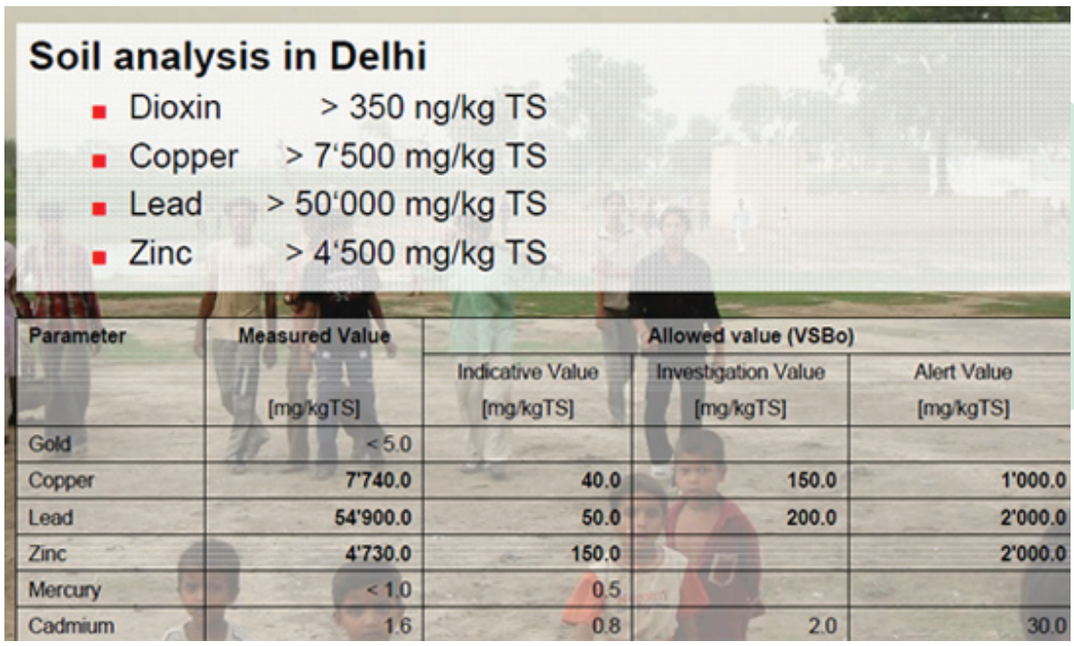
Website: http://www.iop.org/news/11/may/page_51103.html

Case study 2: Guiyu, China

- E-waste recycling region
- Highest level of dioxins ever recorded
- Chendian, a town 9 km away has 12-18 times less dioxins concentration
- Lianjiang and Nanyang river are highly polluted because of e-waste disposal
- Lianjiang river: high level of Ar, Cr, Li, Mo, Sb, Se
- Nanyang river: Ag, Be, Cd, Cu, Ni, Pb, Zn

Case study 3: Seelampur, Delhi, India

- Quote: *"Compressor par hathoda maar, tod uss pipe ko, kheench uss wire ko"* - With a screwdriver, even you can become a dismantler in just two hours
- Various picture are shown demonstrating the negative impacts of dismantling in Seelampur; Delhi



Parameter	Measured Value	Allowed value (VSBo)		
		Indicative Value	Investigation Value	Alert Value
	[mg/kgTS]	[mg/kgTS]	[mg/kgTS]	[mg/kgTS]
Gold	< 5.0			
Copper	7'740.0	40.0	150.0	1'000.0
Lead	54'900.0	50.0	200.0	2'000.0
Zinc	4'730.0	150.0		2'000.0
Mercury	< 1.0	0.5		
Cadmium	1.6	0.8	2.0	30.0

Figure 7: Soil analysis results in Delhi

3.5 Restriction of Hazardous Substances

The following substances are banned as per the RoHS Directive of the EU:

- Lead (Pb)
- Mercury (Hg)
- Cadmium (Cd)
- Hexavalent chromium (Cr6+)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ether (PBDE)

These materials can be substituted:

Table 13: Substitutes for RoHS materials

Restricted Substances	Application	Substituting materials
Lead	Solders	Mixtures containing tin, silver, copper, bismuth, zinc, organic solderability preservatives, nickel, antimony, gold and/or palladium (Van der Pas 2007, Deubzer 2007, Nihon 2010)
Cadmium	Plastic colouring	Other colouring materials
	Contacts	Silver-Nickel (AgNi), Silver-Tin-Oxide ($AgSnO_2$)
Mercury	Switch	Other metals or alloys (e.g. gallium alloy)
	Sensor	
	Contacts	

Hexavalent chromium	Pigment	Trivalent chromium, tungsten carbide
	Anticorrosion agent	
	Plating	
Flame retardants	Flame retardants (FR) in general	Changes of the combination of polymers to reduce the inflammability. Bis(pentabromophenyl) ethane, ethylene bis(tetrabromophthalimide), other halogenated and halogen-free flame retardants like the phosphorous-based FR resorcinol bis(diphenylphosphate) and bisphenol A diphosphate (Danish EPA 2006, Rossi&Heine 2007)
	Wire and cables	Aluminium-tri-hydroxide, magnesium-dihydroxide, boehmite, phosphorus flame retardants, zinc borate, phosphate esters, melamine cyanurate, melamine phosphate, red phosphorus, intumescent products based on ammonium polyphosphate, aluminium phosphinates, aryl phosphates (pinfa 2010)
	Electronic enclosures	Triphenyl phosphate, resorcinol bis- (diphenyl phosphate), bisphenol A bis- (diphenyl phosphate), resorcinol bis(2,6-dixylenyl phosphate) (pinfa 2010)
	Electrical installations	Metal phosphinates (offen combined with-N-synergists), Inorganic Metal phosphinates, Melamine Polyphosphate, Melamine cyanurates, Red Phosphorus, Aryl phosphates and phosphonates, Magnesium hydroxide, Ammonium polyphosphate in combination with nitrogen synergists (pinfa 2010)
	Printed wiring boards	Aluminium Trihydroxide, Aluminium monohydrate, metal phosphinates and polyphosphates, DOPO (Dihydrooxaphos-phaphenantrene), Poly(1,3-phenylene methylphosphonate) (pinfa 2010)

3.6 Green EEE without Hazardous Substances

Manufacturers of EEE play an important role in reducing and avoiding hazardous substances in EEE. Greenpeace's Guide to Greener Electronics assesses the environmental of manufacturers. One category of the assessment is the companies' efforts in reducing such substances.

The following picture shows which large manufacturers have the best and worst environmental performance:

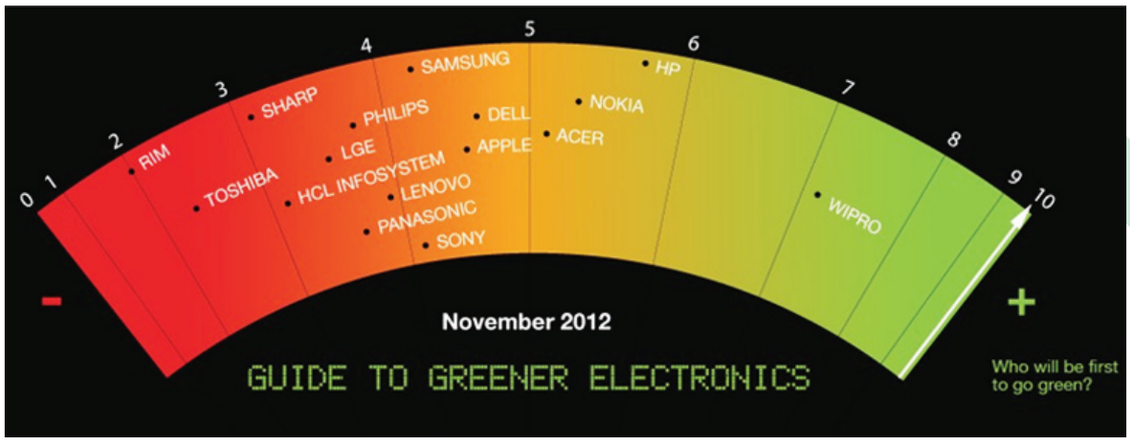


Figure 8: Ranking of EEE manufacturers

Criteria for measuring the performance of companies in the category "avoidance of hazardous substances" are

- Number of products on the market that are PVC and BFR free.
- In addition, the number of products free from other hazardous substances, i.e. Phthalates, beryllium, including alloys and compounds and antimony/antimony compounds.
- Commitment to eliminating PVC and BFR with timeline
- Phase-out of additional substances with timeline(s)

This is the specific assessment of WIPRO, the highest ranked EEE manufacturer, in the category "avoidance of hazardous substances" (Greenpeace 2012):

- Wipro has 80% of its total products free from PVC and BFR. A list of PVC and BFR free products is provided.
- Wipro also launched its first products - two desktop models, WSG68F55W7 and WIV68F55 – free from antimony, beryllium and phthalates. These two products constitute 20% of its product range free from these three hazardous chemicals, which is an encouraging development.
- Wipro commits its timeline to complete phase-out of antimony, beryllium and phthalates from its entire product range by FY-2012.
- To score more points, Wipro needs to phase out all identified hazardous chemicals within the stated timeline.

3.7 Brainstorming Exercise on Hazards of E-Waste

Brainstorm on the following two questions:

- Which measures could be chosen to decrease the negative impacts of e-waste processing on the health of workers, communities and the environment?
- Which measures are advocat\ed by the SPCB in other sectors?

Trainer's note
The answers could be collected on a note board and used for the development of the action plan at the end of the training.

4

E-Waste Management & Handling Rules

4.1 Introduction to This Session

The session on the E-Waste (Management & Handling) Rules 2011 provides the audience with details on their content. It deals with the various provisions of the Rules and introduces them to the participants section by section. Thereby, the responsibilities of the regulators with regard to the Rules are covered as well as the challenges of their implementation.

4.1.1 Objectives of This Session

At the end of this session the participants should:

- Know about the provisions of the Rules
- Know about the various important terms used in the Rules and their definition
- Know about their responsibilities for the implementation of the Rules
- Know about the responsibilities of other stakeholder groups as per provision of the Rules
- Be sensitized about the challenges in implementing the Rules

4.1.2 Overview of This Session

- E-Waste Regulation
- E-waste (Management & Handling) Rules 2011
- Definitions in the Rules
- Responsibilities of the different stakeholders
- Compliance Procedures
- Challenges of Implementing the Rules

The following sections contain the actual training contents.

4.2 E-Waste Regulation

The following policies and regulations are applicable to the management of e-waste.

- The National Environmental Policy 2006
- The Environment (Protection) Act 1986
- The Hazardous Wastes (Management and Handling) Rules 1989 (amended in 2003 & 2008)
- The E-waste (Management and Handling) Rules 2011

- The E-Waste (Management & Handling) Rules, 2011 were notified in May 2011 and have become effective from 1st May, 2012; they have been notified under the Environment (P) Act, 1986

4.3 E-waste (Management & Handling) Rules 2011

It is the **objective of the Rules** (Indian Ministry of Environment and Forests 2011) to put in place an effective mechanism to regulate the generation, collection, storage, transport, import, export, environmentally sound recycling, treatment and disposal of the e-waste.

Mandatory provisions of the Rules are to introduce an Extended Producer Responsibility (EPR) system and a collection system, to organize the registration of dismantlers and recyclers and to oversee the reduction of the hazardous substances (RoHS).

The Rules have the following chapters:

- Chapter I – General, includes applicability and definitions of the terminologies used in these rules
- Chapter II – Responsibilities of each stakeholder
- Chapter III – Procedures for seeking Authorization and Registration for handling e-waste
- Chapter IV – Procedure for Storage of e-waste
- Chapter V – Reduction of Hazardous Substances (RoHS)
- Chapter VI – Miscellaneous includes the Annual Report, Transportation of e-waste, Accident reporting

The following schedules and forms are attached to the Rules:

- Schedule I – E-waste Categories
- Schedule II – RoHS exemptions
- Schedule III – List of Authorities & their duties
- Form 1 – Authorization
- Form 1(a) – Grant of Authorization
- Form 2 – Record maintenance
- Form 3 – Returns filing
- Form 4 – Registration of dismantlers and recyclers

4.4 Definitions in the Rules

The Rules specifically define certain terms which are relevant for the implementation of its provisions:

- **E-waste** means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process which are intended to be discarded
- **Electrical and electronic equipment** means equipment which is dependent on electrical currents or electro-magnetic fields to be fully functional. This includes
  - **IT and telecommunication equipment** such as servers, PC, phones, cell phones etc.
  - **Consumer electronics** such as washing machines, televisions, air conditioning systems etc.
- **Historical E-Waste:** E-waste generated from electrical and electronic equipment as listed in Schedule I, which was available on the date from which these rules come into force
- **Orphaned Products:** Non branded or assembled electrical and electronic equipment as listed in Schedule I or those produced by a company, which has closed its operations or has stopped product support

- **Bulk Consumers:** Bulk users of electrical and electronic equipment such as central government or state government departments, public sector undertakings, banks, educational institutions, multinational organizations, international agencies and private companies that are registered under the Factories Act, 1948 and Companies Act, 1956
- **Extended Producer Responsibility:** Responsibility of any producer of electrical or electronic equipment, for their products beyond manufacturing until environmentally sound management of their end of life products
- **Producer:** any person who, irrespective of the selling technique used,
  - o manufactures and offers to sell electrical and electronic equipment under his own brand; or
  - o offers to sell under his own brand, assembled electrical and electronic equipment produced by other manufacturers or suppliers; or
  - o offers to sell imported electrical and electronic equipment

The following stakeholders are defined in the Rules:

- Every producer, consumer or bulk consumer, involved in the manufacture, sale, and purchase and processing of electrical and electronic equipment or components as specified in schedule I
- Collection agencies, dismantlers & recyclers of E-waste
- Bulk consumer/consumer
- MoEF, CPCB, SPCBs/PCCs and ULBs

4.5 Responsibilities of the Different Stakeholders

Responsibilities of the **Producers:**

- **Collection of e-waste** generated from the 'end of life' of their products in line with the principle of **'Extended Producer Responsibility' (EPR)**, or generated during manufacturing of electrical and electronic equipment and channelization of such waste to registered dismantler or recyclers.
- **Setting up collection centres or take back systems** either individually or collectively.
- **Financing and organizing a system** to meet the costs involved in the environmentally sound management of e-waste generated from the 'end of life' of its own products and historical waste. The producer may choose to establish such a financial system either individually or collectively.
- **Creating awareness** through publications, advertisements, posters etc. or by any other means of communication and information booklet accompanying the equipment with:
  - Information on hazardous constituents
  - Information on hazards of improper handling, accidental breakage, damage or improper recycling of e-waste
  - Instructions after handling the equipment after its use
  - A logo to prevent e-waste being dropped in common garbage bins
- **Obtaining authorization**
- **Maintaining records and filing annual returns**
- Producers have to ensure that new EEE listed in Schedule 1 does not contain **Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyl or polybrominated biphenyl ethers**
- Maximum concentration value of **0.1%** by weight in homogenous materials for Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyl or polybrominated biphenyl ethers and of 0.01% by weight in homogenous materials for cadmium is permitted

Responsibilities of **Collection Centres:**

- **To obtain an authorization** from the concerned SPCBs/PCCs
- To ensure that the **e-waste collected by them is sent to registered dismantlers or recyclers** in a secured manner.
- **To maintain records** of the e-waste handled in Form 2
- **To file annual returns** in Form 3

Responsibilities of **Bulk Consumers:**

- To ensure that e-waste generated by them is channelized to authorized collection centers or registered dismantlers or recyclers or is returned to pick-up or take back services provided by the producers
- Maintain records of e-waste generated by them in Form 2 and make such records available for scrutiny to the SPCBs/PCCs

Responsibilities of **Dismantlers & Recyclers:**

- **To obtain authorization and registration** from the State Pollution Control Board
- To ensure that **no damage is caused** to the environment **during storage and transportation of e-waste**
- To ensure that the **facilities and dismantling & recycling processes are in accordance with the standards or guidelines** published by the Central Pollution Control Board from time to time
- Dismantler to ensure that **dismantled e-waste are segregated and sent to the registered recycling facilities** for recovery of materials
- To ensure that non-recyclable/non- recoverable components are **sent to authorized Treatment Storage and Disposal Facilities** (TSDF)
- Dismantlers shall not process any e-waste for recovery and/or refining of materials, unless registered as recycler for refining and recovery of materials
- Recyclers will **make available all records to the SPCB/PCC** for inspection
- Recyclers to ensure that residue generated after recycling **is disposed off to a hazardous waste Treatment Storage Disposal Facility (TSDF)**
- **To file annual returns** in Form 3

Responsibilities of **Central Pollution Control Board (CPCB)**

- Coordinate with SPCBs/PCCs
- Prepare guidelines for Environmentally Sound Recycling of E-waste
- Recommend standard and specification for processing and recycling of e-waste
- Enforce provisions regarding reduction in use of hazardous substances in manufacture of electrical and electronic equipment
- Provide incentives and certification for green design /products

Responsibilities of **State Pollution Control Boards / Committees**

- Preparation of inventory of e-waste
- Granting authorization
- Granting registration
- Monitoring of compliance of authorization and registration conditions
- Maintaining information on the conditions imposed for authorization

- Taking action against violations of these rules
- Ensure that collection centres do not store e-waste for a period exceeding 180 days.

Responsibilities of Municipal Authorities

- Channelization of e-waste after segregation to either authorized collection centre or dismantler or recycler if found to be mixed with MSW.
- Collection and channelization of e-waste generated from non-branded or assembled electrical and electronic equipment to either authorized collection centre or dismantler or recycler.

4.6 Compliance Procedures

The following compliance requirements exist for dismantlers and recyclers

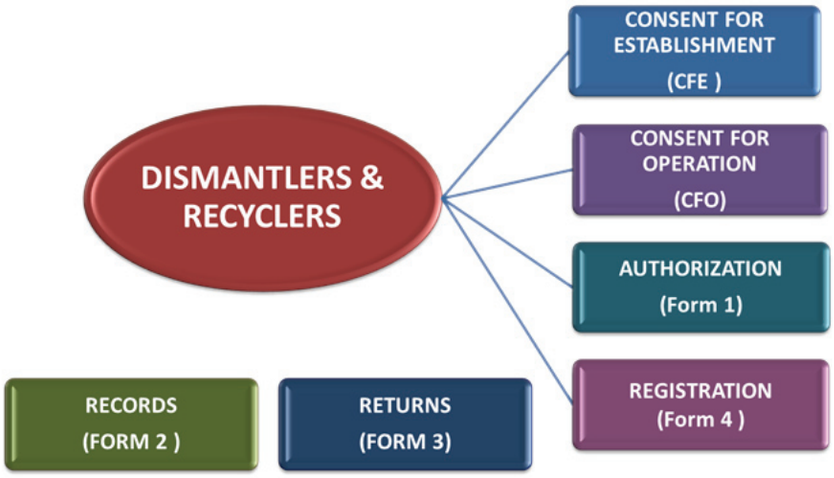


Figure 9: Compliance procedures

Procedure for **seeking authorization**

- Every Producer listed in Schedule 1, collection centre, dismantler and recycler of e-waste shall obtain an authorization from the SPCBs
- Application (Form 1) for authorization should be submitted within a period of 3 months starting from the date of commencement of these Rules
- The SPCB/PCC will grant authorization on being satisfied that the application is complete in all respects and the applicant possesses the necessary technical capabilities, facilities and equipments to handle e-waste safely within a period of ninety days in Form 1(a) for a period of 5 years

Procedure for **seeking registration**

- Every dismantler or recycler of e-waste shall make an application within a period of 3 months from the date of commencement of Rules in Form 4 to the SPCB/PCC
- The SPCB/PCC will grant registration on being satisfied that the application is complete in all respects and the applicant possesses the necessary technical capabilities, facilities and equipments to recycle and process the e-waste within a period of ninety days for a period of 5 years

Waste storage provisions:

- E-waste cannot be stored for a period more than 180 days

4.7 Challenges of Implementing the Rules

The following challenges exist for the implementation of the Rules:

- **Obscure EPR:** The Rules have included the provision of Extended Producer Responsibility to encourage take back system for electronics but its implementation mechanism is obscure. The Rules also do not specify if the producer can charge any visible or invisible fee to get back the products for recycling.
- **No ban on import:** The Rules do not provide stringent guidelines to ensure the ban on import and export of electronic wastes. This restriction on imports of hazardous wastes for the purpose of recycling and disposal is an important clause of the Basel Convention complied by most countries. But the draft Rules fail to prohibit any ban on imports. The unchecked import and export of e-wastes results in landing of the wastes in the informal sectors for dismantling and recycling. Workers from socially and economically underprivileged group of society work to dismantle and separate the useful components from the non useful ones. They work in unsafe and dingy conditions without masks, gloves and necessary precautions. Every little component that can be sold is recovered without considering the damage to health of the workers or the environment. A rigorous clause on import should thus be added in the rules to check the illicit trade and the workforce engaged in the informal sectors should be included in the mainstream by the state pollution control bodies (PCBs) by providing them an alternate source of employment in the collection centers or state authorized dismantling and recycling agencies.
- **Inadequate capacity of prescribed authorities:** Another significant issue that the Rules deals with is the management and disposal of historical products (products present in the market prior to the enforcement of rules) and orphan products (non-branded or assembled). The non-branded/ assembled products or products from the grey market are cheaper, used on a large scale and comprise a large proportion in the waste stream. The Rules have designated Urban Local Bodies (ULBs) with the responsibility to collect and channelize the orphan products to the authorized collection centres, dismantlers or recyclers. It is clear from the Rules that regulatory bodies have been allotted several responsibilities right from authorization and registration to monitoring and implementation of the law. However the regulatory bodies of a large number of states/UTs lack capacity and are also overburdened with other responsibilities. The urban local bodies or municipalities suffer from lack of manpower, expertise and resources. Rules should mention that the agencies, organizations having expertise can be engaged in streamlining the entire e-waste management process. The Public Private Partnership (PPP) model which is currently practiced for Municipal solid waste management, hazardous waste management can also be put into practice. Government should also engage in the capacity building of the regulatory bodies. A thorough development of standards, benchmarks, training must be provided to the PCBs/PCCs. A significant allocation of budget should also be set aside for PCBs/PCCs for systemic implementation of the Rules.
- **Setting up of Collection Systems**
- **Inventorization of E-waste Generation**
- **Promotion for development of infrastructure for recycling**
- **Monitoring Mechanisms for EPR and RoHS**

You can also ask the audience about the challenges they have experienced in the implementation of the Rules

Trainer's note
Collect the challenges the participants name on a pin-board and address them in the sessions to come. Go through these challenges at the end of the training and discuss with the participants whether they now have a better idea on how to tackle these challenges.

5 Inventorization

5.1 Introduction to This Session

The session on inventorization deals with the question of how the generation of e-waste in a certain area can be predicted. For regulators to effectively implement the E-Waste M&H Rules, to allocate the right amount of funds and report on the success of their work, they must know how much e-waste is generated in their jurisdiction. In the future, this figure can be derived more easily once every manufacturer is actually reporting sales figures as per the requirement of the Rules; however, the implementation of this requirement is currently not enforced.

Therefore, the participants are introduced to an estimation method that uses readily available data for calculating the amount of e-waste generated per year. In addition, a validation method is suggested that can be used for verifying whether the estimated quantities are accurate.

5.1.1 Objectives of This Session

At the end of this session the participants should:

- Be knowledgeable on the general approach of conducting an inventorization
- Be able to assess whether a consultant is able to conduct a thorough inventorization of e-waste in the respective city or state
- Have the expertise to find major flaws in an incorrect inventorization approach
- Understand the challenges and hurdles in conducting an inventorization

5.1.2 Overview of This Session

- Inventorization of E-Waste
- Assessment Method – Input and Obsolescence
- Assessment Method – Stepwise Approach
- Validation – Tracker Method
- Exercise on Inventorization

The following sections contain the actual training contents.

5.2 Inventorization of E-Waste

The scope of the inventory study should be defined in terms of geography and product categories.

- **Geographical scope** – City/Region/State or country where inventory needs to be done

- **Product Category Wise Scope** – Computers (Desktops and Laptops), Printers, UPS, televisions, Refrigerators, DVD/VCD Players, Mobile Phones

5.3 Assessment Method – Input and Obsolescence

The market size of WEEE generated can be estimated using the input method:

- Input refers to the **sales and imports** of these products
- The source of the sales data will include **government statistics, secondary data** available from Indian Market Research Bureau (IMRB), Industry Associations, etc.

After collecting the sales data, calculate the average life / obsolescence rate of the products. Average life of a product can be divided into the following parts:

- **Primary usage life** (first user)
- **Second use life**

The inventorization of e-waste can be conducted with a module-based approach. The individual modules are presented below.

Module 1

What?	How?	Why?
•Quantitative estimation of e-waste	•Input and obsolescence method •Secondary data collection for estimating the quantities of e-waste •Quantitative survey to calculate the obsolescence age	•To map the annual quantities of ewaste being generated •To estimate these quantities for coming years

Module 1 – For estimating the quantities of e-waste, Input and Obsolescence method can be used which is explained in detail in later part of this chapter.

Module 2

What?	How?	Why?
•Understanding current disposal Practices	•By carrying out extensive primary Quantitative survey among both the user segments – households and establishments	•To calculate product wise and user segment wise obsolescence rates • To identify the most common methods of disposal used currently • To understand user considerations while disposing

Module 2 - For understanding the obsolescence rates and disposal behavior among the users, a quantitative survey can be conducted across the household and the business establishments of the stipulated area (under the scope of the inventory study)

What?	How?	Why?
•Studying current e-waste recycling practices	•Through Qualitative research with existing recyclers – both informal as well as formal (if any)	•To understand the existing •recycling practices •To identify various stakeholders in the e-waste value-chain; •To evaluate the capabilities and infrastructures of existing stakeholders

Module 3 – To map the current recycling practices of the region, quantitative in-depth interviews can be conducted with different stakeholders of e-waste recycling industry such as scrap collectors, dismantlers and recyclers.

5.4 Assessment Method – Stepwise Approach

In this next section the participants are exposed to the different steps of conducting an assessment on the amount of e-waste generated per year.

First, they are asked what steps they would take for conducting such as assessment.

Trainer's note
Write the steps the participants propose on a white-board or pin-board. Facilitate the discussion in a way that the group decides on a certain sequence of steps. These steps can then be compared with the actual process shown in the next slide.

The process as presented on the slide is a 5-step process:

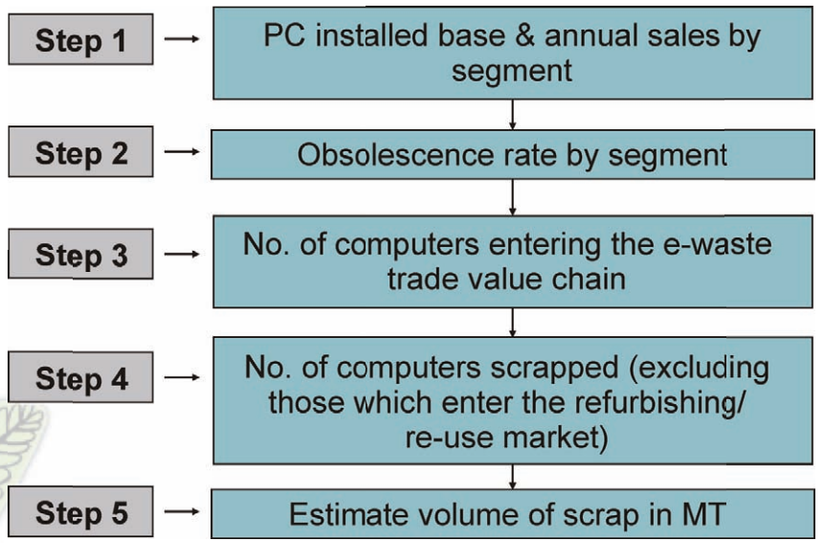


Figure 10: Stepwise approach to inventorization

Subsequently, each step is presented in the detail. The group is asked for each step, how they would implement it. After their inputs have been collected the procedure according to the official assessment method is presented.

STEP 1 - PC installed base & annual sales by segment

Question to the audience: How can you collect this information?

Trainer's note
These questions should be posed for brainstorming only. You do not need to take notes of the inputs provided by the participants.

Suggested approach:

All computing devices can be categorized broadly in:

- *Desktops*
- *Laptops*

Installed base of desktops and notebooks over the last 10 years shall be obtained from IMRB - Integrated Technology and Operations (IMRB-ITOPS)

Installed base and annual market size shall be broken-up into

- *Household*
- *Businesses*

Further, the data shall be categorized by town-class

STEP 2 – Obsolescence rate by segment

Question to the audience: How can you collect this information?

Suggested approach:

ITOPS data: segment wise obsolescence rate (on the basis of town class, nature of business and SEC)

- *Sample Question: On an average, after how many years do you replace your old P.C.*

Primary Survey: questions on the use-life of devices will be asked to households and businesses

Expert interviews: with players in the organized sectors on their experience of the use-life of devices

For the collection of data a sample grid is presented:

Businesses – Obsolescence Rate			
Town size	**Services**	**Manufacturers**	**Traders**
>50 lakh			
10-50 lakh			
5-10 lakh			
1-5 lakh			
Households Obsolescence Rate			
Town size	**SEC A**	**SEC B**	**SEC C/D**
>50 lakh			
10-50 lakh			
5-10 lakh			
1-5 lakh			

Table 14: Sample grid for inventorization

STEP 3 – Number of computers entering the e-waste value chain

Question to the audience: How can you collect this information?

Suggested approach:

Once the sales figures and obsolescence rate are available, we can calculate the number of Desktops and Notebooks which will enter the e-waste trade value chain using following calculation:

N = I.B. x O.R.

- *N is the number of computers entering the e-waste cycle*
- *I.B. is the Installed Base*
- *O.R. is the Obsolescence Rate*

STEP 4 – Number of computers entering the e-waste value chain

Question to the audience: How can you collect this information?

Suggested approach:

For estimating the ratio or percentage break-up of refurbished and scrapped, qualitative data can be collected from the following stakeholders:

- *Scrap collectors*
- *Recyclers or e-waste processors*
- *Organized players in e-waste trade*

Based on the share suggested, the number of computers which are to be scrapped will be multiplied by the average weight of the computers which were sold in the nth year

STEP 5 – Estimation of scrap volume

The following information needs to be taken into account before doing the final estimation:

Technological Advancements:

- Reduction in weight
- Change in composition of desktops and notebooks
- Changes (increase or decrease) in the technical life

Changes in the consumer behavior

- Increase or decrease in the disposal rate

5.5 Validation – Tracker Method

This method will verify the **obsolescence rate** and **quantity estimates** by tracking the movement of some components (trackers) of each product across the e-waste trade value chain.

Example of trackers:

- *LCD in case of mobile phones*
- *CRT in case of televisions*
- *Motherboards & CRT in case of computers*

The **verification of the obsolescence rate** can take place through a qualitative approach:

Once the trackers are identified, qualitative study will be done across the various channel members involved in that e-waste processing

For e.g. in case of TVs, random and repetitive visits will be made to CRT dismantlers and the movement of CRTs will be noted down; 5 to 6 areas of CRT collection shall be identified per city

- *3-4 collectors or recyclers shall be identified in each area*
- *Regular visits to these places shall be conducted to observe models and date of manufacturing over a period of time*

The **verification of the estimated quantity of scrap** can also take place through a qualitative approach:

Interviews will be done with channel members (for the case of CRT) to find out the daily input of e-waste and the break-up of:

- Total CRT accepted for dismantling per day
- Percentage of CRT in working condition that are re-sold in market
- CRT broken or dismantled
- Final ratio of broken CRT and re-sold CRT

Example:

- *Dismantled/re-sold ratio 50:50; 30 CRT dismantlers receive 100 CRTs daily*
- *Therefore, the e-waste generated from televisions in Delhi would be approximately 1500 televisions/ day*

5.6 Exercise: Inventorization

In the exercise on inventorization the participants are supposed to practice the calculation of the amount of e-waste generated in a sample city. The objective of this exercise is to sensitize the participants on the difficulty of drawing inferences from data. Also, it is demonstrated how critical it is to obtain good quality data to be used for the calculation. By conducting this exercise and the calculations themselves, the SPCB / PCC officers become aware of which details to check if an inventorization is conducted by a consultant.

For conducting the exercise, a worksheet with the input data, a calculation example and boxes for data entry are provided. Additionally, a solution sheet and presentation slides with the results are available.

Trainer's note

Several points should be kept in mind when conducting the exercise:

- There should be enough time for conducting the exercise; calculations should take about 45 – 60 min; another 15 min should be planned for presenting the solution of the exercise
- The first part of the calculation is the most challenging. Make sure that the participants read the example provided carefully to understand the method.
- Make sure that the participants use the adequate use time of a PC; a PC at some point during 2007 with a use time of 5 years will enter the e-waste stream in 2012.

6

Efficient E-Waste Collection Mechanisms

6.1 Introduction to This Session

An efficient collection mechanism is the key pre-requisite for each successful e-waste management and recycling framework. The collection system is the entry point of any device in the recycling chain. For the formalization of the Indian e-waste sector it is crucial that end-of-life EEE enter a legal channel. Only then, it can be ensured that the devices are properly treated.

It is thus of vital interest to the regulator that an efficient collection mechanism is in place. Currently, most of the e-waste is channeled through the informal sector (MAIT-GTZ 2007). This is to change as per the provisions of the Rules. As formulated under the Rules, producers are to establish a take-back system for coping with their extended producer responsibility. However, the producers alone will not be able to set up such a system. For a model to work the current stakeholders need to be somehow involved. In this session, some options are presented on how the entry point(s) for material of a new e-waste management system could be organized.

6.1.1 Objectives of This Session

At the end of this session the participants should:

- Be able to name the crucial elements of an effective collection strategy
- Be able to understand the challenges in setting up a collection system
- Know about the specific collection situation in India
- Know about potential options for collection models
- Know about possible support measures by the SPCBs/PCCs for setting up an effective collection mechanism

6.1.2 Overview of This Session

- Background on E-Waste Collection
- Collection in India
- Regulators' Support for E-Waste Collection

The following sections contain the actual training contents.

6.2 Background on E-Waste Collection

In the first slide of this section, several reasons are listed why it is important for regulators to think about the issue of collection. Thus far, collection is taking place rather unorganized in India. As per the Rules an efficient e-waste collection mechanism needs to be established. The benefits of such a mechanism compared to the current system are:

- Prevents material leakages to backyard recycling
- Increases the availability of material for efficient recycling
- Tracking of material/components becomes easier
- Compliance with E-waste (M&H) Rules 2011
- Awareness on e-waste is created among consumers

For e-waste to be handled appropriately, the first step is proper collection of e-waste. This is because of the fact that, once a consumer has no further use for an electronic or electric device he/she tends to either keeps it to him-/herself and buys a new one, or gives it to someone who might be in need of that product. As a result of this, even when the product has come to an end of life stage, it does not reach an authorized recycler or dismantler.

In many instances, the only visible part of an electronic product is its outer shell. Unless that casing is broken or taken off, we rarely see the myriad circuit boards, wiring and electrical connections that make the device actually function. But it's those inner mechanical parts that are so valuable and toxic. A whole bouquet of heavy metals, semimetals and other chemical compounds lurk inside our seemingly innocent laptop or TV. E-waste dangers stem from ingredients such as lead, mercury, arsenic, cadmium, copper, beryllium, barium, chromium, nickel, zinc, silver and gold. So, unless the electronic and electric devices trash reaches an authorized recycler or dismantler, who takes care that all the methodologies adopted are safe and scientific in nature, the e-waste is going to trouble us, if not directly now, may be sometime in the future. For this reason, an efficient e-waste collection system is required which is monitored regularly by the Government authorities on a regular basis.

The majority of the population is involved in their jobs, or schools, or colleges. Nobody bothers to go to a dismantler or recycler, neither does anybody have time to go and search for a nearby recycler. So, the option that we are left with is designing a proper e-waste collection system to bring e-waste into a proper channel. There are a lot of options that consumers can undertake in order to bring out their e-waste recycling and dismantling in a proper scientific manner. Some of the methodologies adopted for proper e-waste collection channeling are discussed later in this chapter.

With now rising e-waste quantities on one hand, and with new regulatory requirement entering into force soon on the other hand, formal recyclers increasingly enter the e-waste recycling sector which is currently dominated by the informal sector. Also, in a hope to get better profits and support from government authorities, a many informal recyclers, dismantlers and refurbishers are seeking government authorization, and many have obtained authorization already. E-waste rule mandates the handling of e-waste only by companies registered with the Central Pollution Control Board.

The reasons why a proper collection channel has not yet been in established in India are manifold. Some of the reasons are

- Strong presence of the informal sector
- Lack of awareness on e-waste among public
- No proper take-back system
    - o Lack of incentives for consumer

- Size of the country, may require multiple systems
- Absence of targets for take-back

The following figure shows which actors generate e-waste and via which exemplary channels the material reaches the formal and informal sector.

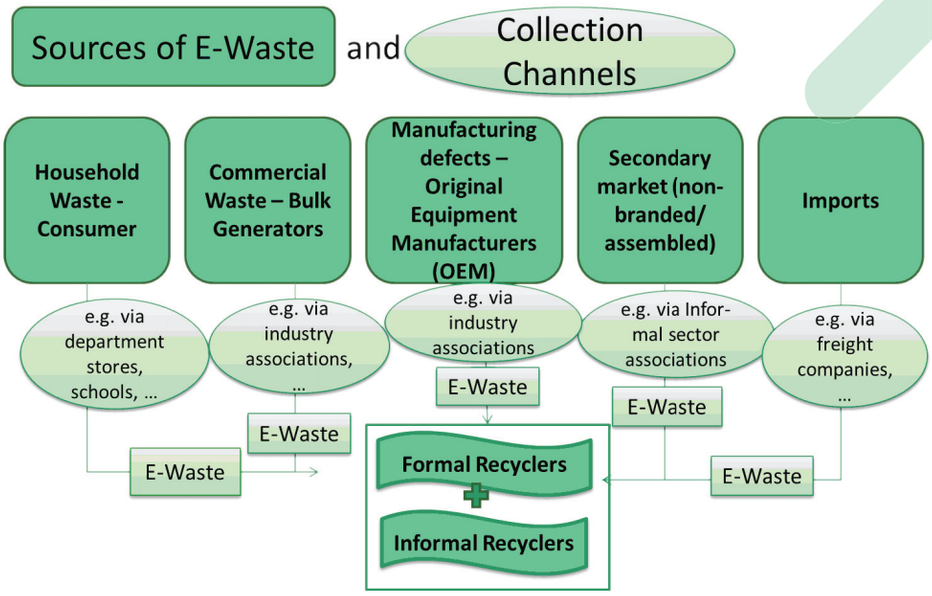


Figure 11: Sources of e-waste and collection channels

6.3 Collection in India

As the figure below shows, the main generators of e-waste are bulk generators such as offices, schools, OEMs, households and the import stream. Import of e-waste is officially banned, yet many old EEE devices enter the country as donations for secondary use.

The key ailments in the Indian e-waste management system are the lack of transparency and lack of awareness. The processing of e-waste is dominated by the unmonitored informal sector. Around 95% of the total e-waste generated is being processed by the unorganized sector, and a mere 5% is in safe hands of the authorized or organized sector that recycle and dismantle in a more environmentally-sound manner.

The main collections modes are the door-to-door collection from waste pickers, auctions from offices and companies, the drop-off of units at collection sites such as bins and collection centres. Also, end-of-life products are sold to actors of the e-waste chain. These actors are from the formal or informal sector and can be collectors, dismantlers or recyclers.

Sources of e-waste in India are (Gupta Reena and Verinder 2011):

– **Manufacturers / OEMs:** About 50% of PCs which are sold all over the country are from the secondary market and are reassembled on the old components. The rest of market share is covered by MNC's (30%) and Indian brands (20%). Besides, manufacturers are major contributors of e-waste. The waste consists of defective IC chips, motherboards, CRTs and other peripheral items produced during the production process. It also includes defective PCs under guarantee procured from consumers as replacement items.

– **Consumers:** About 22% of junk computers are generated from Indian household. The routine process of getting rid of obsolete computers include exchanging from retailers or pass on the same to friends or relatives. The business sector accounts for 78% of all installed PC's in India. The junk computers from business sector are often sold during auction or sometimes donated to educational institutes or charitable institutions for reuse.

– **Import of e-waste:** Import of e-waste is legally prohibited no doubt the reports prove that lots of e-waste is imported from abroad. Due to increased safety rules in Western countries, it is 10 times cheaper to export e-waste to developing countries than it is to locally recycle. Though some e-waste exportation is legal, a large portion is illegal. Electronics exported under the category of 'used' or 'second-hand' goods are not subject to any restrictions, and numerous other loopholes, export schemes, and corrupt officials have been discovered.

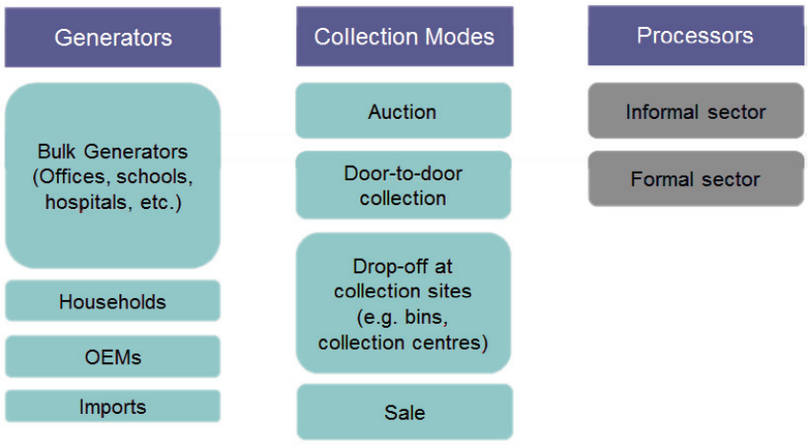


Figure 12: Collection modes in India

Possible working models for the set-up of an efficient collection mechanism are

- An individual producer responsibility (IPR) system
- A collective producer responsibility (CPR) system
- A model integrating the informal sector

The first two options (IPR & CPR) are covered more extensively in the section on the Extended Producer Responsibility. In this section a closer look is taken on the model integrating the informal sector.

The following two slides show an option for intervention in the Indian e-waste sector, as it is implemented by the WEEE Recycle project. Before the project was started the situation of the e-waste sector in the four project cities was as follows:

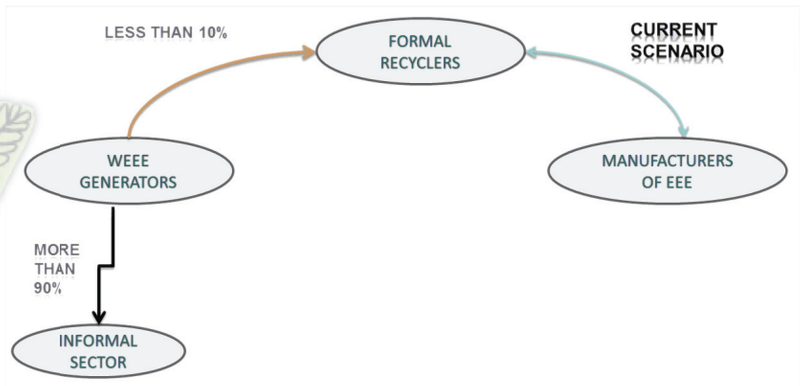


Figure 13: Pre-project situation

In this situation more than 90 percent of the e-waste goes directly to the informal sector. Only 10 percent enters the formal recycling stream which is the legally required stream as per the E-Waste M&H Rules.

The WEEE Recycle project tackles this situation with the adoption of the following approach:

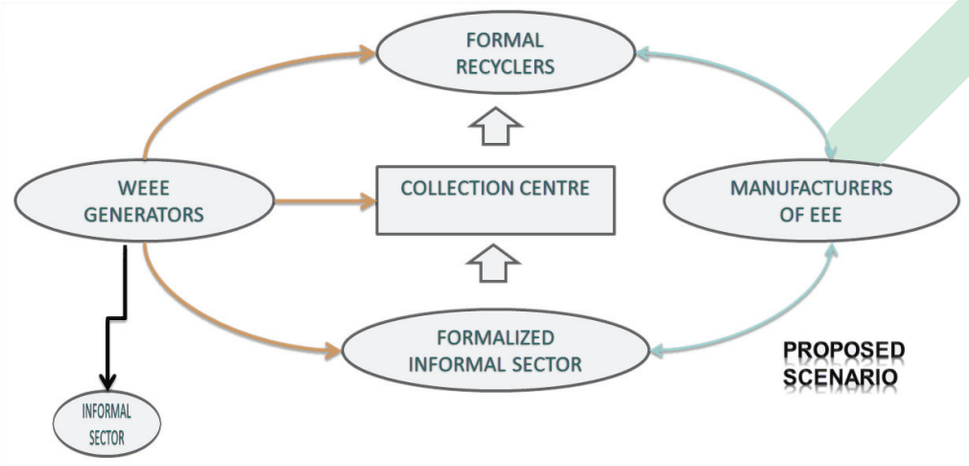


Figure 14: Proposed situation

With the establishment of official collection centres and formalization of the informal sector, e-waste enters the formal recycling stream. In this scenario, the informal sector is not left out after the re-structuring of the sector but assumes a different role. How this role looks like becomes clear in the next slide:

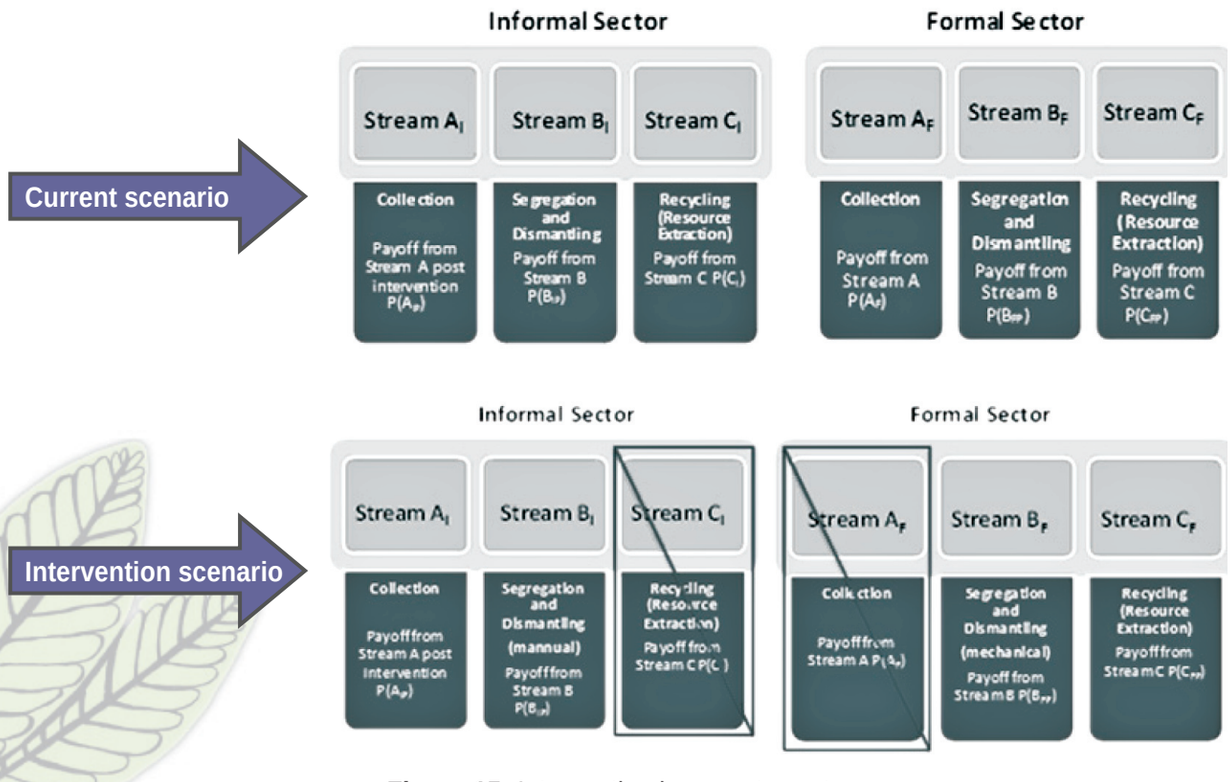


Figure 15: Intervention in e-waste system

In this new situation, the formalized informal sector is responsible for collection of material and the manual dismantling and segregation. Mechanical dismantling and segregation as well as material recovery would lie in the hands of the formal sector.

There are different models for the integration of the informal sector.

One option is the formation of waste collector cooperatives. These cooperatives would receive identity cards from authorized producers, recyclers and dismantlers and would collect material on behalf of these companies. This would generate trust between the collectors and the consumers as the consumer would that the e-waste enters a proper recycling mechanism.

Figure 16: Linking E-Waste Collectors

Another option is the formation of collection agencies that are officially registered with the SPCB/PCCs. In this model the individual collectors would form a collection agency and jointly auction off the material to authorized dismantlers and recyclers.

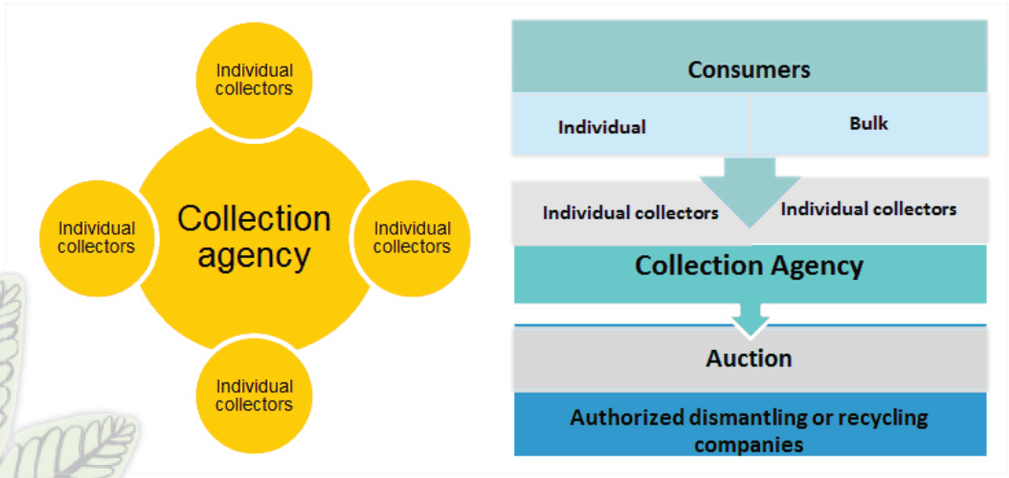


Figure 17: Formation of collection agencies.

A third model is the cooperation between civil society organizations and individual collectors. In this approach, individual collectors would link up with civil society organizations. These organizations would use their legalized status to engage with dismantlers and recyclers and pass the e-waste on to them. The position of the civil society organization could also enhance the willingness of the consumers to hand out end-of-life EEE.

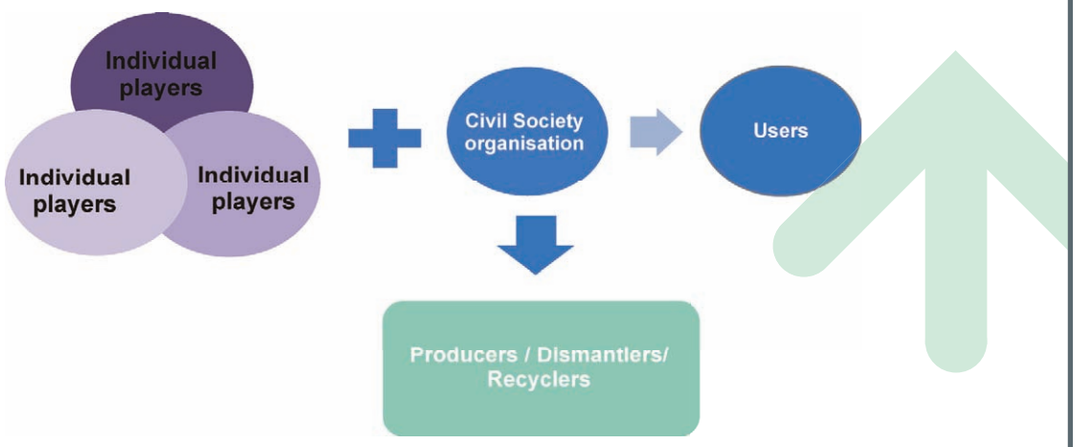


Figure 18: Link-up of collectors with civil society organizations

These are three possible models in which the informal sector would take the initiative. As written above, there are also producer-driven models (IPR and CPR) which will be explained in more detail in the section on EPR.

6.4 Regulators'Support for E-Waste Collection

The final slide of the presentation of the collection approach deals with the question on how regulators can support the establishment of an effective collection mechanism. Several suggestions on how this support could look like are:

- Support in establishing Extended Producer Responsibility as per the mandate of the Rules
- Stringent implementation of all provisions of the Rules
- Effective monitoring mechanism for compliance with the Rules, especially with regards to the channelization of the material passed on by the bulk generators
- Definition of responsibilities and financing structure (e.g. who has to bear transport costs)
- Identifying and incorporating organized informal sector by granting registration to formalized collectors
- Ensuring the participation of recyclers by enforcing that they source their materials from registered collectors only
- Notifications/ administrative orders from central or local government to bulk generators that they are only allowed to pass their material on to registered collectors
- Providing additional incentives for collection and awareness on e-waste

7

Best Practices on Dismantling and Recycling

7.1 Introduction to This Session

In this session an overview is given on the different treatment steps of e-waste. Best practices also with regard to technological options are presented. The session is structured along the three treatment steps of e-waste which are dismantling and segregation, shredding and separation, and material recovery. It is further explained why different treatment types lead to different material yields.

7.1.1 Objectives of This Session

At the end of this session the participants should:

- Understand the differences between the three treatment steps of e-waste
- Know about best-practice option for the three treatment steps
- Be familiar with the technologies mainly used in India
- Understand why different treatment options lead to different material yields

7.1.2 Overview of This Session

- Environmentally Sound E-waste Treatment Technologies
- First Level of Treatment
- Second Level of Treatment
- Third Level of Treatment
- Yields of E-waste Recycling

The following sections contain the actual training contents.

7.2 Environmentally Sound E-waste Treatment Technologies

Scientific dismantling and recycling are of prime importance when we talk about managing the e-waste in an appropriate manner. For environmentally sound treatment, following the steps could be implemented to ensure an efficient processing of e-waste.

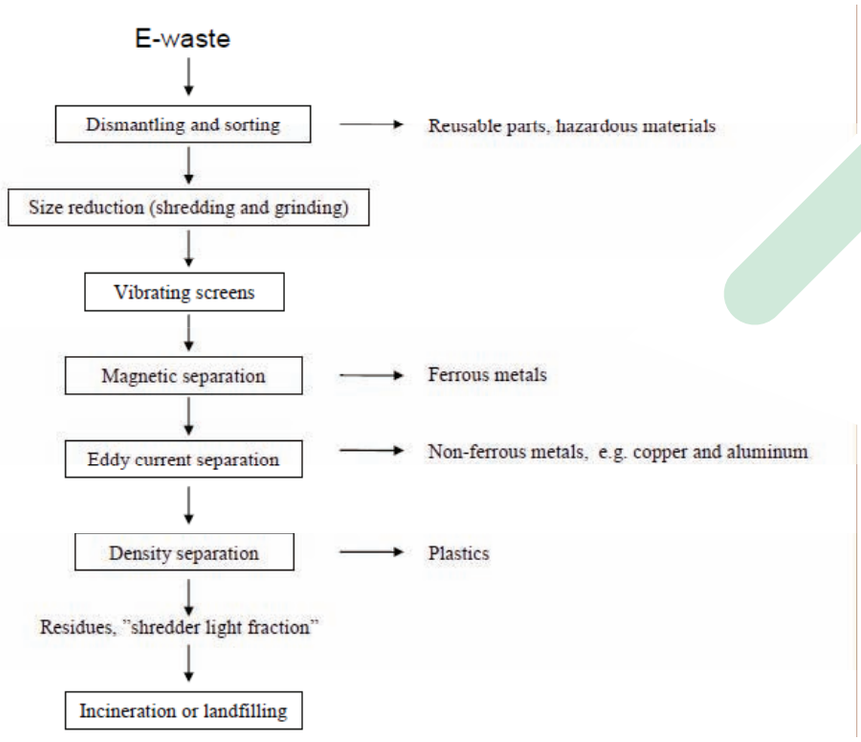


Figure 19: E-waste processing chart (Swedish Environmental Protection Agency 2011)

Environmentally sound E-waste treatment technologies are used at three levels as described below:

- 1st level treatment
- 2nd level treatment
- 3rd level treatment

All the three levels of e-waste treatment are based on material flow. The material flows from 1st level to 3rd level treatment. Each level treatment consists of unit operations, where e-waste is treated and output of 1st level treatment serves as input to 2nd level treatment. After the third level treatment, the residues are disposed of either in TSDF (Treatment, Storage, and Disposal Facility) or incinerated. The efficiency of operations at first and second level determines the quantity of residues going to TSDF or incineration. The simplified version of all the three treatments is shown below.

For non CRT E-waste, the major e-waste treatment facilities in India use the following technologies.

1. Dismantling
2. Pulverization/ Hammering
3. Shredding
4. Density separation using water

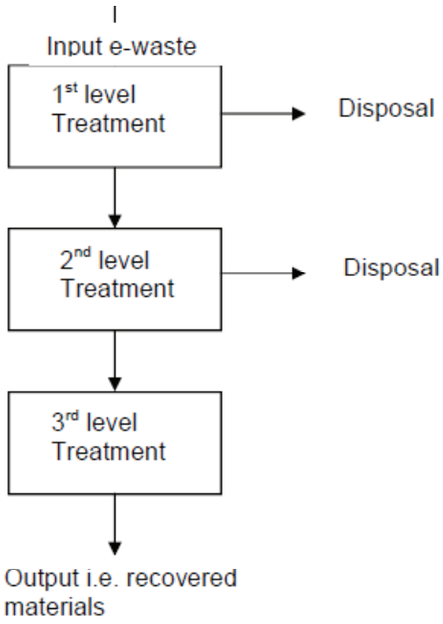


Figure 20: Treatment steps

7.3 First Level of Treatment

There are three unit operations at first level of e-waste treatment as shown below

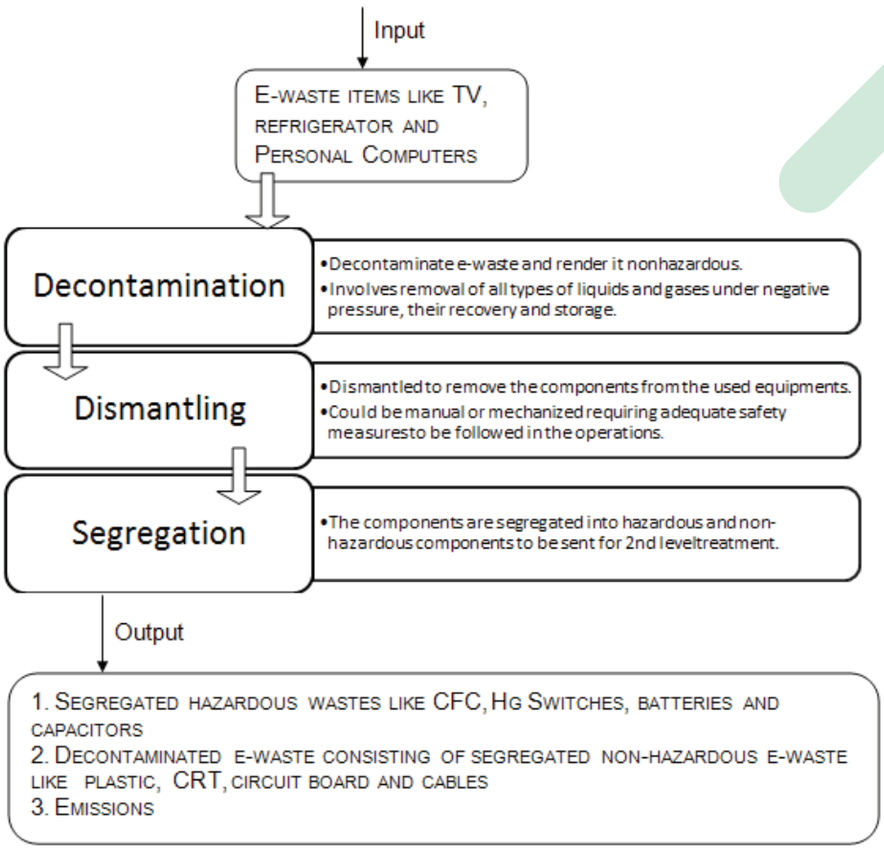


Figure 21: First level of treatment

The following terms explain the individual process steps in more detail:

- **Decontamination** is the first step in the treatment of e-waste to render it non-hazardous. This means removal of all types hazardous substances present in e-waste. Decontamination is carried out prior to processing e-waste for recovery so that it is safe for recycling. Decontamination also involves removal of all types of liquids and gases under negative pressure which are then stored safely. Some equipment may not require decontamination.
- **Dismantling** is the process by which the components are removed from the used equipments. This is the first operational stage in e-waste recycling and is essential for all used equipments. Dismantling could be manual or mechanized. Dismantling operations require adequate safety measures.
- **Segregation** of the dismantled e-waste fractions is an important step in separating the hazardous and non-hazardous fraction and also for channelization of these fractions for the 3rd level Treatment.

Note: All the three unit operations are dry processes, which do not require usage of water.

Emissions: The emissions coming out of 1st level treatment are given in table below:

Table 15: Emissions from 1st level E-waste treatment

Unit Operations/ Emissions	Dismantling	Segregation
Air	✓ (fugitive)	x
Water	x	x
Noise	✓	✓
Land/ Soil Contamination due to spillage	✓	✓
Generation of hazardous waste	✓	✓

7.4 Second Level of Treatment

The two major unit operations in the second level of treatment are hammering and shredding. The proposed technology for sorting, treatment, including recycling and disposal of e-waste is fully based on dry process using mechanical operations. The pre-comminuting stage includes separation of Plastic, CRT and remaining non CRT based e-waste. Equipment like hammer mill and shear shredder will be used at comminuting stage to cut and pulverize e-waste and prepare it as a feedstock to magnetic and eddy current separation. A heavy-duty hammer mill grinds the material to achieve separation of inert materials and metals. After separation of metals from inert material, metal fraction consisting of Ferrous and Non-Ferrous metals are subjected to magnetic current separation. After separation of Ferrous containing fraction, Non-ferrous fraction is classified into different non-metal fractions, electrostatic separation and pulverization.

For non-CRT e-waste the following steps can be applied for the second treatment step of e-waste:

1. The proposed technology for sorting, treatment, including recycling and disposal of E-waste is fully based on dry process using mechanical operations.
2. The pre-comminuting stage includes separation of Plastic, CRT and remaining non CRT based E-waste. Equipment like hammer mill and shear shredder will be used at comminuting stage to cut and pulverize e-waste and prepare it as a feedstock to magnetic and eddy current separation.
3. A heavy-duty hammer mill grinds the material to achieve separation of inert materials and metals.
4. After separation of metals from inert material, metal fraction consisting of Ferrous and Non-Ferrous metals are subjected to magnetic current separation. After separation of Ferrous containing fraction, Non-ferrous fraction is classified into different non-metal fractions, electrostatic separation and pulverization.
5. The ground material is then screened and de dusted subsequently followed by separation of valuable metal fraction using electrostatic, gravimetric separation and eddy current separation technologies to recover fractions of Copper (Cu), Aluminum (Al), residual fractions containing Gold (Au), Silver (Au) and other precious metals. This results in recovery of clean metallic concentrates, which are sold for further refining to smelters. Sometimes water may be used for separation at last stage.
6. Electric conductivity-based separation separates materials of different electric conductivity (or resistivity) mainly different fractions of non-ferrous metals from E-waste. Eddy current separation technique has been used based on electrical conductivity for non-ferrous metal separation from e-waste. Its operability is based on the use of rare earth permanent magnets. When a conductive particle is exposed to an alternating magnetic field, eddy currents will be induced in that object, generating a magnetic field to oppose the magnetic field. The interactions between the magnetic field and the induced eddy currents lead to the appearance of electro dynamic actions upon conductive non-ferrous particles and are responsible for the separation process.

7. The efficacy of the recycling system is dependent on the expected yields/ output of the recycling system. The expected yields/ output from the recycling system are dependent on the optimization of separation parameters like particle size, particle shape, feeding rate (RPM) and optimum operations. Size properties are essential for choosing an effective separation technique. Therefore, eddy current separator is best for granular nonferrous materials having size greater than 5mm. The eddy current separation will ensure better separation of Al fraction in comparison to fraction containing Cu, Ag and Au.
8. Particle shape is dependent on comminuting and separation. Since hammer mills and screens will be used in the proposed technology, the variations are expected to be the same as that of Best Available Technology (BAT).
9. The feeding rate can be optimized based on the speed and width of the conveyor.

For CRTs, the following steps can be implemented:

1. CRT is manually removed from plastic/ wooden casing.
2. Picture tube is split and the funnel section is then lifted off the screen section and the internal metal mask can be lifted to facilitate internal phosphor coating.
3. Internal phosphor coating is removed by using an abrasive wire brush and a strong vacuum system to clean the inside and recover the coating. The extracted air is cleaned through an air filter system to collect the phosphor dust.

Different types of splitting technology used are NiChrome hot wire cutting, Thermal Shock, Laser Cutting, Diamond Wire Method, Diamond Saw Separation, Water Jet separation.

Below a depiction of the second e-waste treatment step is given:

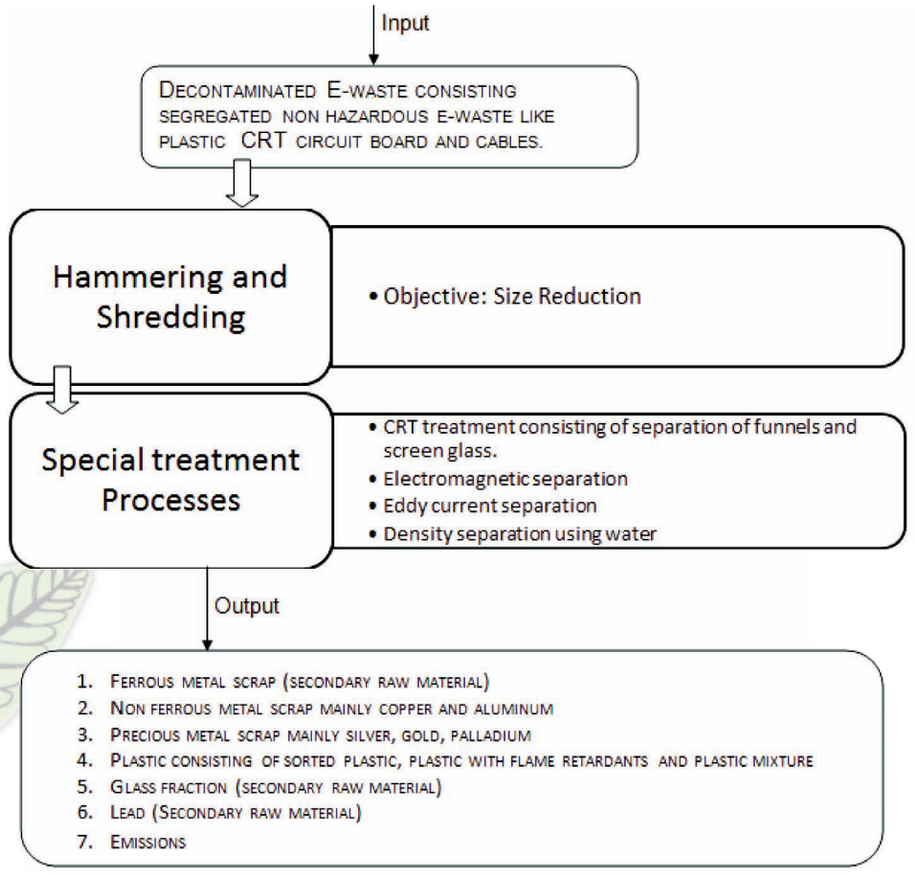


Figure 22: Second level of treatment

Emissions: The emissions coming out of 1st level treatment are given in table below:

Table 16: Emissions from second level of e-waste treatment

Unit Operations/ Emissions	Dismantling	Shredding	Special Treatment Process			
			CRT	Electro magnetic	Eddy Current	Density
Air	√ (fugitive)	√ (fugitive)	X	√ (fugitive)	√ (fugitive)	X
Water	X	X	√	X	X	
Noise	√	√	√	√	√	X
Land/ Soil contamination due to spillage	√	√	√	√	√	√
Generation of hazardous waste	√	√	√	X	X	X

7.5 Third Level of Treatment

The 3rd level E-waste treatment is carried out mainly to recover ferrous, nonferrous metals, plastics and other items of economic value. The major recovery operations are focused on ferrous and non-ferrous metal recovery, which is either geographically carried out at different places or at one place in an integrated facility. The input, output and unit operations at 3rd level treatment are described in the table below.

Table 17: Third level of e-waste treatment

Input/ WEEE residues	Unit Operations/ Disposal/ Recycling Technique	Output
Sorted Plastic	Recycling	Plastic Product
Plastic Mixture	Energy Recovery/ Incineration	Energy Recovery
CRT	Breaking/ Recycling	Glass Cullet
Lead Smelting	Secondary Lead Smelter	Lead
Ferrous metal scrap	Secondary steel/ iron recycling	Iron
Non Ferrous metal scrap	Secondary copper and aluminum smelting	Copper/aluminum
Precious metals	Au/Ag separation (refining)	Gold/ Silver/ Platinum and Palladium
Batteries (Lead Acid/ NiMH and Li ion)	Lead recovery and smelting remelting and separation	Lead
CFC	Recovery/ Reuse and Incineration	CFC/ Energy Recovery
Oil	Recovery/ Reuse and Incineration	Oil recovery/ Energy
Capacitors	Incineration	Energy recovery
Mercury	Separation and Distillation	Mercury

The metal recovery process in the state-of-the-art smelter in Belgium is depicted below:

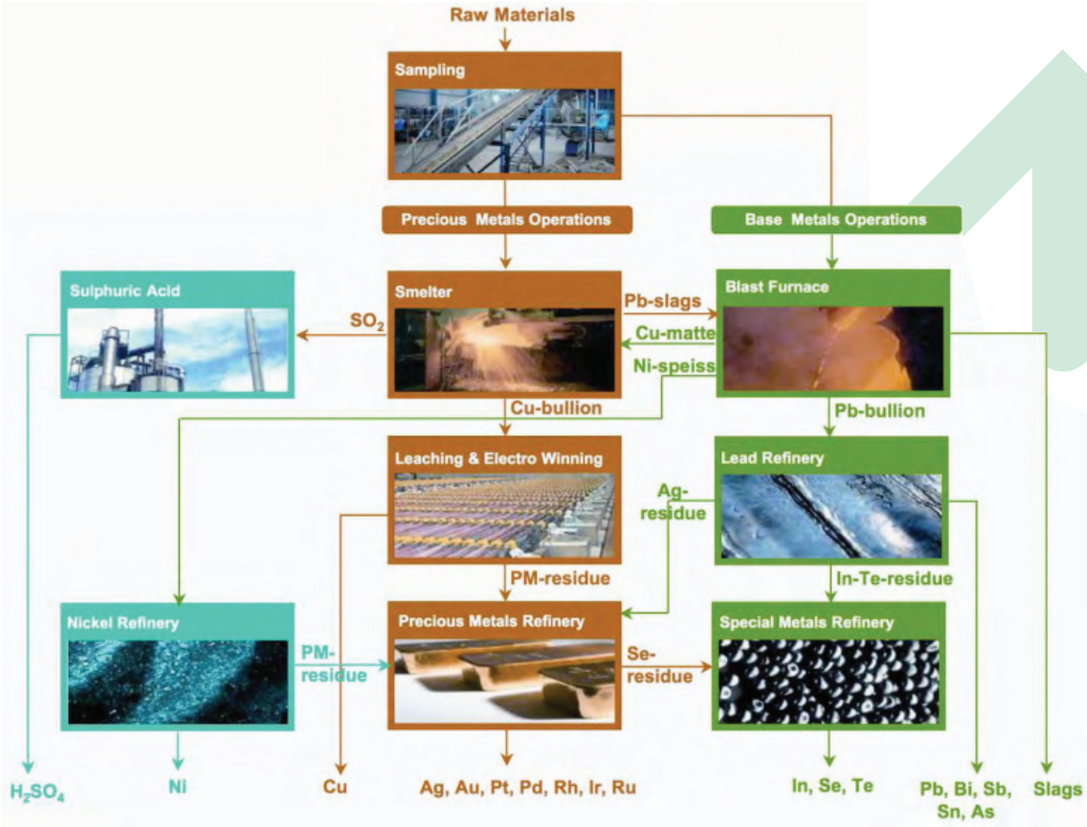


Figure 23: Umicore metal recovery process (Caffarey 2012)

7.6 Yields of E-waste Recycling

Based on whether dismantling is conducted manually or mechanically, different material yields can be obtained:

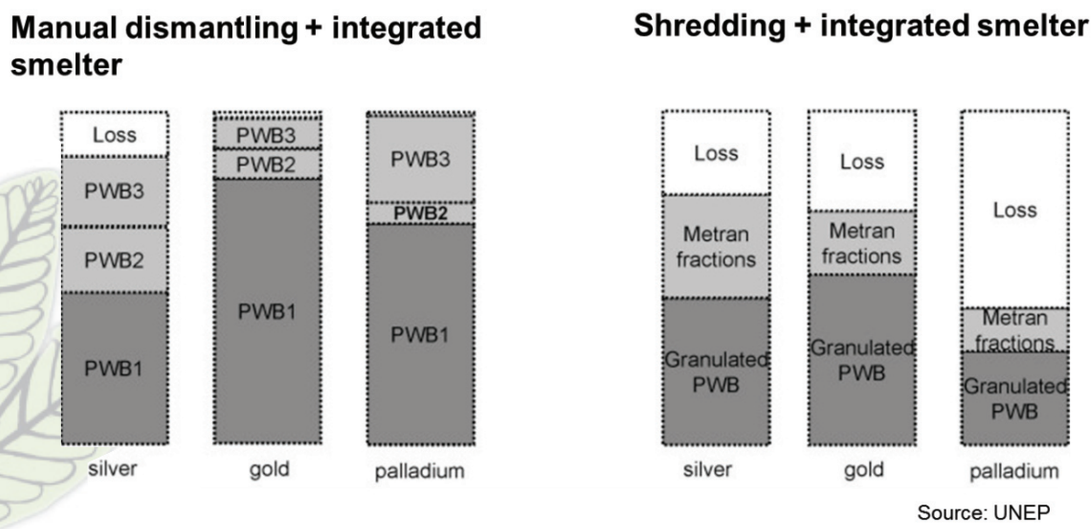


Figure 24: Meskers & Hagelüken 2009

The following figure shows the different metal yields (gold) resulting from different types of e-waste processing. It is distinguished between the location of treatment and the sector where the treatment is undertaken.

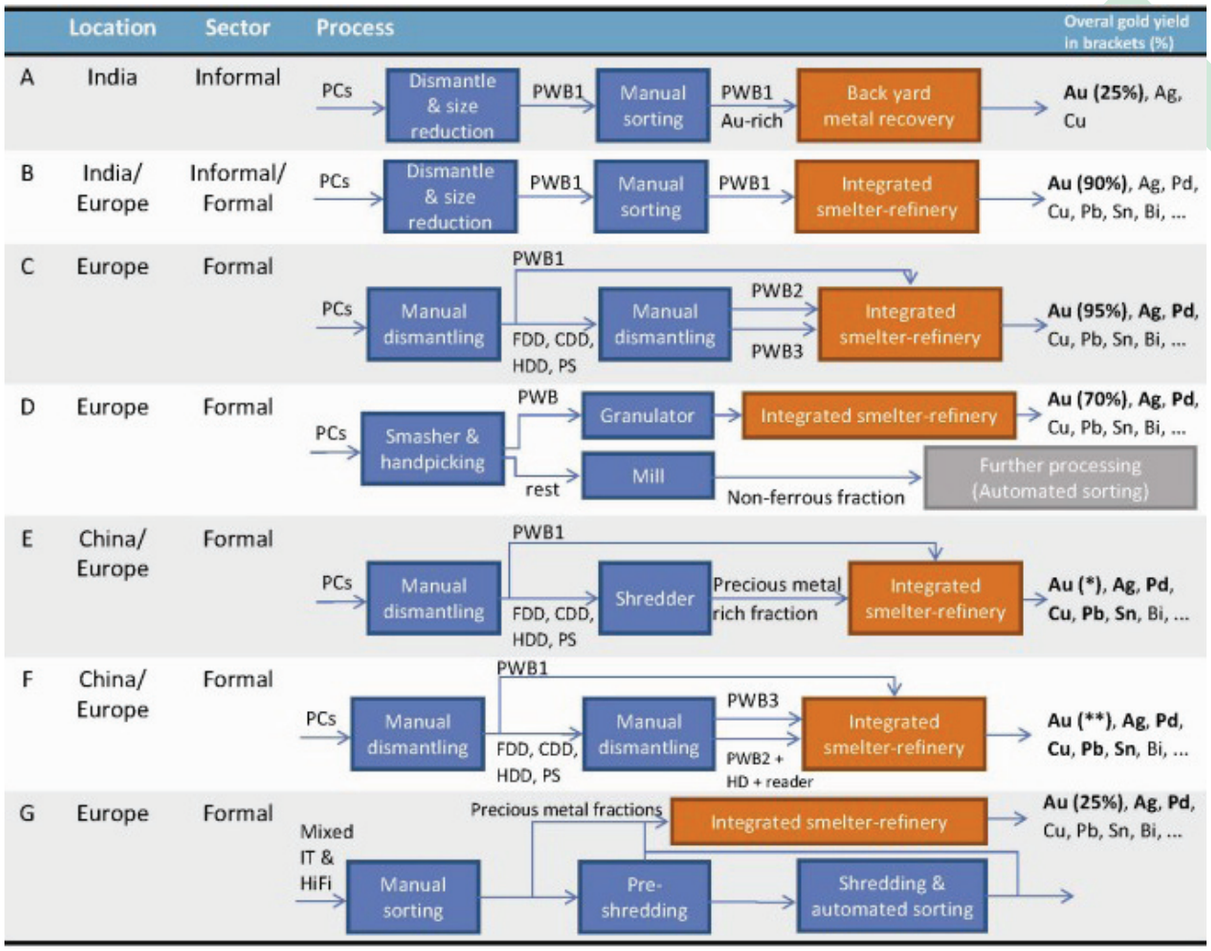


Figure 25: Meskers & Hagelüken 2009

8

Extended Producer Responsibility

8.1 Introduction to This Session

The provisions in the Rules that establish an Extended Producer Responsibility are one of the most important but also one of the most challenging elements. According to the Rules and the EPR principle, it is the producers of EEE who are now responsible for the adequate collection and channelization of e-waste material. How the EPR system is supposed to look like has been left to the discretion of the producers. In the guidelines to the Rules, a collective system and an individual system are mentioned as possible options.

It is now the challenge faced by the regulators to force the producers to take up this responsibility. For enforcing this provision, regulators must first gain understanding on what options for an EPR system are possible. This is the objective of this session.

8.1.1 Objectives of This Session

At the end of this session the participants should:

- Be able to understand the EPR principle
- Know about the duties of the regulators in enforcing the EPR principle
- Know about the possible options for an EPR system
- Understand the fundamental challenged faced by producers to establish an EPR system

8.1.2 Overview of This Session

- EPR Models
- EPR in India
- EPR Examples

The following sections contain the actual training contents.

8.2 EPR Models

Extended Producer Responsibility (EPR) is defined as an environmental protection strategy that makes the manufacturer of the product responsible for the entire life cycle of the product and especially for the take back, recycling and final disposal of the product. Thus, the producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle (Sinha Khetriwal et al. 2007).

EPR also known as manufacturer take back and product stewardship makes it mandatory for a producer to be physically and financially responsible for the collection of end of life electronics and their recovery, so as to minimize or eliminate the hazardous impacts of such products. A principal reason for assigning responsibility to producers is their capacity to make changes at source to reduce the environmental impacts of their products throughout its life cycle. Assigning responsibility to one actor means would avoid the situation where everyone's responsibility becomes no one's responsibility. It is also easier to address the producers who are relatively easier to identify, in the policy making and enforcement process than the consumers (Rossem et al.2006).

The major goals of EPR according to OECD (OECD 2001) are:

- Source reduction (natural resource conservation/materials conservation)
- Waste prevention
- Design of more environmentally compatible products
- Closure of material loops to promote sustainable development

The basic concept is to promote environmental impact reduction at the end of life by:

- Making manufacturers internalize the end of life costs of their products so as to incentivize the design of products that are more recyclable and have lower toxicity

As per the implementation guidelines for the E-waste M&H Rules "EPR is the responsibility of any producer of electrical or electronic equipment, for their products beyond manufacturing until environmentally sound management of their end of life products, the scope of which has to be clearly defined while issuing authorization to individual producers."

The responsibility of producers in an EPR programme varies in terms of type of responsibility and the activities to be undertaken.

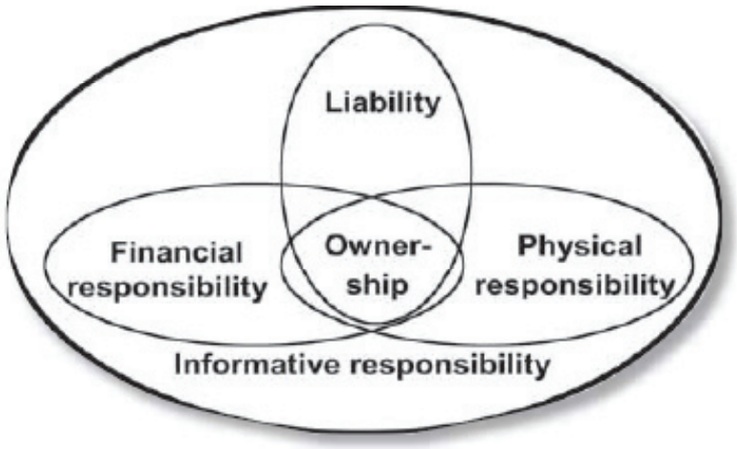


Figure 26: Model for Extended Producer Responsibility (Rossem et al. 2006)

According to the figure above the four types of responsibility that a producer should undertake are:

- **Liability:** Producer/manufacturers should be responsible for proven environmental damages caused by the product.
- **Economic (Financial) responsibility:** Means that the producer will cover all or part of the costs for example; collection, recycling or final disposal of the products he/she is manufacturing.
- **Physical responsibility:** Is used to characterize the systems where the manufacturer is responsible in the actual physical management of the products or of the effects of the products

- **Informative responsibility:** Requires producers to provide information on the environmental properties of the products he is manufacturing.

In principle the more responsibility a producer assumes, the stronger are the EPR mechanisms. However, it is not always possible for a producer to be involved in every aspect of EPR to achieve the above mentioned activities.

The EPR principle can be implemented though a number of policy instruments such as administrative instruments, economic instruments and informative instruments. An EPR programme typically consists of more than one EPR based policy instrument. For instance, a manufacturer is supposed to take back a discarded EEE that he/she has produced (take back requirement). This requirement may be combined with an introduction of a deposit-refund system to give incentives to the consumers to bring back products to an appropriate collection point. A manufacturer may also be required to label material composition of components and to provide information to recyclers regarding the content and structure of their products. Recyclers must meet certain treatment standards. Some of these policy instruments may be incorporated in the revision of existing law governing waste management or the establishment of supplementary law developed in addition to an EPR programme.

Table 18: Examples of EPR based policy instrument (Rossem et al. 2006)

Administrative instruments	Collection and/or take-back of discarded products, achievement of collection, re-use and recycling targets, fulfillment of environmentally sound treatment standards, fulfillment of minimum recycled material content standards, product standard
Economic instruments	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits.
Informative instruments	Reporting to authorities, marking/labelling of products and components, consultation with local governments about the collection network, information provision to consumers about producer responsibility/source separation, information provision to recyclers about the structure and substances used in products.

The emergence and evolution of the concept of EPR clearly reflects a shift in the environmental policy making from the end of pipe approaches to preventative environmental strategies. It has been observed that EPR policies are preferred over non EPR policies in cases when there is a problem of illegal disposal of the waste stream or as a remedy to poorly functioning recycling markets. The EEE are a major focus of EPR across the world and several countries have come up with an EPR based policy for e-waste (Sinha Khetriwal et al. 2007). The composition and the trend of generation of EEE make them environmentally problematic when they come into waste stream.

A general implementation model of EPR could look like this:

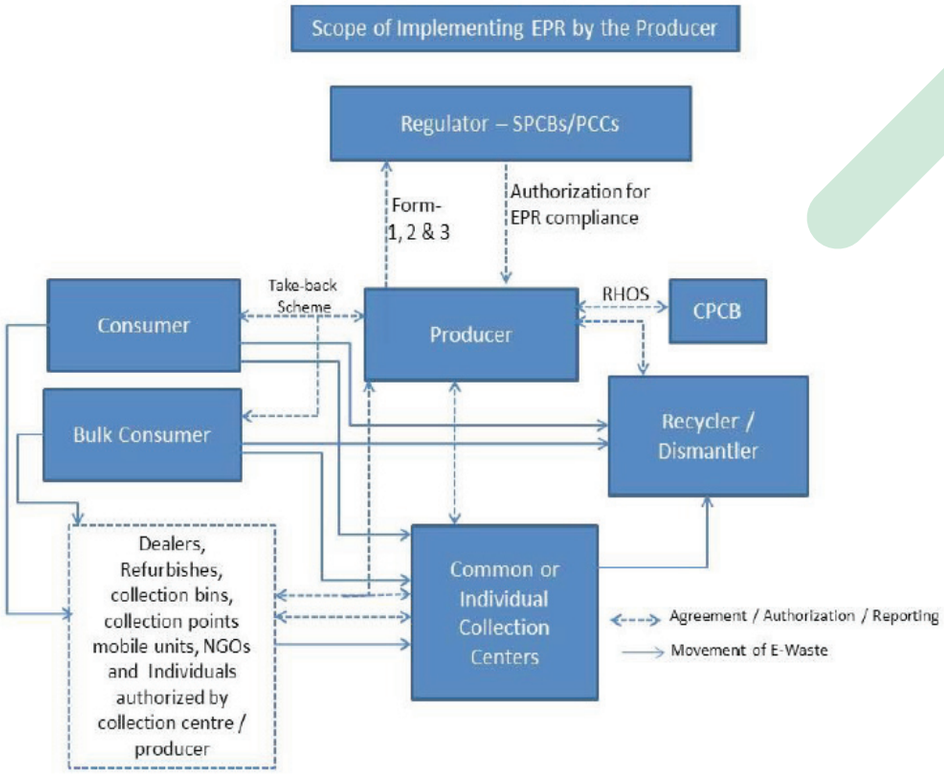


Figure 27: EPR model

In general, the EPR system in India could take two forms, as suggested in the Guidelines. Producers of EEE could either set up an **Individual Producer Responsibility (IPR)** or a **Collective Producer Responsibility (CPR)** system.

The IPR system could be set up as shown in the figure below:

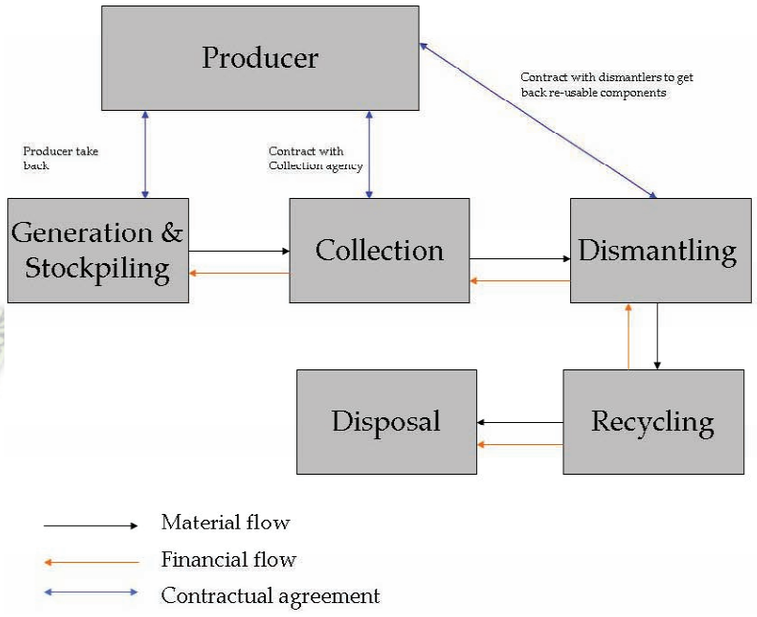


Figure 28: IPR system

The CPR system could be set up as shown in the figure below:

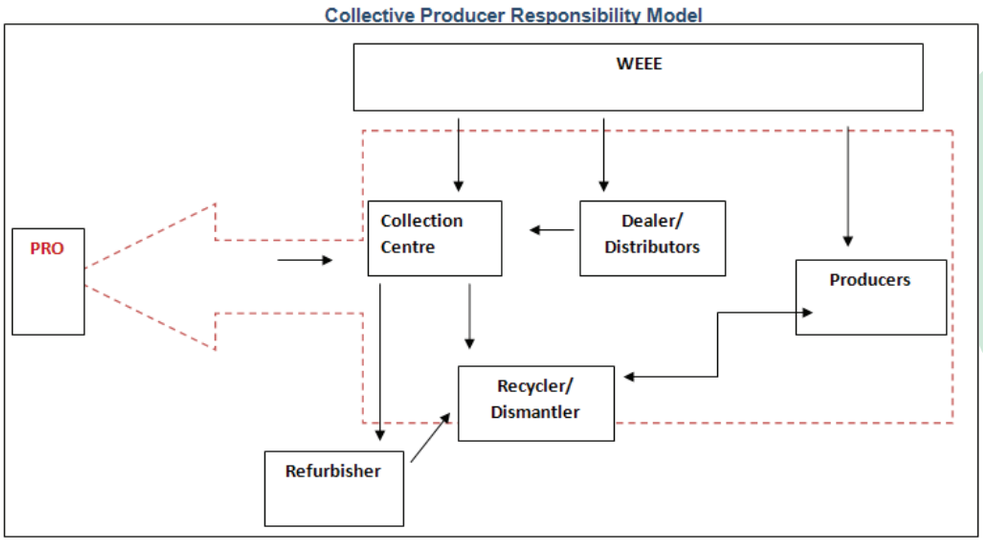


Figure 29: CPR model

In the collective approach, the producers can set up a Producer Responsibility Organization (PRO) which is in charge of the implementation of the EPR. This collective approach with a PRO has several advantages over an individual approach in which each company organizes its own take-back and recycling system. Below, some are arguments are given on why the collective approach is better suited than the individual approach:

Table 19: Advantages of the CPR model

KEY AREA	INDIVIDUAL	COLLECTIVE
Collection & Storage	Less Resource Efficient	More Resource Efficient especially in the case of Multi-Brand retail take-back. Also PRO takes care of and coordinates with all Collection Channels
Reporting & Monitoring	Every producer deals with reports about collection and monitoring individually	PRO takes care of end to end reporting and monitoring for member Brands and Manufacturers and prepares Reports for EPR compliance
Awareness & Capacity Building	Individual Brands approaching same consumer base (e.g. Schools/Colleges) might lead to over-lap and is also less resource efficient	More Resource Efficient. Common awareness and Capacity Building for a consumer base for all brands collectively. Also, a common set of personnel and staff dealing with Operations can be trained collectively.
Recycling	Individual Brands deal with their own set of Vendors and Recyclers	Auditing, Rules and Standards based on the best practices in the Industry. Recyclers chosen based on best Standards. PRO takes care of auditing and Reporting with the Recyclers

A business model for a PRO could look like this:

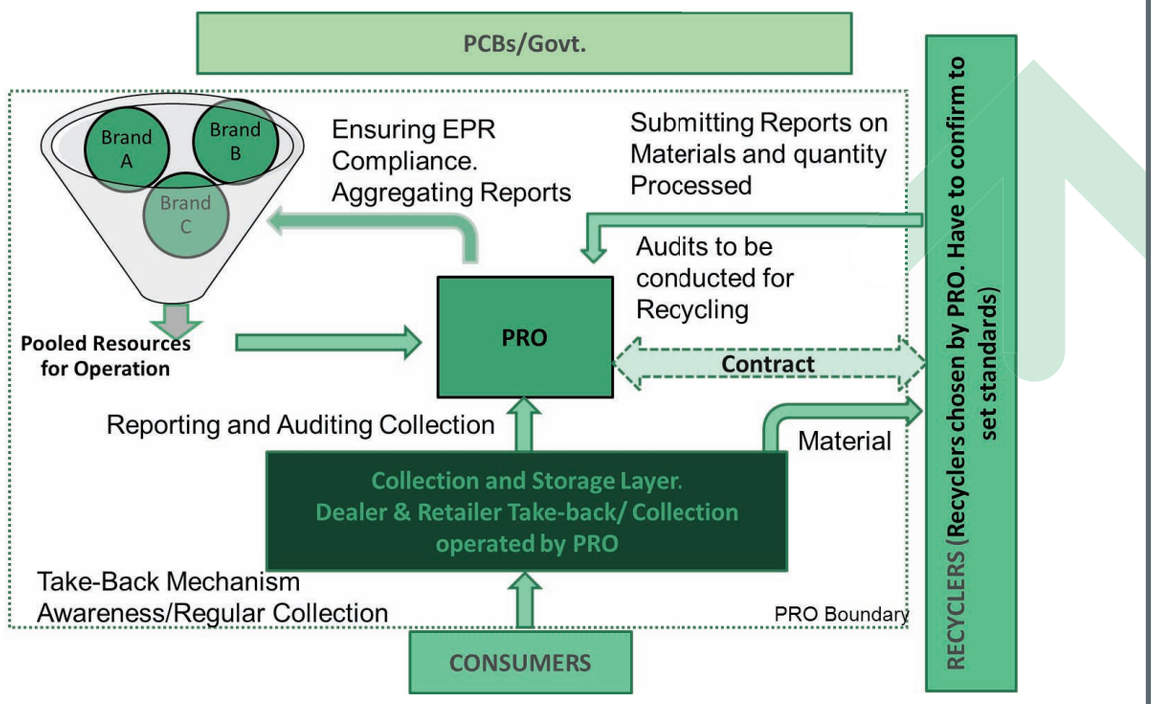


Figure 30: Business model for PRO

Several financing options exist for implementing an EPR system:

- **Advance recycling fee (ARF)** is a fee collected from consumers (producers) at the time of sale, to recycle the products they purchase
- A **disposal fee** model charges the end-user for the cost of recycling
- With a **recycling subsidy**, the recycling party, which can be the producer or a third party, is paid a subsidy per recycled item by the government
- In a **deposit-refund model**, a tax on production and/or consumption is associated with a subsidy proportional to product recycling, where the financing of subsidies can be handled through the taxes collected.

8.3 EPR in India

Ministry of Environment and Forests (MoEF) in India has enforced the regulation on E-waste called the E-waste (Management and Handling) Rules 2011 which has introduced the concept of EPR for WEEE. The E-waste Rules in India makes it mandatory for the producers to be responsible for their products beyond manufacturing until environmentally sound management of their end of life products is achieved. Under this mechanism, producers are also entrusted with the responsibility to finance and organize a system to meet the costs involved in complying with the system.

Since the e-waste Rules were notified in May 2011 and enforced in May 2012, not much has been done by the producers or manufacturers to take back their products. The ambiguous manner in which EPR has been dealt in the Rules and the lax approach of the implementing agencies are the major reasons for slippages in implementation. Some other reasons for the dismal implementation of EPR in India are as follows:

- **Competition from informal sector:** A lot of e-wastes end up in the informal sector in India. In some cases recyclers collect e-waste from informal markets and also send their e-wastes back to the informal sector for recovery of precious metals and reusable items. So, if the producer were

to charge an ARF from the consumer, it has no system to keep track of it, when and by whom the product has been recycled (Agarwal 2012). The informal sectors have an edge over their formal counterparts in terms of their non-compliance with environmentally sound production/specification standards, absence of related costs and tax payment. The materials recovered from WEEE are sold at the secondary materials markets at good prices. Unless, authorized treatment facilities are able to earn higher net profits by processing WEEE in by using more efficient technologies than the informal sector with rudimentary methods the informal sector would have more money to offer to the users of discarded WEEE.

- **Targets:** The E-waste Rules in India have not set any targets for producers to take back their products for recycling. In the absence of recycling targets, it is difficult to monitor progress and improve compliance.
- **Regulation and monitoring:** Incorporating EPR in the Rules was a path breaking step to share the responsibility of implementation with the private sector. However, weak regulation and monitoring have diluted the entire purpose of inclusion of EPR in the Rules.
- **Lack of formal infrastructure:** A major problem in implementing EPR in India is the absence of authorized treatment facilities and collection infrastructure to channelize the e-waste to registered facilities for recycling and recovery. Even after the enforcement of Rules in 2012 very few private parties have come forward to set up and ensure collection of WEEE.
- **Illegally imported EEE:** Illegally imported e-waste poses a great challenge in the effective working of an EPR programme. Around 50,000 tonnes of e-waste are imported to India every year illegally from developed countries (Rajya Sabha Secretariat 2011). The e-waste imported illegally keeps the informal businesses viable. The illegally imported WEEE is present in the market as orphan products and free riders and burdens the entire WEEE management system in terms of collection, sorting, monitoring etc.
- **Identification of producers:** A large share of the market in India comprises of 'no name branded products.' These products are often manufactured by producers who have disappeared from the marker either due to bankruptcy or have withdrawn from the market owing to different reasons. In most cases the transaction between the producers and consumers can also not be tracked down. When such products reach the end of life stage they pose a burden on the formal system.

8.4 EPR Examples

In the final part of the presentation, several examples of EPR models are presented. Figures of the systems in Switzerland, Germany and the Netherlands are shown below:

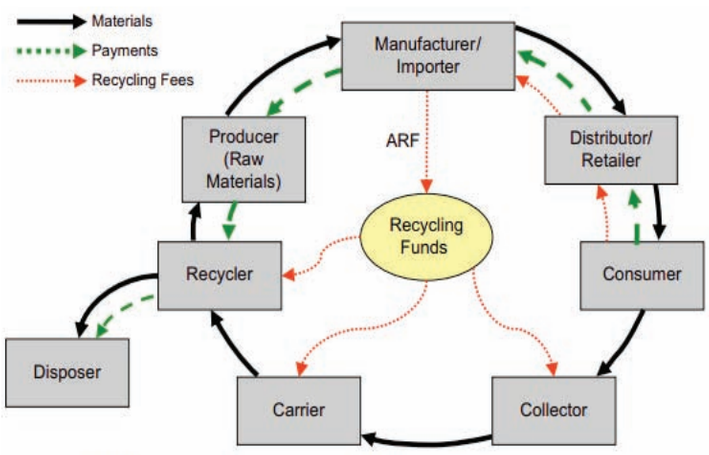


Fig. 1. Flow of materials and finances in the Swiss e-waste management system.

Figure 31: EPR model Switzerland (Sinha Khetriwal et al. 2007)

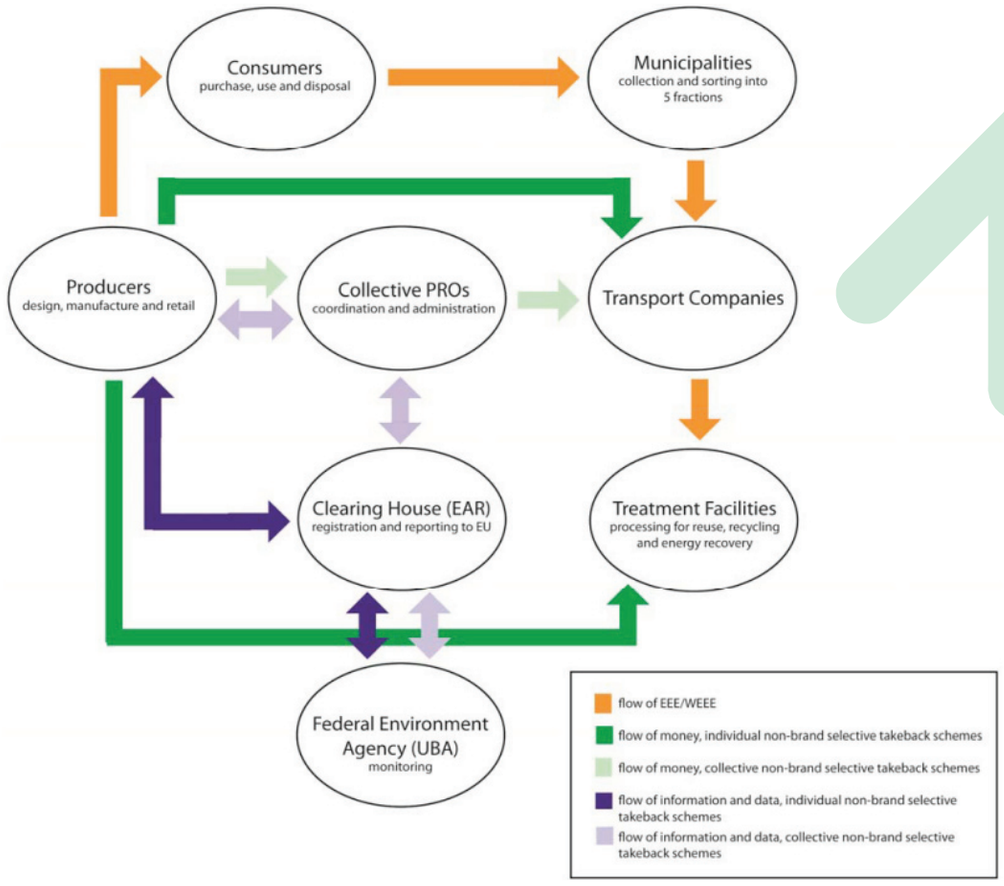


Figure 32: Esther, Lindblad & Mortensen 2011

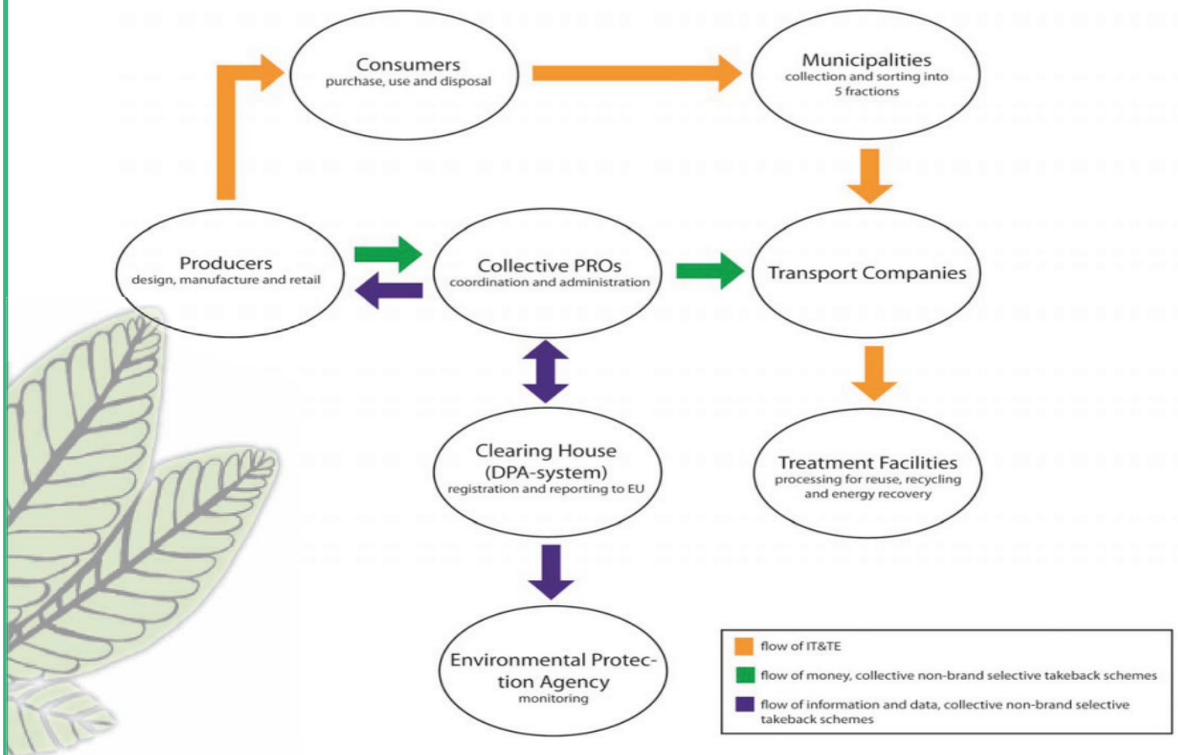


Figure 33: Esther, Lindblad & Mortensen 2011

9

Compliance Mechanisms on E-Waste

9.1 Introduction to This Session

The session on Compliance Mechanisms of E-Waste provides the participants with very specific suggestions on how to ensure the implementation of the Rules and the compliance of the e-waste actors with the Rules. In many cases regulators who have been exposed to the Rules for the first time have difficulties in finding a starting point for the implementation of the Rules.

In this session, suggestions are provided on what steps to take to ensure compliance of each group covered under the Rules. The participants are provided with entire text fragments which can be used for sending out public notices to bulk consumers, producers, collectors, dismantlers and recyclers. In addition, decision-making trees are part of the presentation, making it much easier for the regulators to decide on whether to grant an authorization / registration or not. Finally, specific conditions are suggested which the regulated entities have to fulfill in order to obtain authorization / registration. All of these elements will help the regulators to better ensure the compliance of all stakeholders covered under the Rules.

9.1.1 Objectives of This Session

At the end of this session the participants should:

- Understand their responsibilities regarding the implementation of the Rules
- Have a clear understanding on possible actions to ensure that the actors covered under the Rules comply with the provisions
- Be able to develop own provisions which are left to the discretion of the individual SPCBs / PCCs

9.1.2 Overview of This Session

- Overview
- Action Initiation on Bulk Consumers
- Action Initiation on Producers
- Authorization for Collection Centre
- Authorization Process
- Action Initiation on Dismantlers
- Authorization / Registration for Dismantlers
- Action Initiation on Recyclers
- Registration and Authorization Process
- Overview on Implementation of the Rules

The following sections contain the actual training contents.

9.2 Introduction

The following picture is shown on the first slide of the presentation:

Figure 34: Fisherman

Ask the audience what they see here and how this could be relevant for their work. After collecting a couple of comments you can state that the fisherman symbolizes the SPCBs in their position to collect all the necessary information and take all stakeholders on board. This maybe sometimes difficult as some stakeholders try to escape or hide from the regulative force of the SPCB / PCC.

9.3 Overview

The following figure shows the different steps of the handling and treatment process of e-waste as well as the stakeholders involved at each step:

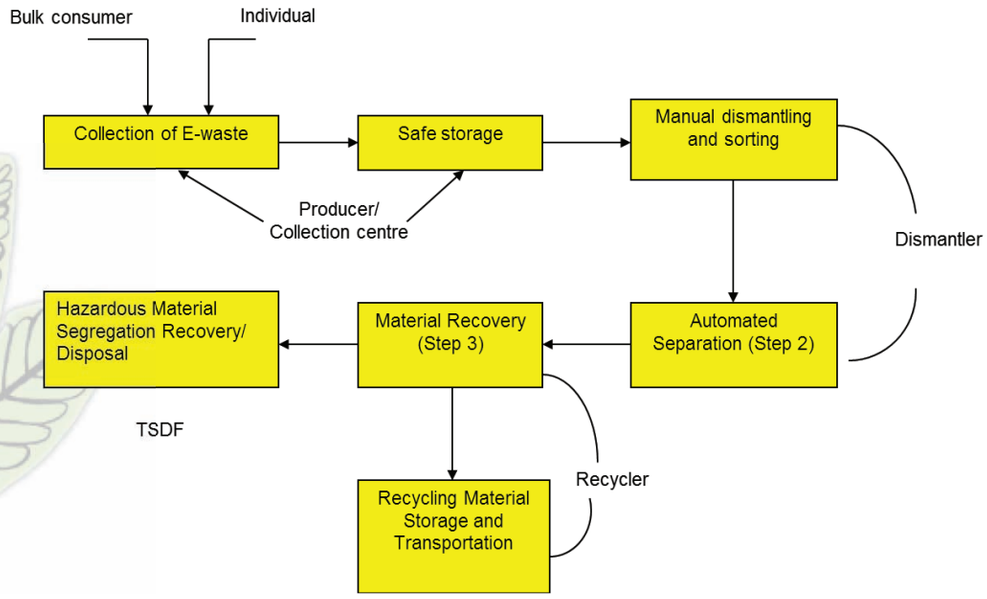


Figure 35: E-Waste stream and stakeholder

In the next slide a potential EPR approach is depicted:

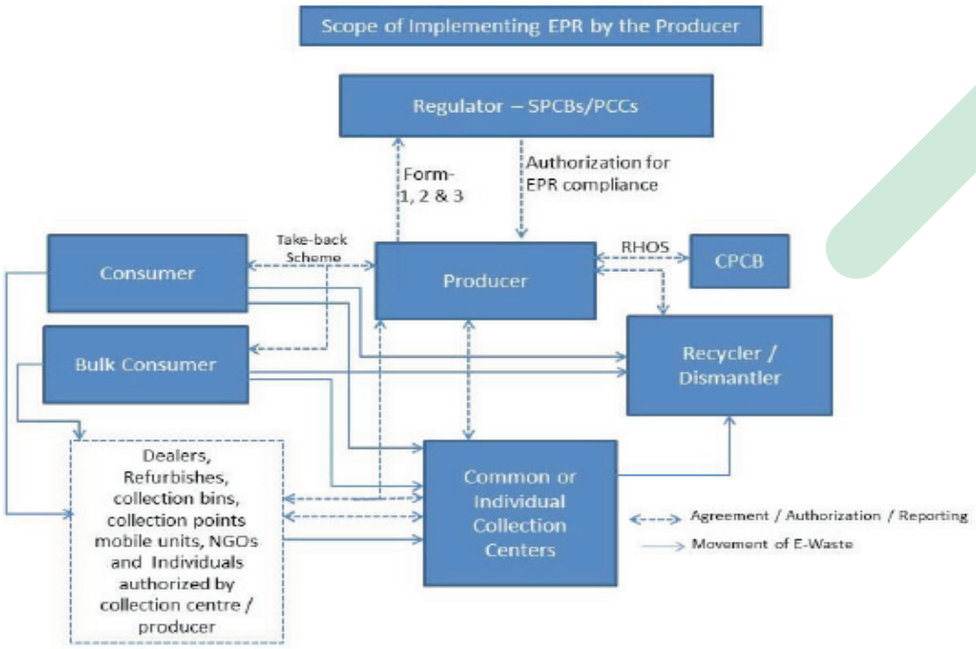


Figure 36: EPR approach

In the table on the applicability of the Rules it is specified which stakeholder has to adhere to which provisions of the Rules:

Table 20: Applicability of the Rules

S. No.	Type of applicant	To maintain records	To maintain records in Form 2	Filing annual return in Form 3	Authorization form 1	Registration form IV	RoHS compliance with CPCB
1.	Consumer	✓	x	x	x	x	x
2.	Bulk consumer	✓	✓	x	x	x	x
3.	Urban local bodies	✓	x	x	x	x	x
4.	Collection centre	✓	✓	✓	✓	x	x
5.	Producer	✓	✓	✓	✓	x	x
6.	Producer manufacturing EEE	✓	✓	✓	✓	x	✓
7.	Dismantler	✓	✓	✓	✓	✓	x
8.	Recycler	✓	✓	✓	✓	✓	x

9.4 Action Initiation on Bulk Consumers

In the next steps it is shown which actions are to be taken to deal with bulk consumers of EEE. A step-wise approach is suggested:

- Step 1 – Circular to government departments for attending workshops
- Step 2 – Public Notice to newspapers/government offices/public places/Doordarshan

- Step 3 – Provide status report to website of SPCB after 1 year
- Step 4 – Inspection of bulk consumers

The following paragraphs can be used as text fragments for giving a public notice to bulk consumers:

- Whereas the Government of India, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) has made the rule herein after called the E-waste (Management and Handling) Rules 2011.
- Whereas, the said Rules came into effect from 1st May 2012 (referred website of SPCB).
- Whereas, these Rules shall apply to every producer, consumer, bulk consumer involved in the manufacturing, sale, purchase and processing of electrical and electronic equipment or components as specified in Schedule 1, collection, dismantler and recycler of E-waste
- Whereas, this is obligatory to bulk consumer under section 6(1) of the said Rules shall ensure that e-waste generated by them is channelized to authorized collection centres or registered dismantlers or recyclers or is returned to pick up or take back services provided by the producers, and under section 6(2), bulk consumers shall maintain records available for scrutiny by the SPCB
- Failure to comply the said obligation is punishable offence under section 15 of E(P) Act, 1986
- In order to assist foe compliance such rules, the State Pollution Control Board has opened a cell for bulk consumers under Dr XYZ, Phone no……

Sd/-
Member Secretary

9.5 Action Initiation on Producers

In the next steps it is shown which actions are to be taken to deal with producers of EEE. A step-wise approach is suggested:

- Step 1 – Public notice
- Step 2 – Procedure for seeking authorization
- Step 2 – Consent conditions

The following paragraphs can be used as text fragments for giving a public notice to bulk consumers:

- Whereas the Government of India, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) has made the rule herein after called the E-waste (Management and Handling) Rules 2011.
- Whereas, the said Rules came into effect from 1st May 2012 (referred website of SPCB).
- Whereas, these Rules shall apply to every producer, consumer, bulk consumer involved in the manufacturing, sale, purchase and processing of electrical and electronic equipment or components as specified in Schedule 1, collection, dismantler and recycler of E-waste
- Therefore, in exercise of the power conferred upon the State Pollution Control Board under Rule 14 (Schedule 3) the undersigned shall invite the attention of the producers on following points:
  - Setting up collection centres or take back systems either individually or collectively
  - Providing contact details such as address, telephone numbers/helpline number of authorized collection centers to consumer(s) or bulk consumer(s) so as to facilitate return of used electrical and electronic equipment
  - Creating awareness through publications, advertisements, posters, or by any other means of communication and information booklets accompanying the equipment:-

- Information on hazardous constituents as specified in sub rule 1 of rule 13
- Information on hazards of improper handling, accidental breakage, damage and/or improper recycling
- Instructions for handling the equipment after its use, along with the do's and don'ts
- Affixing a visible, legible and indelible symbol given below on the products or information booklets to prevent e-waste from being dropped in garbage bins containing waste

- Obtaining an authorization from the concerned State Pollution Control Board in accordance with the procedure under rule 9
- Maintaining records in Form 2 of the e-waste handled and make such records available for scrutiny by the State Pollution Control Board concerned
- Filing annual returns in Form 3, to the State Pollution Control Board on or before 30th June following the financial year to which that return relates
- Failure to comply conditions stated above shall attract actions under the section 15/5 of EP Act

Sd/-
Member Secretary

This notice should be shared with newspapers and other public places

9.6 Authorization Process

The following process should be applied for granting authorization to recyclers and dismantlers:

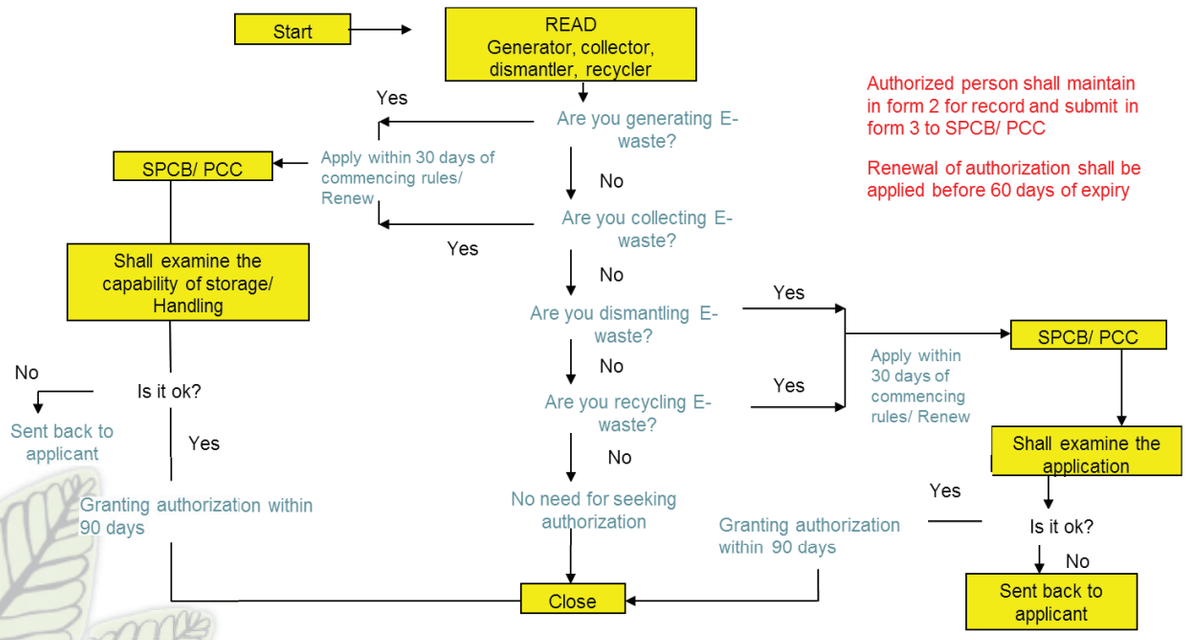


Figure 37: Decision-making tree for registration

9.7 Authorization for Collection Centre

The following conditions are suggested to be fulfilled by collection centres for obtaining an authorization:

General conditions:

- Collection centre should be secured with boundary wall and security personnel
- Both sheds and open spaces with impervious flooring can be permitted for storage of E-waste (IT and TE waste) and open spaces can be permitted for storages of refrigeration/washing machines/air conditioners
- In case of covered sheds, E-waste comprising of IT and TE waste preferably be segregated and stored in suitable containers
- Containers of appropriate size and shapes should be used for segregation of e-waste items (comprising of electronic items) to facilitate effective handling and recycling operations. Containers can be made of either wood or plastic or mild steel or any appropriate material with sufficient strength and shapes (top-open containers, caged, boxes etc) for holding the e-waste. These containers should be placed in such a way that there should be adequate space for movement of man and material. The height of cont. should be limited to 7 feet.
- The collection centre where white goods like refrigerator and air conditioners are also stored should have adequate facilities for handling/arresting leakage of compressor oils, CFCs/HCFCs if any.
- Area for setting up collection centre should not be less than 1000 sq ft
- Calculation of space:
    - Cell phone – 1.0 m3/tonne
    - Telephone – 2.5 m3/tonne
    - Stereos – 7.0 m3/tonne
    - Monitor – 5.0 m3/tonne
    - Computers – 4.0 m3/tonne
    - TV – 6.5 m3/tonne
    - Fridge – 10 m3/tonne
    - Washing machine – 7.5 m3/tonne
    - Air conditioner – 6.0 m3/tonne
- Good housekeeping practices
- Legal Requirements
- To obtain an authorization from the concerned SPCBs/PCCs by providing details such as size of operations (in MT per annum), type of material (electronics o white goods) and list of channelized collection agencies/collection points/collection bins/mobile vans/RWAs/any other arrangements linked with them.
- To ensure that the e-waste collected by them is sent to registered dismantlers or recyclers in a secured manner.
- To maintain records of e-waste handled in Form 2
- To file annual refunds in Form 3
- To make the records available for security by the SPCB/PCC

Guidelines for inspection:

- Whether the producer lay down the collection system network?
- Whether the location of bins is in GIS/GPS system?

- Whether the bins are developed as per the norms?
- (few location to be verified)
- Whether segregation takes place at collection system?
- If so, how much adequate it is:-
- Whether the segregated materials are kept properly in a well-designed store?
- Whether the records are maintained properly?
- What is the overall condition of housekeeping?

Verification of records:

- How much materials are received?
- How much are in store?
- What is the time duration of keeping the materials in store?
- How much is transferred to dismantler?

9.8 Action Initiation on Dismantlers

In the next steps it is shown which actions are to be taken to deal with dismantlers. A step-wise approach is suggested:

- Step 1 – Public notice
- Step 2 – Consent conditions
- Step 3 – Procedure for seeking authorization and registration

The following paragraphs can be used as text fragments for giving a public notice to dismantlers:

- Whereas the Government of India, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) has made the rule herein after called the E-waste (Management and Handling) Rules 2011.
- Whereas, the said Rules came into effect from 1st May 2012 (referred website of SPCB).
- Whereas, these Rules shall apply to every producer, consumer, bulk consumer involved in the manufacturing, sale, purchase and processing of electrical and electronic equipment or components as specified in Schedule 1, collection, dismantler and recycler of E-waste
- Therefore, in exercise of the power conferred upon the State Pollution Control Board under Rule 14 (Schedule 3) the undersigned shall invite the attention of the producers on following points:
    - Obtaining an authorization and registration from the concerned State Pollution Control Board in accordance with the procedure under rules 9 and 11
    - Ensure that no damage is caused to the environment during storage and transportation of e-waste
    - Ensure that the dismantling processes do not have any adverse effect on the health and environment
    - Ensure that the facility and dismantling processes are in accordance with the standards or guidelines published by the Central Pollution Control Board from time to time
    - Ensure that the dismantled e-waste are segregated and sent to the registered recycling facilities for recovery of materials
    - Ensure that non-recyclable/non-recoverable components are sent to the authorized treatment and storage disposal facilities
    - File annual returns in Form 3 to the State Pollution Control Board

- Not process any e-waste for recovery or refining of materials, unless he is registered with State Pollution Control Board as a recycler
- Failure to comply conditions stated above shall attract actions under the section 15/5 of EP Act

Sd/-
Member Secretary

9.9 Authorization / Registration for Dismantlers

The following conditions are suggested to be fulfilled by dismantlers for obtaining an authorization / registration:

General conditions:

- Manual dismantling can be carried out over the dismantling table with space de-dusting hoods connected with bag dust collectors venting out through a chimney of 3 meter above roof level so as to maintain desirable work zone air quality as per the factory act 1948.
- Mechanized dismantling shall comprise of physical separation after opening the material by manual or semi mechanical operations or directly feeding into a crusher (attached with bag dust collectors) to crush the wastes into fragments that will be segregated on a moving belt by manual collection. Fine grinding, gravity separation/ magnetic/ density/ eddy/ current/ electromagnetic separators shall not be employed by dismantlers.
- Dismantling operations shall not include Fine grinding/wet shredding/wet grinding operations. Dismantling operations shall not be permitted for chemical leaching or heating process or melting the materials. Dismantlers shall not shred segregated LCDs.
- Dismantler shall have adequate facilities for disposal of bag filter residues and floor cleaning dust in secure manner or shall obtain TSDF membership
- Dismantlers can be permitted for shredding or cutting printed circuit boards not below the size of 20 mm which have to be handled by employing minimal manual handling and with adequate air pollution control devices
- In case of dismantling refrigerators and air conditioners, skilled manpower having adequate tools and PPEs to manually separate compressors.
- The premise for dismantling operation should fulfill the following requirements:
  - Weather proof roofing and impermeable surfaces for appropriate areas with spillage collection facilities, decanters, degasser and degreasers
  - Appropriate storage for dissembled spare parts
  - Appropriate containers for storage of batteries, capacitors containing PCBs or PCTs
- Impermeable working surface or pavement should be constructed and maintained to prevent the transmission of liquids beyond the pavement surface. The impermeable surface should be associated with a sealed drainage system connected to a collection sump.
- The type of impermeable surface required is likely to depend on a number of factors including
  - The type and quantity of e-waste being stored or processed including whether the e-waste contain hazardous substances and fluids
  - The type and volume of other materials undertaken on the surface
  - The level of maintenance
- Spillage collection facilities include the impermeable pavement and sealed drainage system as the primary means of containment. Spill kits to deal with spillages of oils, fuel and acids should be provided and used

- Other components and residues arising from the dismantling of e-waste will need to be contained following their removal for disposal or recovery. Where they contain hazardous substances they should be stored on impermeable surfaces and inappropriate or bays with waterproof covering. Containers should be clearly labeled. Components should be segregated with respect to their final destination. Batteries should be handled and stored with respect to the fire risk associated with them.

Space requirements:

- A recycler of a capacity of 1 Ton per day shall require a minimum of 5000 sq. feet. Registration to recyclers may be preferred if they have minimum operational capacity of **2MT/day with an area of about 10,000 sq. ft.**

9.10 Action Initiation on Recyclers

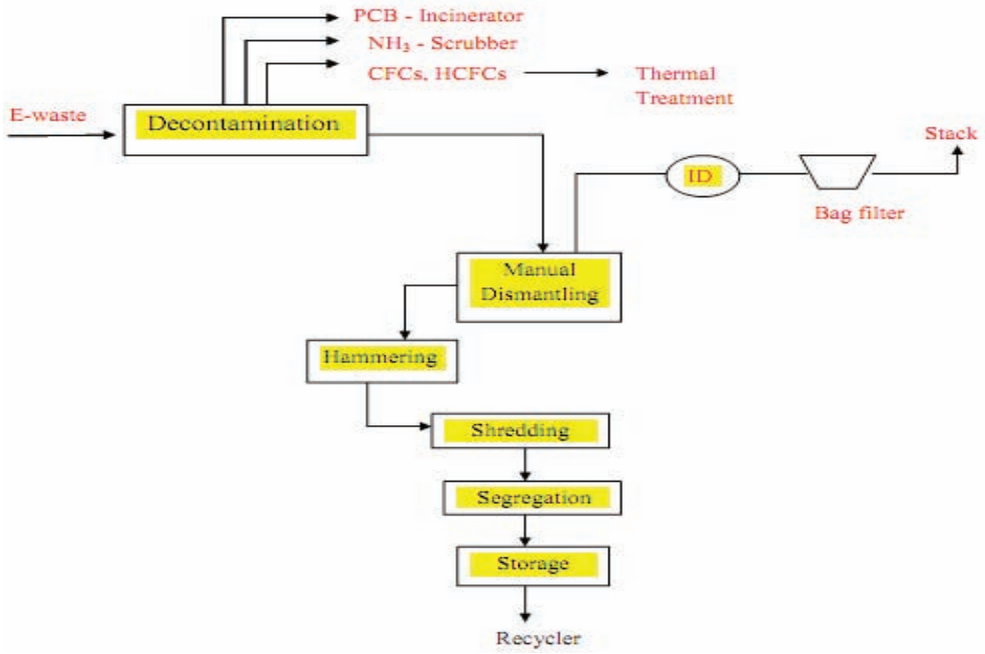


Figure 38: Recycling process

The following options for recycling methods exist:

Input (dismantled and segregated e-waste)	Unit operation/disposal recycling technique	Output
Sorted Plastic	Recycling	Plastic Product
Mixed Plastic	Mixed plastic granules, melting and moulding / co-processing	Low grade plastic products / Energy Recovery
CRT	Breaking/ Recycling	Glass Cullet
Lead scrap	Secondary Lead Smelter	Lead
Ferrous metal scrap	Secondary steel production (foundries/DRI furnaces)	Iron
Non Ferrous metal Scrap	Secondary copper and aluminum smelting	Copper/ Aluminum

Precious Metals	Au/ Ag separation (refining), melting and hydro-metallurgical processes	Gold/ Silver/ Platinum and Palladium
Batteries (Lead Acid/ NiMH and Li ION)	Lead recovery and smelting Re-melting and separation	Lead, Ni and Li
Capacitors	Incineration	Energy recovery
Mercury	Separation and distillation	Mercury

Table 21: Recycling options

In the next steps it is shown which actions are to be taken to deal with recyclers. A step-wise approach is suggested:

- Step 1 – Public notice
- Step 2 – Consent conditions
- Step 3 – Procedure for seeking authorization and registration

The following paragraphs can be used as text fragments for giving a public notice to recyclers:

- Whereas the Government of India, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) has made the rule herein after called the E-waste (Management and Handling) Rules 2011.
- Whereas, the said Rules came into effect from 1st May 2012 (referred website of SPCB).
- Whereas, these Rules shall apply to every producer, consumer, bulk consumer involved in the manufacturing, sale, purchase and processing of electrical and electronic equipment or components as specified in Schedule 1, collection, dismantler and recycler of E-waste
- Therefore, in exercise of the power conferred upon the State Pollution Control Board under Rule 14 (Schedule 3) the undersigned shall invite the attention of the producers on following points:
    - Obtaining an authorization and registration from the concerned State Pollution Control Board in accordance with the procedure under rules 9 and 11
    - Ensure that the facility and recycling processes are in accordance with the standards or guidelines published by the Central Pollution Control Board from time to time
    - Make available all records to the State Pollution Control Board for inspection
    - Ensure that residues generated thereof is disposed of in the treatment and storage disposal facilities
    - File annual returns in Form 3 to the State Pollution Control Board
    - Failure to comply conditions stated above shall attract actions under the section 15/5 of EP Act

The following conditions are suggested to be fulfilled by recyclers for obtaining an authorization / registration:

General conditions:

- A recycling facility shall install adequate wastewater treatment facilities for process wastewater and air pollution control equipments
- Suitable space dedusting equipment shall be installed where manual dismantling, shredding operations are carried out
- Suitable fume hoods connected with bag dust collectors followed by wet (chemical) scrubbers shall be installed for control of fugitive emissions from furnaces or chemical reactor fumes
- The discharges from the facility shall comply with general standards under E(P) Act, 1986 for discharge of wastewater

- In case of air emissions, the unit shall comply with emission values prescribed under Air (Prevention and Control of Pollution) Act, 1981. In case of furnace, a minimum stack height of 30mt shall be installed depending on emission rate of SO2
- The workers involved in recycling operations shall wear proper PPEs (Personal Protective Equipment)
- In additions to dismantling operations, recyclers may adopt suitable technologies for shredding, wet grinding, gravity / magnetic/density/eddy current/electromagnetic separators with adequate air pollution control equipment. It shall be ensured that dust control equipment shall comprise of mechanical dust collectors followed by fabric filters or two stage fabric filters or fabric filter followed by wet (chemical) scrubbers.
- Adequate facilities for disposal of bag filter residue and floor cleaning dust in secure manner or shall obtain membership with TSDF for safe disposal.

9.11 Registration and Authorization Process

The following process should be applied for granting registration to recyclers and dismantlers

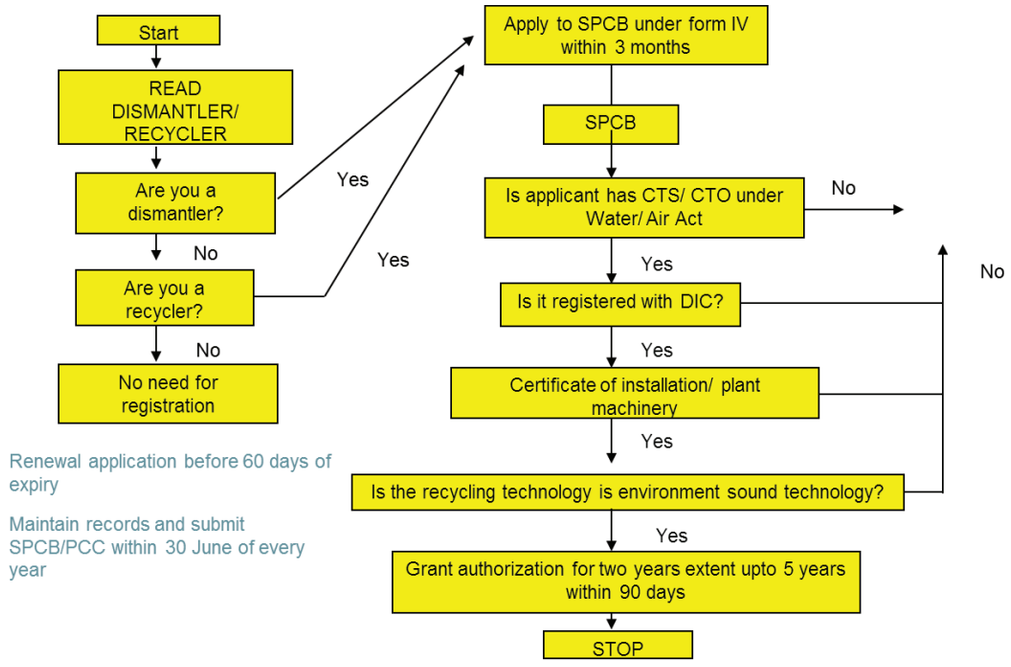


Figure 39: Decision tree for granting registration

A color coding system is proposed for the validation period for registration and authorization of collectors, dismantlers and recyclers. This would make it easier for the regulators to handle the registration and authorization process:

Scale of the unit	**E-waste category (proposed)**		
	Red	Orange	Green
Small (0-5 crore)	–	Dismantler	Collection centre (0-5000 MTA)
Medium (5-10 crore)	–	Dismantler	Collection centre (5000 -20000 MTA)
Large (above 10 crore)	Recycler	Dismantler	Collection centre (above 20000 MTA)

Table 22: Waste category for validation period for authorization/registration

9.12 Overview on Implementation of the Rules

The final content slide again presents the entire framework of the Rules with all actors that are involved.

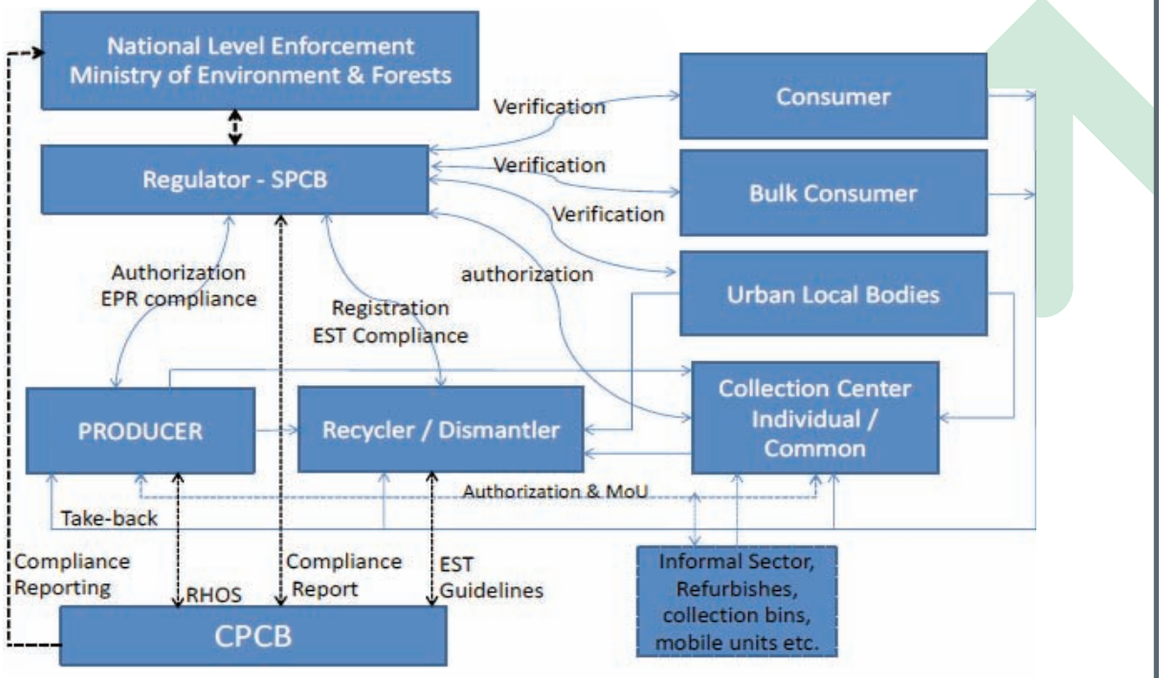


Figure 40: Framework of the Rules

Trainer's note
On the very last slide of the presentation you can invite the audience to pose question on the implementation of the Rules and ask the participants to share their personal experiences with the implementation of the Rules.

10
IEC Activities

10.1 Introduction to This Session

Information, Awareness and Communication (IEC) is an essential component of a successful e-waste strategy, also from the regulators' side. E-waste management and recycling is still not the important topic for everyone which it ought to be. Many households and bulk generators do not yet know about their responsibilities with regard to disposal of e-waste. As per the Rules it is the duty of the actors of the e-waste chain to make the public aware of the proper collection and recycling channels. However, these actors often do not have the resource or position for public awareness campaigns. Regulators should also have an interest in establishing an efficient recycling system. As government bodies they have the means and position to inform the public about the issue of e-waste. Therefore, they should use this role to engage with the public by various means for a change of the current e-waste framework to a more sustainable system.

10.1.1 Objectives of This Session

At the end of this session the participants should:

- Know why IEC is important from the regulators' perspective as well
- Know what measures can be implemented to engage in IEC activities
- Be sensitized on the issue of addressing the right target group
- Have an idea on what IEC they could take

10.1.2 Overview of This Session

- E-Waste Campaign
- E-Waste Campaign Tool Kit
- SPCB Outreach Activities
- Exercise: Developing Measures for E-Waste Campaign

The following sections contain the actual training contents.

10.2 E-Waste Campaign

The first slide of this section deals with the question why an e-waste campaign by the regulator is useful. Reasons are:

- Campaigning activities support the implementation of E-waste Rules for which the regulators are responsible

- Awareness and engagement with the target group may result in a significant increase in collection of e-waste and the environmentally sound recycling of the material

The next slide looks at **what** should be the content of the campaign:

- Clear communication of messages on environmental consequences, economic consequences and social consequences
- It should be considered that different target groups require different strategies in order to be successful; assure that you determine the target group correctly before designing the pitch

How the campaign should be developed is the topic of the following two slides:

- Development of a Communication / outreach strategy on e-waste to communicate with a defined audience through a strategic message to achieve a certain goal
- Elements of communication strategy:
  - Stakeholder engagement
  - Target group
  - Development of Toolkit/ IEC material
  - Implementation mechanism
  - Timelines
  - Financing and resource allocation
- Stakeholder engagement/ analysis for institutionalization
  - Producers & industrial associations
  - Recyclers
  - Bulk Consumers including Private and Public Enterprises, Academic institutions etc.
  - Individual Consumers including resident welfare associations/ LION/ Rotary Clubs
  - For instance: Pune / Delhi Draft City Action Plan on E-waste

Target groups of the campaign should be:

- Residents in the city/ state aged 15 - 45 years
- Socio-Economic Class I & II: Middle to high income earners
- High purchasing power
- Literate (College Education)
- Seek information from the media
- Have access to Television, radio and the Internet

10.3 E-Waste Campaign Tool Kit

Various tools are presented that can be applied by the SPCBs/PCCs to increase the awareness on e-waste. Many of these tools and approaches have already been applied by the WEEE Recycle project. In this case examples and success stories are presented as well:

Inventorization of e-waste in the respective city/state

- KAP Survey: Face to Face interview in randomly selected samples
- Moderator administers the messages to establish attitudes and perceptions
- The same questions repeated after exposure to messages to determine attitude and behavior change

Press Releases/ Written Media Campaigns

- Results of Inventory shared through media
- Target setting - at least two feature stories every month for the 6-12 months of the IEC campaign
- The feature could outline the dangers of the e-waste menace, extent of the problem and the measures to curb the menace.

Television Adverts

- The television advertisements are designed to run on National Channel, Doordarshan by the Ministry of Consumer Affairs, Food and Public Distribution (MoCA) as this channel targets wider audiences. Campaign telecasted for 15 days in 19 regional languages across India.

Oral Communication - Radio

- Interviews of the Experts
- Slogans on improper disposal of e-waste
- Films/ documentaries on E-waste initiatives

Workshops/ Awareness Sessions

- Workshops with different stakeholders like Banks & PSUs, Hotels, Hospitals, Schools, NGOs, and International Organizations etc. to create awareness and develop a collection mechanism. For instance: DoE and WBPCB

Curriculum Development

- Provide undergraduate students the knowledge to understand a contemporary environmental issue including e-waste
- Support in developing research projects on a technology and society related issue
- Develop skills that enhance employability

Engagement with Schools

- Awareness programme for school teachers & children on safe disposal of e-waste
- Awareness package including E-waste films, posters and pamphlets disseminated
- Use Creative Expression medium like games, theatre, art and sculpture, film making/photography
- Information session & meetings with collection agencies
- Visit to an e-waste recycling facility
- Competitions on waste to products & poster making etc.

Additionally, all of these activities can be accompanies by giving out posters, flyers, brochures, or even setting up collection bins for end-of-life EEE.

10.4 SPCB Outreach Activities

In the last part of the presentation outreach activities already implemented by some SPCBs are presented.

Karnataka

- KSPCB in collaboration with NGOs and other organizations is regularly conducting various environment awareness programmes on various events.
- About Rs. 40 Lakhs Budget was allocated for conducting awareness programmes during 2011-12.
- The awareness activities such as organizing seminars, workshops, campaigns, Jathas, street plays, tree plantations, debate, painting, drawing competitions and other environment related activities are carried out in collaboration with NGO's/ Trusts/ Eco-clubs and other organizations throughout the year (Karnataka State Pollution Control Board).

Tamil Nadu

- The Tamil Nadu Pollution Control Board allotted Rs. 2 lakh each for Tirunelveli and Tuticorin Corporations and Rs.1 lakh for Nagercoil municipality, the local bodies have planned to conduct a series of campaigns (The Hindu 2009).

West Bengal

- On 1st July 2011 West Bengal Pollution Control Board launched campaign programmes to create awareness among the common people including both buyers and sellers regarding prohibition of using plastic carry bags (West Bengal Pollution Control Board 2011).

10.5 Exercise: Developing Measures for E-Waste Campaign

At the end of the session it is the participants turn to think about specific measures they can implement for creating more awareness on e-waste in their respective states or cities.

Details:

- The participants should form groups of five people
- Within the group they should first discuss which measures or programmes they could implement to increase the awareness on e-waste (10 min)
- Based on this discussion they should select the most promising measures and define steps which need to be taken for implementing the measures (30 min). Such steps could include: decide on budget, seek permission from superiors, hire designer, contact advertising company, link up with dismantlers and recyclers for co-funding, etc.
- Each group should present the three most relevant options and the necessary steps for implementation to the group (max. 5 min per group)

Trainer's note
For this exercise you can us a flipchart and large sheets of paper. The participants could write their measures on the sheets of papers and present them at the end.

11

Developing an Action Plan

11.1 Introduction to This Session

Many topics have been touched on in this training which is of great relevance to regulators. However, in the end it comes down to the actions actually taken by the regulators. It is the goal of this last part of the training course that the participants use the training experience to develop an action plan which they can take back home and use for starting actions on the implementation of the Rules. Therefore, an introductory part exposes the participants to the general concept of planning and the development of an action plan. The far more important part is the exercise in the end in which small groups concentrate on the specific actions to be taken by the participating SPCBs/PCCs for fulfilling the regulators' duties regarding the implementation of the Rules.

11.1.1 Objectives of This Session

At the end of this session the participants should be able to:

- Understand the general approach to a planning process
- Know how to develop an action plan
- Know which actions they are going to take next for the implementation of the Rules

11.1.2 Overview of This Session

- Approach to Planning
- Taking Stock
- Formulating Goals
- Developing an Action Plan
- Exercise: Developing an Action Plan
- Training Evaluation

The following sections contain the actual training contents.

11.2 Approach to Planning

The first slide shows a very general planning cycle:

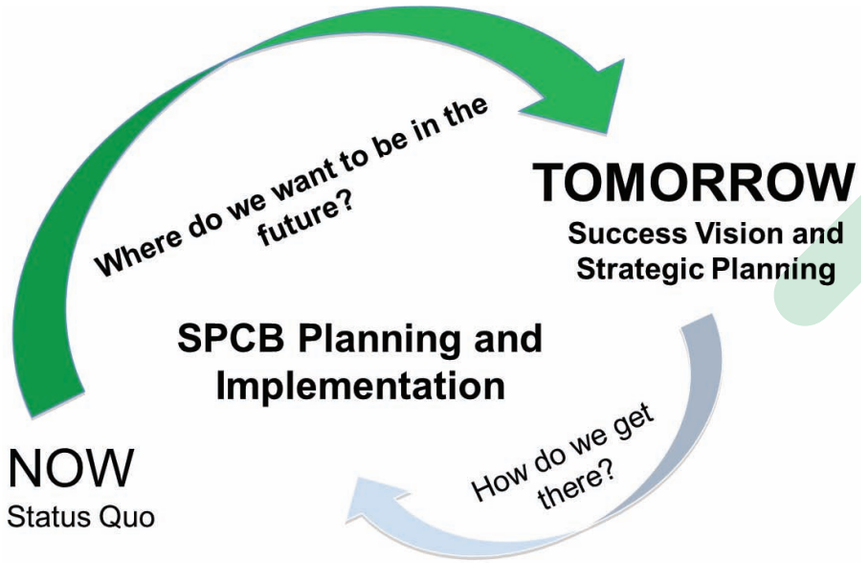


Figure 41: Planning cycle

In planning situation, one starts at the “Now / status quo”. From there on you ask yourself where you would like to be in the future. You define a success vision and engage in the task of developing a strategic plan. The details of this plan point out what you will do for achieving your goal. This very simple approach can be applied to the implementation of the E-Waste Management & Handling Rules 2011.The participants assess where they stand now, what their goal is, and how they can get there.

The next slide gives some more details on the planning process:

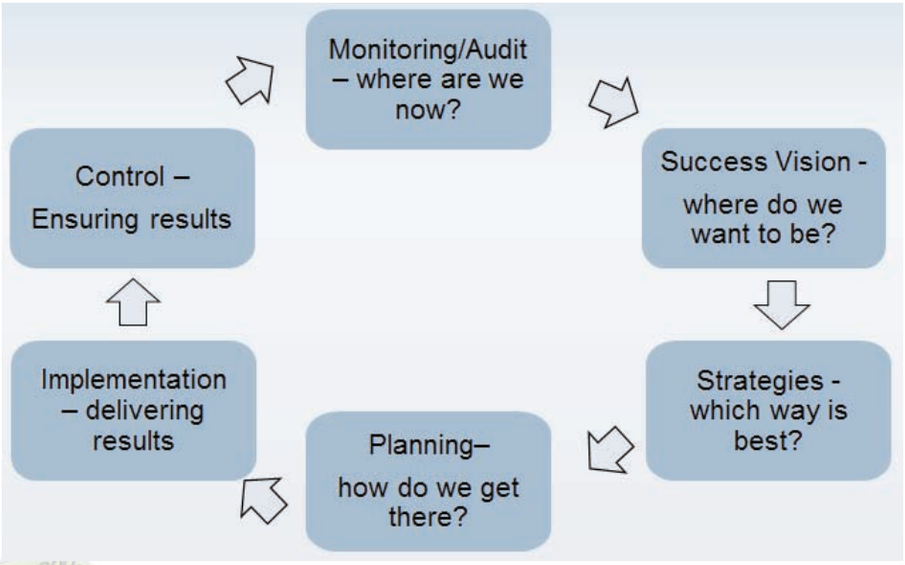


Figure 42: Planning process

In this depiction, also the part of implementation is included. Once you have decided on a strategy, you need to implement it and then monitor whether you achieve the expected results. This is a continuous process that never stops.

The Plan-Do-Check-Act approach is a general 4-step process which helps you to ensure continuous monitoring and improvement of you action plan.

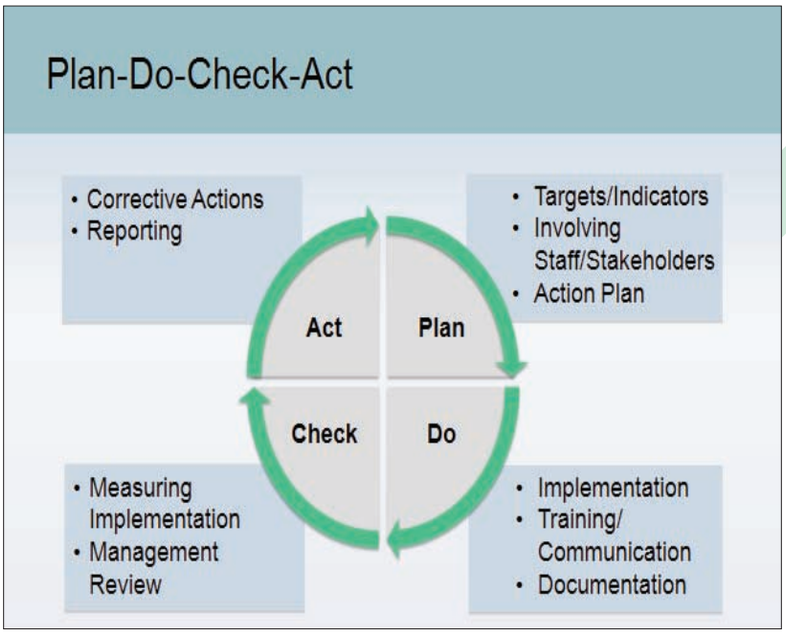


Figure 43: Plan-Do-Check-Act

First, the action to be taken is planned. This is where this session, “Developing an Action Plan”, comes in. Second, the action plan is implemented. Third, results are monitored. And fourth, based on the monitoring, corrective actions are taken to improve the process.

11.3 Taking Stock

In this part, you ask the participants what the current status of the implementation of the Rules is.

Trainer’s note
The answers of the participants can be written on a white- or note-board and kept in mind for the development of the action plan later on.

11.4 Formulating Goals

As a next step, the participants should formulate goals on

- Where the regulators **have to** go as per the specifications of the Rules, and
- Where regulators **want to** go as per their general mandate

Trainer’s note
The answers of the participants can be written on a white- or note-board and kept in mind for the development of the action plan later on.

11.5 Developing an Action Plan

For developing an action plan the following questions need to be answered for each action:

- What needs to be done?
- Who will implement it?
- When will it be implemented?
- Which resources are required for the implementation?

WHAT

For deciding on the WHAT the participants need to consider several fields relevant for the implementation of the Rules where action is required. Possible fields are:

- Awareness
- Registration
- Reporting
- O&HS
- Inventorization

Of course, additional fields can be relevant as well.

Once these fields or **target areas** have been defined, specific **targets** with suitable **indicators** need to be defined. Then, **measures** or actions for achieving these goals need to be developed.

WHO

Subsequently, it needs to be defined for each measure who will be the responsible actor for the implementation. Additionally, it needs to be assessed which will be additional stakeholders that are relevant for the implementation of the measure, however, not directly responsible.

RESOURCES

For each measure it also needs to be assessed whether there are any resources needed for the different tasks? Then, the requirements regarding manpower, expertise, funding, equipment, etc need to be listed. As a final step the participants need to come up with suggestions on how to obtain the necessary resources.

WHEN

For each measure a deadline for the implementation needs to be established. All measures can then be grouped in a Gantt chart or on a timeline for a better visualization of the action plan.

The example of an action plan could look like this:

Action Field	Target	Indicator	Measure	Who?	Resources
Reporting	Send reports in due time	Date of report submitted	Develop a planning process for writing the annual report	SPCB staff	-
Registration	Visit 30 % of the units applying for registration	Number of visits / number of applications	Develop a system for selecting companies to be visited	SPCB staff	Testing equipment
Awareness	Conduct 12 awareness events per year	Number of awareness events	Partner with local groups to implement the events	SPCB staff; local groups	Information materials

Table 23: Example of an action plan

11.6 Exercise: Developing an Action Plan

The following instructions are given on the action plan worksheet:

Task:

- Split up in groups of five
- Discuss with your group members the current situation regarding the implementation of the E-Waste (Management & Handling) Rules
- In the next step you will develop an Action Plan for the effective implementation of the E-Waste (Management & Handling) Rules by the SPCB
- Fill in the Action Plan Template
- Write the main parts of the Action Plan on maximum two large sheets of paper
- Present your Action Plan to the group

Details:

- You should state in which fields of e-waste management you want to / have to take action
- For each of these fields, formulate targets you want to / have to achieve
- For each target, specify indicators which you can use to measure whether the target has been achieved
- For each target, provide one / several measure(s) on how to achieve it
- For each measure, specify who will be responsible within the SPCB for implementation and which other stakeholders need to be involved
- Also specify for each measure, which resources will be required
- Finally, think about a timeline for implementing the action plan. Prioritize the measures, think about dependencies between them and be realistic

Materials required:

- Two large sheets of paper per group
- Different colored markers for each group
- Different colored note cards for each group

Trainer's note
The groups have about 100 minutes for developing the action plan
The presentation of the action plan should last max. 10 min
Plan some time for a final discussion at the end of the session

11.7 Training Evaluation

In the evaluation of the training you can use a written training evaluation sheet which is provided to you in the annex. The participants are asked to fill out the sheet and hand it back to you.

Besides this quantitative evaluation you should also facilitate a discussion about training in which each of the participants can voice his or her impressions on the training. As materials for this discussion you can use:

- The participants' expectations on the training which you have collected in the beginning of the training; you can now ask the participants whether these expectations have been fulfilled or not

- The challenges faced by the participants in implementing the Rules; these had also been collected on a flipchart; you can now ask the participants whether they feel better prepared to tackle these challenges

Trainer's note
You should have enough time at the end of the final to evaluate the training and have a final discussion with the participants. Plan with a minimum of 45 min for the evaluation and final discussion.

12
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Annexure-1

Exercise: Inventorization

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Exercise: Inventorization

Task:

- In this exercise you are asked to perform a sample PC e-waste inventorization using data and figures provided to you below
- You are asked to calculate the generation of e-waste in Samplecity in 2014
- You will find template for the input and calculation of data below

Input data:

Unit sales for PCs in Sample city per year in lakhs:

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
HH	0.3	0.4	0.6	0.9	1.2	1.5	2.5	4	6	8	11
Business	0.7	0.9	1.3	2	3	4	7	9	13	15	19

Market share of different PC types (2003 – 2007)

	PC1	PC2	PC3
HH	30 %	40 %	30 %
Business	10 %	30 %	60 %

Market share of different PC types (2008 – 2013)

	PC2	PC3	PC4
HH	20 %	50 %	30 %
Business	30 %	20 %	50 %

Weight of PC types in kg

PC1	PC2	PC3	PC4
14	11	9	7

Use-life of an average PC in years for PC bought in respective year

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
HH	6	5	5	5	5	5	5	4	4	3	3
Business	5	5	4	4	4	4	4	4	3	3	2

Rate of reuse

Each year **30%** of the PCs that have reached their end-of-life go for refurbishment. The extended use time across all PCs types for these refurbished PCs is **1 year** for households as well as businesses.

EXAMPLE:

In this example we are also looking for the amount of PCs going to the e-waste stream during 2014. The question is how do you calculate the percentage share of PCs scrapped from a certain year?

The following table gives you the use time of PCs for this example:

Use-life of an average PC in years for PCs bought in the respective year

	2009	2010	2011	2012	2013
HH	4	3	3	2	2
Business	3	3	3	2	1

Regarding the reuse of the PCs, the following scenario is in place: Each year **30% of the PCs** that have reached their end-of-life **go for refurbishment**. The extended use time across all PCs types **for these refurbished PCs is 1 year** for households as well as businesses.

For deriving the percentage share please follow the subsequent steps:

- PCs sold to households in year 2009 are used for 4 years. Following the assumptions given above, the PC is in use in 2009, 2010, 2011, and 2012. Thus, 70 % of the PCs sold in 2009 go to scrap directly and can be attributed to the generated e-waste in 2013. 30 % of the PCs sold in 2009 go for refurbishment during 2013, are in use one year longer, and enter the e-waste stream during 2014. This quantity (30% of waste PCs sold in 2009) thus becomes e-waste generated in 2014.
- The same logic applies to PCs sold in 2010. Of the amount of PCs sold in 2010, 70% enter the waste stream in 2013 and 30% enter the waste stream in 2014.
- PCs sold to households in 2011 are used for 3 years. The PC is thus in use in year 2011, 2012, and 2013. During 2014, 70% of the PCs sold in 2011 enter the e-waste stream.
- The values for the additional years are calculated accordingly

The share of PCs sold in the respective year that enters the e-waste stream in 2014 thus looks the following way:

	2009	2010	2011	2012	2013
HH	30%	30%	70%	70%	–
Business	–	30%	70%	70%	70%

Calculation tables:

PCs being disposed during of 2014 *in percent* as per year of purchase

Year				
HH				
Business				

PC units being disposed during 2014 (in lakhs) from respective year

Year				
HH				
Business				

Units of PC per type being disposed during 2014 (in lakhs) from respective year

		Year			
	PC Type				
HH					
Business					

Weight in lakhs kg

		Year			
	PC Type				
HH					
Business					

Weight in MT

		Year			
	PC Type				
HH					
Business					
	Total				

Total in 2014 MT	

Annexure-2

Exercise:
Inventorization - Solution

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Exercise: Inventorization - Solution

PCs being disposed during 2014 in percent as per year of purchase

	2008	2009	2010	2011
HH	30 %	70%	70%	
Business		30%	70%	70%

PC units being disposed during 2014 (in lakhs) from respective year

	2008	2009	2010	2011
HH	0.45	1.75	2.8	
Business		2.1	6.3	9.1

Units of PCs per type being disposed during 2014 (in lakhs) from respective year

	PC Type	2008	2009	2010	2011
HH	PC2	0.09	0.35	0.56	0
	PC3	0.225	0.875	1.4	0
	PC4	0.135	0.525	0.84	0
Business	PC2	0	0.63	1.89	2.73
	PC3	0	0.42	1.26	1.82
	PC4	0	1.05	3.15	4.55

Weight in lakhs kg

		2008	2009	2010	2011
HH	PC2	0.99	3.85	6.16	0
	PC3	2.025	7.875	12.6	0
	PC4	0.945	3.675	5.88	0
Business	PC2	0	6.93	20.79	30.03
	PC3	0	3.78	11.34	16.38
	PC4	0	7.35	22.05	31.85

Weight in MT

		2008	2009	2010	2011	
HH	PC2	99	385	616	0	
	PC3	202.5	787.5	1,260	0	
	PC4	94.5	367.5	588	0	
Business	PC2	0	693	2,079	3,003	
	PC3	0	378	1,134	1,638	
	PC4	0	735	2205	3185	Total
	Total	396	3,346	7,882	7,826	19,450.00

Annexure-3

Exercise:
E-Waste Quiz

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Exercise:
E-Waste Quiz

Task:

- Select the correct answer from the questions below
- You have 10 min for completing the questionnaire

Questions:

1) When were the E-waste rules notified?

   a) 14th May 2010
   b) 12th May 2011
   c) 10th June 2009
   d) 1st May 2012

2) According to the E-waste categories as per the rules, identify the odd one out from the following:

   a) Television
   b) Air-Conditioners
   c) Laptops
   d) Refrigerators

3) In the context of Recycling, what does ARF stand for?

   a) Average Recycling Fee
   b) Aggregate Recycling Fee
   c) Advanced Recycling Fee
   d) Advanced Remuneration Fee

4) One ton of scrap from discarded computers contains gold more than

   a) 17 tons of gold ore
   b) 8 tons of gold ore
   c) 12 tons of gold ore
   d) 25 tons of gold ore

5) Which toxic compound is not found in E-waste

   a) Mercury
   b) Cadmium
   c) Neon
   d) Lead

6) According to Chapter V of the E-waste rules dealing with Reduction in the use of Hazardous Substances, identify the permitted concentration of hazardous substances

   a) 0.05% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.005% by weight in homogeneous materials for cadmium
   b) 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.01% by weight in homogeneous materials for cadmium

c) 0.01% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.1% by weight in homogeneous materials for cadmium

d) 0.2% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.025% by weight in homogeneous materials for cadmium

7) What is the amount of E-waste generated in India in 2012?

a) More than 4 lakh tons
c) Between 2 to 3 lakh tons
b) Between 7 to 8 lakh tons
d) More than 10 lakh tons

8) Battery of electronics item comes under E-waste Management and Handling Rules?

a) True
b) False

9) What Hazardous Chemicals is used in the recovery of Precious Metal by informal sector?

a) Nitric acid
c) Mercury amalgam
b) Caustic Soda
d) All of the above

10) What is the percentage of plastic in an average mobile handset?

a) 10%
c) 40%
b) 30%
d) 20%

11) The state Boards and committees shall prepare and submit to the Central Pollution Control Board with an annual report with regard to the implementation of these rules by

a) 30th December every year
c) 31st March every year
b) 12th May every year
d) 30th September every year

12) To ensure that e-waste pertaining to orphan products is collected and channelized to authorized collector/ dismantler/ recycler, this responsibility lies with the

a) Municipal Corporation
c) Department of Environment
b) Pollution Control Board
d) Department of IT

13) How many toxic substances can be found in 1 PC?

a) More than 500
c) More than 1000
b) More than 100
d) More than 10000

14) What is the maximum number of day for which every producer, collection center, dismantler or recycler can store E-waste?

a) 90 days
c) 240 days
b) 60 days
d) 180 days

15) Which of the following harmful compounds is released when PVC is burnt?

a) Hydrogen Chloride
c) Barium Chloride
b) Ammonium Chloride
d) Copper Chloride

Annexure-4

Answer Sheet for E-Waste Quiz

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Answer Sheet for E-Waste Quiz

Task:

- Select the correct answer from the questions below
- You have 10 min for completing the questionnaire

Questions:

1) When were the E-waste rules notified?

a) 14th May 2010
b) 12th May 2011
c) 10th June 2009
d) 1st May 2012

2) According to the E-waste categories as per the rules, identify the odd one out from the following:

a) Television
b) Air-Conditioners
c) Laptops
d) Refrigerators

3) In the context of Recycling, what does ARF stand for?

a) Average Recycling Fee
b) Aggregate Recycling Fee
c) Advanced Recycling Fee
d) Advanced Remuneration Fee

4) One ton of scrap from discarded computers contains gold more than

a) 17 tons of gold ore
b) 8 tons of gold ore
c) 12 tons of gold ore
d) 25 tons of gold ore

5) Which toxic compound is not found in E-waste

a) Mercury
b) Cadmium
c) Neon
d) Lead

6) According to Chapter V of the E-waste rules dealing with Reduction in the use of Hazardous Substances, identify the permitted concentration of hazardous substances

a) 0.05% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.005% by weight in homogeneous materials for cadmium

b) 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.01% by weight in homogeneous materials for cadmium

c) 0.01% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.1% by weight in homogeneous materials for cadmium

d) 0.2% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominateddiphenyl and 0.025% by weight in homogeneous materials for cadmium

7) What is the amount of E-waste generated in India in 2012?

a) More than 4 lakh tons
c) Between 2 to 3 lakhtons
b) Between 7 to 8 lakh tons
d) More than 10 lakh tons

8) Battery of electronics item comes under E-waste Management and Handling Rules?

a) True
b) False

9) What Hazardous Chemicals is used in the recovery of Precious Metal by informal sector?

a) Nitric acid
c) Mercury amalgam
b) Caustic Soda
d) All of the above

10) What is the percentage of plastic in an average mobile handset?

a) 10%
c) 40%
b) 30%
d) 20%

11) The state Boards and committees shall prepare and submit to the Central Pollution Control Board with an annual report with regard to the implementation of these rules by

a) 30th December every year
c) 31st March every year
b) 12th May every year
d) 30th September every year

12) To ensure that e-waste pertaining to orphan products is collected and channelized to authorized collector/ dismantler/ recycler, this responsibility lies with the

a) Municipal Corporation
c) Department of Environment
b) Pollution Control Board
d) Department of IT

13) How many toxic substances can be found in 1 PC?

a) More than 500
c) More than 1000
b) More than 100
d) More than 10000

14) What is the maximum number of day for which every producer, collection center, dismantler or recycler can store E-waste?

a) 90 days
c) 240 days
b) 60 days
d) 180 days

15) Which of the following harmful compounds is released when PVC is burnt?

a) Hydrogen Chloride
c) Barium Chloride
b) Ammonium Chloride
d) Copper Chloride

Annexure-4

Exercise:
Developing an Action Plan

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Exercise:
Developing an Action Plan

Task:

- Split up in groups of five
- Discuss with your group members the current situation regarding the implementation of the E-Waste (Management & Handling) Rules
- In the next step you will develop an Action Plan for the effective implementation of the E-Waste (Management & Handling) Rules by the SPCB
- Fill in the Action Plan Template below
- Write the main parts of the Action Plan on maximum two large sheets of paper
- Present your Action Plan to the group

Details:

– You should state in which fields of e-waste management you want to / have to take action
– For each of these fields, formulate targets you want to / have to achieve
– For each target, specify indicators which you can use to measure whether the target has been achieved
– For each target, provide one / several measure(s) on how to achieve it
– For each measure, specify who will be responsible within the SPCB for implementation and which other stakeholders need to be involved
– Also specify for each measure, which resources will be required
– Finally, think about a timeline for implementing the action plan. Prioritize the measures, think about dependencies between them and be realistic

Materials:

– Two large sheets of paper per group
– Different coloured markers for each group
– Different coloured notecards for each group

Action Field	Target	Indicator	Measure	Responsibility / Stakeholder	Resources	Deadline

Action Field	Target	Indicator	Measure	Responsibility / Stakeholder	Resources	Deadline

Action Field	Target	Indicator	Measure	Responsibility / Stakeholder	Resources	Deadline