Final Report

ITU-D
Study Group 2

Question 8/2

Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material

6th Study Period
2014-2017

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Preface

ITU Telecommunication Development Sector (ITU-D) study groups provide a neutral contribution-driven platform where experts from governments, industry and academia gather to produce practical tools, useful guidelines and resources to address development issues. Through the work of the ITU-D study groups, ITU-D members study and analyse specific task-oriented telecommunication/ICT questions with an aim to accelerate progress on national development priorities.

Study groups provide an opportunity for all ITU-D members to share experiences, present ideas, exchange views and achieve consensus on appropriate strategies to address telecommunication/ICT priorities. ITU-D study groups are responsible for developing reports, guidelines and recommendations based on inputs or contributions received from the membership. Information, which is gathered through surveys, contributions and case studies, is made available for easy access by the membership using content-management and web-publication tools. Their work is linked to the various ITU-D programmes and initiatives to create synergies that benefit the membership in terms of resources and expertise. Collaboration with other groups and organizations conducting work on related topics is essential.

The topics for study by the ITU-D study groups are decided every four years at the World Telecommunication Development Conferences (WTDCs), which establish work programmes and guidelines for defining telecommunication/ICT development questions and priorities for the next four years.

The scope of work for **ITU-D Study Group 1** is to study "**Enabling environment for the development of telecommunications/ICTs**", and of **ITU-D Study Group 2** to study **"ICT applications, cybersecurity, emergency telecommunications and climate-change adaptation"**.

During the 2014-2017 study period **ITU-D Study Group 2** was led by the Chairman, Ahmad Reza Sharafat (Islamic Republic of Iran), and Vice-Chairmen representing the six regions: Aminata Kaba-Camara (Republic of Guinea), Christopher Kemei (Republic of Kenya), Celina Delgado (Nicaragua), Nasser Al Marzouqi (United Arab Emirates), Nadir Ahmed Gaylani (Republic of the Sudan), Ke Wang (People's Republic of China), Ananda Raj Khanal (Republic of Nepal), Evgeny Bondarenko (Russian Federation), Henadz Asipovich (Republic of Belarus), and Petko Kantchev (Republic of Bulgaria).

Final report

This final report in response to **Question 8/2: "Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material"** has been developed under the leadership of its two Co-Rapporteurs: Juan Pablo Ceballos Ospina (Colombia) and Ananda Raj Khanal (Nepal Telecommunications Authority (NTA), Republic of Nepal); and appointed Vice Rapporteur: Géraud-Constant Ahokpossi (Benin). They have also been assisted by ITU-D focal points and the ITU-D Study Groups Secretariat.

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This report has been prepared by many experts from different administrations and companies. The mention of specific companies or products does not imply any endorsement or recommendation by ITU.

Please consider the environment before printing this report.

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i. Executive summary

This report outlines the minimum standards for processing Waste Electrical and Electronic Equipment (WEEE) and considers the responsibilities of different stakeholders including producers, consumers, managers and intermediaries involved in the process. Likewise, it describes the different techniques for recovering metals present in WEEE and reducing hazardous waste. Information on non-compliant and counterfeit devices is included, as well as the integration of informal recyclers and the impact of WEEE on the health of people who are in contact with them are included in the report as social aspects of the management of WEEE.

The takeback process is elaborated in detail as practiced in Colombia. The cost of the takeback process in Colombia is compared with models used in other countries. Recommendations are given on implementing takeback at lower cost. Likewise, reference is made to the different aspects of WEEE as business opportunities in terms of research, metal refining, and so on.

In addition, this report highlights the essence of different contributions and case studies submitted for consideration by this Question.

The report also takes note of the detailed work carried out by ITU Telecommunication Standardization Sector (ITU-T) in particular, the "Guidelines for developing a sustainable WEEE management system: ITU-T L-series Recommendations – Supplement 4".

Chapter 1 deals with the regulatory framework of the technological aspects of a WEEE management system.

Chapter 2 proposes alternative methods for the recovery and exploitation of hazardous materials present in WEEE.

Chapter 3 deals with social aspects of WEEE management system including counterfeit or non-conforming (substandard) ICT devices, integrating the informal sector, impacts of poor WEEE management on human health, identifies vulnerable population groups, routes for pollutants entering the environment, routes of exposure and the consequences of exposure.

Chapter 4 deals with the economic aspects of WEEE management system highlighting the different aspects of takeback of WEEE from ICTs, as well as economic impact and business opportunities associated with WEEE and provides Recommendation for a WEEE management financing model.

Chapter 5 is devoted to highlighting the salient features of the different contributions and case studies received from the member administrations and other organizations during the study period.

Chapter 6 presents the conclusions and recommendations of the report.

The report also has two annexes, a list of abbreviation and acronyms and a list of references.

ii. Background

The report for Question 24/1 "Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material" was submitted to the Membership in 2014. The Question under study was developed during the 2010-2014 period and focused on strategies and policies for the sustainable management of WEEE at the national, regional and global levels, highlighting the rates of consumption and Waste of Electrical and Electronic Equipment (WEEE) (current and future figures), in addition to the sorting and classification of WEEE.

The report identified the challenges that countries were faced with while implementing a strategy for the proper management of WEEE, and included experiences of reuse and correct disposal of this type of waste. Experiences of countries in Africa, Americas, Asia-Pacific, Commonwealth of Independent States (CIS) and Europe, and contributions from international organizations, among others, were also included.

The strategies and policies proposed to establish standards for WEEE management, different stakeholders in the chain were identified including governments, regulators, producers, importers, retailers, consumers and others such as Non-Governmental Organizations (NGOs) and foundations. The roles and responsibilities of each of these stakeholders were also identified in the report.

The report also presented some conclusions drawn from the work done in the previous study period and produced a series of recommendations for developing countries, with the purpose of determining and implementing a WEEE policy to achieve positive results in terms of effectively addressing a challenge currently faced by countries as a result of inadequate management of WEEE from ICTs (Final Report on Question 24/1 – Summary, 2013).[1] In this study period (2014-2017), the focus was on highlighting the technical, the economic and social aspects of the WEEE management system.

During the study period 2014-2017, several experiences were presented that provided greater knowledge as to how to improve the dissemination of the Question, how to guarantee greater success in the collection of information through surveys and were to migrate the Question in order to cover the Sustainable Development Goals (SDGs) and attract more interest from the change generators to implement policies, standards and recommendations regarding the WEEE management.

Among the experiences lived during the study period the following can be highlighted:

– It is important to take into account that when working with methods for capturing information, the study questions should represent the interest of each one of the countries, as well as having closed questions so they answer specifically what has been asked.

– A closer relationship should be encouraged between the delegates and the governments of the states where they come from, since this leads to capturing and disseminating the information relevant to the Question.

– It is ideal to promote sessions online between the experts in developed countries and those from developing countries as this may allow sharing experiences that can enrich the processes of the rational environment management of the WEEE.

Question 8/2 is of priority interest to all Member States since its different strategies are directly related to the objectives of sustainable development. Support to the delegates, academia and other experts that can contribute to the improvement of the strategies/policies for WEEE management should be ensured.

iii. Introduction

The use of technological devices during the 21st century has succeeded in promoting the large-scale development of products, goods and services including the expansion of access to communications and process optimization. The dependence of human beings on such devices is beyond doubt, and the result has been an accelerated increase in the use of information and telecommunication technologies to the extent that experts in the field consider that a fourth industrial revolution, associated with the use of different devices and technologies in which the physical and digital worlds merge, is drawing near. Such a revolution will have an impact on a wide range of disciplines, industries and everyday life.

1 Final Report on Question 24/1: Strategies and policies for the proper disposal or reuse of telecommunications/ICT waste material at: https://www.itu.int/pub/D-STG-SG01.24-2014.

However, electronic devices, in addition to being novel and functional, have also become a dormant problem for the environment, public health and the socio-economic context. The lack of knowledge and/or lack of interest of the population in general concerning WEEE are the main factors that have created that state of affairs. It is a growing problem, to the extent that in connection with Question 24/1 “Strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material” estimates were submitted from the meeting of the Basel Convention and other world authorities on WEEE suggesting that by 2020 generation of WEEE from computer equipment will increase by between 200 and 400 per cent, according to 2007 figures. This has stimulated interest by governments and NGOs who believe that it is important to leave a world in better condition to future generations.

The International Telecommunication Union (ITU) with the support of all its Member States has put forward and documented several strategies to promote the adequate management of electronic waste, primarily those generated from ICTs. With that in mind, ITU has issued technical documents prepared by experts on the subject which may be used by countries that might need assistance in matters pertaining to WEEE/ICTs.

In line with the above, the current report presents a compilation of contributions by member countries during the 2014-2017 period regarding the minimum standards that producers, users and managers must take into account to guarantee the proper management of electronic waste. It also describes different techniques for recovering precious and scarce metals and potentially hazardous materials from WEEE in order to recycle those resources into new productive processes.

1 CHAPTER 1 – Operational framework of technological aspects of a WEEE management system

This chapter advocates that every country should develop a national policy on effective and efficient management of WEEE. It provides a detailed operational guideline on different stages and activities of WEEE management.[1] It sets out some minimum standards for the environmentally sound management of Waste Electrical and Electronic Equipment (WEEE) from Information and Communication Technologies (ICTs), which may serve as guidelines for governments and managers in least developed and developing countries regardless of their specific circumstances. It also seeks, within the framework of the concepts of "sustainability" and "management system", to promote compliance with such requirements for the benefit of human health and the environment, by discouraging inappropriate management of this type of waste.

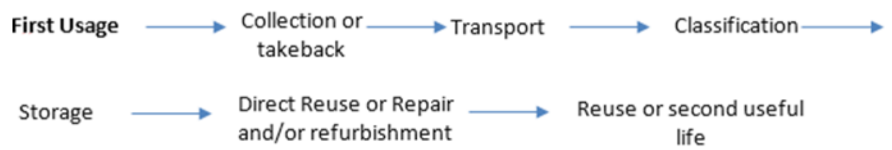
1.1 Need for national policy on WEEE management for least developed and developing countries

The management of e-Waste is one of the greatest challenges faced by the ICT sector. This stream requires sustainable management of products at the end of their useful lives due to the environmental, social and economic implications associated with it. It is important to understand that these wastes are heterogeneous and have specific characteristics. Therefore, its management, treatment and disposal must be carried out responsibly. Every member state should develop and implement a national policy on WEEE management. Such policy should include but not be limited to national vision and mission, objectives and targets and time bound implementation plans. A clear monitoring and evaluation framework should be developed. Policy must above all include a commitment by managers to ensure the correct management of electronic waste from ICTs, including protection of the environment and the health of workers and the wider community, as well as measures to control hazards associated with WEEE management. Policy must be implemented through appropriate objectives and appropriate targets and indicators must be defined in order to measure the performance of the management system. The policy must be published and brought to the attention of the manager's in-house and external customers.

1.2 Preliminary considerations regarding the WEEE management system

Figure 1 shows the phases or stages leading up to the reuse or second useful life cycle of Electrical and Electronic Equipment (EEE) from ICTs. This will provide guidance on setting minimum standards that may be complied with by WEEE/ICT managers[2] and imposed by governments in least developed and developing countries, specifically for the pre-processing and some of the processing stages for such waste, following their second useful life cycle (see **Figure 2**).

Figure 1: Stages in the reuse of electrical and electronic equipment/ICT

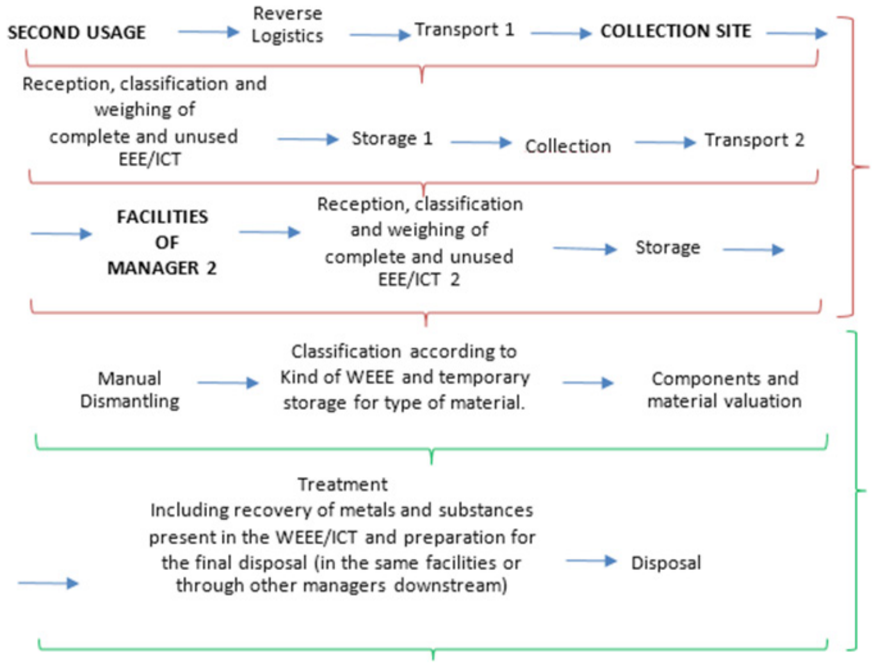


Source: Document SG2RGQ/55, "Minimum standards to be complied with by WEEE/ICT managers when pre-processing such waste in least developed and developing countries", Republic of Colombia, 2015.

[1] Document SG2RGQ/55, "Minimum standards to be complied with by WEEE/ICT managers when pre-processing such waste in least developed and developing countries", Republic of Colombia.

[2] Managers: entities in the recycling chain with the environmental permits or licenses to carry out some or all stages of environmentally sound WEEE/ICT management, starting with dismantling and sorting.

Figure 2: Stages in the management of waste electrical and electronic equipment from ICTs



NOTE. There might be two (2) moments of: collection, transport, reception, classification and storage. The first one from the places where the WEEE/ICT are generated to the collection site and later from there to the manager's facilities. However, it might be that the waste come directly from the places where those are taken back, to the manager facilities. There might be some new collection, transport and reception stages from some manager facilities to other managers specialized in the treatment and disposal of electronic waste. The waste weighing takes place in several moments as control measure inside different stages.

"Sustainability" seeks a balance between the economic, environmental and social aspects of an organization, and the requirements set forth in this document deal with each of these aspects in one way or another within the framework of a "WEEE/ICT management system" (see **Figure 3**).

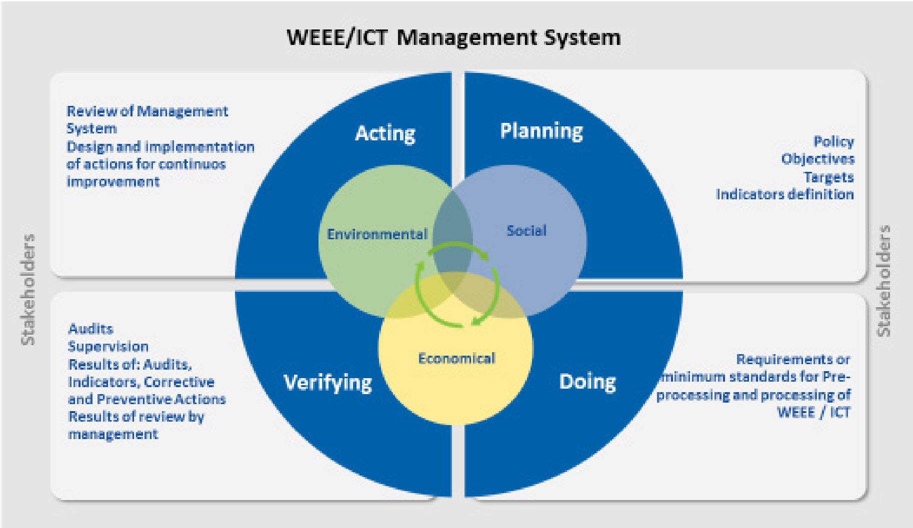
The requirements or standards set forth in this document do not exempt managers from compliance with existing norms governing the management of WEEE from ICTs (WEEE/ICT) or from compliance with national legislation regarding the environment, industrial safety and health, and quality.

It will be the responsibility of EEE/ICT producers (manufacturers, marketers, importers or assemblers) operating individually or collectively (in accordance with the principle of "Extended Producer Responsibility" (EPR)), or of the party or parties entrusted with responsibility for managing electronic waste in each country, to ensure that the standards set out in this document are complied with by all managers and intermediaries or logistical operators[3] involved in the recycling chain. In order to facilitate action by managers, producers shall be required to provide information on the presence and location of any hazardous substances contained in the WEEE/ICT.

Subject to the legislation of each country, managers may commence with a statement of compliance on the basis of which the competent environmental authority issues them with licenses or permits that can be withdrawn if, in the exercise of their oversight and control activities, it becomes clear that the entities concerned are failing to comply with the relevant norms and standards. The assumption is that managers comply with the principle of "due diligence", i.e. knowledge of all relevant legal obligations and transparency in dealings with their commercial partners.

[3] Intermediaries or logistical operators: entities in the recycling chain responsible for activities such as collection and takeback, transport and storage.

Figure 3: WEEE/ICT management system



Source: Document SG2RGQ/55, "Minimum standards to be complied with by WEEE/ICT managers when pre-processing such waste in least developed and developing countries", Republic of Colombia, 2015.

Account must be taken of the established technological waste management hierarchy (direct reuse, reconditioning and repair for reuse; recovery of materials for use in new products and applications; and disposal). Disposal must be the last resort and used only when there is no other alternative.

For the pre-processing stages and the initial phases of processing, account shall be taken of requirements in regard to: infrastructure; available human skills; documentary support (processes and procedures); equipment, tools and machinery; registers; and information and communication systems.

1.3 WEEE management process

To achieve the objectives set out in the national policy, implementation of the following activities are recommended. These activities are divided into different stages and sub-activities within each stage.

1.3.1 Pre-processing

The pre-processing stages include those described below.

1.3.1.1 Collection and transport from collection site to premises

Regarding the collection and overland transport of obsolete and/or disused (complete) electrical and electronic equipment (EEE/ICT) to the premises of Manager 1, it is important to take into account the following minimum requirements.

a) Containers, labeling and identification

The EEE must be placed in appropriate resistant containers of suitable size, allowing them to be moved mechanically (forklifts) without breakage. They must be packaged according to type (classified grey or brown), with the necessary care to prevent breakage, and containers must be covered and duly labeled and identified with information on their contents, as follows: type of EEE/ICT, date of packing, weight (kg), quantity (units), batch number, responsible official, etc.

b) Transport companies and vehicles

Depending on legislation in force in each country, transport companies must have the required authorizations according to the type of waste and means of transport used. The vehicles transporting the obsolete and/or disused EEE/ICT overland must comply with various general requirements (if the complete equipment is not deemed to be hazardous waste) or with norms for the transport of hazardous merchandise (if the equipment is classified as hazardous).

Among the general requirements, in order to ensure the security and stability of the load and staff transporting it, each container must be fastened to the vehicle using the necessary devices which must be located, as a minimum, at each of the four corners of the container; the vehicles must be covered and must have documentation certifying that technical/mechanical inspections and servicing have been carried out recently and that the vehicle in question complies with established standards governing emissions from fixed sources; and they must be equipped with multipurpose extinguishers, road equipment and toolkits.

c) Registers

Registers must be produced to record the collection and subsequent delivery of the WEEE/ICT in the form of a "transport document", with data on type of waste, provenance, batch number, weight (kg), quantities (units), equipment brand, serial number of each piece of equipment (read by barcode scanner upon reception), destination and data on vehicle (number plate and type), signature of responsible official, etc.

1.3.1.2 Reception, sorting and weighing

a) General aspects

Reception of obsolete and/or disused items of EEE must be effected in an organized manner. Unloading must be mechanically assisted, their weight checked and, if necessary, they must be repacked in other containers while avoiding the uncontrolled tipping over of equipment containing, for example, CRT, LCD or plasma screens. Checks must be carried out to ensure that the quantities reaching Manager 1 correspond to those expected as recorded in the "transport document".

The handling of WEEE (packing, loading and unloading, storage, movements within the manager's premises, etc.) must be effected with care in order to avoid damage to equipment and possible leakage of hazardous substances. Obsolete equipment received in complete form must be weighed, re-sorted (e.g. keypads, mice, printers, scanners, CRT monitors, flat screen monitors, laptops, mobile phones, CRT TVs, flat screen TVs, etc.), reweighed, relabelled and re-identified according to the following data: type of WEEE/ICT, weight (kg), quantity (units), batch number, container number, assigned shelf place, date, responsible official, etc., before being shelved to await dismantling.

b) Equipment, tools and machinery

These must include: scales for weighing the electronic waste; forklifts for the initial handling of the containers (weighing) and subsequent shelving following resorting. Scales and forklifts must be serviced at least every six months, and scales must also be calibrated at least every six months or as required.

c) Registers

The following registers must be produced and kept: transport document; certificates of maintenance and calibration for scales; certificates of maintenance for any equipment used (e.g., forklifts).

1.3.1.3 Storage

a) Infrastructure and general considerations

Obsolete and/or disused (complete) EEE/ICT must be stored in a specific area of the plant, which must be clearly signed and covered and comply with relevant conditions, including impermeable surfaces in storage areas. The quantities of WEEE stored must not exceed the plant's six-month processing capacity.

b) Documentary support (processes and procedures)

A procedure must be in place, as specified in the relevant Material Safety Data Sheets (MSDS), and emergency cards with data on the most representative hazardous substances contained in WEEE/ICT, for use in the event of breakages.

c) Equipment, tools and machinery

Forklifts must be available for shelving the containers once sorted. Heavy-duty shelving is required for the optimized use and organization of space in the plant's warehouse area.

d) Information systems

An information system, or at least a database, must be in place for the registration of data including the type of WEEE/ICT, weight (kg), quantity (units), batch number, container number, assigned shelf place, responsible official, and date.

e) Maintenance registers

Registers must be provided to record regular maintenance of heavy-duty shelving (at least every 12 months) to minimize hazards.

1.3.2 Processing

The processing stage include the following:

1.3.2.1 Manual dismantling

a) General

This refers to the process whereby obsolete and/or disused items of EEE/ICT are dismantled manually and separated into parts. In least developed and developing countries, this type of dismantling should be encouraged, as it generates jobs and ensures that the separated components are of high quality. If there is any doubt regarding the presence of hazardous substances in the components of dismantled and sorted electronic waste, the components must be treated as hazardous (for example, if it is not known whether or not condensers contain polychlorobiphenyls (PCBs), or whether the content of brominated flame retardants in plastics is less than the national limits). **Note**: each country must work to define permissible limits for the various substances that may be found in WEEE/ICT in order to determine whether or not they must be classified as hazardous.

Demanufacturing does not include the separation of CRT screens into funnels and screens (this process will be covered in the processing document), since such procedures entail processing that includes breaking, crushing, separation and cleaning in such a way as to prevent emissions from fluorescent coatings or glass dust and ensure compliance with occupational exposure limits. Mechanical dismantling is not permitted unless carried out under controlled conditions so as to ensure safe handling of hazardous substances associated with the WEEE/ICT. Mechanical reduction, compacting or grinding of electronic waste components that do not contain hazardous substances is permitted in order to reduce their volume and facilitate handling.

b) Documentary support (processes and procedures)

Procedures and instructions regarding the manual demanufacturing of WEEE/ICT must be documented. This applies to laptops, flat screen monitors, CRT monitors, CPUs, printers, mobile phones, CRT TVs, flat screen TVs, scanners, and so on.

c) Information systems

Use must be made of a system or database for recording WEEE/ICT movement from warehouse shelves to dismantling area, assigning each WEEE container or recipient to the dismantling area, and monitoring weight, quantity and responsible officials, also making use of equipment serial numbers.

1.3.2.2 Sorting by type of WEEE and storage by type of material

a) Sorting

Once manually dismantled, electronic waste from ICTs can be classified as: clean materials such as ferrous metal, copper, ferrite, aluminum, acrylics, acetates, rubber, and magnesium; components for treatment in the presence of hazardous substances and recoverable metals/materials (on the manager's premises or those of other managers downstream), including batteries according to type (lead-acid, alkaline, nickel-cadmium (Ni-Cd), nickel-metalhydride (Ni-MH), lithium-ion (Li-ion), etc.). CRT, LCD, and plasma screens; fluorescent lighting units; printed circuit boards; thermoplastics; toners; dusts; cables; cartridges; inks; etc. Fractions designated as hazardous must not be mixed with other materials in order to bring the total volume below the threshold for classification as hazardous waste. If doubt arises about the presence of hazardous substances in certain components, they must be treated as hazardous. The staff responsible for manual dismantling must take the demanufactured product to the materials sorting area, where the responsible staff checks its quality; if faults are detected, it is returned for correct dismantling.

b) Storage

At this stage it is useful to consider the following aspects.

General considerations and infrastructure: clean materials and components containing hazardous substances arising from the dismantling must be stored in different areas away from where complete electronic waste items are located and must be properly identified. Any hazardous waste must be provided with appropriate safety sheets and emergency cards for the principal hazardous substances they contain, taking account of the compatibility matrix.

Elements containing lithium must be stored separately in a restricted access area in such a way as to prevent exposure to heat, sunlight, humidity and water, as they are liable to ignite or explode if exposed to high temperatures. Batteries must be stored in areas protected from humidity and rain, with waterproof covers. Mercury lamps and CRT, LCD and plasma screens that are accidentally broken must be stored in closed and clearly identified containers. Areas where lamps are stored must be ventilated in order to prevent and control emissions into the environment; they must be easily accessible to authorized staff, but must be frequented as little as possible.

Containers, labelling and identification: manually dismantled materials and components must be stored in appropriate containers, taking due account of section 1.3.1.1 *a)* of this report. Containers must be labelled and identified according to the following data: description or type of material or component, weight (kg), container number, shelf position, responsible official, date, etc. These data must be reflected in the information system along with the destination of the material or components in each container. Containers containing potentially hazardous WEEE/ICT components must be identified using symbols corresponding to different hazardous substances.

1.3.2.3 Recovery and resale of materials and components

a) General

Recovery and resale means selling clean materials and other components obtained from the demanufacturing process (only in the event that their treatment and disposal are dealt with by a different manager), for recycling into production processes and the application of other processing methods for recovering metals. Recovery and resale of clean materials is possible if there is a market for them and if their use has no negative impacts. Percentages for WEEE recovery must be established by national governments in line with their requirements, which may gradually increase, depending on specific conditions and requirements.

b) Transport companies and vehicles

The conveyance of clean materials from Manager 1 to interested companies must take account of the standards set forth above, as no hazardous substances are involved. With regard to sending components to other managers downstream within the same country for metal recovery, requirements regarding transportation will depend on whether or not the components are listed as hazardous waste under national legislation. If they are considered hazardous, the following requirements must be met in addition to those indicated above, the transport companies must have insurance or guarantees covering accidents or errors that may occur when the WEEE/ICT are moved, and must have mandatory basic training course certificates for drivers of vehicles used to transport hazardous merchandise. Vehicles must have reflective identification signs and devices, along with visibly placed plates bearing the United Nations (UN) number for the hazardous waste that is being transported; basic emergency response equipment (fire extinguisher, protective clothing, flashlight, first aid kit, collection and cleaning equipment, absorbent material, and any other items indicated on the emergency card); at least two multipurpose extinguishers, one in the cabin and others near the load; a warning device that sounds when the vehicle is in reverse; emergency cards and safety sheets in the official language of each country; a contingency plan for response to accidents during operations involving the transport of hazardous merchandise; and a list of telephone numbers for notification in the event of emergencies.

c) Documentary support (processes and procedures)

Environmental licenses must be requested in advance from downstream managers for treatment and final disposal of waste with hazardous content, and any processes that apply to both clean materials and components from which metals/materials will be recovered must be followed up until treatment and disposal certificates are obtained for the quantities and types of material delivered.

d) Registers

The following registers must be established and maintained: relative balance by weight of incoming obsolete and/or disused (complete) items of EEE/ICT vs recovered materials and components sent to other processing areas or to downstream managers (taking account of stored material, the balance must be effected for each batch or at least every six months); a transport document signed by the parties specifying the material or component transported, the weight (kg), container number, issuing batch, destination and vehicle data (plate, type); checklist of conditions to be satisfied by the vehicle, signed by the parties; treatment and disposal certificates; and environmental licenses of downstream managers.

1.3.2.4 Treatment and disposal

a) Infrastructure and general considerations

For recovery of metals and waste such as printed circuit boards, batteries, thermoplastics, toners and toner dust, cartridges, cartridge ink, etc., processing may be carried out on the premises of Manager 1 or by third parties (downstream managers), depending on capacity and licenses available for the processing and disposal of each type of waste. Storage under waterproof covers must be guaranteed in order to prevent hazardous material from entering the environment.

b) Documentary support (processes and procedures)

Documented processes and procedures must be in place for treatment and disposal according to the type of waste. To this end, certain **technical criteria** must be met, as indicated below.

- Disposal percentages must be defined by national governments in accordance with their requirements; these may decrease gradually, depending on the degree of development of the WEEE/ICT management system.
- Crushing, pressing and compacting of WEEE/ICT components destined for processing and disposal are prohibited.
- Sending abroad those WEEE/ICT items which a country does not have the technology to manage will entail trans-border conveyance of hazardous waste, for which purpose either the provisions of the Basel Convention shall apply, in the case of countries that have ratified that Convention, or provisions of other conventions or agreements concluded between countries. Export registers must be kept.
- Hazardous waste must be treated separately (no mixing of different types of hazardous waste or of hazardous waste with other materials). Documented processes and procedures for treatment and disposal must be in place, according to the type of waste.

c) Equipment, tools and machinery

These will depend on the physical and chemical processes applied for treatment and recovery of materials/metals from components containing hazardous substances in WEEE/ICT.

d) Registers

The producer or the entity responsible for WEEE/ICT management in each country must maintain control over the waste from source to final destination ("cradle to grave"), keep up to date the list of managers and logistical operators or intermediaries involved in the recycling chain with which it is necessary to have contracts or agreements for the management of specific types of WEEE, and must have their environmental permits and licenses as well as certificates for the processing and disposal of waste sent by the said managers once the management cycle has been completed. In addition, records related to trans-boundary movements of waste must be kept, as well as registers of methods of waste treatment and disposal by types and quantities of waste processed, types and quantities of metals/other materials obtained, type and quantities of resulting fractions, and methods of disposal (manager and other managers downstream). Registers must be supported by the mass balance records and treatment and disposal certificates.

1.3.3 Verification

This stage of the WEEE/ICT management system deals with auditing and supervision.

Audits may be carried out by first, second or third parties. For first-party audits, each manager must have in-house auditors trained for the purpose and capable of carrying out audits objectively and impartially. Second-party audits are carried out by interested parties, e.g. the EEE/ICT producers organized into collective systems or acting individually, or the managers and logistical operators or intermediaries forming part of the recycling chain, in order to verify compliance with national WEEE/ICT management policy or standards and with those set forth in the present document. Third-party audits can be carried out by external independent organizations offering registration or certification of compliance.

Supervision, on the other hand, is the responsibility of the competent national environmental authorities mandated to exercise oversight and control of compliance with norms and minimum standards on the part of managers and logistical operators or intermediaries, and to impose sanctions for non-compliance.

At this stage, established indicators must be applied to verify proper operation of the system as well as corrective and preventive measures and reviews by management.

1.3.4 Revision of WEEE management system

On the basis of the results of the application of indicators, audits, management reviews, preventive and corrective action, and so forth, the WEEE/ICT management system shall be revised with a view to devising and taking action to improve its performance, on an ongoing basis.

Note: 1) Cross-cutting requirements are indicated in **Annex 2** of this document.

2 CHAPTER 2 – Alternatives for the recovery and exploitation of hazardous materials present in WEEE

This Chapter describes several alternative recovery and exploitation methods[4] (rather than treatment and disposal) that are technically feasible for hazardous waste contained in waste from telecommunications (WEEE/ICT). This may help guide governments and other interested parties in least developed and developing countries, whatever their specific circumstances and requirements, in investigating in greater depth and, where appropriate, implementing these methods of recovery and exploitation in their territories or seeking access to such methods.

One of the main concerns relating to the proper management of Waste Electrical and Electronic Equipment (WEEE) is the presence of hazardous materials which calls for recovery and use with the aid of advanced techniques, rather than treatment and disposal. Treatment and disposal of hazardous waste from WEEE can entail a number of undesirable environmental consequences, even if the processes themselves are conducted in an appropriate way (e.g., using landfill security cells), environmental liabilities[5] are created in one way or another. These liabilities are unwelcome, but may be preferable to the effects of simply abandoning such waste to the elements or burial without regard to minimum technical conditions (impact on surface water and groundwater, soil and the general environment). Nevertheless, recovery and use of hazardous waste may be a better option than treatment and disposal.

2.1 Composition of WEEE

WEEE consists of a range of materials that are called "clean" (not containing harmful substances), including copper (Cu), aluminum (Al), clear glass, plastic, rubber and ferrous metals. Others on the other hands contain harmful substances such as arsenic (As), chromium (Cr), mercury (Hg), nickel (Ni), beryllium (Be), selenium (Se), and cadmium (Cd), as well as precious and rare metals, all of which require advanced treatments in order to be recovered and reused. It is clear that manufacturers must continually advance research with the aim of eliminating and/or finding substitutes for substances found in Electrical and Electronic Equipment (EEE) that are hazardous and difficult to recover.

WEEE contains valuable metals such as gold (Au), silver (Ag), platinum (Pt), gallium (Ga), palladium (Pd), tantalum (Ta), tellurium (Te), germanium (Ge) and selenium (Se), as well as rare earth metals like yttrium (Y), europium (Eu), and the ore coltan. This provides a clear incentive for their proper management, as the refinement of such metals using proper techniques not only helps to generate revenue but also contributes to important environmental goals, energy efficiency, conservation of natural resources and employment creation. So-called "urban mining" (recovery of metals from WEEE) has advantages over traditional mining (extraction of virgin metals from ore); the former has been shown to require less energy and emit lower quantities of CO_2.

A range of hazardous substances may be present in WEEE. These are shown in **Table 1**.

Table 1: Possible hazardous substances present in WEEE

Substances	Presence in WEEE
Halogenatedcompounds	
PCB (polychlorinated biphenyl) **Flame retardants for plastics**	Capacitors, transformers

[4] Document 2/220, "Minimum standards to be complied with by WEEE/ICT managers when preprocessing and processing such waste in least developed and developing countries", Republic of Colombia.

[5] Environmental liability: as with a financial liability, an environmental liability is a "debt" resulting from a deterioration of one of the environmental components, which must be liquidated at some point or paid for with the use of energy.

Substances	Presence in WEEE
TBBA (tetrabromine-bisphenol-A)	(Thermoplastic components, cables, motherboards, circuits, plastic casings, etc.)
PBB (polybrominatedbiphenyl)	TBBA is currently the flame retardant most widely used in circuit boards and housings
PBDE (polybromine-diphenyl ether) **Chlorofluorocarbon (CFC)**	Refrigeratorunits, insulatingfoams
Heavy metals and other metals	
Arsenic	Small quantities between light-emitting diodes, in processors of liquid crystal displays (LCDs)
Barium	“Getters” in cathode ray tubes (CRT) in ventilation chamber of CRT screens and fluorescent lamps
Beryllium	Electricity supply boxes (power sources)
Cadmium	Rechargeable Ni-Cd batteries, fluorescent layer (CRT screens), photocopiers, contacts and switches, and in old cathode tubes
Chromium VI	Hard drives and data storage
Lead	CRT screens, circuit boards, wiring and solder
Mercury	Fluorescent lamps in LCDs, in some switches with mercury (sensors). Flat screen lighting systems, coffee machines with automatic switch-off systems or alarms containing mercury relays
Nickel	Rechargeable Ni-Cd and Ni-Hg batteries and electron guns in CRT monitors
Rare-earth elements (Yttrium, Europium)	Fluorescent layer (CRT monitors)
Selenium	Old photocopiers
Zinc sulphide	Interior of CRT monitors, mixed with rare-earth metals
Others	
Radioactive substances (americium)	Medical equipment, fire detectors and smoke detectors, among others

Source: Ministry for the Environment and SustainableDevelopment (MADS), LineamientosTécnicos para el Manejo de RAEE, 2010.

2.2 Recovery and use of hazardous waste present in WEEE

The following sections describe some methods of recovery and exploitation of hazardous waste material present in WEEE.

2.2.1 Recovery of metals present in WEEE

The extraction of metals found in low concentrations in primary minerals consumes considerable amounts of energy. WEEE is a source of primary metals comparable to primary minerals. In fact, the quantity of gold recovered from one ton of WEEE from computers is greater than the quantity recovered from 17 tons of gold ore (Abdul Khaliq, Muhammad Akbar Rhamdhani, 2015).

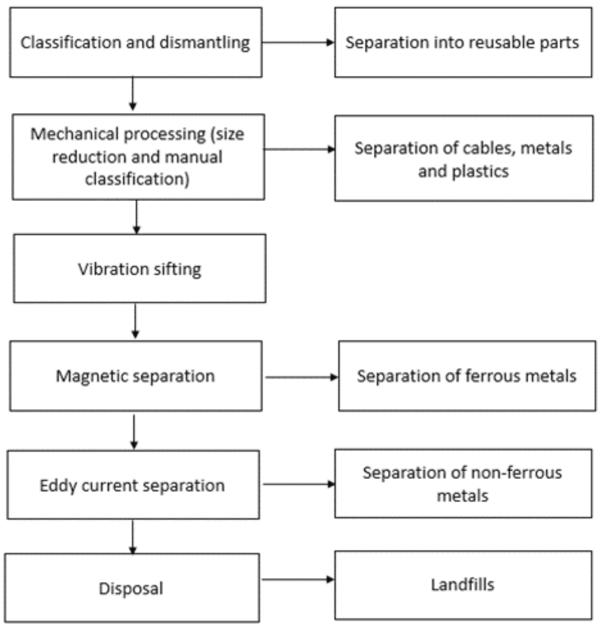
Sustainable resource management requires the isolation of hazardous metals from WEEE and maximizes the recovery of precious and rare metals. The value distribution of precious metals in printed circuit boards and calculators is more than 80 per cent. After precious metals, copper is the next highest value metal to be extracted from WEEE. The extraction of precious metals gold (Au), silver (Ag) and palladium (Pd) and base metals copper (Cu), lead (Pb) and zinc (Zn) from WEEE has significant associated value that should not be wasted (Abdul Khaliq, Muhammad Akbar Rhamdhani, 2015).

Rare metals are crucial for ICT equipment (mobile phones, computers, etc.) and are also of great value for the development of solar panels. It is estimated that the use of rare metals in the market has more than doubled since 2000. The most common rare metals in ICT equipment are indium, yttrium, gallium and arsenic, although mobile phones can contain more than 20 rare metals, including titanium, barium and tantalum. Shortages of these metals, together with increased demand, are encouraging recycling and the development of alternative materials that can perform the same functions.

In order to carry out this type of recycling, the industries responsible need information on the type and quantity of rare metals contained in the components and modules of ICT equipment. This information generally has to be provided by the manufacturers, although specialized characterization and measurement methods can be used to obtain it.

Figure 4 shows the WEEE processing steps used to separate metallic and non-metallic fractions. This initial stage facilitates the subsequent recovery of individual metals.

Figure 4: Management of WEEE to separate metallic and non-metallic fractions



Source: Abdul Khaliq, Muhammad Akbar Rhamdhani, Geoffrey Brooks and Syed Masood, Metal Extraction Processes for Electronic Waste and Existing Industrial Routes: A review and Australian Perspective, 2015.

2.2.2 Methods of recovering metals from WEEE

Following the initial stages of separating out metallic and non-metallic fractions from the WEEE (using physical and chemical means; see examples in **Table 2**), the separated fractions can be subjected to metallurgical processes (hydrometallurgical, pyrometallurgical, electrometallurgical, biometallurgical, and combinations of these). Hydrometallurgical and pyrometallurgical processes are the most widely used and can be followed by electrometallurgical/electrochemical processes (for example electro-refining or electro-winning) in order to separate and recover selected metals.

WEEE processing using biometallurgical processes, such as bioleaching of metals from WEEE, is limited to laboratory studies but is a route worth exploring owing to its great potential.

– **Hydrometallurgy:** this involves extraction and recovery of metals from aqueous solutions. The process is carried out on a solution containing one or more metals of interest in the form of ions, which are separated and isolated specifically through reversible reactions and physical differences between the solutions. The resulting solution is rich in the ions of interest and possesses characteristics that are conducive to the next stage. *Generally, the metals extracted using this technique come from ores that have previously been leachedusing ammonium sulphate or chloride. Hydrometallurgical processes usually take place at low temperatures (between 25 and 250 C). Operating pressures can vary from a few kilopascals (kPa) to as much as 5 000 kPa. Finally, the metals are recovered from the solution through electro-refining (electrometallurgy) or chemical reduction processes (...)* (Wikipedia, 2015).

Table 2 shows the most widely used hydrometallurgical processes for recovering metals from WEEE.

Table 2: Hydrometallurgical processes used to recover metals present in WEEE

Metalrecovered	Key characteristics of the process	Main product	Year
Au	Computer chips treated with $HN0_3$ to dissolve base metals, leaching with aqua regia, precipitation of gold with ferrous sulphate	Au	2007
Au and Ag	Electronic scrap less than 0.5 mm treated with KI and I_2 or NaCl, solvent extraction to recover gold and silver	Au and Ag	2007
Ni	Nickel leaching from ceramic capacitors, using a 1M solution of HNO_3 at 90°C, 90 minutes of reaction and pulp density of 5g/1	Ni	2007
Au (98%), Pd (96%), Pt (92%), Ag (84%)	Dissolution of base metal in H_2SO_4 and MgCl, dissolution of precious metals in HCl and bromide ions, cementation of gold with zinc powder	Au and platinum powder group	2006
Cu (98%)	Dissolution of copper with H_2SO_4 and aqua regia, electro-winning of copper	Cu	2006
Cu, Ag (93%), Pd (99%), Au (95%)	Leaching of copper with sulphuric acid, leaching of palladium with chlorine, leaching of gold and silver with thiourea, absorption of gold, silver and palladium with activated carbon	AgCl, Cu, Pd, Au	2005
Au (92%), Ag, Pd	Dissolution of base metal in HCl or H_2SO_4, leaching of silver, gold and palladium with HCl and $NaClO_3$, precipitation of gold with $FeCl_2$	Sponge Au	2005
Au	Leaching of electronic scrap with basic solutions of NaCl, $CuCO_3$ and HCl	Residual Au	2004
Sn, Pb	Dissolution of welds/solders in acidic Ti solutions. Titanium and lead recovered by electrolysis	Sn and Pb	2003
Cu, Pb, Sn	Leaching of electronic cards with HNO_3, electrolysis for base metals	Cu, Pb, Sn	2002

Metalrecovered	Key characteristics of the process	Main product	Year
Au	Thermal treatment, leaching of gold with aqua regia, solvent extraction of gold with diethyl malonate, precipitation of gold with ferrous sulphate	Metallic Au	1997
Au	Alkaline treatment in autoclave at 80°C-190°C to remove aluminium, treatment in autoclave with low oxygen pressure to remove non-ferrous metals	Concentrate rich in valuable materials	1993
Ni and Au	Leaching of base metals with sulphuric acid and with ferric sulphate reducing agent, aqua regia to leach precious metals	Ni and Au solution	1992

Source: Oliveros, H., *Metodología para recuperar metales preciosos: oro, plata y grupo del platino, presentes en desechos electrónicos*, Universidad Nacional de Colombia, Medellín, 2011.

– **Pyrometallurgy:** like hydrometallurgy, pyrometallurgy involves the application of high temperatures to recover and purify metals. It can be used to extract metals from their ores, directly or from concentrates, using heat. The temperatures applied normally exceed 950°C. This is a rapid technique that can be used to process large quantities of mineral.

Energy input is required to sustain the temperature at which the process occurs. This energy usually comes from the exothermic reaction of some form of carbon, such as coke, or from electrical power. Depending on the process, a reducing agent may be added, which may be combustible. When the exothermic reaction of the source material is sufficient to sustain the process temperature (without the addition of external fuel or electricity), the process is said to be autogenous. The pyrometallurgical processes most widely used to recover metals present in WEEE are shown in **Table 3**.

Table 3: Pyrometallurgical processes used to recover metals present in WEEE

Technique	Metalrecovered	Processcharacteristics	Results obtained
Noranda ProcessQuebec, Canada	Cu, Au, Ag, Pt, Pd, Se, Te, Ni	Copper smelting and copper concentration, converter, smelting furnace, electro-refining of metal	High recovery rate of copper and precious metals
BolidenSmelting, Ronnskar, Sweden	Cu, Au, Ag, Pt, Pd, Zn, Pb, Ni	Concentrates reactor, 100 000 tons per year, copper converting and refining, refining of precious metals	High recovery rate of copper and precious metals
Umicore, Belgium	Preciousmetals, Se, Te, base metals	Leaching of copper, electro-refining of precious metals, 250 tons of electronic scrap per year, smelting furnace with monitoring of gas emitters, plastic substitutes for coke	Recovery of precious metals, Sb, Bi, Se, Te, In
Dunn's patent for gold refining	Gold	Electronic scrap reacted with chlorine. Temperature of 300°C to 700°C, dissolution of impurities in hydrochloric acid, dissolution of silver in nitric acid and ammonium hydroxide; samples of gold recovery	Recovery of 99.9% pure gold from electronic waste
Day's patent for recovering metals present in scrap with refractory ceramic	Preciousmetals, platinum, palladium	Scrap charged in a plasma furnace with a temperature of around 1 400°C, ceramic in slag, silver and copper also recovered	Recovery of platinum and palladium from electronic scrap, with recovery of 80.3% and 94.2% respectively

Technique	Metalrecovered	Processcharacteristics	Results obtained
Aleksandrovich's patent for recovery of platinum group metals and gold from electronic scrap	Platinum group and gold	Smelting of metals with carbon reducer	Platinum group metals and gold recovered

Source: Oliveros, H., *Metodología para recuperar metales preciosos: oro, plata y grupo del platino, presentes en desechos electrónicos*, Universidad Nacional de Colombia, Medellín, 2011.

Hydrometallurgical processes have additional advantages over pyrometallurgical processes, as they are reliable, precise and controllable. Furthermore, pyrometallurgical processes are highly polluting as they emit SO_2 (sulphur dioxide) and CO_2 (carbon dioxide).

Table 4 sets out by way of an example the recovery of metal and non-metal fractions from electronic circuit boards using physical and chemical processes, which can be combined in different ways to obtain the specific elements of interest.

Table 4: Recycling of printed circuit boards

Processes	Type	Features	Benefits
Chemical	Vacuum Pyrolysis	Oils and gases generated can be used within the process. The solid waste generally contains no metallic fractions which should be subject to further processing (combination with physical processes).	Non-metallic fraction as an oil can be used in the asphalt aggregate.
	Supercriticalflows	Friendly to the environment. Separate the metallic fraction of the non-metallic.	Depending on the temperature, can be removed brominated flame retardants. In the solid phase a great deal of metal that are retained can be exploited by hydrometallurgy.
	Biolixiviation	This process uses microorganisms to extract metals by the generation of organic acids that aid in leaching of metals. Friendly to the environment. It is important to control the type of microorganisms.	The removal of the metal component left free non-metallic fraction to process.
Physical	Electrostatic force	No emissions. Separating the metallic fraction of non-metallic.	Non-metallic fraction obtained in these processes can be exploited in construction aggregate and polymer filters.
	Magneticseparation	Separation of magnetic and non-magnetic metals. Not very efficient.	
	Gravityseparation	Separationfromspecificgravities.	

Source: (Hadi, Xu, Lin, Hui, & Mckay, 2015) at http://bibdigital.epn.edu.ec/bitstream/15000/10369/3/CD-6168.pdf.

The advanced techniques described above (hydrometallurgy and pyrometallurgy) can be combined with other chemical and physical processes to obtain precious and rare metals. The techniques must be controlled and will depend on the metal to be obtained (Cui & Zhang, 2008).

– **Recovery of metals from batteries**: of these elementsit is possible to recover lithium (Li), nickel (Ni), cadmium (Cd), and other metals using hydrometallurgical and pyrometallurgical processes.

Table 5: Recycling of batteries

Battery type	Recycling process
Alkalinemanganese and zinc carbon batteries	Hydrometallurgical and pyrometallurgical processes are viable to recover zinc, steel and ferro-manganese or padding for use in the construction industry.
Nickel cadmium batteries	Pyrometallurgical processes are used to recover cadmium of 99% purity, which is reused to produce new Ni-Cd batteries as well as ferronickel.
Nickel metal hydride batteries	These are processed to recover nickel, iron and other metals.
Rechargeable lithium ion batteries	This kind is processed to recover cobalt, iron and other metals.
Lead-acid Batteries	Lead is recovered for reuse in new batteries.
Button batteries	Silver oxides are collected for recycling silver by jewelers for use in watches. Batteries also can be recycled to recover mercury, zinc and steel.

Source*:* http://www.conama10.conama.org/conama10/download/files/CT%202010/1000000204.pdf.

2.2.3 Methods of recovering other usable materials present in WEEE

Apart from printed circuit boards, different techniques are available for recovering materials considered to be hazardous such as those present in Cathode Ray Tubes (CRTs) or batteries. These are described below.

– **Recovery and use of materials present in CRT screens**

Almost all the components of these screen can be reused, except for the fluorescent coating. This has to be handled as a hazardous waste material, as it contains rare earth metals europium and yttrium for which there is no proven method of recovery.

Other components, including the metal mask or shadow mask and the clean glass from the CRT, can be recycled as ferrous metal and glass respectively and subsequently recycled into productive processes, if they are shown to be free of lead or substances from the fluorescent coating.

The funnel or lead glass present in the screens has been used as aggregate in concrete blocks. This process does not involve lead extraction in any form, since only the funnel is used and is ground down to an average particle size of 4 mm. The smaller particles are processed together with sand and other mineral residues, using various washing, separation and drying techniques, which results in two fractions: one with an average particle diameter greater than 0.063 mm, and another with a smaller average particle diameter. The latter is waste and is transported to a landfill site. The fraction of particles between 0.063 mm and 4 mm is stored, analyzed and, if suitable, used as fine aggregate in concrete blocks.

The fraction with particles larger than 4 mm is washed and separated using flotation and gravity techniques. Non-reusable waste is dried and sent to licensed plants, while the rest is analyzed and used as coarse aggregate in concrete block production (Jansen Recycling BV, 2009). Lead oxide (PbO) is widely used for encapsulation and/or as aggregate for cement, in what is known as aggregate crystallized in clinker (Gong, Tian, Wu, Tan, & Lv, 2015).

– **Recovery of usable materials present in Liquid Crystal (LCD) and plasma screens**

Inside these screens there are fluorescent lamps (for backlighting) containing mercury, as well as indium-tin oxide and fluorescent coatings in the plasma and liquid crystal screens. Mercury can be recovered from the lamps (in specialized plants), as well as other substances in these screens, using appropriate techniques. This requires closed and controlled environments where operators will not be directly exposed and where particle extraction systems are provided to ensure compliance with national emission limits. The filters must be replaced in accordance with the manufacturer's recommendations.

If metals present in the fluorescent coating are not recovered, the latter must be sent for disposal using methods for which environmental permits have been granted (incineration or security cells in landfill). Levels of mercury, other heavy metals, and particulate matter at processing sites must be measured and monitored frequently, to ensure that occupational exposure limits are not exceeded in the workplace and at storage sites.

Mercury lamps: containers must be provided for the storage of output fractions, and must be designed to prevent the release of mercury, as well as industrial vacuum cleaners with activated carbon filters. Quantities of mercury lamps stored and treated should be monitored (they must remain below 150 000 units, equivalent to less than 500 grams of stored mercury). Apart from mercury, metal parts, plastics and phosphorous dust can be obtained from these lamps and must be subsequently treated. Emissions into the air, water and soil must comply with national maximum permissible levels.

Table 6: Treatment methods for fluorescent lighting components

Output fraction	Intendedproduct	Destination
Glass	Crystal	Crystal glass industry
		Lightingindustry
	Glazing	Ceramicsindustry
	Abrasive cleaningsand	Cleaningindustry
	Black coppersmelting flux	Metallurgicalindustry
	Clinker	Cement/construction industry
	Sand substitute	
	Lowerasphaltlayer	
	Glass wool	
	Silicon substitute	
Mercury	Cathode	Chlorine/caustic soda industry
	Mercury	Lightingindustry
	Phosphorous/fluorescent dust	Controlledwaste dumps
Dusts	Waste	Controlled dumps
	Reuse	Rare earthindustry

Output fraction	Intendedproduct	Destination
Metallic components and covers	Metal fluxes	Metallurgicalindustry
Plastics	Plastic (mixed)	Plastics industry
	Plastic waste	Controlledwaste dumps

Source: WEEELABEX – Treatment, 2011

Managers carrying out treatment and downstream managers must have the capacity to handle processing fractions that cannot be recovered and pose environmental and health risks (e.g., dispatch to landfill – secure cell with prior encapsulation or incineration under controlled conditions and in compliance with the norms in force in each country), and must maintain appropriate registers.

It is clear that recovery can facilitate the exploitation of hazardous waste found in WEEE. More in-depth study is unquestionably needed regarding the environmental cost-benefit aspects of using recovery and exploitation processes, which offer possible benefits in terms of energy efficiency and preservation of the environment, balanced against the possible degree of contamination from secondary waste produced by those processes and the implications of their proper management.

3 CHAPTER 3 – Social aspects of WEEE management

This chapter considers the social implications of poor WEEE management. This will provide guidance for governments and managers in least developed and developing countries, irrespective of their particular circumstances, in taking appropriate action.

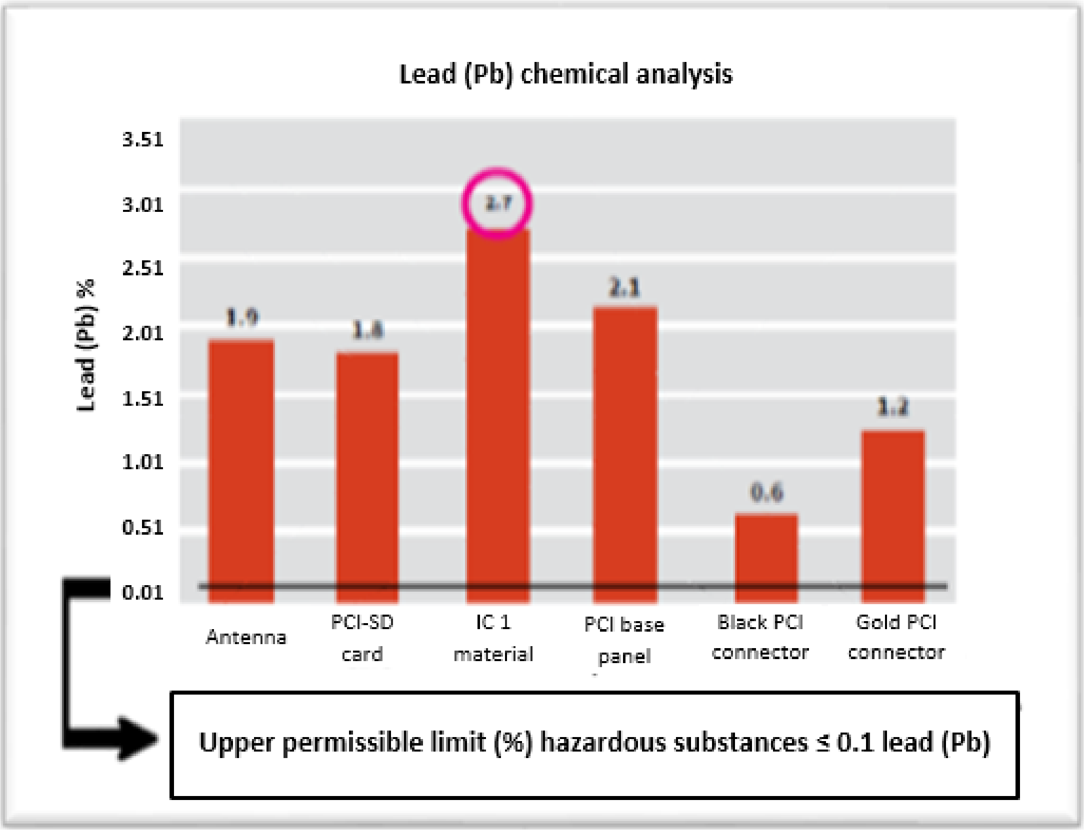
3.1 Counterfeit or non-conforming (substandard) ICT devices

Counterfeit devices (primarily mobile phones and accessories) are identical copies of an original brand, or similar to the original brand (in terms of the brand or design).

The problem with these devices relates to their impact on private companies and on governments, as they lower revenues (for manufacturing companies and for tax and excise authorities). The "goodwill" factor is undermined as consumers come to associate these defective devices with the brand itself. They also pose health risks, as many of these devices are not subject to the specifications or studies carried out by the major brands, resulting in the risk of devices short-circuiting or even, in the case of some devices such as mobile phones, of exploding. User privacy is reduced, as in many cases the IMEI (International Mobile Equipment Identity) has been duplicated.

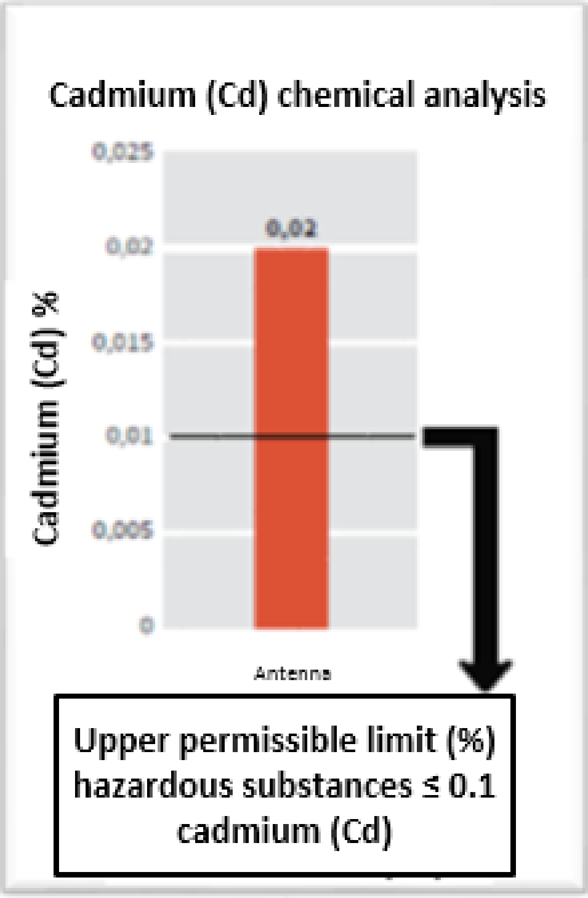
With regard to environmental and social considerations, studies carried out by the Nokia Institute of Technology in Brazil have discovered quantities of substances such as cadmium and lead in counterfeit mobile phones in quantities greater than those specified by RoHS (Restriction of Hazardous Substances) standards (see **Figures 5 and 6**). Similarly, studies carried out in India based on genuine and counterfeit mobile phones have found that unbranded mobile phones contained around 35 to 40 times lead levels considered to be acceptable for the consumer, whereas the genuine mobile phones complied with RoHS standards.

Figure 5: Lead (Pb) concentrations in counterfeit mobile phones



Source: Mobile Manufacturers Forum, 2015.

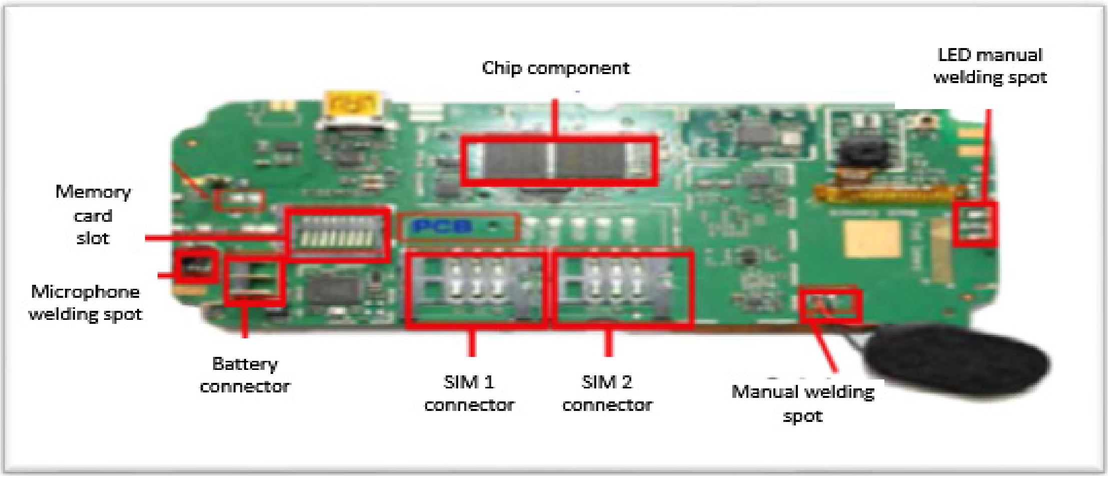
Figure 6: Cadmium (Cd) concentrations in counterfeit mobile phones



Source: Mobile Manufacturers Forum, 2015,

Figure 7 shows the parts of printed circuit boards (PCBs) where the highest levels of lead were detected in unbranded mobile phones.

Figure 7: Parts of the mobile phone in which hazardous components are found



Source: Mobile Manufacturers Forum, 2015.

Quite apart from not complying with RoHS standards, counterfeit mobile phones do not comply with requirements on voltage, sound, or electromagnetic compatibility, among other characteristics, which puts consumers at risk. Counterfeit equipment is a threat to cyber security because it is difficult to trace, as it either has no IMEI or a false one. This encourages cybercrime. Theft of mobile phones for resale on the black market has become more frequent.

The low quality of the devices may result in premature obsolescence, and if non-compliance with RoHS standards is factored in (i.e. higher than permitted quantities of hazardous substances such as lead and cadmium) the only possible result is an increase in the environmental and economic costs of managing WEEE from counterfeit equipment. Such devices thus constitute a risk in every sense: safety and security, health, environmental and economic, among others. It is therefore crucial to combat their proliferation by increasing consumer awareness of the negative impact of buying fake devices, and by providing resources to identify and attack black markets dealing in this type of device. Each country must review and, if necessary, reform its legislation relating to this type of fraud to prevent any further increase.

The World Intellectual Property Organization (WIPO), the World Trade Organization (WTO), the European Commission (EC), the Organization for Co-operation and Economic Development (OECD) and the World Customs Organization (WCO), have jointly implemented initiatives aimed at protecting intellectual property rights and combating counterfeit products.

In relation to these problems, Question 8 of ITU-T Study Group 11 ("Guidelines for implementations of signaling and protocols, and for addressing counterfeit ICT devices")[6] sets out a reference framework and the requirements that must be met when implementing solutions for combating the circulation and use of counterfeit or modified (tampered) devices.

This report considers the challenges posed by non-conforming equipment, including ways of defining and identifying counterfeit devices, producers and distributors, and limiting imports of such devices.

3.2 Impacts of poor WEEE management on human health

3.2.1 Vulnerable population groups

Children and women living in impoverished economic conditions in places where WEEE recycling takes place make up the largest proportion of informal recyclers. However, it is not easy to know the number of informal workers due to lack of data.

The International Labour Organization has indicated that children are the group most commonly employed in WEEE recycling because their small hands enable them to dismantle electronic devices more easily. This population group is the most vulnerable, in view of the risks to health from exposure to hazardous substances such as heavy metals, brominated flame retardants, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and other harmful fumes. Given the relatively small weight and size of children, the impact of exposure on their bodies is considerably greater than for adults (Perkins, Brune Drisse, Nxele & Sly, 2014).

3.2.2 Current situation regarding impact on human health

Recycling of WEEE in developing countries is a latent problem, given that their economies are based on mostly informal businesses and do not provide any safeguards for the safety and security of workers living in poverty or for the environment in processes for extracting valuable materials (ferrous and non-ferrous metals, precious metals, etc.) using rudimentary techniques and illegally selling the material obtained (Sepúlveda *et al.*, 2010).

Informal recyclers or "recycling enterprises" collect items of equipment, sort and separate them manually and/or using tools before applying crude processes using heat and chemical compounds.

[6] Complete document available in TD1337 (GEN/11).

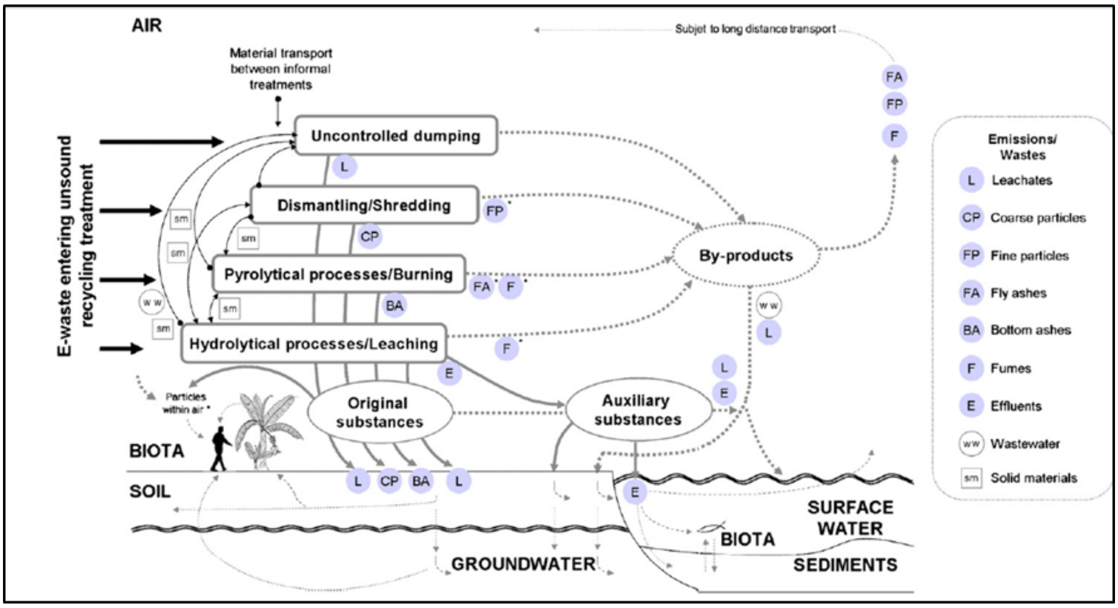
Among the most common techniques are: open burning of Printed Circuit Boards (PCBs) and cables, burning PCBs to separate components or solder cover, grinding and melting of plastic, cable burning to obtain copper, heated and acidic leaching of PCBs, recovery of gold from PCBs using cyanide and salts, or nitric acid and mercury amalgamation leaching, manual dismantling of CRTs and open burning of plastics (Sepúlveda *et al.*, 2010).

This problem is growing and the clandestine nature of these activities makes it difficult for the responsible authorities (governments, ministries of health, etc.) to monitor them adequately, which results in an increased incidence of diseases related to exposure to the more than 1,000 toxic compounds that can be present in WEEE.

3.2.3 Routes for pollutants entering the environment

There are a number of techniques (some safer than others) for recovering useful materials from WEEE. If these processes are not carried out with the necessary precautions, they can impact on the environment (**Figure 8**).

Figure 8: WEEE recycling activities in China and India, types of emissions produced and pathways of propagation into the environment



Source: Sepúlveda *et al.*, 2010.

There are three ways in which contaminants/compounds can be present during the process of extracting valuable materials (Sepúlveda *et al.*, 2010):

1) Original substances: the constituent compounds of WEEE;
2) Auxiliary substances: used in the recycling process (cyanide, aqua regia, etc.);
3) By-products: obtained by the transformation of the initial constituents using auxiliary substances.

All these substances react differently and, depending on the route, they can be seen as emissions or process outputs (see **Figure 8**):

1) Leaching from waste activities (L);
2) Particulate matter from dismantling activities (CP);
3) Ashes from burning of material (FA and BA);
4) Fumes from mercury amalgams, PCB desoldering or other types of burning (F);

5) Wastewater from dismantling or screening of materials (WW);

6) Effluents from cyanide leaching or other mercury amalgamation leaching activities (E).

Informal recycling of such waste poses many risks to human health, since these emissions affect people through different mediums (air, water and soil) and can directly affect both recyclers and third parties who frequent places near recycling sites. It has been shown that concentrations of lead, dioxins/furans and polybrominated diphenyl ether (PBDE) in the air at sites dedicated to the management of this type of waste are higher than in the major cities of Asia. Such concentrations, above World Health Organization permitted levels, can be detrimental to human health (Sepúlveda *et al.*, 2010).

3.2.4 Routes of exposure

There are several types of compounds which, through ingestion, inhalation or skin contact, can have negative effects on human beings if exposure has occurred in conditions of poor protection and/or unsafe recycling of components.

Annex 3 contains an exposure summary by *Grant et al.* in 2014, on the compounds present in WEEE management, exposure routes, the ways in which contaminants travel, and diseases that may be associated with exposure of the human body to these substances.

A serious risk of contamination is associated with informal recycling of materials from WEEE, such as burning of plastics or other materials, or when "desoldering" of printed circuit boards is done with chemical compounds such as cyanide and certain acids which produce fumes that can be inhaled if no protection is provided and can cause health problems in people exposed to them (Perkins, Brune Drisse, Nxele & Sly, 2014).

Moreover, this inappropriate recycling usually ends up polluting the environment (water, soil and air), causing many of the by-products obtained in the recycling to end up in bodies of water or to be bioaccumulated by animals and humans (as is the case of mercury).

Children are sensitive to WEEE exposure. They can be affected by the process of informal recycling even before birth, by compounds of cadmium, lead, nickel and other elements that accumulate in the placentas of exposed pregnant women (Guo *et al.*, 2010). This is also true of breastfeeding children ingesting milk in which pollutants have accumulated.

Adverse effects have been observed in infants living near sites where such waste is recycled (Grant *et al.*, 2013) (Perkins, Brune Drisse, Nxele & Sly, 2014).

In addition to indirect exposure, there is "exposure in the home" whereby children are generally affected either because recycling procedures are done at home or because some components adhere to clothing (Grant *et al.*, 2013) (Perkins, Brune Drisse, Nxele & Sly, 2014).

3.2.5 Consequences of exposure

The effects of the individual substances involved have been studied intensively; however, the effects of mixtures of compounds, such as those present in fumes produced by informal recycling of WEEE, are less well understood.

The potential effects on the health of people exposed to WEEE fumes includes pulmonary function impairment, effects on thyroid glands, cytotoxicity and genotoxicity, low birth weight, and mental health problems.

It is also likely that exposure to these substances has carcinogenic effects and causes endocrine disruption that can affect normal development. (Perkins, Brune Drisse, Nxele & Sly, 2014).

Grant and collaborators (2013) conducted an analysis of several studies concerning exposure to WEEE, of which 23 reported a link between exposure to WEEE and mental and physical health and neuro developmental and learning outcomes. Of those 23 studies, 16 reported a link between exposure to WEEE and physical health problems such as changes in thyroid function, effects on reproductive health, poor lung development, and changes in cell function (Grant *et al.*, 2013).

It was also found that children between the ages of eight and nine years living in a city dedicated to WEEE recycling (Guiyu, People's Republic of China) exhibit less vitality than those living in cities that do not carry out these activities, as well as having significantly higher levels of lead in the blood (Grant *et al.*, 2013).

In Montevideo, a study on children's exposure to informal recycling of WEEE, specifically cables, found that 24 per cent of the children studied had levels of lead in the blood higher than WHO permitted levels (Pascale *et al.*, 2016).

Similarly, it has been found that in women exposed to these compounds, deposits of contaminants accumulate in body fat, and that, because breasts are composed largely of fatty tissue, there is a strong possibility that the compounds in question can be passed on to a child during pregnancy, either through the placenta or in breast milk (Minh Tue *et al.*, 2014).

4 CHAPTER 4 – Economic aspects of WEEE management

This chapter presents the economic aspects of WEEE management taking into account a number of existing ICT equipment takeback schemes in various countries. It also provides recommendations for other governments considering the implementation of a WEEE management system or interested in reducing costs of transporting such waste.

4.1 Takeback schemes

The takeback process is of the greatest importance within the WEEE management chain, since it is the start of the process and without it there would be no inputs to manage.

The takeback process is structured around four main elements: (1) standards that govern the system; (2) operational areas for collection and processing of WEEE; (3) financing of the system; and (4) means of monitoring/controlling the flow of WEEE within and outside the system's jurisdiction, with the assistance of all those involved in the chain (consumers, producers, distributors and government bodies).

One of the main strategies for promoting takeback is based on the principle of "extended producer responsibility" and measures to raise consumers' awareness. This has led to successes in some countries and failures in others, depending on the social conditions prevailing in the country.

The following section describes a number of collection/takeback schemes in different countries and puts forwards some recommendations to optimize the process.

4.2 Takeback recommendations

As seen in the initiatives of other countries, successful collection can be guaranteed only if the producer, distributor, consumer and government get involved, and in addition implement the following recommendations (which we submit for discussion by the Q8/2 Study Group):

1) Make people aware of the impacts of WEEE and why they should be handed on to formal recycling programs;
2) Motivate financial support from the Government of each country to reduce transportation costs;
3) Create common collection points where consumers can return unused EEE;
4) Promote discounts on new electronic devices when returning unused equipment to distributor stores;
5) Conduct a study of the informal WEEE recycling sector in the relevant jurisdiction by the government, to determine formalization and minimize impacts on health and the environment;
6) Encourage producers to implement collection programs (ideally CST) to guarantee takeback of a significant amount of WEEE;
7) Set WEEE collection targets by the State in order to make producers set targets for their takeback programs;
8) Promote awareness-raising programs for rural populations with the aim of making them use collection points in urban areas as far as possible;
9) Promote partnerships among different post-consumption businesses with a view to sharing operating costs such as transportation and hazardous waste disposal.

4.3 Economic impact and business opportunities associated with WEEE

Every day vast quantities of electronic products, and therefore also greater volumes of WEEE, are produced as a direct result of EEE consumption[7] which cites the United Nations University (UNU) estimates of growth from 41 million tons per year to 47 million tons in 2017. Such waste takes up much space and contains toxic materials such as lead and mercury that can affect the environment and human health.

The increase in WEEE is apparently related to the use of latest generation computers and mobile devices as "obsolete" devices are discarded to take advantage of the new models, causing WEEE levels to rise massively and out of control.

Since EEE nowadays have a very short life cycle, it is essential to recycle them in order to keep waste levels to a minimum.

4.3.1 Business opportunities

Apart from environmental and health benefits, appropriate management of WEEE can also create economic benefits such as financial and infrastructure investment and legislation on recycling and reuse of materials derived from WEEE.

Current problems can thus become economic opportunities, as well as opportunities for social progress, especially in least developed countries, because reusing and recovering materials from WEEE and reducing hazardous materials requiring disposal can guarantee better incomes under a recycling scheme.

Making use of this waste locally (instead of exporting it to developed countries) would ensure higher incomes (saving on costs of paperwork and shipping) and obviate the need to store waste, potentially contaminating water and soil and encouraging informal operations in unsafe conditions that entail the risk of exposure to contaminants.

Considering both the imports and exports of WEEE and the impact of this trade on the economy and the environment, it is essential to set priorities, as well as ensuring investment and legislation at the national level in the countries concerned, in order to strengthen joint efforts by the international community to ensure proper WEEE disposal and use.

WEEE should be seen not just as a problem for the environment and public health (with millions of people performing informal, unsafe WEEE processing jobs) but as an economic opportunity that can be made profitable.

4.3.2 A source of employment

WEEE recycling mainly involves manual work, often done by children (because of the small size of components), so there is much scope for increasing the number of formal workers working safely, stimulating the economy through spending and avoiding exposure of children to these unsafe environments. This would be a reliable source of employment that would offer decent jobs, leveraging the use of labour specialized in processing WEEE and other occupations. It would also help to reduce unemployment rates in developing economies. EEE manufacturers should be encouraged to participate in assistance funds to reuse and recycle materials with the aim of creating green jobs.

7 Document SG2RGQ/50, "ITU-D activities on e-Waste", BDT Focal Point for Question 8/2.

4.3.2.1 Recovery of metal (increased revenue, reduced energy consumption)

Urban mining (both legal and illegal) has increased in recent years because precious and/or rare metals are needed for manufacturing EEE. Because of this, recovery of these metals properly and in a manner safe for workers and the environment has become a priority. However, few countries are doing this on a formal basis, unlike developing countries, where the cost of exporting such waste is high. It is therefore necessary to encourage the creation of regional companies dedicated to the safe extraction of these metals, which would create business opportunities for emerging economies (minimizing costs of transport, environmental permits, etc.), generating healthy competition with large refining plants or promoting the expansion of large companies to other countries and creating more green jobs. In addition, recovering metals present in WEEE can reduce mining operations to extract virgin material from the earth, leading in turn to reduced energy requirements (water and electricity) and reduced environmental impact (emissions, discharges, and so on).

4.3.2.2 Cost reduction

Reducing hazardous compounds in electronic devices can help small enterprises managing these substances to maximize their income by making use of their waste materials and thus reducing costs related to the treatment of hazardous waste.

4.3.2.3 Monetary incentives

It is essential to assess the feasibility of using WEEE components in the manufacture of new devices, which could reduce costs of raw materials and offer economic benefits for recycling facilities as well as companies manufacturing such devices. This would reduce the final cost of new products and making them more affordable for the public.

4.3.2.4 Research

Considerable financial and intellectual resources are needed for research into ways of promoting environmental protection and the development of better and more efficient WEEE recycling processes that will enable us to obtain raw materials in an appropriate way and minimize the hazardous by-products and compounds found in WEEE today.

This would promote technological improvements in new electronic devices, lower energy consumption, delay obsolescence, and ensure that the main components can be reused and processed easily.

Both private and public organizations might be interested in investing not only locally but internationally to promote global economic, social and environmental well-being.

It is evident from the above that, aside from the environmental benefits of the WEEE recycling process, there are also many financial and economic benefits. WEEE recycling facilities are becoming increasingly indispensable around the world and require global cooperation to ensure compliance and enforcement, the adoption of laws, and the promotion of corporate social responsibility.

4.4 Economic models for financing the WEEE management system

Before defining suitable economic models, it is important to note that there are two types of cost in the WEEE recycling chain: treatment costs and structural costs.

Technical costs are those relating to temporary storage, takeback, transport and treatment (for the case of minimum standards, it refers to the stages included in implementation).

4.4.1 Treatment costs

These are affected by a number of variables, including the cost of energy, hourly labour costs, and machinery depreciation. The company Cyrcle Consulting has defined net costs using the following equation:

$$\begin{aligned}\mathit{Net\ cost\ of\ treatment}\\ &= \mathit{positive\ value\ fraction}\\ &- \mathit{operating\ costs\ (including\ energy, staff\ costs\ and\ depreciation)}\\ &- \mathit{negative\ value\ fraction} - \mathit{profit\ margin\ plan}\end{aligned}$$

Source: Cyrcle consulting, 2015.

When revenues associated with falling markets are not sufficient to offset costs for appropriate management of fractions with a negative value (hazardous waste management), or operating costs are especially high (hourly employee costs, energy costs, and others), the net cost of treatment will be negative. Positive net treatment costs are common in countries with consolidated treatment plants (such as refineries in European countries) and a stable market.

4.4.2 Structural costs

These costs are associated with measures for monitoring the proper functioning of the system. This comprises five categories:

Strengthening measures: control costs recorded by producers in complying with obligations and assuming their responsibilities.

Auditing: costs of audits of plants and other facilities in the WEEE recycling chain with the aim of preventing inappropriate practices.

Awareness raising: costs connected with measures to raise public awareness on proper management of WEEE, with emphasis on promoting takeback, that is, return/appropriate disposal of electronic waste.

Guarantees: this includes the case of a producer ceasing to exist, or cases in which for other reasons the enterprise cannot fund the proportion of WEEE which it is expected to manage. In Europe, for such eventualities the WEEE Directive provides for financial guarantees for domestic electrical goods on the market.

Other costs: costs that do not fall into any of the above categories.

4.4.3 Principle of extended producer responsibility

As has already been explained, this is the principle according to which producers of EEE are required to ensure appropriate management of their devices once they have come to the end of their useful life.

This principle is the basis of economic systems for financing WEEE on the assumption that producers will be responsible for WEEE management.

4.5 Recommendation for a WEEE financing model

Among the different models evaluated by Cyrcle Consulting, the common elements that might be adapted include the following:

– Payments by entities and persons delivering WEEE to formal WEEE collection points must be exempt from taxes. This could help to create a positive incentive to bring waste management into the formal sphere, and could create a financial barrier to informal recyclers and force them to adapt to formal channels.

- In the long term, the effectiveness of the system can be ensured provided that it is an EPR-based system organized by the private sector, given that the latter has been shown to offer greater incentives to reduce the economic impact of WEEE management.
- Fair competition between those involved in takeback of equipment and recyclers must be established. This is one of the key factors in maintaining the long-term cost-benefit relationship, subject to clearly defined minimum quality standards.
- There must be clear transparency in respect of actual costs in order to raise consumers' awareness and that of society in general as regards the financial implications of ensuring adequate WEEE management. This can be achieved by informing the public of the ways in which funds are allocated for WEEE management.
- The waste collection system should not aim to compete with local reuse or with the reconditioning sector:
  - From a social perspective, this sector helps people on low incomes to have access to WEEE.
  - From the environmental perspective, it helps to extend the useful life of EEE and postpone final disposal and recovery of material.
  - From the economic perspective, the reuse value of an item of electronic equipment and its components is far higher than its material value.
- In the case of an EPR-based system, it is essential to define clearly the producer, as that may refer not only to the brand product but also include all the local entities that produce, assemble or import new or used EEE on the market.
- Where counterfeiting occurs (as in the case of Ethiopia), strengthening measures are needed, especially in EPR-based systems, in order to prevent the creation of asymmetries in the legal manufactured goods market.

Within the area considered by Cyrcle Consulting, it is clearly important to ensure equitable division of responsibilities among the main interest groups:

- Transport and treatment (technical costs), based on EPR and in line with the approach most widely used globally and supported by the industry:
  - Households that consume EEE, through a tariff based on the electricity bill, are responsible for financing access to waste (takeback, transport, and treatment). Access to the cost of waste is currently one of the factors in the high cost of WEEE recycling in most developing countries.
  - Making consumers responsible for financing this step can help bring about a gradual change in the attitudes of consumers, who expect economic compensation for handling WEEE even when discarded for recycling. This must not affect the current reuse and negotiations on reconditioning, which must be included in the proposed scheme.
- Distribution of costs for access to WEEE by consumers helps to prevent the formal private sector from becoming overloaded, which might result in higher product prices. This would create incentives for the black and contraband goods markets and would increase the willingness to implement the proposed system properly (Cyrcle Consulting, 2015).
- While the economic model described here is intended for Ethiopia, which faces problems similar to those of other developing countries, it can be implemented in any country in need of a system of financing to ensure sound WEEE management. Nevertheless, this must be determined by the competent authorities of each government, and the governments must analyze the particular conditions of their country and adjust the model accordingly.

5 CHAPTER 5 – Contributions and case studies

In this chapter, the summary of the contributions and case studies are presented. Those contributions and case studies which have been used in the main body of the report have not been included in this chapter.

5.1 Brazil: Technically feasible options for exploiting hazardous waste contained in waste from telecommunications/ICTs

Brazil submitted a contribution on ways of minimizing the generation of electronic waste through reuse.[8]

5.1.1 Digital vs analogue TV

Working with chemical substances like lead, chromium and mercury is potentially very dangerous, as these elements can poison people and contaminate soil and water. However, we still need to handle those elements because lead, for example, was used for many years in soldering and in Cathode Ray Tubes (CRT), while bromine compounds were used as a component of flame retardants.

To illustrate the impact of these substances, we note that in Brazil there are 34.5 million CRT television sets still in use in Brazilian homes. With the transition from analogue to digital broadcasting ongoing and the imminent "Analogue Television Switch-Off" (ASO) in several Brazilian cities, most of this equipment will be discarded.

In response to this problem, Brazil has cut down on the disposal of CRT TV sets through a public policy of encouraging the use of DTV converters in order to extend the useful life of many of the old TV sets. The Brazilian Government supplies converter boxes for low-income population groups and most will be used for CRT TV sets. This policy will cut the number of CRTs requiring disposal.

5.1.2 Suggestions for dealing with hazardous substances in WEEE

- Educate manufactures and consumers about restriction on the use of hazardous substances;
- EEE providers must indicate whether hazardous substances are included in their products and in what amounts. Brazil has a specific norm applicable to this;
- Forbid WEEE disposal in landfills without previous treatment and recycling;
- Guide ICT manufacturers on recycling and disposal of their products once they come to the end of their useful life;
- Stimulate a profitable WEEE recycling industry and market;
- Make products less harmful, changing industrial processes in order to reduce or eliminate hazardous substances;
- Recycle and reuse hazardous waste. As an example, lead is used to manufacture crystal glass;
- In order to transform hazardous waste into something less harmful, use methods like natural decomposition (bioremediation via microbial biodegradation or phytoremediation using living plants to clean up contaminated water, soil and air), incineration to minimize volume and convert waste into ash that can be manipulated and chemically "digested" (to extract usable substances).
- Chambers of trade and commerce can trade hazardous waste as feedstock for other industries. For example, cement manufactures may reuse non-toxic ashes from recycling or incineration

[8] Document 2/330, "Alternatives of exploitation technically feasible for hazardous waste contained in waste from telecommunications (ICT); Federative Republic of Brazil.

plants, and ground components of equipment housing (polymers), liquid crystal displays (after indium extraction) and television screens can be used as aggregate in concrete.

5.1.3 Map of recyclers in Brazil

Brazil is introduced a summary of a study carried out back in 2013 in which the technical and economic viability of inverse Logistic of the RAEE in Brazil was assessed; one of the outcomes was a map highlighting the recycling density around the country. Manaos is the place with the largest number of recyclers as it is a trade free zone, hence very difficult to control. The map was developed by the Industrial Development Brazilian Agency (ABDI as per its Portuguese acronym). Likewise this contribution summarizes the development of other documents/studies upon Brazil, related to the RAEE´s management and its employment contribution.[9]

5.2 Burundi: Current situation with regard to the management of waste electrical and electronic equipment (WEEE)

As stated by the shared contribution,[10] the volume of electrical and electronic wastes grow day by day in Burundi. These wastes mainly come from not working or obsolete mobile phones, radio, radiocommunication and TV devices, electrical appliances (refrigerators, air conditioners, etc.). There is a major environmental impact due to this increase in WEEE, directly related to the inadequate management in the collection and processing of these equipment and devices. Another reason for the augmentation of e-Waste in Burundi is the migration from analogue to digital TV signal and the changes.

Additionally, the contribution included data describing the current situation of Burundi regarding population, internet and mobile subscribers, TV and broadcasting stations, mobile and internet penetrations, volume of WEEE collected, among others. Likewise, the document presented initiatives for WEEE management that included private partners.

5.3 Chile: WEEE management model

In 2002, the Chilenter foundation was created in Chile for the purpose of reconditioning disused computers. Between 2004 and 2008, the foundation reconditioned about 23,000 computers, and in 2009 carried out the first WEEE recycling pilot program, expanding the mission to care for the environment in accordance with internationally recommended guidelines for WEEE management. The foundation's efforts are aimed at promoting reuse and recycling, reducing landfills and promoting responsibility. Some of the waste is exported to Belgium under an agreement with Belgian companies for recycling and extraction of elements such as gold and silver. The foundation has managed about 1,400 tons of WEEE for the purpose of extracting precious metals and components and safe disposal of hazardous waste. According to the latest study by the UNU, every Chilean produces 9.9 kg of electronic waste per year, well above the world average of 5.9 kg, making Chile the most polluting country in Latin America in terms of WEEE.

In order to promote a culture of comprehensive WEEE management, the Chilenter Foundation together with 27 artists, and with the support of the Chilean Presidency, has developed an art exhibition "TransformArte" which has attracted more than 70,000 visitors. The works exhibited are made with bits and pieces of obsolete computers. The aim is to raise citizens' awareness of environmental damage and problems caused by WEEE. This can promote the sale of art from recycled materials, with economic, social and environmental benefits.

9 Document SG2RGQ/229, "Map of Brazilian e-Waste recyclers (ICT)", Federative Republic of Brazil.

10 Document 2/405, "Current situation with regard to the management of waste electrical and electronic equipment (WEEE) in Burundi", Republic of Burundi.

5.4 People's Republic of China: WEEE collection

In the People's Republic of China most WEEE collection is done by the informal sector, which pays the consumer for reusing or recycling equipment at the end of its life cycle. It has been shown that the formal system cannot compete with the informal sector owing to high rates of reuse and the absence of any defined costs for "cherry picking" treatment.

Given these problems, several pilot programs were launched in response. One was the "Old appliances for new" programs, which was intended to encourage the purchase of domestic appliances. In this scheme, consumers returning WEEE to official collection sites obtained a 10 per cent discount on the price of a new appliance. Subsidies for recycling logistics and discounts on new equipment were borne entirely by the Government. This program was not financially viable, despite being successful with the public. This was because informal recyclers were able to recycle more material than by using formal methods and were more successful, by crude measures, in obtaining valuable metals, albeit at the expense of workers' health and the environment.

Best of 2 Worlds ("Bo2w") is a project promoted by StEP and coordinated by the United Nations University. It combines the strengths of Western WEEE management with the particular conditions prevailing in China in order to explore more efficient recycling techniques (Wang and Huisman, 2011).

This initiative determined that the process of formalizing recycling has an acceptable level of profitability until the hourly cost for each employee begins to rise annually, and the recommendation from these schemes has been to implement a more automated process and promote control of informal recycling (Wang & Huisman, 2011).

This reflects the need for a model that has government support to regulate informal recyclers, create incentives and raise public awareness, so that instead of selling informally, people deliver waste to competent entities for proper management.

5.5 Colombia: WEEE initiatives

Colombia, as a Co- Rapporteur for Question 8/2, submitted a number of contributions which have been used in the main body of this report and are not repeated in this chapter. Colombia's takeback scheme has been included here which is not included in the main body of the report.

5.5.1 Take bake scheme: "Computers for Education"

"Computers for Education" (*Computadores para Educar*) started in 2000 with the aim of providing reconditioned computer equipment for the country's public educational institutions. As time passed, WEEE began appearing as equipment reached the end of its useful life, suffered irreparable damage, or had features that precluded reconditioning. Computers for Education accordingly created the National Centre for Electronic Waste Recovery (CENARE), where WEEE has been properly managed. In 2011, a takeback initiative was launched as part of this dynamic to collect equipment from educational institutions.

Takeback was established as an integrated methodology for collecting disused equipment from public educational centers. This method included different players, the main ones being reconditioning centers and educational establishments involved in the program.

The takeback and reuse of disused computers involved three separate channels. The first and the one with the biggest impact involves supporting educational establishments that benefited from the program in previous years. The second makes use of donated equipment that was not in good condition for reconditioning. The third channel involved support for public bodies of indigenous communities and nature reserves.

5.5.2 Cost associated with takeback scheme

In order to perform the necessary takeback logistics operations, two key players in the process are required: logistical operators in the field, who are responsible for visiting beneficiary public educational institutions to coordinate the amount, date and packaging of obsolete equipment; and agents dealing with the transportation of collected equipment, responsible for visiting educational establishments (rural or urban) and picking up packaged equipment and conveying it to CENARE.

The development of these processes is vital for takeback and accounts for about 85 per cent of the total annual cost of the WEEE management model implemented by Computers for Education, which is 10 times more than current revenue of CENARE.

Through the years, equipment collection has led to an increase in costs due to the need to cover a larger amount of equipment collected in different geographic areas of the country. This has resulted in an increase in collection costs of approximately 7 per cent since the previous year.

With this takeback structure, for the 2011-2014 period, takeback covered nearly 1 434 tons of equipment, equivalent to 71 220 items of equipment, with associated transport costs of 2.20 million dollars (about 1 500 dollars per ton). The logistics operation cost around 164 000 dollars, which gives a total of 1 600 dollars per ton of WEEE taken back (not taking account of income/expenses related to the operation of the CENARE plant).

It should be noted that the costs associated with Computers for Education takeback management correspond to urban and rural areas across the entire country, which complicates the operation and increases the cost of transportation. If the takeback operation concentrates solely on collecting equipment in urban areas, an estimated 60 per cent reduction of the total takeback cost can be achieved. It is therefore important to raise environmental consciousness and promote education about proper WEEE disposal nationwide, and thus raise public awareness and elicit support from local governments to promote selective collection centers.

5.5.3 Other WEEE initiatives in Colombia

There are also private initiatives in Colombia, such as EcoComputo. This is a privately funded program, supported by the Ministry of Environment and Sustainable Development, that manages computer equipment by promoting the principle of "Extended Producer Responsibility" (EPR).

This program has developed from an initiative involving the national Government and the ANDI (National Association of Business Managers of Colombia) to promote social responsibility, and has succeeded in bringing together a group of over 40 public and private companies for the selective collection and management of waste materials from computers and peripheral devices. This association aims to implement Resolution 1512 of 2012 of the Ministry of Environment and Sustainable Development (MADS).

EcoComputo is responsible for receiving and processing computer equipment from collection points sited at busy locations in major cities like shopping centers and supermarkets, thus facilitating delivery.

However, this initiative falls short, since there is no collection in rural areas, which hampers WEEE management in those areas.

Another project that has been implemented is the Comprehensive Electronic Waste Reconditioning and Recycling Project in Colombia (2008-2012), in which Computers for Education was a founding member of the Project Technical Committee, together with the Ministry of Environment, Housing and Territorial Development (now the Ministry of Environment and Sustainable Development), the Colombian Chamber of Computing and Communications, the National Cleaner Production Centre and the Swiss Federal Laboratories for Materials Science and Technology (EMPA). The aim of the project was to improve living conditions of the local population by ensuring proper handling of electronic waste, reducing negative impacts on the environment and human health, and promoting economic activities. This project was concluded when the agreement with EMPA expired.

5.6 Germany: Standard to ensure proper WEEE management

ElektroG (now Elektro G2- 2015) is the Law related to WEEE management derived from the transposition of the Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) Directives in conjunction with German legislation, which are intended to ensure appropriate marketing, takeback and management of EEE.

The aim of this standard is to ensure proper WEEE management by the Public Waste Management authorities (PuWaMa), EEE producers and "The Clearing House" (EAR in German, a private programme supported by the Government). For 2006 the goal was to manage four kg of WEEE per capita and increase that quantity (United Nations University – Institute for sustainability and Peace, 2011). The PuWaMa is responsible for establishing collection points in cities where consumers can deposit their disused EEE, while producers are responsible for taking them back from these points and treating them.

In Germany, three takeback methods are used by producers: Individual Brand-selective Takeback Schemes (IBTS); Individual Non-Selective Takeback schemes (INST) and Collective Takeback Scheme (CTS).

IBTS: collects only producer brand WEEE at PuWaMa points. This forces the PuWaMa to collect items of equipment and separate them by brand. Alternatively, in some cases the producers place collection points for their brands, to facilitate collection by the state. The producer is obliged to reimburse additional costs incurred by the PuWaMa because it goes beyond the obligations stipulated in the ElektroG law.

INST: the producer collects only the EEE that it produces, regardless of the brand. This is performed with a company able to manage these types of waste (an End-of-life full Services Provider, ESP). This, however, accounts for only a small percentage of total WEEE.

CTS: a collective model whereby several groups of producers, regardless of brand, collect a specific line of EEE products that are already obsolete. This scheme is considered the most efficient, as it ensures the management of more than 60 per cent of the total WEEE managed every year in Germany; however, the producer is required to reimburse the additional costs incurred by the PuWaMa because they have to separate WEEE into different lines, going beyond the obligations under the ElektroG law.

Distributors are required to deliver WEEE to the PuWaMa, if they have reception points for obsolete EEE, as a condition for the acquisition of new EEE (discount for returning unused equipment).

Consumers are required not to mix WEEE with other types of waste, and have the support of the PuWaMa that seeks to raise awareness among consumers and inform them of the appropriate collection points.

5.6.1 Financial incentives

The European Parliament proposed the imposition of a fee at the point of sale to improve collection. The fee is used to finance awareness-raising activities, to enable producers to increase the amounts of WEEE collected. The funds are also used to remunerate the PuWaMA, thereby ensuring a higher collection quality.

5.6.2 Takeback costs for ICT devices

During 2010 in Germany the cost per ton of WEEE from ICT was around 220 euros, including transport logistics, storage, recycling, treatment and disposal (United Nations University – Institute for Sustainability and Peace, 2011).

5.7 India: Measures to integrate the informal sector through the environmentally sound management of WEEE from ICTs in developing countries

India submitted a contribution on social aspects of e-Waste.[11]

The proper management of e-Waste constitutes a source of employment for both skilled and unskilled workers at different stages of the process. However, there are also informal collectors and recyclers, particularly in developing and least developed countries, who channel WEEE outside formal systems. They are involved at various stages in the waste management process, generally without the knowledge or the appropriate conditions to do it in the correct way, which may have adverse impacts on the environment and on the health of waste collectors and the general population, especially taking into account the fact that WEEE contains hazardous waste. In this respect, it is vital to bring the informal sector within the formal sector, rather than competing with or prohibiting it (International Labour Organization, 2012).

In accordance with the Indian e-Waste Rules 2011, the producer may manage a system of e-Waste directly or with the help of any professional agency, relying on the participation of interested parties (consumers, major consumers, NGOs, informal sector, neighborhood associations, traders, distributors, and so on). In addition, India has rules and policies concerning the importance of the role of the informal sector in the elimination of e-Waste, and the Government is making significant efforts to integrate this sector so that it becomes a fundamental pillar of a sound WEEE management system.

In the light of the above, there is a strong need for training, advocacy and awareness-raising in relation to the potential hazards of e-Waste processing, without neglecting the structural problems affecting policy implementation, low literacy rates and poverty among informal waste collectors and processors. Intervention by the State and the formal sector is thus crucial for the creation of green jobs and sustainable mechanisms and policies, including the application of Corporate Social Responsibility (CSR) criteria to support informal sector actors (by improving conditions of health and education), and for legislation concerning organization (associations, cooperatives) and training, technical assistance, capacity building and skills development, and funding (subsidies, low-interest loans, etc.), which will benefit all interested parties.

Nevertheless, very few producers are demonstrating the willingness to invest in partnerships with the informal sector. In India as in other countries, there is a high degree of dependence on the informal e-Waste collection and handling sector. The strength of this sector lies in the enormous size and low cost of its workforce, which provides significant coverage. Master plans should accordingly designate sites where these collectors can do their work (landfills, designated areas for reprocessing, storage, etc.), to prevent their proliferation across cities.

5.8 Iran University of Science and Technology: Disposal or reuse of ICT waste in Iran

The University of Iran shared a contribution related to developing investigation, highlighting policies and strategies adopted by Iran for the management of WEEE; it is also introducing some activities

[11] Document 2/225, "Proposal to develop specific action plans to integrate informal sector, towards sustainable Telecommunication/ICT waste management in developing nations", Republic of India.

carried out, relevant to electronic waste. Next, summary of policies adopted in Iran for the improvement of RAEE recycling.[12]

5.8.1 E-Waste policies in waste material management (recycled)

- Creating an integrated system in reclaiming and recapturing seller / manufacturer and transporting electronic wastes and disposals;
- Legislating for municipalities to manage the collecting the e-Waste as collection centers.
- Increasing the priority e-Waste at the national level;
- Managing and rearranging the players who have important role in the e-Waste recycling;
- Considering financial support and investment in the e-Waste recycling; and,
- Creating of formal infrastructure for the electronic waste recycling.

In this regards, commission of environmental infrastructure and industry also has determined legislation for managing the method of e-Waste recycling. The objectives of legislation are listed as follows:

- Protecting the environment and public health against the harmful effects caused by electrical waste;
- Establishing the appropriate procedures for imported and regulated electrical products, transport and recycling electronic waste disposal;
- The requirement for meeting the above objectives have been presented as follows:
- Obligation of the ministry in collaboration with organizations to provide the required facilities for recycling waste electric and electronic units;
- Obligation of environmental organizations for staff training in terms of knowledge of materials and equipment used in electrical devices; and,
- Monitoring the recycling locations to ensure about no contamination periodically.

5.9 ITU Association of Japan: Proposal for a method of recycling lead-acid batteries

The ITU Association of Japan submitted a contribution on ways of recycling hazardous waste in WEEE, involving specifically the reuse of lead-acid batteries.[13]

5.9.1 General considerations

Currently various types of battery are used to store electricity for ICT equipment at base stations in communication networks. In rural and remote areas of developing countries, solar panels are also used. However, lead-acid batteries are still most widely used, not only in communication networks but also in various branches of industry owing to their record of cost effectiveness. The ITU Association of Japan describes the production of secondary batteries in 2010, noting that more than 36 billion dollars' worth of lead-acid batteries were produced.

Examples of applications are for the car, forklifts, UPS system, electric vehicles at the airports, and power storage battery for ICT/telecommunications, etc. as shown in **Section 5.1.3**. Average battery life is greatly dependent of the conditions how the battery is used, however, it is generally said to be about 3 to 4 years. After that, old batteries are collected and disassembled and divided into metallic lead, diluted sulfuric acid and plastic for recycling.

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12 Document SG2RGQ/191, "Disposal or reuse of ICT waste material in Iran", Iran University of Science and Technology (Islamic Republic of Iran).

13 Document 2/336, "Proposal for recycling method of lead acid battery", ITU Association of Japan (Japan).

However, majority of those disposed old batteries can be regenerated with low cost by the proposed Super-K and can be re-used. It is considered useful for electricity storage for small scale electric power plants in non-electrified regions in developing countries.

5.9.2 Extending the life of lead-acid batteries

An additive for lead-acid batteries called "Super-K" is useful to reduce the ICT-wastes in particular in the developing countries and contributes to their economy by lengthening battery life and regenerating old-abandoned lead-acid batteries. Super-K is effective to regenerate disposed old batteries for re-use. With Super-K the life of a typical lead acid battery can be dramatically extended at least for 1.5 to 2 times. A major cause of deterioration of lead-acid battery is "Sulphation" of negative electrode. Super-K is effective to suppress deterioration of negative electrode. The contribution details the principle why and how Super-K works to extend battery life.

After regeneration charging by Super-K, battery capacity will recover like a new battery. Lead-acid battery is a secondary battery that has more than 70 per cent production share among all secondary batteries, and now most widely used in various industry sectors.

The cost for batteries occupies a big portion of total cost of the plants, and reducing cost of batteries become important. People in rural non-electrified region in developing countries need much amount of lead-acid batteries for Telecommunications/ICTs and this technology will help to bring down the cost spent for lead-acid batteries which were replaced in a short cycle.

Batteries out of use may be collected and regenerated there and may be returned to the site from the nearest recycling centers. The contribution details the equipment required for the battery recycle center.

5.9.3 Specific examples of use

a) **Batteries for electric forklifts:** Japan Battery Regeneration, Inc. is helping to regenerate old batteries with "Super-K". Old batteries that once would have been replaced with new ones can now be used for several more years thanks to the proposed activator.

b) **Trucking companies:** a transportation company in Tokyo that operates 200 trucks have been using "Super-K" for more than 10 years. The company once had to buy about 50 new replacement batteries every year. Since it started to use "Super-K" once a year, it has never had to buy new batteries.

c) **Rural houses that generate electricity for their own use:** some households use recycled lead-acid batteries to store electricity generated by photovoltaic solar panels so as not to be dependent on the commercial network. They use "Super-K" to extend the useful life of recycled batteries, which can be used in conjunction with solar panels and/or wind generators. This could be useful in developing countries.

Using such activated batteries to supply electricity can contribute to the economy of rural communities. Currently, other than in Japan, "Super-K" and its related technology are used in Thailand, Nepal and the People's Republic of China, etc., and battery regeneration and recycling centers are in operation.

5.10 Russian Federation: Guidance for WEEE management

The Russian Federation shared the technical aspects e-Waste management, with the complete cycle of operations with e-Waste including collection, storage, transportation, disassembly and reuse to ensure environmentally sound management of WEEE.[14] The contribution shares guidelines for

[14] Document 2/358, "Draft Guidelines for e-Waste management", Russian Federation.

implementing an environmentally sound management system and includes recommendations on problems that arise in connection with WEEE management.

The following specific measures could be proposed to address WEEE issues:

1) Elaboration (improvement) of regulation on WEEE management;
2) Continuous analysis of the electronic equipment market;
3) Development of a WEEE control and management system for proper recycling and reuse from an economic and environmental perspective;
4) Social advertising campaigns promoting careful use and repair (to the extent practicable) of household appliances and consumer electronics, and keep them up to date as necessary;
5) Regular sharing of good practices with international organizations and foreign partners.

The proposed measures would ensure real and sustainable progress towards implementation of a WEEE management system.

In the Russian Federation, collection, storage and recycling of WEEE is governed by the state standard (GOST) "Resources saving. Waste treatment. Guideline on the safe collection, storing, transporting and disassembling of waste electrical and electronic equipment except for mercury-containing devices and appliances" adopted in 2012.[15] The standard sets out a basic set of guidelines for WEEE management.

According to Russian legislation, recycling of EEE is considered to be a priority in waste treatment. In relation to international standards, waste management follows a hierarchical sequence:

1) WEEE that is potentially reusable;
2) WEEE that can be recovered to obtain secondary material and energy resources.

The document also sets out aspects that must be considered for the collection, storage, transport and disassembly of WEEE, as well as opportunities for reuse.

5.11 Senegal: Initiatives for environmentally sound management of electronic waste

Senegal has shared its experience and on the current situation in that country as regards e-Waste management.[16]

5.11.1 WEEE management initiative

Senegal has for more than ten years been committed to improving access to new information and communication technologies as a way of reducing, as far as possible and as quickly as possible, the gulf between the countries of the north and the south of Africa. The problem of storage and recycling of e-Waste is seen in terms of three main aspects: programmed obsolescence, rapid replacement of equipment, and reduced useful life.

These technologies generate reusable materials as well as hazardous substances. Apart from being heavy and bulky, WEEE contains valuable material which for good economic reasons can be recycled, while the hazardous materials may give rise to serious environmental and public health problems.

The practices of waste recyclers in Senegal and other African countries, and the use of unorthodox methods to extract reusable material, highlight the importance of this problem. Such practices result in environmental damage which may jeopardize public health. In response to these problems, Senegal, through its State Agency for Information Technology (ADIE), has set up a project for the management

15 Document2/238, "Experience of Russian Federation in e-Waste management", Russian Federation.
16 Document SG2RGQ/105, "Initiative of Senegal in the management of electronic and electrical waste", Republic of Senegal.

of electrical and electronic waste. This project now recycles waste from major private companies. As government departments are the largest users of IT equipment, thereby unwittingly creating an environmental "time bomb", their e-Waste is being recycled with the support of the Prime Minister, who has issued a circular requiring government departments to return obsolete EEE to ADIE in the interests of environmentally sound management.

Some recommendations from this experience includes the following:

- Measures to encourage widespread use of regional recycling units where e-Waste can be channeled to optimize the value chain and achieve economies of scale.
- Establishment of an eco-authority in each country to help existing smaller bodies, together with sound e-Waste management initiatives and development of public-private partnerships.
- Encourage industrial manufacturers of electrical and electronic equipment to participate in an assistance fund for the reuse of IT material in order to create green jobs.
- Ensure that waste processing is a criterion for validating environmental and social impact studies.
- Improve cooperation in the problem areas being studied under all Study Group 1 and 2 Questions, and especially Q8/2 (in accordance with the WSIS recommendations through Action Line 11).

5.11.2 Inadequate WEEE management consequences

Senegal submitted a contribution related to the current situation upon the management of electronic waste.[17] How is it that for a decade the State of Senegal has started an improved access to new information and communication technologies to quickly reduce the possible gap between North and South? The electronic and electric equipment renovation rate has increased as a result, thus providing concern about electronic waste or RAEE. A project has been set-up by the State´s Agency for Technology of Information (ADIE) to counteract against the above. Some relevant recommendations upon the consequences of a RAEE´s bad management have been discussed.

5.11.3 Challenges of miniaturization of EEE

Currently, it is believed that as electronic and electric devices become smaller, they will be more advanced and hold less hazardous materials.[18] This is usually not the case since these materials are not reduced. An in-depth diagnosis of AEE reveals many subtleties. As the evolution is towards increasingly smaller technology, little by little the manufacturers are turning their backs on the environment. For example, for some equipment such as computers or TV sets, the CRT technology is being replaced by LCD, lowering the amount of used led but increasing the quantities of mercury. Though weight comparisons are not comparable, the toxicity level or the risk of mercury contamination is higher and depending upon the temperature around, it could cause a real damage to the environment and human health.

These types of situations could be present in most of EEE including cell phones, and even if they became lighter they could contaminate more due to the toxic substances they include.

Therefore, miniaturization should not consider only the topic of weight, as the trend analysis on weight would not be relevant to the environment and health impacts. On the contrary, it should consider the type of compounds used for the production of these small devices (such as smartphones, tablet, etc.) which are very contaminant and difficult to treat. In summary, the advent of miniaturization of AEE brings up a new paradigm for the rational environment management of RAEE, highly dependent upon the ICT´s development.

[17] Document SG2RGQ/228, "Initiative du Sénégal dans la gestion des Déchets Electroniques et Electriques (DEE)", Republic of Senegal.

[18] Observations from the Republic of Senegal.

5.12 Sri Lanka

5.12.1 ICT e-Waste management

Sri Lanka describes the technical aspects of the problem of e-Waste management in the country.[19]

Sri Lanka currently has about 24 million mobile phone subscribers. Some 22 million mobile phones are imported annually, as well as 0.9 million video display units and 4 million radio/cassette units. Since 2010 broadband subscriptions have been growing by around 60 per cent per year and are still growing. Standards are being developed with a view to introducing digital TV by 2017, and there are 43 commercial radio stations and 22 television channels. These rapid technological changes will result in a shorter life cycle for existing ICT equipment and more rapid obsolescence of ICT equipment. The switch to digital TV will have a huge impact and result in increased ICT waste in the near future. Sri Lanka has established a waste management unit to regulate the handling of hazardous waste, solid refuse and chemicals, in accordance with the National Environment Act No. 47 of 1980 and related rules and regulations.

The Central Environmental Authority (CEA) has launched an "Electronic Waste Management project" under a Memorandum of Understanding (MOU) with 14 partner companies in the field of telecommunications and domestic and office appliances and with service providers, with the aim of managing WEEE. The CEA has issued six licenses for companies to collect e-Waste under the supervision of the Telecommunications Regulatory Commission of Sri Lanka (TRCSL). These operators collect PCs, laptops, TV sets, CRT and LCD monitors, printers, and other equipment. Some mobile operators, together with the CEA, have launched school-level education programs on e-Waste. Digital media projects, e-Waste education campaigns, takeback initiatives at public locations, and other activities, have been launched.

There have been some challenges on the implementation of strategies, including the lack of appropriate standards and regulations and limited environmental awareness among stakeholders and the general public. A number of policy initiatives have been implemented in response, including the establishment of a regulatory framework and a Public-Private Partnership (PPP) on e-Waste, as well as public awareness-raising measures.

Sri Lanka still lags behind other countries in terms of telecommunications/ICT waste management. This issue was not addressed by the Act when it was adopted in 1980.

5.12.2 Telecommunication/ICT waste material management projects in Sri Lanka

Sri Lanka describes the activities and guidelines on e-Waste management.[20] The first activity was a meeting with the participation of all stake holders, to develop strategies for the proper disposal or reuse of telecommunication/ICT waste material; the second was the declaration of a National Week on the "Elimination of Polythene Plastic and Electronic Waste". It was also highlighted that the Telecommunications Regulatory Commission conducted several events on collection of telecommunication/ICT waste material during the mentioned special week.

On the same way, awareness raising programs were made by the Central Environmental Authority district offices. Collection of ICT waste and the development of strategies and guidelines to encourage industry players and general public on the proper disposal or reuse of telecommunication/ICT waste were developed by the Telecommunications Regulatory Commission of Sri Lanka. The document also presented several recommendations regarding awareness campaigns and management of ICT waste.

[19] Document 2/354, "ICT-waste in Sri Lanka", Democratic Socialist Republic of Sri Lanka.

[20] Document 2/400, "Telecommunication/ICT waste material management projects in Sri Lanka", Democratic Socialist Republic of Sri Lanka.

5.13 United States of America: WEEE management models

In the United States of America several WEEE management models have been implemented under the jurisdictions of individual states. However, they share the same form of financing:

1) Extended Producer Responsibility: the producer is responsible for collection and recycling.
2) Advanced Recycling Fee (ARF): this fee is paid by the consumer when purchasing the equipment and depends on the size and type of electronic device. In California, the fee is paid together with a contribution towards a state recycling foundation and goes towards paying for WEEE collection and qualified recyclers (covering the cost of managing this type of waste).

Regardless of whether the producer or consumer assumes direct financial responsibility, the costs of WEEE management are ultimately included in the sale price. This can lead to a reduction in sales, so the financial impact is on the producer, causing the price to rise and the consumer to pay for it (Namias, 2013).

The US state of California led the state legislative movements in WEEE recycling matters with its Electronic Waste Recycling Act, which seeks to reduce hazardous substances from electronic products at the end of their life cycle. This law requires retailers/stores to charge a WEEE recycling fee ranging from USD 6 to 10 from consumers purchasing certain electronic items such as Cathode Ray Tubes (CRT), Liquid Crystal Displays (LCD) or plasma screens.

Stores or retailers can retain 3 per cent of the fees collected in order to cover takeback costs. The remaining "tax" is sent to the Equalization Board, which reimburses the recycling centres (such as *Green Citizen)* that recycle WEEE from consumers and businesses (Namias, 2013).

In the US state of Maine, manufacturers adhering to the social responsibility model have since 2006 covered the waste management cost of monitors, televisions and laptops.

In the Maine WEEE system, responsibility is shared between the municipalities (which cover collection and processing costs) and manufacturers (which cover consolidation, transport and processing costs) (Namias, 2013).

5.14 Institute of Electrical and Electronics Engineers (IEEE): Standards for environmental assessment of electronic products

The Institute of Electrical and Electronics Engineers (IEEE) in its contribution presented the standards applied for the environmental assessment of products, office computers, personal IT equipment, accessories and other electronic devices.[21]

5.15 BDT activities related to the management of WEEE

During the course of the present study period BDT has undertaken a number of activities relating to the management of WEEE. These are described in detail in the documents SG2RGQ/147, 2/328, 2/167, SG2RGQ/233.[22]

[21] Document 2/212, "IEEE Standards for Environmental Assessments", Institute of Electrical and Electronics Engineers (IEEE).
[22] Documents SG2RGQ/147, 2/328 and SG2RGQ/233, "ITU-D activities on strategies and policies for the proper disposal or reuse of telecommunication/ICT waste material", 2/167, "ITU-D activities on e-Waste", BDT Focal Point for Question 8/2.

5.16 Work of ITU-T on WEEE

A number of important new international technical standards known a as ITU-T L-series Recommendations are developed by ITU-T summarized below.

– ITU-T Recommendations related to WEEE /e-Waste:

- **Recommendation ITU-T L.1000** (Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices).
- **Recommendation ITU-T L.1001** (External Universal power adapter solutions for stationary information and communication technology devices).
- **Recommendation ITU-T L.1100** (Procedure for recycling rare metals in information and communication technology goods).
- **Recommendation ITU-T L.1010** (Green battery solutions for mobile phones and other hand-held information and communication technology devices).
- **Recommendation UIT-T L.1101** (Measurement methods to characterize rare metals in information and communication technology goods).
- **Recommendation UIT-T L.1400** (Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies).
- **Recommendation UIT-T L.1410** (Methodology for environmental life cycle assessments of information and communication technology goods, networks and services)

Source: ITU, 2015

– ITU-T L-series recommendation Supplement 4:[23]

This Recommendation provides a set of guidelines that countries can refer to when designing or adjusting their e-Waste management systems. It provides guidance on policy/legal framework, collection mechanisms, financial mechanisms and engagement with all relevant stakeholders.

5.17 Results of the 2016 survey

The results of the consolidated survey conducted by BDT on Questions 6/2, 7/2 and 8/2 are summarized in the Document 2/372[24] and **Annex 4**.

[23] https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-L.Sup4-201604-I!!PDF-E&type=items.

[24] Document 2/372 + Annex, "Overview of input received through the ITU-D Study Group 2 consolidated survey for Questions 6/2, 7/2 and 8/2", Telecommunication Development Bureau.

6 CHAPTER 6 – Conclusions and recommendations

There is no single model for the environmentally sound management of WEEE, but there are certain minimum standards that may provide guidance for countries that do not have a management system or wish to improve their current system and ensure environmentally friendly waste management. It is, however, essential for all the players in the chain (governments, producers, vendors, consumers and managers) to play an active part in implementing these programs.

There are various ways of obtaining valuable materials from different WEEE fractions, but there are few that have no impact on the human organism or environment. That is why it is essential for those involved to take account of the techniques described in **Chapter 2**, as they may provide guidance in ensuring that useful materials are extracted in the appropriate way. It should also be noted that research is producing more and improved refining techniques every day and these too must be considered.

It is important for governments to commit producers to ensuring takeback of WEEE that have come to the end of their useful life, on the basis of the principle of "extended producer responsibility", using selective collection schemes. The aim of this is to ensure that a greater quantity of electronic waste is collected. The State, for its part, must promote awareness-raising campaigns, clear policies, and an appropriate system of waste management.

Takeback/collection is the start of the chain, and it is thus important to review successful collection schemes internationally that may provide guidance for countries that do not yet have a takeback system or wish to improve an existing scheme.

It has been shown that WEEE can open up business opportunities, including the recovery and use of precious and/or rare metals. This has been confined to a small number of countries, which often means that States wishing to ensure appropriate waste management are obliged to export waste. For this reason it is important to promote the creation of regional refining centres to minimize the transport costs, maximize the quantity of material treated, and ensure a positive environmental impact.

Studies are needed on the numbers and conditions of work of informal recyclers of plastics, copper and precious metals, as their activities pose constant risks for the environment and health through exposure to contaminants, from the fetal stage onwards, and various studies have shown the risks of cancer, gene toxicity and diminished general vitality, among other adverse effects.

Use of counterfeit equipment has been increasing as a result of the many informal channels of access to such equipment, mostly involving people who are unaware of its origins or lack the economic wherewithal to acquire authentic devices. This is why governments, with help from WHO, ITU, ICT ministries and cellular phone operators, must conduct campaigns to educate people and dissuade them from acquiring counterfeit devices.

Governments must facilitate the creation and implementation of a WEEE management system, not forgetting their role of vigilance and monitoring which they must carry out transparently and impartially in order to ensure compliance with any standards they may adopt.

Developing countries should run simulation models that can help them to determine the most economically favorable scenarios that will ensure the financial viability and sustainability of a system for managing disused EEE and WEEE, with due regard to striking an appropriate balance between the economic, environmental and social aspects, in order to achieve the desired impact.

All countries need to evaluate the successful financial models used internationally which they can adapted to their own particular national conditions.

References

– E-Stewards. Standard for Responsible Recycling and Reuse of Electronic Equipment. 2013.

– ICONTEC. Norma Técnica Colombiana NTC-ISO 14001. Sistemas de Gestión Ambiental, Requisitos con Orientación para su Uso. 2004.

– ICONTEC. Norma Técnica Colombiana NTC-ISO 9001. Sistemas de Gestión de la Calidad, Requisitos. 2008.

– ICONTEC. Norma Técnica Colombiana NTC-OHSAS 18001. Sistemas de Gestión en Seguridad y Salud Ocupacional, Requisitos. 2007.

– Ministerio de Transporte de Colombia. Decreto 1609 de 2002. Por el cual se reglamenta el manejo y transporte terrestre automotor de mercancías peligrosas. 2002.

– Responsible Recycling – R2. Norma de Reciclaje Responsable R2 para Recicladores de Productos Electrónicos. 2013.

– Unión Internacional de Telecomunicaciones – UIT &MercyWaanjau. Tendencias en las Normas de Telecomunicaciones, Reglamentación Inteligente para un Mundo en Banda Ancha. Capítulo 9 Residuos-e y Reciclaje: ¿Quiénes el Responsable? 2012.

– WEEELABEX. Logística, Documentonormativo. 2011.

– WEEELABEX. Recogida, Documentonormativo. 2011.

– WEEELABEX. Tratamiento, Documentonormativo. 2013

– Abdul Khaliq, Muhammad Akbar Rhamdhani, Geoffrey Brooks and Syed Masood, Metal Extraction Processes for Electronic Waste an Existing Industrial Routes: A review and Australian Perspective, 2015.

– Jansen Recycling BV. Processing of CRT-Glass, 2009.

– Bertona, Alberto. Ambiente Ecológico. Pasivos Ambientales. http://www.ambiente-ecologico.com/ediciones/2001/077_01.2001/077_Columnistas_AlbertoBertona.php3.

– E-Stewards. Standard for Responsible Recycling and Reuse of Electronic Equipment. 2013.

– Hagelüken, C. Improving Metal Returns and Eco-Efficiency in Electronics Recycling – A Holistic Approach for Interface Optimisation between Pre-Processing and Integrated Metals Smelting and Refining. In Proceedings of the IEEE International Symposium on Electronics and the Environment, Scottsdale, AZ, USA, 8–11 May 2006.

– ICONTEC. Norma Técnica Colombiana NTC-ISO 14001. Sistemas de Gestión Ambiental, Requisitos con Orientación para su Uso. 2004.

– ICONTEC. Norma Técnica Colombiana NTC-ISO 9001. Sistemas de Gestión de la Calidad, Requisitos. 2008.

– ICONTEC. Norma Técnica Colombiana NTC-OHSAS 18001. Sistemas de Gestión en Seguridad y Salud Ocupacional, Requisitos. 2007.

– Intellectual Property Watch. ITU Looks Into Issues Of Counterfeit, Substandard ICT Products, 2014.

– http://www.ip-watch.org/2014/11/18/itu-looks-into-issues-of-counterfeit-substandard-ict-products/.

– ITU News. Lucha contra dispositivos TIC falsificados y de no conformidad, 2015. http://itunews.itu.int/es/5673-Lucha-contra-dispositivos-TIC-falsificados-y-de-no-conformidad.note.aspx.

– M.C. Vats , S.K. Singh – Department of Environmental Engineering, Delhi Technological University (Formerly Delhi College of Engineering), Delhi 110042, India.

- Ministerio de Ambiente y Desarrollo Sostenible – MADS, Lineamientos Técnicos para el Manejo de RAEE, 2010.
- Ministerio de Transporte de Colombia. Decreto 1609 de 2002. Por el cual se reglamenta el manejo y transporte terrestre automotor de mercancías peligrosas. 2002.
- Ministerio TIC de Colombia. Adiós a los Dispositivos Piratas. En TIC Confío, 2016. http://www.enticconfio.gov.co/index.php/lo-mas-tic-jovenes/1288.html. En TIC Confío, Ministerio TIC, Colombia, 2016.
- Mobile Manufacturers Forum. Teléfonos Móviles Falsificados Sub-estándar. Guía de Recursos para los Gobiernos.
- http://spotafakephone.com/docs/eng/MMF_CelularesFalsificados_ES.pdf. Celulares Falsificados.
- Oliveros, H. Metodología para recuperar metales preciosos: oro, plata y grupo del platino, presentes en desechos electrónicos, Universidad Nacional de Colombia, Medellín, 2011.
- Document 2/225, "Proposal to develop specific action plans to integrate informal sector, towards sustainable Telecommunication / ICT waste management in developing nations", Republic of India. August 2015.
- Responsible Recycling – R2. Norma de Reciclaje Responsable R2 para Recicladores de Productos Electrónicos. 2013.
- Document SG2RGQ/38, "Update on the work of Question 13 – 'Environmental impact reduction including WEEE' of ITU-T Study Group 5", Telecommunication Standardization Bureau. March 2015.
- Unión Internacional de Telecomunicaciones – UIT &MercyWaanjau. Tendencias en las Normas de Telecomunicaciones, Reglamentación Inteligente para un Mundo en Banda Ancha. Capítulo 9 Residuos-e y Reciclaje: ¿Quiénes el Responsable? 2012.
- Wikipedia. Hidrometalurgia, 2016. https://es.wikipedia.org/wiki/Hidrometalurgia.
- Wikipedia. Pirometalurgia, 2016. https://es.wikipedia.org/wiki/Pirometalurgia.
- "The Modern Lead Acid Battery (SaishinNamariChikudenchi)", The Nikkan Kogyo Shimbun, ISBN978-4-526-06407-4
- ITE-IBA Letters Vol. 4, No.1, P14-P18 International conference on lead-acid batteries: held on 7-10 June 2011 in Albena, Bulgaria, P76-77, paper by Dr. AkiyaKozawa and John C. Nardi
- ITE-IBA Letters Vol. 4, No.2, P30-P32, on polymer activator for lead acid battery
- Chemistry Today No. 506, May/2013, P30-P35 on the activator Super-K (Gendai Kagaku: published by Tokyo Kagaku Dojin)
- "How to Use ITE's Organic Polymer Activator for Recovery of Deteriorated Lead-acid Batteries" by ITE Japan & JBR Inc.
- Pascale, A., Sosa, A., Bares, C., Battocletti, A., Moll, M., Pose, D., Feola, G. (2016). WEEE Informal Recycling: An Emerging Source of Lead Exposure in South America. Annals of Global Health, 82, 197-201.
- Perkins, D., Brune Drisse, M.-N., Nxele, T., & Sly, P. (2014). WEEE: A Global Hazard. Icahn School of Medicine at Mount Sinai., 80, 286-295.
- Sepúlveda , A., Schluep, M., Renaud , F., Streicher , M., Kuehr, R., Hagelüken, C., & Gerecke, A. (2010). A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India. Environmental Impact Assessment Review, 30, 28-41.
- Grant, K., Goldizen, F., Sly, P., Brune, M.-N., Neira, M., van den Berg, M., & Norman, R. (2013). Health consequences of exposure to WEEE – a systematic review. The Lancet, 1, 350-361.

- Guo, Y., Huo, X., Li, Y., Wu, K., Liu, j., Huang, J. Xu, X. (2010). Monitoring of Lead, cadmium chromium and nickel in placenta from an e waste recyling town in China. Science of the total environment, 3113-3117.
- Minh Tue, N., Katsura, K., Suzuki, G., Tuyen, L., Takasuga, T., Takahashi, S.,Tanabe, S. (2014). Dioxin. related compounds in breast milk of women from vietnamese e waste recycling sites: levels, toxic equivalents and relevance of non-dietary exposure. Ecotoxicology and Envirionmental Safety, 106, 220-225.
- Namias, J. (2013). The future of Electronic Recycling in the United States. Obstacles and Domestic Solutions. New York: Earth Engineering Center, Columbia University.
- United Nation University- Institute for sustentabily And Pace. (2011). E- waste Management in Germany.
- Wang, F., & Huisman, J. (2011). Formalization of ewaste Colection and recycling in China. United Nation University, Institute for Sustainability and Peace.
- ITU-T L-series Recommendations – Supplement 4: Guidelines for developing a sustainable e-waste management system.
- http://www.uncclearn.org/sites/default/files/inventory/integrated_weee_management_and_disposal-395429-normal-e.pdf.

Abbreviations and acronyms

Various abbreviations and acronyms are used through the document, they are provided here for simplicity.

Abbreviation/acronym	Description
ABDI	Industrial Development Brazilian Agency (Agência Brasileira de Desenvolvimento Industrial) (Federative Republic of Brazil)
ADIE	State Agency for Information Technology (Agence De l'Informatique de l'État) (Republic of Senegal)
ARF	Advanced Recycling Fee
ASO	Analogue Switch-Off
CEA	Central Environmental Authority
CENARE	National Centre for Electronic Waste Recovery (Centro Nacional de Aprovechamiento de Residuos Electrónicos) (Republic of Colombia)
CRTs	Cathode Ray Tubes
CSR	Corporate Social Responsibility
CTS	Collective Takeback Scheme
EC	European Commission
EEE	Electrical and Electronic Equipment
EMPA	Swiss Federal Laboratories for Materials Science and Technology (Eidgenössische Materialprüfungs- und Forschungsanstalt)
EPR	Extended Producer Responsibility
ESP	End-of-life full Services Provider
IBTS	Individual Brand-selective Takeback Schemes
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IMEI	International Mobile Equipment Identity
INST	Individual Non-Selective Takeback schemes
IT	Information Technology
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
LCD	Liquid Crystal Display
MADS	Ministry of Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible) (Republic of Colombia)
MoU	Memorandum of Understanding

Abbreviation/acronym	Description
MSDS	Material Safety Data Sheets
NGO	Non-Governmental Organization
OECD	Organization for Co-operation and Economic Development
PCB	Printed Circuit Board
PPP	Public-Private Partnership
PuWaMa	Public Waste Management authorities
RoHS	Restriction of Hazardous Substances
SDGs	Sustainable Development Goals
TRCSL	Telecommunications Regulatory Commission of Sri Lanka (Democratic Socialist Republic of Sri Lanka)
UN	United Nations
UNU	United Nations University
WCO	World Customs Organization
WEEE	Waste Electrical and Electronic Equipment
WIPO	World Intellectual Property Organization
WSIS	World Summit on the Information Society
WTO	World Trade Organization

Annexes

Annex 1: List of documents received for consideration by Question 8/2

All documents received for consideration by Question 8/2 are listed below.

Question 8/2 Contributions for Rapporteur Group and Study Group meetings

Web	Received	Source	Title
2/445	2017-01-18	Rapporteurs for Question 8/2	Report of the Rapporteur Group meeting on Question 8/2, Geneva, 18 January 2017
2/436	2017-02-22	Vice-Chairman, ITU-D Study Group 2 , and Co-Rapporteur for Question 8/2	Study Groups, study Questions, and working method for WTDC-17
2/432	2017-02-22	Colombia (Republic of)	Proposal on the future of Question 8/2 for the study period 2017-2021
2/420 [OR]	2017-02-17	Rapporteur for Question 8/2	Final Report for Question 8/2
2/405	2017-02-02	Burundi (Republic of)	Current situation with regard to the management of waste electrical and electronic equipment (WEEE) in Burundi
2/400	2017-01-31	Sri Lanka (Democratic Socialist Republic of)	Telecommunication/ICT waste material management projects in Sri Lanka
RGQ/245	2017-01-09	Co-rapporteur for Question 8/2	Draft final report for Question 8/2
RGQ/233	2016-12-08	BDT Focal Point for Question 8/2	ITU-D activities on strategies and policies for the proper disposal or reuse of telecommunication/ ICT waste material
RGQ/229	2016-12-08	Brazil (Federative Republic of)	Map of Brazilian e-waste recyclers (ICT)
RGQ/228	2016-12-08	Senegal (Republic of)	Initiative du Sénégal dans la gestion des Déchets Electroniques et Electriques (DEE)
RGQ/201 [OR]	2016-11-04	Co-Rapporteurs for Question 8/2	Draft Final Report for Question 8/2
RGQ/191	2016-10-27	Iran University of Science and Technology, Iran (Islamic Republic of)	Disposal or reuse of ICT waste material in Iran
2/381 +Ann.1	2016-09-15	Colombia (Republic of)	Draft Report Question 8/2
2/377	2016-09-14	Colombia (Republic of)	Economic aspects related to the take-back of Waste Electrical and Electronic Equipment – WEEE in Colombia and the impact on the health of children exposed to e-Waste

Web	Received	Source	Title
2/372	2016-09-13	Telecommunication Development Bureau	Overview of input received through the ITU-D Study Group 2 consolidated survey for Questions 6/2, 7/2 and 8/2
2/358	2016-09-13	Russian Federation	Draft Guidelines for E-waste management
2/354	2016-09-12	Sri Lanka (Democratic Socialist Republic of)	ICT-waste in Sri Lanka
2/336	2016-08-09	The ITU Association of Japan	Proposal for recycling method of lead acid battery
2/330	2016-08-12	Brazil (Federative Republic of)	Alternatives of exploitation technically feasible for hazardous waste contained in waste from tele-communications (ICT)
2/328	2016-08-15	BDT Focal Point for Question 8/2	ITU-D activities on strategies and policies for the proper disposal or reuse of telecommunication/ ICT waste material
2/264	2016-04-28	Rapporteur for Question 8/2	Report of the Rapporteur Group Meeting on Question 8/2, Geneva, 28 April 201
RGQ/166 +Ann.1	2016-04-26	World Health Organization (WHO)	Child health and e-waste
RGQ/147	2016-04-05	BDT Focal Point for Question 8/2	ITU-D activities on strategies and policies for the proper disposal or reuse of telecommunication/ ICT waste material
RGQ/119	2016-03-04	Colombia (Republic of)	Propuesta Encuesta Cuestión 8/2
RGQ/116	2016-03-04	Colombia (Republic of)	Results of tabulation of survey
RGQ/115 +Ann.1	2016-03-14	Colombia (Republic of)	Definición de alternativas de recuperación y aprovechamiento para los residuos peligrosos - RESPEL contenidos en los residuos procedentes de las telecomunicaciones RAEE-TIC / Aspectos socia-les relacionados con la gestión ambientalmente racional de los residuos electrónicos
RGQ/105	2016-02-19	Senegal (Republic of)	Initiative du Sénégal dans la gestion des Déchets Electroniques et Electriques (DEE)
2/238	2015-08-27	Russian Federation	Experience of Russian Federation in e-waste management
2/225	2015-08-27	India (Republic of)	Proposal to develop specific action plans to integrate informal sector, towards sustainable Telecommunication/ICT waste management in developing nations

Web	Received	Source	Title
2/220	2015-08-12	Colombia (Republic of)	Minimum standards to be complied with by WEEE/ICT managers when pre-processing and processing such waste in least developed and developing countries
2/219	2015-08-12	Colombia (Republic of)	Question 24/1 and Question 8/2
2/218	2015-08-12	Rapporteur for Question 8/2	Proposed questions for the survey – Topic: electronic waste from information and communication technologies (ICT)
2/212	2015-08-04	Institute of Electrical and Electronics Engineers, Inc.	IEEE Standards for Environmental Assessments
2/167	2015-07-22	BDT Focal Point for Question 8/2	ITU-D activities on e-Waste
2/140	2015-05-08	Rapporteur for Question 8/2	Report of the Rapporteur Group Meeting on Question 8/2, Geneva, 1 May 2015
RGQ/55	2015-03-29	Colombia (Republic of)	Minimum standards to be complied with by WEEE/ICT managers when pre-processing such waste in least developed and developing countries
RGQ/50	2015-03-12	BDT Focal Point for Question 8/2	ITU-D activities on e-Waste
RGQ/38	2015-03-11	Telecommunication Standardization Bureau	Update on the work of Question 13 – “Environmental impact reduction including e-Waste” of ITU-T Study Group 5
RGQ/12	2014-12-15	Rapporteur for Question 8/2	Draft work plan for Question 8/2
2/102 +Ann.1	2014-10-02	United Nations University (UNU)	E-Waste Project (Waste of electrical and electronic appliances)
2/87 +Ann.1	2014-09-08	General Secretariat	Report on WSIS Stocktaking 2014
2/81 +Ann.1	2014-09-04	Colombia (Republic of)	Borrador plan de trabajo para la Cuestión 8/2
2/48	2014-08-14	BDT Focal Point for Question 8/2	Work of ITU in the area of e-Waste

Liaison Statements

Web	Received	Source	Title
RGQ/198	2016-10-27	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 (Question 8/2) on approved Supplement on success stories on e-Waste management
2/283	2016-07-20	ITU-T Study Group 11	Liaison Statement from ITU-T SG11 to ITU-D SG2 Q8/2 on update of Q8/11 work

Web	Received	Source	Title
2/272	2016-05-18	ITU-T Study Group 5	Liaison statement from ITU-T Study Group 5 to ITU-D Study 1 and 2 on updates on ITU-T SG 5 activities relevant to ITU-D study groups
RGQ/91	2015-11-25	ITU-T Study Group 5	Liaison Statement from ITU-T SG5 to ITU-D SG 2 on ITU D Q8/2 work for the 2014-2017 study period
RGQ/33	2015-03-03	ITU-T Study Group 5	Liaison Statement from ITU-T Study Group 5 to ITU-D Study Group 2 on the Executive Summary of the ITU-T Study Group 5 Meeting

Annex 2: Cross-cutting requirements that apply to all stages

a) Infrastructure

The infrastructure must be suitable in terms of size and technology, depending on stages that are developed within each manager. Physical infrastructure must comply with the norm of each country in earthquake resistance terms. The Manager´s facilities must be fully insured against all risks.

Apart from the above, the facilities must have: signaling (SOS, fire, obligation, prohibition, warning); maps and evacuation routes; safe and signaled access and exits; artificial and natural illumination and ventilation to prevent and control the accumulation of particulate matter; loading and unloading areas with minimum required dimensions avoiding vehicles parking (to load and unload) in public zones; security and alarms systems (security cameras, fire detectors, movement sensors amongst others) to prevent stealing and risks.

Managers in charge of WEEE/ICT management must have the adequate infrastructure according to the stages undertaking within.

b) Human talent

The personnel involved in the stages of pre-processing must have certificates issued by an entity of the State, evidencing their theory-practical training of a minimum of 250 hours on topics related to environmentally sound management of WEEE/ICT; it is suggested to include vulnerable population and the informal sector (up to a minimum of 60 per cent of job posts).The Government must establish an obligation to take refresher courses and take exams every two (2) years. For certain aspects of pre-processing stages and in processing (treatment and disposal) the intervention of skilled labor is required, since there are processes that must be performed and supervised by qualified personnel.

Staff responsibilities and authorities must be clearly defined when participating in each one of the stages of WEEE/ICT management. There must be internal training for the plant personnel in topics such as: WEEE/ICT management; WEEE/ICT contents; health and environment risks; actions to take in cases of breaking of the different types of obsolete and unused EEE; procedures and processes established inside the center; Personal Protective Equipment- PPE; tools handling, and so on.

In addition, people in charge to operate forklift inside the manager´s facilities, must have certificates authorizing them to use the equipment as well as a certificate to work at heights, the latter to be renewed yearly. To work at heights, the personnel must have the needed elements (life lines, harness, snap hooks, etc.,) and with a previous authorization issued by the immediate authority. Certificates must be issued by a certification entity supported by the Government.

Employees must use Individual Protection Equipment – IPE, according to the kind of WEEE to manage, processes, procedures and activities to develop and considering identified risks; all to be recorded in a document called "profesiograma". (Professional diagram). Depending upon the WEEE/ICT type to manage during different stages, the personnel as a minimum must have: toed safety boots (dielectric), long-sleeved coveralls, gloves Kevlar / nitrile, clear mono-goggles with anti-fog lens, helmet, insertion ear protectors, sleeves Kevlar, among others; ergonomic controls and of noise levels must be implemented. It must impose stringent measures of occupational health and safety in plants specialized in the treatment of mercury lamps, with the obligation of workers to wash their hands upon leaving the work area and use all elements of individual protection.

Enrolling tests must be conducted, both periodical and when leaving, including blood and urine tests for led and mercury levels due to breaking of CRT, LCD and plasma screens and fluorescent lamps. Smoking, eating, cellphone using and music listening must be forbidden in working areas. It must be defined the obligation to wash hands when workers leave operating areas. The plant and working areas must remain in adequate cleaning and healthy conditions.

c) Documentary support (processes and procedures)

The following must be documented and must be kept registers: dangers identification matrix, risks valuation and determination of controls; matrix of environmental aspects and impacts and definition of controls(elimination, substitution, engineering controls, administrative controls); Programme on safety and health at work; training and induction and re-induction plans (these must be assessed); emergency plans including evacuation drills; professional diagram; correct usage of chemicals not present in electronic waste coming from the ICT; procedures for: measuring of led and mercury in and outside working areas to verify whether these are found within the professional exposure threshold; accidents and incidents attention, application of corrective and preventive actions and diffusion of lessons learned.

d) Equipment, Tools and Machinery

There must be multipurpose extinguishers, Solkaflam (types 1 2 3) and D, according to the type of WEEE stored and fireproof shelves; shelves and extinguishers must be located at suitable and easily accessible sites. The following must be available: hydraulic stevedores, electric screwdrivers, drills, manual screwdrivers, manual sanders, Torx screwdrivers, tweezers Straight tip, cold-chisels, metal spatulas, precision screwdrivers, among others. The plant must have a conveyor belt or carts to move the equipment inside the plant to the de-manufacturing area. There must be logging sheets for equipment and machinery and maintenance and calibration certificates for the same.

e) Registers

Records must allow tracking of the EEE/ICT that will be managed from their collection until their disposal (origin-destination), including their processing through the different stages and stakeholders of the recycling chain, ensuring the mass balance by batch and each year, where the weight of obsolete and unused EEE/ICT to be managed, must be equal to the materials and components resulting from that management plus stocked and stored material, as well as acceptable losses (<= 5%); for calculating the mass balance must consider weight control of waste containers and, if it is applicable, the weight of stowage on which the containers are located, in order to deduct and get the net weight of WEEE. Daily records of assignment, condition and time of use of tools, verification of scales calibration, delivery of Personal Protective Equipment- PPE and all registers resulting from the application of documentary support must be kept.

Keeping time of the records generated from the WEEE/ICT management must be five (5) years or more according to the norms in each country, and these might be by magnetic of physical means.

f) Information systems

Producers of EEE/ITC individually or collectively must manage, feed and update a data base with information of managers, logistic operators or Intermediaries involved in the recycling chain, including the following details as a minimum: company name, address, telephone, batch, type and quantity of WEEE/ICT, kind of applied operation, permit or license (number, date, scope and validity), type and quantity of WEEE sent for disposal, responsible manager for disposal, type of applied operation, permit or license (date, number, scope and validity) amongst others. Producers are obliged to periodically inform the relevant authorities about their management results (individually or collectively) and about compliance of targets.

g) Communications

The managers must have access to internet, cell phones and fixed lines, radiophone, and so on, for communication inside and outside of plant as well as having at hand a list of entities covering job risks, health institutions, and entities for emergency care amongst others.

Annex 3: Chemical classification of the WEEE components with routes of exposure

Figure 1A: Chemical classification of the WEEE components with routes of exposure

Persistant organic pollutants	Component of electrical and electornic	Ecological source of exposure	Route of exposure
Brominated flame retardants Polybrominated diphenyl ethers (PBDEs) Polybrominated biphenyls (PBBs)	Flame retardants for electronic equipment	Air, dust, food, water, and soil	Ingestion, inhalation, and transplacental
Polychlorinated biphenyls (PCBs)	Dielectric fluids, lubricants and coolants in generators, capacitors and transformers, fluorescent lighting, ceiling fans, dishwashers, and electric motors	Air, dust, soil, and food (bio-accumulative in fish and seafood)	Ingestion, inhalation or dermal contact, and transplacental
Dioxins			
Polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs)	Released as combustion byproduct	Air, dust, soil, food, water, and vapour	Ingestion, inhalation, dermal contact, and transplacental
Dioxin-like polychlorinated biphenyls	Released as a combustion byproduct but also found in dielectric fluids, lubricants and coolants in generators, capacitors and transformers, fluorescent lighting, ceiling fans, dishwashers, and electric motors	Released as combustion byproduct, air, dust, soil, and food (bioaccumulative in fish and seafood)	ngestion, inhalation, and dermal absorption
Polyaromatic hydrocarbons (PAHs)	Released as combustion byproduct	Released as combustion byproduct, air, dust, soil, and food	Ingestion, inhalation, and dermal contact
Elements			
Lead (Pb)	Printed circuit boards, cathode ray tubes (CRTs), light bulbs, televisions, solder, and batteries	Air, dust, water, and soil	Inhalation, ingestion, and dermal contact
Chromium (Cr) or hexavalent chromium	Anticorrosion coatings, data tapes, and floppy disks	Air, dust, water, and soil	Inhalation and ingestion
Cadmium (Cd)	Switches, springs, connectors, printed circuit boards, batteries, infrared detectors, semi-conductor chips, ink or toner photocopying machines, cathode ray tubes, and mobile phones	Air, dust, soil, water, and food (especially rice and vegetables)	Inhalation and ingestion
Mercury (Hg)	Thermostats, sensors, monitors, cells, printed circuit boards, cold cathode fluorescent lamps, and liquid crystal display (LCD) backlights	Air, vapour, water, soil, and food (bioaccumulative in fish)	Inhalation, ingestion, and dermal contact
Zinc (Zn)	Cathode ray tubes and metal coatings	Air, water, and soil	Ingestion and inhalation
Nickel (Ni)	Batteries	Air, soil, water, and food (plants)	Inhalation, ingestion, dermal contact, and transplacental
Lithium (Li)	Batteries	Air, soil, water, and food (plants)	Inhalation, ingestion, and dermal contact
Barium (Ba)	Cathode ray tubesmand fluorescent lamps	Air, soil, water, and food	Ingestion, inhalation and dermal contact
Berylium (Be)	Power supply boxes, computers, x-ray machines, ceramic components of electronics	Air, food, and water	Inhalation, ingestion, and transplacental

Source: (Grant, et al., 2013)

Annex 4: Results of the 2016 survey

The contribution by BDT[25] summarizes the replies to the questions regarding Question 8/2 contained in the ITU-D Study Group 2 consolidated survey for Questions 6/2, 7/2 and 8/2 on electronic waste generated by the Information and Communications Technologies (ICT), conducted between February and June 2016.

One of the salient results of the survey is the fact that 58 per cent of countries responding to the questions on Question 8/2 have minimum standards for WEEE management, but only 33 per cent have developed techniques for using hazardous substances from WEEE/ICTs, most notably the recovery of mercury from lighting units.

Regarding the question as to whether there has been an assessment of the quantity of WEEE generated by governments, only 31 per cent replied in the affirmative.

The survey also requested information on any impacts (positive or negative) of WEEE management, resulting in a range of replies, although there was agreement among some countries that job creation could be one of the most important aspects of WEEE management, followed by increased economic benefits, reduced pollution, an impact on the carbon footprint and workers' health, among others.

As regards WEEE management, the survey highlights the fact that only 50 per cent of the countries replying have some form of public-private partnership. The other 50 per cent indicated that such activities are left to private entities or, in a few cases, to informal enterprises.

It is also worth noting that 25 per cent of Member States participating in the survey apply WEEE management fees, which are primarily paid by producers, followed by other stakeholders and consumers. None reported such fees being paid by the government.

Of the 16 countries replying to the question "*What steps of the WEEE management stages (collection, transport, storage, refurbishment, dismantling, classification, treatment and disposal) do you carry out in your country? (more than one answer possible)*", 14 countries indicated that they carry out collection, 13 carry out transportation and storage, 10 undertake refurbishment, 11 undertake dismantling, 10 declassification, seven carry out treatment, and only six undertake disposal.

Another related question concerning the stages carried out abroad was answered by nine countries of which eight manage treatment and final disposal externally. The main countries that undertake such processes themselves are China, European countries, and the United States.

The results of the survey suggest the need to assist States in the environmentally sound management of WEEE, starting with a definition of minimum standards to achieve that objective.

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25 Document 2/372 + Annex, "Overview of input received through the ITU-D Study Group 2 consolidated survey for Questions 6/2, 7/2 and 8/2", Telecommunication Development Bureau.

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