Successful electronic waste management initiatives

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Acknowledgements

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Executive Summary

Summary

Worldwide, the growing volume of end-of-life and near-end-of-life ICT equipment resulting from increased use and uptake of ICTs has become a matter of concern over the last decade. Obsolescence (whether real, built-in, induced or perceived) has triggered a reduction in the life span of equipment and an increase in the volume of obsolete devices disposed of or stored at home or in the office, both in the public and private sector.

However, this is only one side of the problem. Waste electrical and electronic equipment (WEEE) could present serious health and environmental hazards, as it contains, among other things, heavy metals, persistent organic compounds and flame retardants.

Moreover, inadequate final disposal, incorrect processing and illegal recycling performed by unskilled workers may release toxic substances into the air, soil and ground water, causing serious health and environmental problems.[1]

ICT equipment and components, including computers, notebooks, tablets, printers, monitors, mobile phones and all modern electronic products, contain multiple potentially toxic substances, such as mercury, lead, cadmium, beryllium, chromium, barium and brominated flame retardants. These can be released as a result of illegal or informal recycling activities, or when equipment is disposed of in open dumps and landfill sites or uncontrolled sites, where burning, water damage and decomposition with other organic products can result in serious environmental consequences. Many of these substances may also accumulate in adipose tissue, posing a potential health risk.

Another important factor is the presence of precious metals, such as gold, silver, and platinum, rare earth elements,[2] and coltan.[3] Over half a century ago, the worldwide economy depended on iron, copper, gold and silver as raw materials to manufacture most essential products. Technological innovations are now impossible without dozens of different metals and their alloys, and rare earth elements are at the core of the group. These elements are absolutely fundamental, if not irreplaceable, to those manufacturing high tech products.

In addition to this, there is the transboundary movement of electronic waste (e-waste), which, since the 1980s, has been directed either illegally or misleadingly from developed countries to developing countries, including least developed countries (LDCs) in Africa, the Americas, Arab States, Asia-Pacific, CIS, and Europe regions. This has resulted in an urgent need to establish multiple global initiatives to address, mitigate, and solve this problem.

Recovering, reusing and recycling the various materials, metals, and components that electrical and electronic equipment (EEE) contain is a profitable practice, but the lack of regulation, technology and infrastructure, combined with limited awareness and knowledge about the negative consequences of inadequate WEEE management, is one of the current challenges that countries are facing.

In this regard, it is critical to establish a legal framework with clear and strict regulations (a regulatory framework) in order to improve the environmentally sound management of e-waste and to develop

1 Karin Lundgren, *The global impact of e-waste: Addressing the challenge* (Geneva, International Labour Organization, 2012). Available at www.ilo.org/sector/Resources/publications/WCMS_196105/lang--en/index.htm.

2 Rare earth elements, also referred to as rare earth metals, are a set of 17 chemical elements, comprising scandium (atomic number 21), yttrium (atomic number 39) and the so-called lanthanide group: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium, with atomic numbers ranging from 57 to 71. Although scandium and yttrium are not part of the lanthanide group, they behave physically in a very similar way.

3 Coltan is a metallic ore consisting of columbite and tantalite.

and implement minimum standards for proper management systems. Recovery, reuse and recycling must be strategically planned so as to unleash the huge potential of non-renewable natural resources and create jobs through the valorization of a range of elements and components in a circular economy model.

Aside from environmental benefits, tackling the problem of e-waste from several angles will result in other substantial benefits, including educational and financial, for multiple sectors of society and for governments themselves, thereby contributing to bridging the digital divide and promoting social inclusion.

This report is intended to provide an overview of some examples and experiences of effective WEEE management initiatives from around the world. These initiatives could serve as a basis for developing best practice in the sound management of e-waste and could be replicated in other parts of the world.

Context and background

The importance of information and communication technologies (ICTs) to economic, productive and social development is undeniable. These technologies are key to the new economic model, based on societies in which information and knowledge are shared. At the same time they contribute to integration and well-being, and the extent to which people can access and use ICTs defines new social categories that deserve to be taken into account: *info-included* and *info-excluded*[4].[1], [2]

- The ICT sector is at a key point in its expansion, in terms of both mobile broadband and the Internet. This is partly due to the diversity and affordability of mobile devices and the increased coverage of mobile networks. According to the ITU *Measuring the Information Society Report 2017* mobile broadband networks (3G or above) reach 85 per cent of the global population. High-speed mobile broadband have spread quickly over the last three years and now reach almost 53 per cent of the global population, enhancing the quality of Internet use. However, at the end of 2017, almost 3.9 billion people (52 per cent of the world population) did not use the Internet[3].
- Almost one in two people (48%) around the world uses the Internet, but in the least developed countries (LDCs) the figure is only 18 per cent. Developed countries are home to 1 billion Internet users, compared with 2.6 billion users in the developing world.
- In developing countries, the number of mobile broadband subscriptions continues to grow at double-digit rates, reaching a penetration rate of 48 per cent. The total number of mobile-broadband subscriptions was expected to reach 4.2 billion by the end of 2017.
- Fixed broadband penetration remains below 1 per cent in Africa and LDCs. Strong growth in China is driving fixed broadband penetration in the Asia-Pacific region, which was expected to exceed 12 per cent by the end of 2017.

Although there are great inequalities and inequities in access to ICTs, there is constant growth in the global production and sale of electrical and electronic equipment (EEE). Increasing consumer demand for the newest technologies and the relatively short life cycle of some ICT devices mean that equipment becomes obsolete and then waste, known as waste electrical and electronic equipment (WEEE) or e-waste.

Over the past two decades, global growth in electronic equipment production and consumption has been exponential. This is largely due to the increasing penetration of products in the developing country market, the development of a replacement market in developed countries, and a high rate of product obsolescence, together with lower prices and increased Internet use and ICT uptake.

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4 Info-exclusion is a new category of exclusion, in addition to other social, economic and cultural inequalities, that applies to people who suffer or are at risk of exclusion in the form of restricted access to and use of ICTs that could in certain circumstances improve a person's social situation. The concept of info-inclusion describes the opposite situation, where a person can access ICTs and has the capacity to use them.

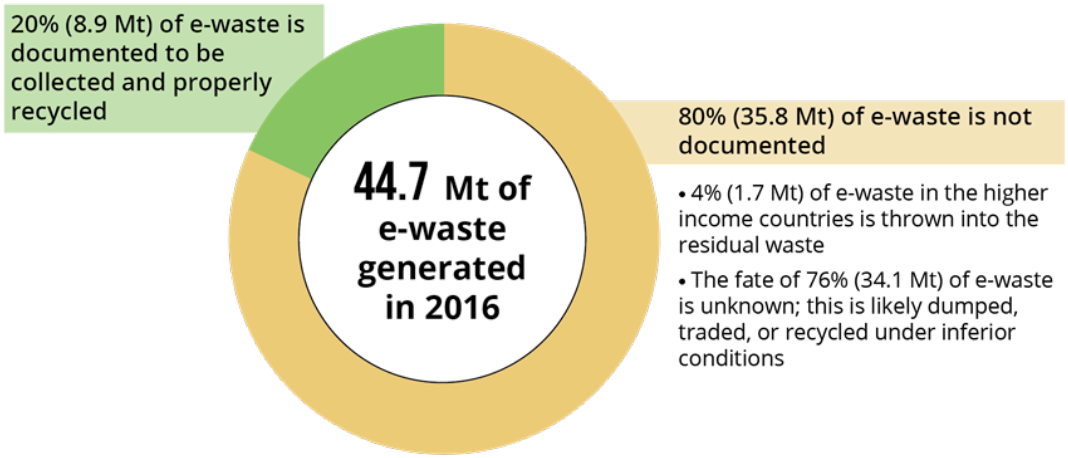
Electrical and electronic waste is the fastest growing, with an annual growth of 4 per cent. About 40 million tonnes of e-waste are generated each year and the *United Nations University Solving the E-waste Problem (StEP) Initiative* estimates that volumes could grow by as much as 500 per cent over the next decade in some countries.[4]

These figures are calculated using an internationally adopted measurement framework.[5] The latest data are published in *The Global E-waste Monitor 2017*, developed by the Global E-waste Statistics Partnership.[6]

The methodology (used to estimate data for those countries that do not produce e-waste statistics at the national level) calculates the amount of e-waste generated from harmonized modelling steps and data sources. The 2017 report estimated the total amount of e-waste generated in 2016 reached 44.7 million tonnes, compared to 42.5 million tonnes in 2014. An increase to 52.2 million tonnes in e-waste is expected by 2021.

On the other hand, the collection, reuse, reconditioning and recycling of WEEE is not common practice. Globally, only 8.9 million tonnes of e-waste has been documented as being collected and recycled, which accounts for about 20 per cent of all e-waste generated, leaving 80 per cent of e-waste unaccounted for as shown in Figure 1.

Figure 1: Collection rate for e-waste in 2016 (in millions of tonnes)



Source: Baldé 2017

Many countries have inadequate management systems or legal frameworks to deal with e-waste. In contrast, some have been using specialized systems to collect WEEE from final owners and process it in specialized treatment facilities. Nevertheless, a large percentage of WEEE is still not being collected or treated in an environmentally friendly manner or with health considerations in mind. In many cases, electrical and electronic waste generated worldwide is sent illegally to LDCs and developing countries, where inefficient techniques are used to extract materials from it. However, non-optimal treatment and illegal activities are not limited only to low-income countries. Developed countries also have large flows of undocumented e-waste that are processed (illegally or semi-legally) according to lower quality standards.

There are also other challenges to be faced, including:

- an increasing volume of WEEE, which will require adequate and specialized treatment;
- shorter life cycles induced by manufacturers;
- design and manufacturing methods that prevent disassembly and assembly;

- non-open technologies and sophisticated design and composition of products;
- use of materials that are scarce in nature;
- use of hazardous components in manufacturing;
- uncontrolled waste flow and lack of traceability;
- lack of standards and control by governments;
- child labour;
- digital and social inequality and lack of employment and opportunities.

The management of e-waste is one of the biggest challenges facing the ICT sector. This waste stream is different from municipal solid waste, and its management, treatment and final disposal must be carried out responsibly owing to the different environmental, social, cultural and economic implications. To tackle this challenge, the social actors need active participation by governments, the private sector and consumers, particularly those involved in the ICT sector and environmental matters.

It is important to introduce sustainability principles into the processes of reusing, reconditioning, recycling and final disposal of WEEE, both globally and locally. These principles must be accompanied by appropriate technological management tools, technical standards, public policies and regulatory frameworks that favour sustainable processes.

For each country researched, the volume of WEEE is examined, along with the current national and international normative framework, the application of standards that enable the processes involved to be improved, and other factors that can lead to sustainable objectives being met in the various e-waste management initiatives studied.

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Chapter 1: Legal framework

1.1 International legal framework applicable to electronic waste

Environmental movements and international regulations on environmental issues originated in the 1970s in Europe and the United States of America, after the environmental crisis, which demanded a response to the erosion of rights and the inappropriate use of nature.[1]

Today, the issue of e-waste is increasingly recognized and reflected in multiple treaties between countries seeking to promote actions to reduce the environmental impact that results from the illegal traffic of e-waste.

Within the international regulations applicable to WEEE, there are now global instruments that apply directly and indirectly to this type of waste. They include the following:

- **Basel Convention** on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
- **Amendment to the Basel Convention** concerning the prohibition of the export of hazardous wastes
- **Vienna Convention and Montreal Protocol**, designed to protect the ozone layer by reducing the production and consumption of many substances responsible for the depletion of the ozone layer
- **Stockholm Convention** on Persistent Organic Pollutants
- **Rotterdam Convention** to protect the environment from the adverse effects of toxic pesticides and other chemicals
- **Minamata Convention** to protect human health and the environment the adverse effects of mercury and mercury compounds.

In addition to these international regulations, some specific regulatory frameworks have been used as models in other countries. All member States of the European Union have WEEE legislation and several Latin American countries have taken the relevant European Union directive as a reference in introducing or adapting their own regulations.

The situation in many developing countries has been complicated by lack of national legislation, implementation or control. This has often led to the creation of a semiformal, informal or even illegal economy that includes recycling, repair and commercialization of materials, causing serious risks to health and the environment through lack of knowledge of the processes involved.

There has also been illegal trade between countries and the export of second-use and obsolete electronic products to LDCs and developing countries.

Consequently, developing the legal framework for environmentally responsible management of e-waste should be on the agendas of all governments and the international community, so as to permit the formulation of public policies and actions that are sustainable in the short and long term.

1.1.1 Basel Convention

In the 1970s, there was an increase both in the generation of hazardous waste and in public awareness of its pollutant effects. Many developed countries worked to establish legislation on the generation, storage, transport, treatment and disposal of hazardous wastes, but disparities in national regulations, the tightening of domestic laws, the high costs of disposing of hazardous wastes in their country of origin and lower transport costs at the international level led them towards the cheap option of disposing of hazardous wastes in the developing world, where environmental awareness was much less developed and regulations and enforcement mechanisms were lacking.

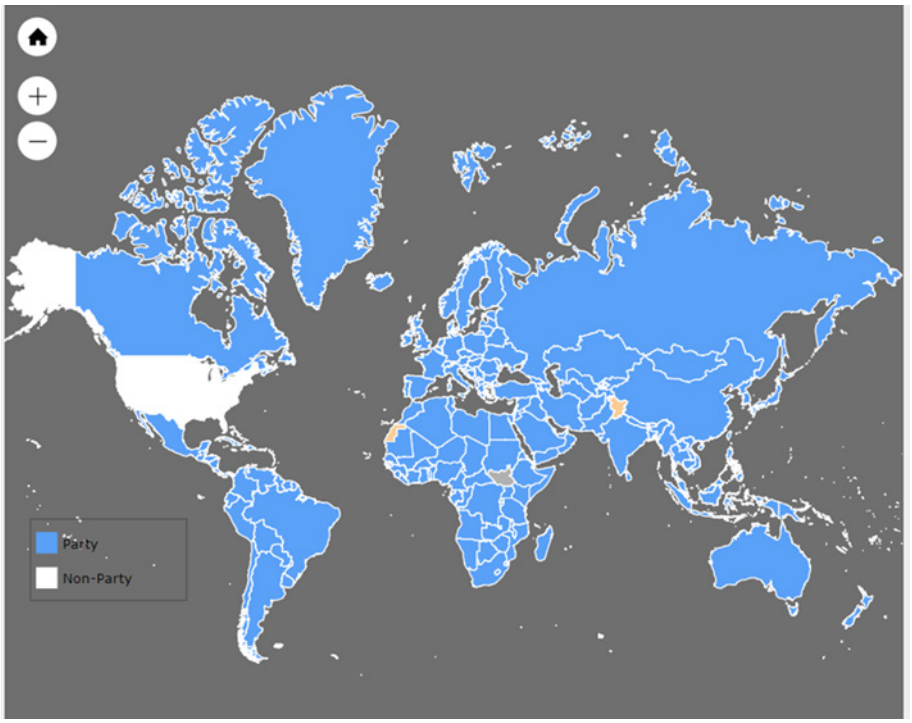
An increase in transboundary movements, especially to LDCs and developing countries, convinced governments that urgent international action was needed. Hazardous and toxic wastes were illegally disposed of on open land, and other illicit activities took place in several African countries. Such illegal activities presented serious consequences for human health and the environment. This provoked a reaction from developing countries, particularly in Africa.[2]

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal[3] is an international treaty intended to regulate the transboundary management of hazardous wastes, thereby protecting human health and the environment from the inadequate generation, storage, transportation, treatment and final disposal of hazardous waste.

In order to tackle these problems and address existing inadequate actions, this treaty was sponsored by the United Nations Environment Programme (UNEP) at the end of the 1980s. It was adopted on 22 March 1989 and entered into force on 5 May 1992. To date, there are 186 parties to the treaty.

The map on the official website of the Basel Convention shows the current status of ratifications.

Figure 2: Ratification map for Basel Convention



Source: www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.Aspx

The Convention is inspired and supported by seven international principles: environmentally sound management of hazardous and other wastes, reduction at source, caution, integrated pollution control, proximity, sufficiency and prior informed consent.

Its aims are:

- to reduce the volume and nature of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes, except where it is perceived to be in accordance with the principles of environmentally sound management; and

- a regulatory system applying to cases where transboundary movements are permissible, to prevent illegal traffic.

While electronic devices contain elements that are considered dangerous in the manufacturing process, they should not in all cases be considered as strictly dangerous when no longer in use. It was for this reason that, bearing in mind certain issues arising specifically in relation to electronic waste, the twelfth meeting of the Conference of the Parties to the Basel Convention (May 2015) adopted technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention.[4]

These guidelines focus on clarifying aspects related to the transboundary movement of electronic wastes and used equipment that may or may not constitute e-waste. Countries define and evaluate the distinction between waste and non-waste materials in different ways when examining used equipment intended, for example, for direct reuse by the original owner, use that extends its original purpose, fault analysis, repair or refurbishment. Some parties to the Basel Convention may consider waste equipment used for fault analysis, repair or refurbishment as waste, while others do not. In addition, these guidelines consider that e-waste constitutes hazardous waste or 'other wastes' and therefore falls within the scope of the Convention. This distinction is useful for enforcement agencies to assess whether the provisions of the Basel Convention relating to transboundary movements apply, as the Convention only applies to hazardous and other wastes.

The guidelines help to identify, classify and distinguish between non-waste and waste, employing the concepts of used electrical and electronic equipment (UEEE) and waste electrical and electronic equipment (WEEE).

According to the guidelines, used equipment is waste in a country if it is defined as or considered to be waste under the provisions of that country's national legislation. Used equipment should normally be considered waste if:

(a) the equipment is destined for disposal or recycling, instead of failure analysis or reuse, or its fate is uncertain;

(b) the equipment is not complete – essential parts are missing and the equipment cannot perform its key functions;

(c) the equipment shows a defect that materially affects its functionality and fails relevant functionality tests;

(d) the equipment shows physical damage that impairs its functionality or safety, as defined in relevant standards, and cannot be repaired at a reasonable cost;

(e) the protection against damage during transport, loading and unloading operations is inappropriate, e.g. the packaging or stacking of the load is insufficient;

(f) the equipment is particularly worn or damaged in appearance and its appearance reduces its marketability;

(g) the equipment has among its constituent part(s) hazardous components that are required to be disposed of under national legislation or are prohibited to be exported or are prohibited for use in such equipment under national legislation;

(h) there is no regular market for the equipment;

(i) the equipment is destined for disassembly and cannibalization (to gain spare parts); or

(j) the price paid for the equipment is significantly lower than would be expected for fully functional equipment intended for reuse.

The conditions under which a device is considered non-waste are:

(a) When it is not destined for any of the operations listed in Annex IV to the Convention (recovery or disposal operations) and it is destined for direct reuse, or extended use by the original owner for the purpose for which it was originally intended and the following is provided or is in place both prior to and during transport:

  (i) A copy of the invoice and contract relating to the sale and/or transfer of ownership of the used equipment, and documentation accompanying the equipment, *inter alia*, a signed declaration that indicates that the equipment has been tested and is destined for direct reuse and fully functional, and information on its future user or, where this is not possible, its retailer or distributor.

  (ii) Evidence of evaluation or testing in the form of a copy of records (certificate of testing – proof of functionality) on every item within the shipment and a protocol containing all recorded information. Testing of used equipment should be performed before shipment in the country of export.

  (iii) A declaration made by the person who arranges the transport of the equipment that none of the equipment within the shipment is defined as or is considered to be waste in any of the countries involved in the transport (countries of export and import and, if applicable, countries of transit).

  (iv) Each piece of equipment is individually protected against damage and to prevent hazards during transportation, loading and unloading, in particular through sufficient packaging and stacking of the load.

(b) When the person who arranges the transport of the used equipment claims that the equipment is destined for failure analysis, or for repair and refurbishment with the intention of reuse, or extended use by the original owner, for its originally intended purpose, the following conditions are met:

  (i) The documentation described below accompanies the equipment.

  (ii) A valid contract (or equivalent document, in cases where there is no change of ownership of the equipment) exists between the person who arranges the transport and the legal representative of the facility where the equipment is to be repaired or refurbished or undergo failure analysis. The contract should contain a minimum set of provisions.

In this way the Basel Convention technical guidelines seek to clarify and provide guidance on how to identify e-waste and used equipment moving between countries, with the aim of controlling illegal traffic. The guidelines are designed to provide conditions of equity for all parties to the Convention and to encourage proper recovery, repair, reuse and recycling of electronic components and non-hazardous equipment.

1.1.2 Vienna Convention and Montreal Protocol

The Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer[5] are concerned with the protection of the ozone layer around the Earth.

Scientific confirmation of depletion of the ozone layer prompted the international community to establish a cooperative mechanism to take action to protect the ozone layer. This was formalized in the Vienna Convention on the Protection of the Ozone Layer, which was initially approved and signed by 28 countries on 22 March 1985.

The Montreal Protocol is an international treaty that was signed by multiple countries in 1987 and entered into force in 1989 as a global measure to address the problem of the deterioration of the ozone layer, which affects the people of the world. Its aim is to reduce the production and consumption of

ozone-depleting substances in order to reduce their abundance in the atmosphere, thereby protecting Earth's weak ozone layer. [6]

The Montreal Protocol requires the control of nearly 100 chemicals in several categories. For each chemical group or annex, the treaty establishes a timetable for the phasing out the production and consumption of these substances, with a view to possibly eliminating them altogether.[7]

Compliance with the standards established in the Protocol, its amendments and adjustments have controlled the use of chemical substances by adding non-ozone-depleting substitute substances to industrial development. The accumulation of ozone-depleting gases has slowed and even decreased, which has reduced the risk of further damage to the ozone layer.[8]

This Protocol aims to set maximum deadlines for eliminating the production and consumption of the main substances that are depleting the ozone layer. Among the main measures proposed are:

- establishment of control dates for substances that deplete the ozone layer;
- restriction on trade with non-protocol states;
- prohibition on the import or export of depleting substances or products containing them
- classification of member countries;
- adoption of a financing mechanism.

The 197 parties to the Protocol have committed to meet targets for the production of chlorofluorocarbons (CFCs), halons and methyl bromides. These chemicals, which are used in industry and have domestic applications in refrigeration systems, air conditioners, extinguishers and aerosols, are causing the thinning of the ozone layer.

In terms of WEEE management, the Montreal Protocol is an important instrument because it covers ozone-depleting substances present in refrigerators, freezers and other refrigeration equipment and provides for management and disposal, as well as for reducing production.[9]

The Montreal Protocol is one of the most successful examples of international cooperation to overcome a major problem of global dimensions that threatens the environment. Since the negotiation of the Protocol in 1987, its parties have had to adapt it continually in response to new scientific evidence and technological advances. The production and consumption of hazardous groups of ozone-depleting chemicals have been successfully suppressed in developed countries and the same process is under way in developing countries. Overall, about 95 per cent of ozone-depleting chemicals have so far been eliminated. This is a very remarkable effort by the parties.[10]

On 16 September 2009, the Vienna Convention and the Montreal Protocol became the first treaties in the history of the United Nations to achieve universal ratification.

1.1.3 Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants[11] is an international agreement regulating the treatment of certain toxic substances. It is a mechanism promoted by UNEP.

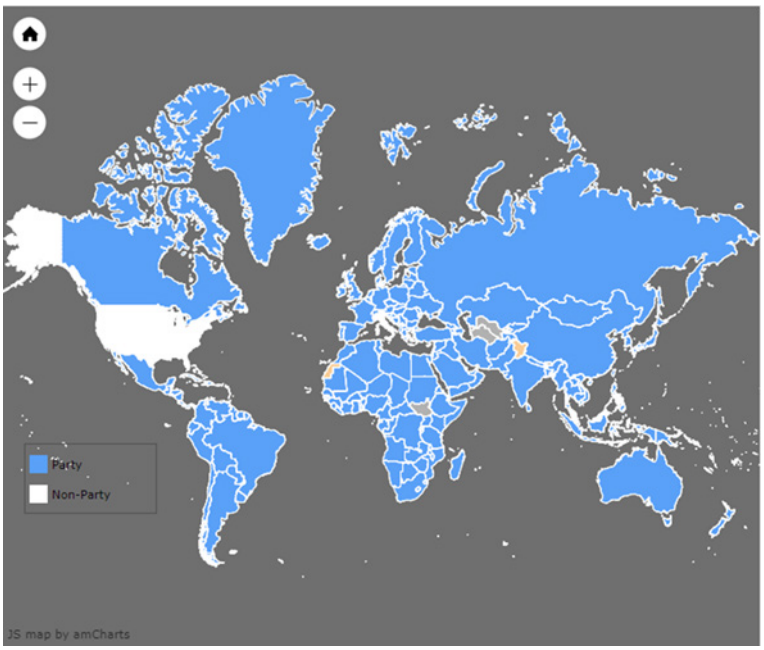
Persistent organic pollutants (POPs) are organic, i.e. carbon-based, compounds. They possess a particular combination of physical and chemical properties that, once released into the environment:

- remain intact for exceptionally long periods of time (many years);
- are widely distributed in the environment as a result of natural processes involving soil, water and, above all, air;
- easily accumulate in the fatty tissue of living organisms, including humans, and are found in higher concentrations at the highest levels of the food chain;

- are toxic to both humans and wildlife.

The Convention was adopted on 22 May 2001 in Stockholm and entered into force on 17 May 2004. It currently has a total of 152 signatories and 182 parties. The map on the official website shows the current status of ratifications worldwide.

Figure 3: Ratification map for Stockholm Convention



Source: http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx

Initially, the agreement recognized that 12 POPs caused adverse effects on humans and the ecosystem. These 12 were classified into three categories:

1 Pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex and toxaphene.

2 Industrial chemicals: hexachlorobenzene and polychlorinated biphenyls (PCBs).

3 By-products: hexachlorobenzene, polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), and PCBs.[12]

At the fourth and fifth meetings of the Conference of the Parties to the Convention, in 2009 and 2011, amendments were made to Annexes A (disposal), B (restriction) and C (unintentional production) and an additional list of ten chemicals was included (the *new* POPs).

The implications of the decision to list new chemicals include: implementing control measures for each chemical; developing and implementing action plans for chemicals produced unintentionally; developing stock inventories of chemicals; reviewing and updating national implementation plans; including the new chemicals in reports; and including the new chemicals in the efficacy assessment programme.

The Stockholm Convention establishes an obligation for its parties to develop the necessary measures to prohibit the production, use, import and export of POPs, including industrial compounds such as PCBs, pesticides such as DDT, and toxic substances such as dioxins.

In relation to the management of WEEE, the Stockholm Convention is particularly important because of the PCBs contained in electrical transformers in electrical equipment and in the capacitors of some devices.[13]

These toxic substances, which are persistent and bio-accumulative, have the ability to travel great distances, affecting human health and the ecosystem. The Stockholm Convention is designed to be global in nature so that the same level of protection will be provided throughout the world, but this requires strong involvement and control by countries, and the WEEE and ICT sector is no stranger to it.

1.1.4 Rotterdam Convention

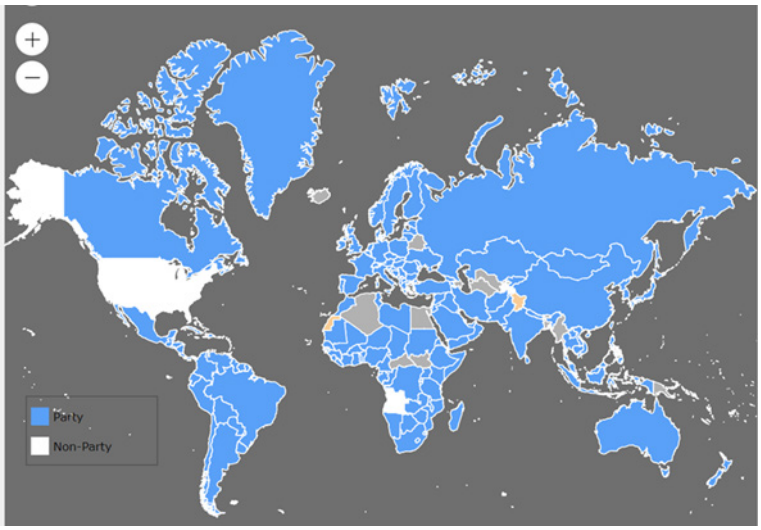
The text of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade [14] was adopted on 10 September 1998 by a Plenipotentiary Conference in Rotterdam (The Netherlands). Between September 1998 and February 2004, the Convention was implemented on a voluntary basis; it entered into force on 24 February 2004.

The objectives of the Convention are to promote shared responsibility and joint efforts by parties in the field of international trade in certain hazardous chemicals in order to protect human health and the environment from potential harm, and to contribute to the environmentally sound use of these chemicals by facilitating the exchange of information on their characteristics, establishing a national decision-making process on their import and export, and disseminating such decisions to the parties.

Originally, the number of signatories was 72; there are now 160 parties to the Convention.

The map on the official website shows the current status of ratifications worldwide.

Figure 4: Ratification map for Rotterdam Convention



Source: www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx

The Rotterdam Convention creates legally binding obligations for the implementation of the prior informed consent (PIC) procedure, which is based on the existing voluntary PIC procedure initiated by UNEP and the Food and Agriculture Organization of the United Nations (FAO) in 1989 and concluded on 24 February 2006.

To achieve its objectives, the Convention has two basic provisions: the PIC procedure and the exchange of information.[15]

The Convention establishes a first line of defence against future tragedies by preventing unwanted imports of hazardous chemicals, particularly in developing countries. By giving all countries the ability to protect themselves against the risks of toxic substances, it will have placed everyone on an equal footing and raised global standards for the protection of human health and the environment. The PIC procedure is a mechanism for obtaining and officially disseminating the decisions of importing parties

on whether they wish to receive the chemicals listed in Annex III to the Convention in the future and to ensure compliance with those decisions by exporting parties. For each chemical listed in Annex III that is subject to the PIC procedure, a decision guidance document is prepared and forwarded to all parties. The purpose of this document is to assist governments in assessing the risks associated with the handling and use of the chemical in question and to take more fundamental decisions on its future import and use, taking into account local conditions.[16]

The Rotterdam Convention and the Stockholm and Basel Conventions have certain points in common. [17], [18]

Several of the industrial chemicals covered by the Stockholm Convention are also subject to the Rotterdam Convention, for example:

- PCBs: capacitors are estimated to constitute the second largest source of PCBs. PCBs have various industrial uses in refrigeration systems and in the electrical industry (capacitors and transformers).[19]
- Polychlorinated terphenyls (PCTs): different industrial uses such as flame retardants, plasticizer applications, hydraulic fluids and lubricants (PCB substitutes).[20]
- Polybrominated biphenyls (PBBs): different industrial uses such as flame retardants for synthetic fibres and moulded thermoplastic parts, plastics, coatings and lacquers.[21]

The Basel Convention establishes a global mechanism for the control of transboundary movements of hazardous and other wastes. It resembles the Rotterdam Convention in that it promotes the exchange of information and contains provisions to control trade. The Rotterdam Convention expressly excludes waste. Consequently, a chemical that has become waste will fall within the scope of the Basel Convention, not the Rotterdam Convention,[22] except when applicable in light of the chemical characteristics. The technical guidelines on transboundary movements of electrical and electronic waste and UEEE apply in particular to the distinction between waste and non-waste.

1.1.5 Minamata Convention

The Minamata Convention on Mercury is a global treaty to protect human health and protect the environment from the adverse effects of mercury and mercury compounds. The Convention was adopted in October 2013 at a Plenipotentiary Conference held in Kumamoto, Japan, and to date has 128 signatories and 92 ratifications.[23]

Mercury is a chemical of global concern owing to its long-range transport in the atmosphere, its persistence in the environment after anthropogenic introduction, its capacity to bio-accumulate in ecosystems and its significant adverse effects on human health and the environment.[24]

Highlights of the Minamata Convention include the banning of new mercury mines, the elimination of existing mercury mines, the elimination and gradual reduction of mercury use in a range of products and processes, measures to control emissions to the atmosphere and to land and water, and regulation of the informal sector of artisanal and small-scale mining for gold extraction. The Convention also addresses the interim storage of mercury and its disposal once it becomes waste, sites contaminated with mercury, and health problems.[25]

The Convention calls attention to a global and ubiquitous metal that, although of natural origin, has wide applications in objects of daily use and is released into the atmosphere, soil and water from a variety of sources. The control of anthropogenic emissions of mercury throughout its life cycle has been a key factor in shaping obligations under the Convention.

For example, electronic boards, activated glass (LCD) and batteries may contain extremely contaminating elements that do not degrade completely, such as mercury. Mercury is critical for most everyday

electronic devices, such as smartphones, notebooks, batteries and lighting equipment, but it is very polluting, even in small concentrations.

The United States Environmental Protection Agency estimates that a 32-inch LCD contains 4 mg of mercury that is used for fluorescent light illumination, but that another 4 mg are discarded in the manufacturing process. Therefore, if the waste from the production of an LCD and the waste at the end of its life cycle are not treated, it will impact the environment with 8 mg of mercury.[26]

1.2 International schemes and initiatives to promote WEEE management

Schemes of management and extended producer responsibility (EPR) exist, and there are multiple international initiatives dedicated to working and providing solutions in this area. In many cases, technical guidelines and rules on e-waste are available:

- The Basel Convention has established two initiatives on e-waste: the Partnership for Action on Computing Equipment (PACE), bringing together stakeholders including industry, governments, academic institutions and civil society; and the Mobile Phones Partnership Initiative (MPPI), which aims to cover the two sectors of greatest expansion in the ICT market.
- PACE has developed several sets of technical guidelines for the repair, reconditioning, recovery and recycling of computer equipment and has defined criteria for labelling reconditioned used equipment and certifying environmentally sound repair, reconditioning and recycling plants.[27]
- The Solving the E-waste Problem (StEP) Initiative is a global collaboration that uniquely and globally leads thinking, knowledge, awareness, innovation and development in the management of the recovery, reuse, recycling and prevention of electronic waste.
- ITU has technical guidelines, environmental standards and recommendations to ensure the use of good practices in the management of waste from the ICT sector.

1.2.1 Management schemes for WEEE

Waste electrical and electronic equipment (WEEE) initiatives must not only be aware of international and national regulatory frameworks, but must also rely on global models and technical standards to help them improve their processes in terms of sustainability. It is therefore necessary to learn about management schemes and other international initiatives to promote WEEE management activities.

At the international level, several management schemes have been established for the management of e-waste, including:

- extended producer responsibility (EPR);
- payment of specific taxes;
- free regulation of own market.

The term *extended producer responsibility* was first presented in the report *Modeller för Förlängt producentansvar* (Model for Extended Producer Responsibility), written for the Swedish Ministry of the Environment by Lindhqvist and Lidgren in 1990.[28]

The EPR concept is an environmental policy principle that promotes total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the product life cycle, and especially to the take-back, recovery and final disposal of the product.[29]

In an EPR system, each country's law defines a regulatory framework and assigns producers, manufacturers, assemblers or importers responsibility for organizing and processing their WEEE. Usually, this leads to the creation of companies or associations where producers contribute to a common fund that covers collection and disposal costs. Current trends favour this system.

There are, however, multiple modalities – individual, collective or mixed – and EPR is implemented through different administrative, economic and informative instruments. The composition of these instruments determines which modality applies.[30]

The three cornerstones of EPR are the following principles:

- pollution prevention;
- considering the life cycle;
- polluter pays.

EPR is an environmental policy approach based on the premise that the extended responsibilities of a producer are not limited to the final stage of the product life cycle, but also include other stages of the life cycle, where conventional responsibilities are insufficient to ensure optimal protection of the environment. It offers an alternative to the tax-based and free market–based systems.

In the *tax-based system*, producers pay a tax to the State. The State is then responsible for organizing collection and final disposal systems through companies with the relevant environmental certification to operate. These companies receive payment for their services from the funds generated by the tax collected.

In the *free market–based system (free regulation system)*, legislation establishes goals to be achieved but does not specify who is responsible for the process. Therefore, all actors involved in the value chain are free to act according to market conditions as long as they comply with the legislation.[31]

It must also be taken into account that informal systems exist. In some countries, an unorganized, and in many cases uncontrolled, system can be observed, where control over the processed volume and its traceability is lost. In these systems, small groups of collectors buy obsolete equipment from consumers to sell to other collectors, who dismantle it and sort it into different waste types. In turn, these collectors resell the waste to recyclers, who recover metals, plastics and other components. In other cases, those involved in the chain are scrap collectors or drivers, who collect equipment from public places or landfill sites. These systems require attention.

1.2.2 Mobile Phone Partnership Initiative

Following the deployment of mobile telephony, the Mobile Phone Partnership Initiative (MPP)I[32] was launched in 2002 during the sixth meeting of the Conference of the Parties to the Basel Convention, when 12 manufacturers signed a declaration entering into sustainable partnership, with the Basel Convention and in cooperation with other stakeholders, to develop and promote the environmentally sound management of end-of-life mobile phones. In July 2005, a further three telecommunication operators signed a declaration entering into sustainable partnership. The main activities of the initiative include:

- identifying environmental best practice;
- developing specific guidelines;
- giving advice on the reuse and renewal of mobile equipment and recovery, recycling, collection and transboundary movement of used equipment;
- providing information and raising awareness about advances in the design of electronic products, in the context of the EPR concept.

In this way, MPPI aims to achieve better product management; influence consumer behaviour towards more environmentally friendly actions; promote the best options for disposal, recycling and renewal; mobilize political and institutional support for environmentally sound management; and develop an initiative that can be replicated to create new public–private partnerships for the environmentally sound management of hazardous waste streams and other wastes.

Since its inception,[33] MPPI has issued various technical guidelines that may be of use to e-waste management initiatives operating at the global level. They include the following:[34]

1. Glossary of Terms (Final Draft). 25 March 2009
2. Guideline on the Refurbishment of Used Mobile Phones (Revised and Approved Draft). Mobile Phone Partnership Initiative Project 1.1. 25 March 2009
3. Guideline on the Collection of Used Mobile Phones (Approved Draft). Mobile Phone Partnership Initiative Project 2.1. 25 March 2009
4. Guideline on Material Recovery and Recycling of End-of-Life Mobile Phones (Approved Draft). Mobile Phone Partnership Initiative Project 3.1. 25 March 2009
5. Guideline on the Awareness Raising-Design Considerations (Revised and Approved Draft). Mobile Phone Partnership Initiative Project 4.1. 25 March 2009
6. Guideline for the Transboundary Movement of Collected Mobile Phones (Approved Final Draft). Mobile Phone Partnership Initiative Project 2.1. 25 March 2009
7. Guidance document on the environmentally sound management of used and end-of-life mobile phones. 15 September 2008

1.2.3 Partnership for action on computing equipment

The Partnership for Action on Computing Equipment (PACE)[35] was launched at the ninth meeting of the Conference of the Parties to the Basel Convention, held in Bali, Indonesia, from 23 to 27 June 2008. As a multi-stakeholder partnership, it provides a forum for governments, industry leaders, non-governmental organizations and the academic world to address the environmentally sound management, restoration, recycling and disposal of used and end-of-life IT equipment. PACE aims to increase the environmentally sound management of such equipment, taking into account social responsibility and the concept of sustainable development and promoting exchange of information on the concept of life cycle. This gives it a holistic approach to both EEE and WEEE.

PACE is open to participation by new partners with specialized knowledge, manufacturers themselves, refurbishment or recycling companies, academic institutions, environmental groups, international organizations, and governments in general. Its distinctive feature is that it fosters innovative approaches to management, prolonging the life cycle of equipment, promoting repair and overhaul, promoting the principle of locality, encouraging open final disposal, and discouraging shipment to developing countries.

PACE has developed several sets of technical guidelines for the repair, reconditioning, recovery and recycling of computer equipment and has defined criteria for labelling reconditioned used equipment and for the certification of environmentally sound repair, reconditioning and recycling plants.[36]

These technical guidelines are of great utility and should be considered as support materials by the various e-waste management initiatives operating at the global level. They include:

1 Guidance Document on the Environmentally Sound Management of Used and End-of-Life Computing Equipment

2 Report on ESM criteria recommendations. Approved 9 March 2009; revised 15 March 2011

3 Glossary of Terms

4 Guideline on Environmentally Sound Testing, Refurbishment, and Repair of Used Computing Equipment

5 Guideline on Environmentally Sound Material Recovery and Recycling of End-of-Life Computing Equipment

6 Guidance on Transboundary Movement (TBM) of Used and End-of-Life Computing Equipment

1.2.4 Solving the e-waste problem

The Solving the E-waste Problem (StEP)[37] Initiative was created in 2007 by the United Nations University to address the WEEE problem worldwide. As a global collaborative initiative its mission is:[38]

- To foster inclusive, solutions-oriented member dialogue, cooperation and consensus by providing a global platform for sharing information, knowledge and recommendations founded on expert scientific research and multi-stakeholder sectoral experience.
- To work internationally with receptive external partners to develop fair and objective policies to stimulate and demonstrate practical, measured and effective responses to e-waste prevention, management and processes, paying particular attention to the areas of product design, repair and refurbishment, improved management systems and capacity building for recycling.
- To lead the e-waste management discussion worldwide by providing a scientific basis from which to inform and actively change the awareness, knowledge, attitudes and behaviour of the international business and consumer public.

Led by the Sustainable Cycles programme (SCYCLE) of the UNU Institute for Environment and Human Security, by May 2018, StEP had more than 55 members among businesses, international organizations, governments, non-governmental organizations and academic institutions around the world. In this way, it is building an international platform for the exchange and development of knowledge in order to increase efforts made all over the world.[39]

The StEP Initiative has overseen numerous trainings and workshops, as well as the production of several research reports and policy briefs, and advises governments on the development of policies, legislation and management systems, developing sound recommendations for the formulation of national and international policies. In addition, it is dedicated to researching, analysing and facilitating pilot projects and policy recommendations. All this material is available on the StEP website and is of interest to any global e-waste management initiative.

The Best of 2 Worlds (Bo2W) project [40] has been developed as part of the recycling work of the StEP Initiative. Bo2W aims to define the best recycling technique for e-waste in emerging economies. It seeks technical and logistical integration of best pre-processing practice in developing countries to manually dismantle e-waste and best end-processing practice to treat hazardous and complex components at international, state-of-the-art end-processing facilities.

In addition to the Bo2W project, the StEP Initiative has developed several other activities of interest, including academic programmes such as the E-Waste Academy – Managers Edition (EWAM) and E-Waste Academy – Scientists Edition (EWAS). EWAM focuses on the practical application of these

science-based solutions, in particular policy development and e-waste system design. Aimed at politicians and government officials, as well as small and medium-sized recycling companies, it provides a neutral platform to stimulate fruitful discussion between politicians and those responsible for small and medium-sized enterprises while facilitating the exchange of best practices. EWAS is aimed at doctoral students, postdoctoral researchers and researchers at the start of careers in the social and physical sciences investigating the political, social, economic, environmental, health or technological aspects of e-waste.

As can be seen, UNU plays a very important role, not only in the diffusion of knowledge but also in developing and improving the quality of sustainable development processes, where the role of the Universities is clear at a global level.

1.2.5 ITU standards and partnerships

Many United Nations agencies, in particular ITU, have been working actively on issues relating to e-waste management.

In 2016, ITU, the World Health Organization (WHO), the United Nations Educational, Scientific and Cultural Organization (UNESCO, through its Regional Office for Science in Latin America and the Caribbean), the United Nations Industrial Development Organization (UNIDO), the World Intellectual Property Organization (WIPO), UNU, the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), the Secretariat of the Basel Convention and the Basel Convention Regional Centre for the South American Region in Argentina decided to initiate cooperation for the sustainable management of e-waste worldwide. This resulted in the study *Sustainable management of electrical and electronic waste equipment in Latin America*[41] being carried out as a collaboration among these organizations. Building an effective partnership still requires the participation of other relevant partners at the local, national, regional and global levels, but it is clear, particularly from the section above on the StEP Initiative, that universities play a very important role. It would be interesting to include them in such alliances, especially in work being carried out in developing countries.

Among other initiatives, ITU has joined PACE and StEP. It has also organized workshops for capacity building on environmentally responsible management of WEEE, aiming to develop standards and policies to be incorporated in national and regional e-waste management strategies.[42], [43]

ITU has prepared technical guidelines and environmental standards to ensure good practice in the management of waste from the ICT sector. Its studies in the areas of e-waste reduction, recycling methods, reuse of materials and other topics related to the subject have been taken into account in recommendations and related supplements, such as ITU-T recommendations in Table 1.[44]

Table 1: List of ITU-T Recommendations on e-waste and related ITU supplements

ITU Recommendations, related supplements and Publications	Description
ITU-T L.1000	Universal power adapter and charger solution for mobile terminals and other ICT devices (approved 13 June 2011)
ITU-T L.1001	External universal power adapter solutions for stationary information and communication technology devices (approved 29 November 2012)
ITU-T L.1002	External universal power adapter solutions for portable ICT devices (approved 14 October 2016)
ITU-T L.1010	Green battery solutions for mobile phones and other hand-held information and communication technology devices (approved 13 February 2014)

ITU Recommendations, related supplements and Publications	Description
ITU-T L.1100	Procedure for recycling rare metals in information and communication technology goods (approved 22 February 2012)
ITU-T L.1101	Measurement methods to characterize rare metals in information and communication technology goods (approved 22 March 2014)
ITU-T L.1200	Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment (approved 29 May 2012)
ITU-T L.1300	Best practices for green data centres (approved 29 June 2014)
ITU-T L.1310	Energy efficiency metrics and measurement methods for telecommunication equipment (approved 29 July 2017)
ITU-T L.1400	Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies (approved 22 February 2011)
ITU-T L.1410	Methodology for the assessment of the environmental impact of information and communication technology goods, networks and services (approved 7 December 2014)
ITU-T L.1420	Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations (approved 6 February 2012)
ITU-T L Suppl. 4	Guidelines for developing a sustainable e-waste managements system (approved 19 December 2014)
ITU-T L Suppl. 5	Life-cycle management of ICT goods (approved 19 December 2014)
ITU-T L Suppl. 20	Green public ICT procurement (approved 23 October 2015)
ITU-T L Suppl. 21	Implementation guidance for small and medium-sized enterprises on information and communication technology supply chain due diligence concerning conflict minerals (approved 27 April 2016)
ITU-T L Suppl. 24	ITU-T L.1500: Overview of climate change effects and possible impacts (approved 27 April 2016)
ITU-T L Suppl. 25	ITU-T L.1502: Best practices for infrastructure adaptation to climate change (approved 27 April 2016)
ITU-T L Suppl. 26	ITU-T L.1410: Case study: The assessment of greenhouse gas emissions of a hybrid satellite broadband system over its life cycle (approved 27 April 2016)
ITU-T L Suppl. 27	Success stories on e-waste management (approved 14 October 2016)
ITU-T L Suppl. 28	Circular Economy in Information and Communication Technology: Definition of approaches, concepts and metrics (approved 14 October 2016):
ITU-T L Suppl. 32	Supplement for eco-specifications and rating criteria for mobile phones eco-rating programmes (approved 27 April 2016)
ITU-T L Suppl. 33	Assessment of energy consumption of information and communication technology services (approved 27 April 2016)

ITU Recommendations, related supplements and Publications	Description
Flipbook	Sustainable management of waste electrical and electronic equipment in Latin America[45]

Source: ITU

WEEE initiatives must not only be aware of the international and national regulatory framework, but must also rely on global models and technical standards to help them improve their processes with regard to sustainability.

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Chapter 2: E-waste management initiatives in the CIS and Europe regions

This chapter analyses successful e-waste management initiatives at the regional level. Countries were selected from Africa, Asia–Pacific, Americas, CIS, and Europe regions, which all present different characteristics with regard to e-waste management solutions. The study establishes similarities, strengths, weaknesses and challenges in order to define the best model for WEEE management centres to adopt. Information for the study was gathered from specific literature, publications, reports, Internet sites and statistical sources, as well as from international organizations, such as the World Bank, Interamerican Development Bank, United Nations, International Telecommunication Union, and the *e-Waste Assessment Methodology Training & Reference Manual*.[1]

This section details the features of selected initiatives in the CIS and Europe regions.

1 ACS Recycling Electrònics de Catalunya, S.L. Catalonia, Spain

2 UKO, Moscow, Russia

3 RECILEC, Andalusia, Spain

2.1 ACS Recycling Electrònics de Catalunya, s.l., Spain

ACS Recycling was established as a privately funded company in 2013[1] and is located in the Barcelona industrial belt. It is dedicated to comprehensive and specialized WEEE management and duly authorized by the Agència de Residus de Catalunya (Catalonia Waste Agency). It performs tasks ranging from collection and processing to recycling and recovery.

From its facilities in Sant Quirze del Vallés in the province of Barcelona, ACS Recycling centralizes the collection, sorting and decontamination of waste and separates different parts and materials for subsequent re-marketing as components or recycled raw materials. In addition, it has established the first authorized preparation-for-reuse centre in Catalonia.

ACS Recycling works with small, medium-sized and large companies and operates within the main extended producer responsibility (EPR) system. It offers specialized services allowing clients to optimize processes, reduce costs and maximize the value of their waste, while facilitating strict compliance with pertinent legislation and involvement in environmental protection. In addition, ACS Recycling actively participates in environmental awareness campaigns through training offered to companies, associations and educational centres.[2]

2.1.1 Population and e-waste levels in the region

Spain has a population of 46 million. In the north-east, the autonomous community of Catalonia has 7.5 million inhabitants and Barcelona, its capital, 1.6 million inhabitants.[3]

Approximately 33 000 t of WEEE was generated across all municipalities of Catalonia in 2016, according to the annual statistics of the Catalonia Waste Agency.[4]

According to the United Nations Solving the E-waste Problem (StEP) Initiative, the amount of e-waste generated in Spain in 2014 was 817 kt in total and 17.8 kg per inhabitant.[5] The amount of e-waste generated in Spain in 2016 was 930 kt in total and 20.1 kg per inhabitant.[6]

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Table 2: Overview of e-waste in Spain

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	46.40	IMF WEO
Purchasing power	USD per inhabitant	2012	30 412	IMF WEO
EEE put on market	kg per inhabitant	2012	16.1	UNU-IAS SCYCLE (2015)
	*kilotonnes	2012	744	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	20.1	*The Global E-waste Monitor 2017*
	*kilotonnes	2016	930	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*

*Kilotonne = 1000 tonnes

2.1.2 Human resources involved

The initiative can be classified as a medium-sized enterprise, employing a workforce of 28 people in 2016.[7]

2.1.3 Applicable regulatory framework

As ACS Recycling is located on Spanish territory, it is subject to national and European Union regulations, as well as regulations of the autonomous community of Catalonia.

At the international level, the following Conventions have been considered (for further information see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, and Their Disposal, signed on 22 March 1989 and ratified on 7 February 1994; entered into force on 8 May 1994.[8]
- Vienna Convention for the Protection of the Ozone Layer, acceded to on 25 July 1988, and Montreal Protocol on Substances that Deplete the Ozone Layer, signed on 21 July 1988 and ratified on 16 December 1988.[9]
- Stockholm Convention on Persistent Organic Pollutants, signed on 23 May 2001 and ratified on 28 May 2004; entered into force on 26 August 2004.[10]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed on 11 September 1998 and ratified on 2 March 2004; entered into force on 31 May 2004.[11]

At the European level, the European Union Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) applies. Nationally, Royal Decree 110/2015 on waste electrical and electronic equipment, Royal Decree 180/2015 regulating waste transportation within State territory and Law 22/2011 on waste and contaminated soil all apply. Finally, at the Catalonia level, Legislative Decree 1/2009, which implements Law 9/2008 regulating waste, applies.[12]

Article 30 of Royal Decree 110/2015 stipulates that priority is to be given to preparing WEEE and its components, subassemblies and consumables for reuse, indicating that this should take place as soon as possible after the initial collection by authorized managers under the conditions specified in Annex IX to the Decree. To do so, users may be able to deliver WEEE directly to preparation-for-reuse centres or the WEEE may be checked and sorted in WEEE collection facilities. Once preparation for reuse is completed, the waste will be reused as EEE or recovered components.[13]

2.1.4 Standards and certification

ACS Recycling is authorized as a waste manager by the Catalonia Waste Agency (authorized manager code No. E-1508.14) and has an authorized preparation-for-reuse centre in Catalonia.[14]

The company has been awarded quality assurance certificates ISO 9001 and 14001 and has joined the European Union Eco-Management and Audit Scheme (EMAS).[15]

Its processing facility was authorized by the Catalonia Waste Agency in 2014. The licence was extended in 2016 and the company obtained authorization to manage up to 12 000 Mt of all WEEE categories. All ACS Recycling processes are adapted to comply with Royal Decree 110/2015. ACS Recycling has the first authorized preparation-for-reuse centre in Catalonia, called ACS Reuse.

2.1.5 WEEE managers/operators and refineries

There are the following WEEE managers/operators in Spain:

- ACS Recycling is authorized as a waste manager by the Catalonia Waste Agency (authorized manager code No. E-1508.14).

Refineries for metals used in electronics can perfectly refine material from both mineral concentrates and properly sorted electronic scrap. Companies such as Xstrata, Umicore, Boliden, Dowa or Aurubis have spent decades researching and developing highly efficient technologies for obtaining and refining metals or strategic compounds. With the adoption of the new regulations requiring European Union and other OECD countries to manage WEEE, these companies immediately adapted their processes to refine electronic boards and used batteries.[16]

2.1.6 Main activities of the initiatives

ACS Recycling offers clients comprehensive management of all types of WEEE. In addition, it manages large appliances, including those with hazardous components, such as air conditioners, devices containing chlorofluorocarbons, hydrochlorofluorocarbons, hydrocarbons and ammonia or large printers, as well as small appliances, including those with hazardous components, such as computers, telecommunication equipment, condensers, LED monitors and screens, cathode ray tubes, cables and batteries.[17]

The comprehensive WEEE management offered by ACS Recycling comprises the following services:[18]

- Consultation and training: ACS Recycling advises clients on resource optimization, in compliance with pertinent legal provisions. It also offers environmental training to companies, associations and educational centres.
- Container deposit: ACS Recycling has containers of various capacities and models for deposit at client facilities.
- Collection and transport: ACS Recycling has a fleet of vehicles authorized for the transport of waste by the Catalonia Waste Agency (authorization code No. T-4618), allowing it to offer fast and efficient collection.

- Classification and storage: Once at the plant, WEEE is classified and stored until its environmentally friendly treatment.
- Decontamination and fragmentation: All pollutants are removed and transferred to specialized processing plants and the various recoverable fragments are separated for re-marketing as components or raw materials.
- Data protection: ACS Recycling ensures the protection of trademarks, corporate images and data through the certified destruction of equipment and data carriers.
- Certification: ACS Recycling issues a certificate attesting the proper environmental management of waste, in compliance with regulations in force.
- Assessment: The products resulting from the process are assessed to establish the market value of resulting fragments and the cost of the recycling process.

ACS Recycling has facilities with a combined surface area of 7 000 m^2 (i.e. covered plant — 4 000 m^2; enclosed courtyard — 2 500 m^2; office space — 500 m^2), strategically located at the motorway junction in Sant Quirze del Vallés in the Barcelona industrial belt. The plant is divided into the following sections:[19]

Figure 5: ACS recycling facilities

Source: ACS ©

- Selection and classification: Once the arrival of material at the plant is documented, WEEE is separated according to subsequent treatment.
- Mechanical treatment: This concerns WEEE with little precious material content. WEEE is compacted with a hammer mill that can be adjusted to the size of input material. The process optimizes residual waste through the use of magnetic separators, magnetic drums, eddy current separation and a final manual test.
- Monitors and screens: Monitors and screens are treated differently according to type, i.e. CRT, LCD or LED, involving the possibility of deep decontamination and the separation of fragments with high recovery value.
- Manual dismantling: Manual dismantling is performed when waste can be dismantled simply and contains high value material.

Figure 6: Recycling plant manual dismantling

Source: ACS ©

2.1.7 ACS Reuse: Authorized preparation-for-reuse centre in Catalonia

ACS Reuse is a division of ACS Recycling dedicated to giving EEE a second life. Once repaired and inspected by technicians, WEEE is remarketed through eBay,[20] sparing the economic and environmental burden of its destruction and the treatment of waste generated and meeting demand on the secondary market.[21]

Figure 7: Authorized preparation for reuse centre

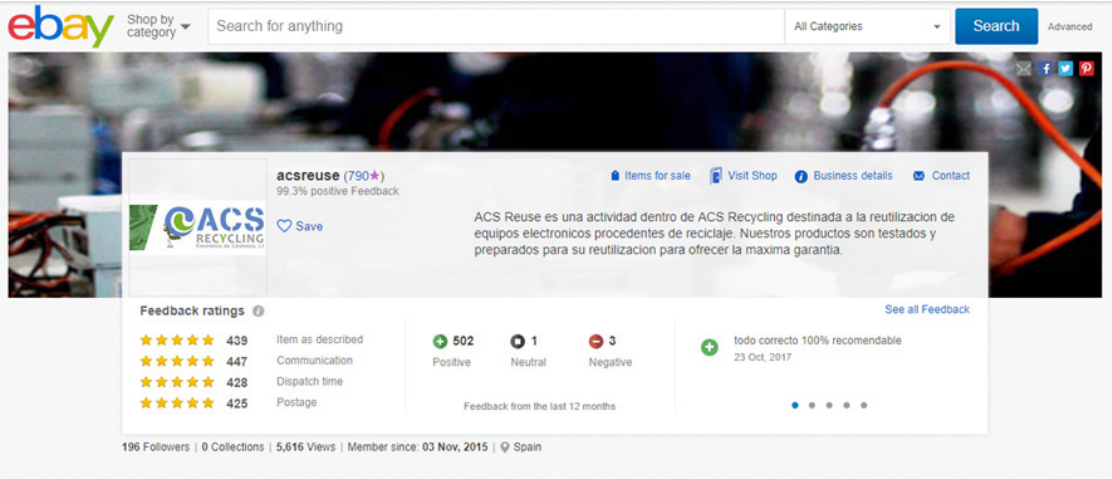
Source: ACS ©

With this activity, ACS Recycling has become the first centre dedicated to the preparation of WEEE for reuse to be authorized by the Catalonia Waste Agency, helping producers, distributors and users of EEE to comply with the relevant legal and environmental obligations, as, with the promulgation

of Royal Decree 110/2015 on WEEE, reuse has become a priority in the waste treatment chain. All stakeholders must consequently prioritize reuse, as required by Article 30 of Royal Decree 110/2015, which stipulates that, in applying the principle of waste hierarchy, priority must be given to preparing WEEE and its components, subassemblies and consumables for reuse.

Through its distribution channels and either direct sales or donations to social entities, ACS Recycling facilitates access to new technologies for lower-income social sectors, thereby promoting the use of technology by a greater number of people.

Figure 8: Remarketing WEEE through eBay



Source: ACS © – www.ebay.ie/usr/acsreuse

2.1.8 Other activities

Corporate social responsibility activities are done through the donation of equipment, education, awareness raising and dissemination activities in various media forms as well as through and research, teaching, innovation, and outreach,[2].

2.1.9 Conclusions

ACS Recycling is a young company, founded in 2013, trying to provide the full range of services required by WEEE producers, in compliance with current regulations, based on the principle of extended producer responsibility. Services include consultation on environmental issues, logistics and management of all categories of WEEE.

According to its website, ACS Recycling has designed its processes to optimize treatment of WEEE, eliminate contaminants, minimize non-recoverable waste and maximize returns on WEEE, either in the form of fragments that are sent to workshops, managers and treatment plants for conversion into second generation raw materials or through the reuse of equipment and components. ACS Recycling has an established quality assurance system for its processes. Similarly, it has security protocols in place for the protection of client corporate images and the privacy of data contained on the equipment processed. In 2016, it obtained approval for its processes in the form of ISO and EMAS standards.

2 Outreach is an activity emphasizing a relationship between an organization and the community and establishing mutually beneficial dialogue between the organization and society. In many Latin America universities, outreach is considered one of a three core functions of the university, alongside teaching and research. Outreach views education as a public good and a universal human right. Outreach is a transformative educational process in which everyone learns and teaches, seeking horizontal exchange. It is a process which seeks to solve societal problems.

2.2 UKO recycling and waste management, Russian Federation

UKO, located in the vicinity of Moscow, is one of main recyclers in Russia. It was founded in 2008 with the principal objective of processing e-waste.[22] It is currently qualified to handle all categories of waste and operates in accordance with the technological, sanitary and environmental standards in force in the Russian Federation.[23]

UKO declares its mission to be caring for nature, disposing of waste with quality and professionalism, providing the most convenient service and creating a clean and healthy environment for humanity. Its policy is to minimize the amount of waste destined for landfill sites, stating that, thanks to its equipment, only 10 per cent of material processed requires final disposal, while the other 90 per cent enters the recycling circuit.

2.2.1 Source of financing and investors

UKO is privately financed. It does, however, receive financial support from the United Nations Industrial Development Organization (UNIDO) and the Global Environment Facility for its refrigerator and air conditioner treatment plant.[24]

2.2.2 Population and e-waste levels in the region

The Russian Federation has a population of 143 million. The Central Federal District has 38.9 million inhabitants and Moscow, its capital, 12 million inhabitants.[25]

According to the StEP Initiative, the amount of e-waste generated in Russia in 2014 was 1 231 kt in total, or 8.7 kg per inhabitant.[26] The amount of e-waste generated in Russia in 2016 was 1 392 kt in total, or 9.7 kg per inhabitant.

Table 3: Overview of e-waste in the Russian Federation

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	143.87	IMF WEO
Purchasing power	USD per inhabitant	2012	17 698	IMF WEO
EEE put on market	kg per inhabitant	2012	11.3	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	1 599	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	9.7	*The Global E-waste Monitor 2017*
	kilotonnes	2016	1 392	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*.

2.2.3 Human resources involved

UKO has a professional team of engineers experienced in recycling and processing and an interest in following global trends and market needs.

While there is currently no information on the overall number of staff employed by the company, the refrigerator and air conditioner recycling plant employs a team of six people, which will soon increase to twelve, working in two shifts.

2.2.4 Applicable regulatory framework

The initiative is subject, *inter alia*, to the following laws of the Russian Federation:[27], [28]

- Federal Law on consumption and production waste[29]: This Federal Law defines the legal basis for the processing of production and consumption of waste in order to prevent the harmful effects of such waste on human health and the environment, as well as the re-insertion of this type of waste into the economic cycle as an additional source of raw materials.
- Federal Law on the protection of the environment[30]: This Federal Law defines the legal basis for State policy in the field of environmental protection to ensure balanced solutions to socio-economic challenges, preservation of the environment, biodiversity and natural resources in order to meet the needs of present and future generations, while strengthening the rule of law in environmental protection and safety.

  Furthermore, it regulates relations between society and nature in the context of the undertaking of economic and other activities having an impact on nature, as the fundamental element of the environment and the basis of life on Earth, within the territory of the Russian Federation, on the continental shelf and in the Exclusive Economic Zone of the Russian Federation.
- Federal Law on the industrial safety of hazardous production facilities[31]: This Federal Law establishes the legal, economic and social bases for ensuring the safe operation of hazardous production facilities and aims to prevent accidents at such facilities, while ensuring the readiness of legal entities and individual entrepreneurs operating them to localize and eliminate the consequences of any such accidents.
- Federal Law on precious metals and precious stones[32]: This Federal Law establishes the legal framework for the regulation of relations arising from the geological surveying and exploration of precious metal and stone deposits and their extraction, production, use and trade (civil transactions). In its list of basic concepts, it provides the following definition of precious metals:

  "Gold, silver, platinum, and platinum group metals (palladium, iridium, rhodium, ruthenium and osmium). Precious metals can be in any state or form, including native or refined, or in ore, alloys, semi-finished products, industrial products, chemical compounds, jewellery and other products, coins, scrap and production and consumption waste."
- Decree No. 284 of the Government of the Russian Federation of 9 April 2016: This Government Decree concerns the establishment of rates of environmental levies per group of products for recycling after the loss of their consumer properties, payable by manufacturers and importers of goods that do not provide themselves for the recycling of waste generated by the use of the goods.[33], [34]

Criminal sanctions are established for illegally trading in precious metals, regulated by the Criminal Code of the Russian Federation:

- Criminal Code, No. 63-FZ of 13 June 1996, chapter 22 (Crimes in the sphere of economic activity), article 191 on the illegal trade in precious metals, precious stones and pearls
- Criminal Code, No. 63-FZ of 13 June 1996, chapter 22 (Crimes in the sphere of economic activity), article 192 on the violation of the rules on the surrendering of precious metals and stones to

the State (non-compliance with the obligatory surrender to the State of precious metals and stones for assessment or compulsory sale after extraction from recycled resources)

- Code of Administrative Offences, No. 195-FZ of 30 December 2001, article 19.14 on the violation of rules on the extraction, production, use, handling, receipt, accounting and storage of precious metals, pearls, precious stones and products containing them.

2.2.5 WEEE managers/operators and refineries

There are two refineries[35] that process printed circuit boards and integrated circuits in Russia, Uralelectromed, and the Kyshtym Copper Electrolyte Plant.

2.2.6 Main activities of the initiatives

The company operates in accordance with legislation and technological, sanitary and environmental standards in force in the Russian Federation and is authorized to perform a wide range of activities for many types of waste:

- recycling of office equipment (electronic and office equipment, , household appliances);
- recycling of lamps (mercury, fluorescent, incandescent, electronic);
- removal and disposal of paint and paint residue;
- recycling of organic and inorganic acids, alkalis, solvents and emulsions;
- management of synthetic and mineral oils and grease;
- waste disposal of oxides, hydroxides and salts;
- removal of batteries;
- recycling of plastics and rubbers (including old tyres);
- disposal of laboratory waste, chemical waste and production waste;
- elimination of pesticides and sludge;
- removal and disposal of liquid waste;
- wastewater disposal;
- collection of garbage (garbage containers, bins, etc.);
- removal and disposal of food waste;
- removal of debris;
- disposal of municipal solid waste;
- disposal of bulky waste;
- removal of foliage and snow;
- waste management;
- disposal and transport of hazardous waste (all types);
- removal and disposal of biological waste;
- removal and disposal of medical waste.

The company has its own specialized fleet of vehicles for the transport of solid waste and facilities for the treatment of metallic and secondary plastic waste.

With regard to WEEE, UKO is the first recycling company to join the Association of Trading Companies and Manufacturers of Household Electrical Equipment and Computers (RATEK). In addition, it is a

founding member of the Waste Electrical and Electronic Equipment (WEEE) Recyclers Association, which includes all the sector main players.[36]

UKO facilities are quite large and include several sheds. Material arriving at the UKO scrapping plant is sorted and assigned to different sectors according to size (from small appliances to refrigerators) and type of processing required.

UKO equipment includes:

- several conveyor belts used for equipment with ferrous metal housings, e.g. gas stoves, refrigerators, washing machines and other large household appliances;
- facilities for the removal of freon from air conditioners and refrigerators;
- various presses for compacting waste paper and polyethylene foam and sheeting;
- plastic waste compactors;
- various auxiliary devices for the treatment of a wide range of solid waste, especially computer equipment;
- devices for recycling printer cartridges, etc.;

Figure 9: UKO e-waste management

Source: UKO ©

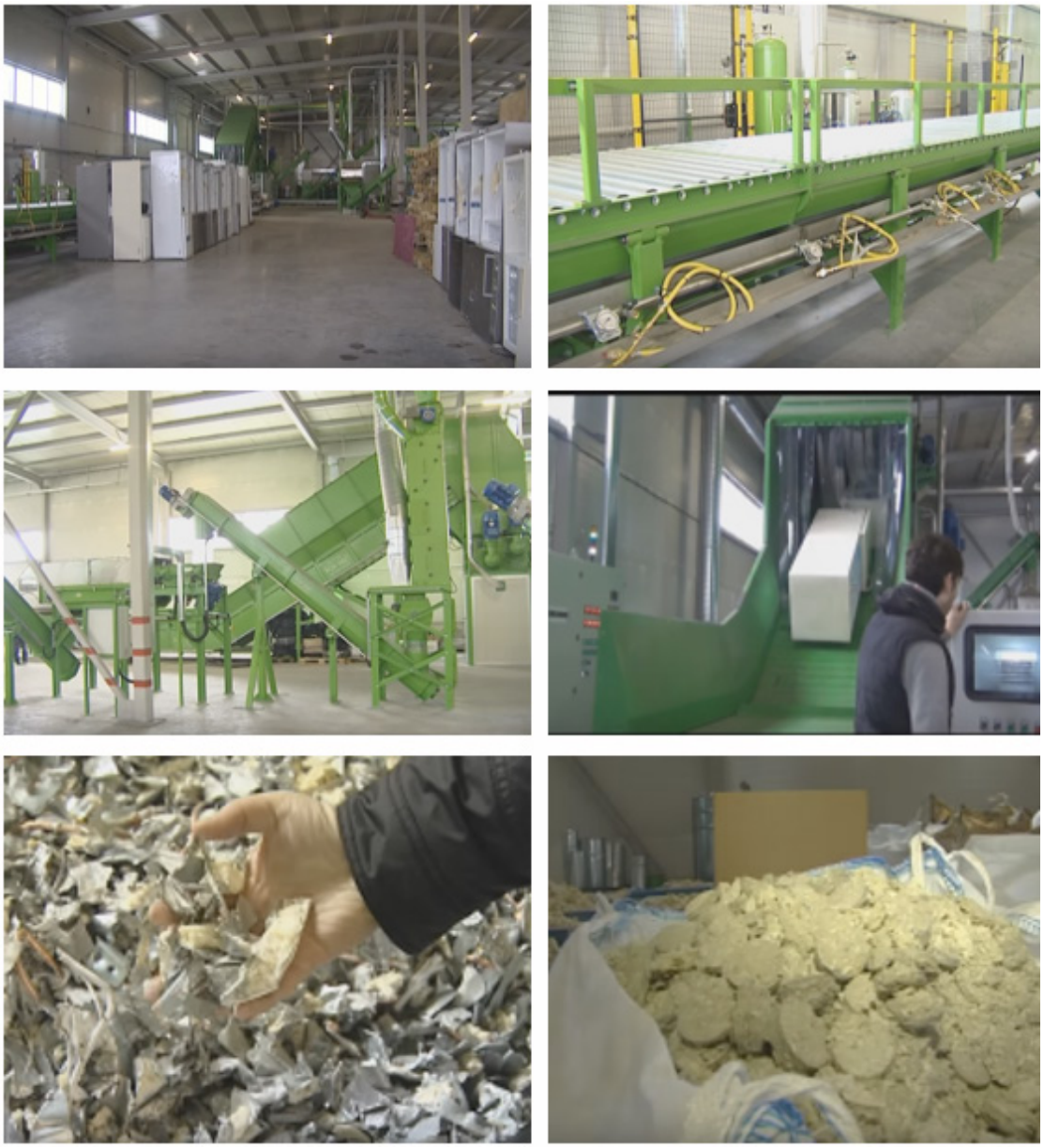
E-waste is manually sorted, processed and shipped to refineries, as required by federal law. Two refineries in Russia process printed circuit boards and integrated circuits: Uralelectromed and the Kyshtym Copper Electrolyte Plant. Ferrous metals are pressed and compacted and sent to nearby companies (Cherepovets and Novolipetsk Steel).

Figure 10: E-waste being manually sorted, processed and shipped

Source: UKO ©

UKO has recently opened a refrigerator and air conditioner treatment plant, where 100 per cent of the chlorofluorocarbons are recovered — unique in Russia. This project is financially supported by UNIDO, the Global Environment Facility, and UKO funds.

Figure 11: UKO refrigerator and air conditioner treatment plant



Source: UKO ©

In addition to the recycling of metals, plastics and polyurethane foam are also processed with a view to producing innovative construction materials. A patent is currently pending. UKO expects to have a specific plant for this process.

Since 2010, UKO has partnered with the Eldorado retail chain, the largest retailer of household appliances in Russia, in a number of campaigns to promote recycling, whereby customers would receive discounts for delivering old household appliances for recycling.

According to UKO, the eight campaigns held between 2010 and 2014 resulted in the collection of more than 2.5 million devices, or a total volume of 430 000 m^3, equivalent to 4 450 articulated lorries.

Figure 12: UKO campaigns

Source: UKO ©

UKO also works with two other major appliance retailers, DOMO and M.Video. In 2011, for example, UKO won a tender for the purchase of all non-reusable material from DOMO (45 outlets in 35 cities across Russia).

UKO is a Samsung partner for recycling faulty equipment. It has similar partnerships with other well-known manufacturers, including Liebherr, Miele, Polaris, Caramel, Asko, De'Longhi, Kenwood, Ariete, Scarlett, Bork, Beko and Nikon. It also works with several State companies and organizations, such as the Federal Tax Service and the Central Electoral Commission of the Russian Federation.[37]

UKO also receives material through collection campaigns organized by public environmental organizations or movements, such as "*RazDelny Sbor Moskva*" [Moscow collection? Sorted!], which holds regular collections publicized via social media.[38]

UKO, through its Eco-Consulting service, offers environmental advice, audits, assistance on applicable legislation and regulations, economic evaluation of waste management and process monitoring.

2.2.7 Other activities

With regard to corporate social responsibility activities, the following information from the company website applies:

- UKO actively participates in the Federal Government social and environmental activities and campaigns to raise awareness of the need to sort waste at source;
- UKO supports the most vulnerable social sectors by offering free waste collection services to orphanages and social protection institutions;
- UKO employees frequently give seminars on materials and green lifestyles;
- UKO has an important presence in the media and its facilities are frequently visited by various publications, bloggers, TV channels and public companies for green campaign spots.[39]

2.2.8 Conclusions

UKO has been successfully building its WEEE recycling activity since 2008. It relies mainly on agreements with major household appliance retailers for the collection of material, as well as large manufacturers of electronics and household appliances and State enterprises and organizations. It receives products from all over the country. Given the relevance of the sector, UKO has received financial support from UNIDO and the Global Environment Facility for the construction of a refrigerator and air conditioner recycling plant. It also has an important role in the process of transitioning to good waste-management practices as a member of EEE manufacturer and recycler associations. In addition,

it participates in public collection and promotional campaigns and offers consultancy services for environmental waste management issues.

2.3 Recilec S.A, Spain

RECILEC S.A.[40] is one of the first companies authorized to manage WEEE, including batteries and accumulators, in Andalusia, in line with environmental requirements. RECILEC is committed to offering efficient, customized solutions for the comprehensive management of WEEE, batteries and accumulators, while complying with regulations and protecting the environment.

RECILEC was identified by the Andalusian regional government Ministry of the Environment in 2003 to provide a management solution for WEEE generated in Andalusia. After more than a year as a pilot initiative, RECILEC was established as a commercial society in May 2004 with the help of the Ministry, Indumetal Recycling, and the Fomento de Construcciones y Contratas (FCC) construction company.

Initially, a plant was constructed in Aznalcóllar, Seville, on land that had been previously contaminated by toxic sludge from the Boliden Mine, under a development plan established by the regional government Ministry of Innovation.

More than EUR 9 million was invested into the construction of the plant, occupying a plot of land covering 24 200 m^2 and containing facilities with a total surface area of 11 500 m^2.[41] The RECILEC treatment plant in Aznalcóllar is the only plant in Spain able to process all ten categories of WEEE referred to in Royal Decree 110/2015. It also has treatment facilities in Loja[42] and Mérida[43] that manage only some of the WEEE categories.

2.3.1 Source of financing and investors

After a pilot period, RECILEC was established as a commercial society in May 2004, with the help of the Andalusian regional government Ministry of the Environment, through its then environmental management company, Egmasa[44] (now known as the Environment and Water Agency of Andalusia), the FCC construction company and Indumetal Recycling.[45]

The two major stakeholders are FCC and Indumetal Recycling, each with a stake of 37.5 per cent. The Environment and Water Agency of Andalusia holds a stake of 25 per cent.

2.3.2 Population and e-waste levels in the region

Spain has a population of 46 million. In the south-west, the autonomous community of Andalusia has 8 399 043 inhabitants and Seville, its capital, 693 878 inhabitants.[46]

According to data from the collective EPR systems (Ecolec, Ambilamp, ERP, Ecotic, Ecolum, ECO-WEEE and Ecofimática), the community of Andalusia collected 24.2 kt of WEEE in 2015.[47]

According to the StEP Initiative, the amount of e-waste generated in Spain in 2014 was 817 kt in total, or 17.8 kg per inhabitant.[48] The annual volume of e-waste generated in Spain in 2016 was 930 kt in total, or 20.1 kg per inhabitant.

Table 4: Overview of e-waste in Spain

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	46.40	IMF WEO
Purchasing power	USD per inhabitant	2012	30 412	IMF WEO
EEE put on market	kg per inhabitant	2012	16.1	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	744	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	20.1	*The Global E-waste Monitor 2017*
	kilotonnes	2016	930	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*.

2.3.3 Human resources involved

RECILEC can be classed as a medium-sized to large company, directly employing 50 staff. It generates a further 250 jobs indirectly.[49], [50]

In addition, it has one treatment plant in Aznalcóllar and two other treatment facilities, in Loja and Mérida.

2.3.4 Applicable regulatory framework

As RECILEC is located on Spanish territory, it is subject to national and European Union regulations, as well as the regulations of the autonomous community of Andalusia.

At the international level, the following Conventions have been considered (for further information see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, and Their Disposal, signed on 22 March 1989 and ratified on 7 February 1994; entered into force on 8 May 1994. [51]
- Vienna Convention for the Protection of the Ozone Layer, acceded to on 25 July 1988, and Montreal Protocol on Substances that Deplete the Ozone Layer, signed on 21 July 1988 and ratified on 16 December 1988.[52]
- Stockholm Convention on Persistent Organic Pollutants, signed on 23 May 2001 and ratified on 28 May 2004; entered into force on 26 August 2004.[53]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed on 11 September 1998 and ratified on 2 March 2004; entered into force on 31 May 2004.[54]

At the European level, the European Union Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) applies. Nationally, Royal Decree 110/2015 on waste electrical and electronic equipment, Royal Decree 180/2015 regulating waste transportation within State territory and Law 22/2011 on waste and contaminated soil all apply. Finally, at the Andalusia level, Decree 356/2010

on unified environmental authorization,[55] Law 7/2007[56] on the integrated management of environmental quality and Decree 73/2012 on the regulation of waste in Andalusia all apply.

State regulations emanating from Royal Decree 110/2015 on WEEE concern preparation for reuse, while recent European Union directives seek to maximize recycling, minimize waste production and promote the reuse and re-marketing of waste.

In Andalusia, regulations require the extraction of gases from refrigerating equipment, but such an approach is not adopted throughout Spain. The Andalusian government requires such gases to be packaged, liquefied and exported to incineration plants in Belgium or France. With no such facilities in Spain, this greatly increases the cost of the process.[57]

2.3.5 Standards and certifications

RECILEC is a large company and, according to its website, seeks to improve its processes and sustainability by applying the following standards at its Aznalcóllar Plant:

- ISO 9001:2015, certified by Bureau Veritas Certification
- ISO 14001:2015, certified by Bureau Veritas Certification
- OHSAS 18001:2007, certified by Bureau Veritas Certification.

RECILEC has the following authorizations and certifications:

- Waste manager registration for Andalusia — GRU No. 50 for recovery and classification and GRU No. 150-T for professional transport[58], [59]
- Unified environmental authorization for the management of WEEE and batteries and accumulators for its Aznalcóllar plant in Seville (AAU/SE/425/08). Hazardous Waste Manager AN-425
- Unified environmental authorization for the management of WEEE and batteries and accumulators for its Loja plant in Granada (AAU/GR/0058/N/09). Hazardous Waste Manager AN-425
- Authorization for the collection and transport of non-hazardous waste in Extremadura A-91369819/EX/RT-61
- Authorization for the collection and transport of hazardous waste in Extremadura A-91369819/EX/102
- Authorization for X-ray tube dismantling, removal and destruction operations, according to RD 1085/2009, under No. EV-SE-015
- Authorization as an installation and maintenance company for air conditioning equipment
- Entry in the register of industrial establishments adhering to the Ministry of Industry, Tourism and Trade radiological surveillance protocol (IVR-140).

2.3.6 WEEE managers/operators and refineries

RECILEC is authorized to manage the recovery, classification and professional transport of WEEE in Andalusia.

The Istanbul Gold Refinery (IGR) established IGR Spain in 2012 as the Spanish arm of the largest refinery in Turkey. It is one of 63 refineries accredited by the London Bullion Market Association (LBMA) and a benchmark in the precious metals sector. IGR Spain is the delivery point for Spanish customers of RECILEC. Once delivered and inspected in Spain, the metal is sent to Istanbul for processing and analysis, in line with international standards.[60]

Refineries for metals used in electronics can perfectly refine material from both mineral concentrates and properly sorted electronic scrap. Companies in Europe such as Xstrata, Umicore, Boliden, Dowa or Aurubis have spent decades researching and developing highly efficient technologies for obtaining and refining metals or strategic compounds. With the adoption of the new regulations requiring European Union and other OECD countries to manage WEEE, these companies immediately adapted their processes to refine electronic boards and used batteries.[61]

2.3.7 Distinctions received by the initiative

RECILEC was awarded the WEEE-Labex certification in 2014 by the WEEE-Forum, a European non-profit association of 39 WEEE management companies representing EEE manufacturers in Europe. It is the second company in Europe to receive this certification, for its rigorous decontamination and recycling of equipment containing refrigerant gases.[62]

2.3.8 Main activities of the initiatives

RECILEC has the only WEEE treatment plant in Spain equipped to process all categories of WEEE under one roof. Beyond treatment, it offers comprehensive management services, including collection and transport of waste to its own facilities. Some processes are performed manually and others automatically.

Its integrated management of WEEE comprises the following services:[63]

- collection;
- transport;
- storage;
- treatment;
- decontamination;
- valorization;
- dismantling.

The dismantling of electro-medical and industrial air conditioning equipment is carried out at client premises.

Figure 13: Daily operations at the Aznalcóllar plant

Source: Recilec/Aznalcóllar Plant ©

2.3.9 Other activities

With regard to corporate social responsibility activities through the donation of equipment, education, awareness and dissemination activities in various media forms, the following information can be found on the company website.

The RECILEC business model is built on research and development and innovation, continuous training of its human resources and the application of the best available waste management technologies.[64]

It is also involved in promotional campaigns, such as one entitled "*La naturaleza no necesita que le echemos ningún cable*" [Nature needs no cables] — a product of collaboration agreements between the Andalusian Federation of Electrical Appliances (FAEL) and the collective extended responsibility systems of ECOLEC, ECOTIC, the European Recycling Platform (ERP), RECYCLIA and RECILEC.[65]

RECILEC conducts training and dissemination activities, such as its course on municipal waste management competences, organized by the Granada administrative body. Its plant was visited by an Italian parliamentary commission looking into WEEE processing and illegal trade and by INTERPOL as part of seminars on the illegal WEEE trade held at the Aznalcóllar plant. The plant had been chosen by INTERPOL as being the largest in Spain and having incorporated most of the treatment lines available on the market. It was also visited by a government delegation from El Salvador, which had chosen it as a model for its own approach to e-waste management.[66]

In 2016, RECILEC reached an agreement with Madre Coraje, a non-governmental organization, on preparing WEEE for reuse, with the objective of reducing the amount of waste generated and promoting a circular economy, in compliance with Royal Decree 110/2015 on WEEE, which requires reuse to be prioritized, and recent European Union directives seeking to maximize recycling, minimize waste production and promote the reuse and re-marketing of waste.

RECILEC collects and transports waste from collection points to the final destination. Once the waste is at its facilities, RECILEC sorts it and determines whether it may be sent for treatment to the Madre Coraje preparation-for-reuse centre in Jerez de la Frontera, Cádiz. Madre Coraje carries out the corresponding electrical safety and performance tests, removes personal data from any computer equipment, undertakes repairs, and cleans, labels and prepares recovered appliances for sale. [67]

2.3.10 Conclusions

RECILEC is a pioneer in waste management, authorized in Andalusia for the processing of WEEE, batteries and accumulators in accordance with environmental standards. It is a large company with bases in Seville, Valencia and Granada and is a source of employment for the region. It has two major stakeholders: FCC and Indumetal Recycling, each with a stake of 37.5 per cent. The Environment and Water Agency of Andalusia holds the remaining stake of 25 per cent.

RECILEC seeks to improve its processes and sustainability by meeting the requirements of standards and certifications. It is registered as an authorized manager for the recovery, classification and professional transport of waste and has obtained the WEEE-Labex certification.

The Aznalcóllar facility is the only WEEE treatment plant in Spain equipped to process all categories of WEEE under one roof. Beyond treatment, it offers comprehensive management services, including collection and transport of waste to its own facilities.

RECILEC is not directly responsible for the preparation of equipment for reuse or sale. These tasks are performed by Madre Coraje, a non-governmental organization, at its preparation-for-reuse centre, in accordance with State regulations on preparation for reuse.

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Chapter 3: E-waste management initiatives in the Asia-Pacific region

3.1 Attero, Electronics Asset Management Company, India

In India, the economy has seen continued growth since the turn of the century, in large part attributable to the ICT sector. This ICT growth has, however, also led to increased e-waste in the region. According to the Consumer Electronics and Appliances Manufacturers Association (CEAMA)[1] in its report *E-waste in India: Implications, issues and recommendations for handling home appliances and consumer electronics,*[2] more than 90.5 per cent of e-waste in India is managed by the unorganized and informal sectors, with dealers in waste dismantling discarded products, rather than recycling them properly. Only around 1.5 per cent of e-waste is recycled by formal recyclers.[3] Fortunately, some companies, such as Attero, have tried to create a formal e-waste collection and sorting system and are actively working to establish an effective take-back programme for the efficient management of end-of-life electronics.

Attero is one of the largest electronic asset management companies in India and actively promotes green reuse and recycling. It has an e-waste management plant, ensuring the responsible and environmentally friendly extraction of materials and precious metals. In addition, it has a reverse logistics network and a project integrating the informal recycling sector, and is seeking to establish an effective electronic recovery programme through awareness-raising events and collection campaigns.[4]

Attero has developed an efficient and extensive reverse logistics network, with 20 collection centres throughout India to facilitate the efficient collection of e-waste.[5] The company has been in operation since 2007.[6]

3.1.1 Source of financing and investment

Attero is a private company but, in order to carry out its activities, it has the support of the following investment entities:[7]

kalaari capital	Kalaari Capital: venture capital company focused on technology.
DFJ	Draper Fisher Jurvetson: venture capital firm.
GH GRANITE HILL CAPITAL PARTNERS	Granite Hill India Opportunity Fund: venture capital fund.
IFC International Finance Corporation WORLD BANK GROUP	International Finance Corporation: part of the World Bank. It promotes sustainable economic growth in developing countries by financing private sector investments, mobilizing capital in international financial markets and providing advisory services to companies and governments.
ForumSynergies	Forum Synergies: provides investors with a better private capital model that manages risk and generates superior returns on opportunities offered by the rapid growth of the market in India.

3.1.2 Population and e-waste levels in the region

The Asia-Pacific region has an approximate population of 4.5 billion and India around 1.35 billion.[8] [9]

According to the StEP Initiative, the amount of e-waste generated in India in 2014 was 1 641 kt in total, or 1.3 kg per inhabitant.[10] The amount of e-waste generated in India in 2016 was 1 975 kt in total, or 1.5 kg per inhabitant.[11]

Table 5: Overview of e-waste in India

Subject	Unit	Year	Amount	Source
Population	inhabitants in million	2018	1 299.8	IMF WEO
Purchasing power	USD per inhabitant	2012	3 851	IMF WEO
EEE put on market	kg per inhabitant	2012	2.5	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	3 026	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	1.5	*The Global E-waste Monitor 2017*
	kilotonnes	2016	1 975	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*.

According to the Associated Chambers of Commerce of India (ASSOCHAM), India generated 1.5 million tonnes of e-waste in 2015. Mumbai (96 000 t/year) is the leading e-waste generator, followed by Delhi-NCR (55 000 t/year), expected to grow at a rate of 25 per cent to reach 95 000 t by 2017, and Bangalore (52 000 t/year). Chennai, Kolkata, Ahmedabad, Hyderabad and Pune fill out the list with 47 000, 35 000, 26 000, 25 000 and 19 000 t/year respectively.[12] [13]

3.1.3 Human resources involved

The initiative can be classified as a very large enterprise as it has a significant number of employees (201–500)[14] and is one of the largest recycling and refurbishing plants in India, with 20 collection points throughout India in order to provide its services.

3.1.4 Applicable regulatory framework

It is important to take into account the legal and statutory framework and its impact on the initiative surveyed.

At the international level, the following Conventions have been considered (for further information see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, and Their Disposal, signed on 15 March 1990 and ratified on 24 June 1992; entered into force on 22 September 1992[15]
- Vienna Convention for the Protection of the Ozone Layer, acceded to on 18 March 1991, and Montreal Protocol on Substances that Deplete the Ozone Layer, acceded to on 19 June 1992[16]
- Stockholm Convention on Persistent Organic Pollutants, signed on 14 May 2002 and ratified on 13 January 2006; entered into force on 13 April 2006[17]

- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, acceded to on 24 May 2005; entered into force on 22 August 2005.[18][19]

The StEP Initiative lists the following regulations that apply at the national level:

- E-Waste (Management) Rules, March 2016.[20] These rules apply to any e-waste producer or consumer and to collection, dismantling and recycling centres involved in the manufacture, sale, acquisition and/or processing of EEE or components. The categories of waste included are the following:
  - IT and telecommunication equipment
  - Appliances and consumer electronics such as televisions, washing machines, refrigerators, air conditioners and fluorescent and other mercury-containing lamps.
  - The main policy approach is based on EPR. The 2016 E-Waste (Management) Rules required the Central Pollution Control Board (CPCB) to prepare for application of the e-waste regulations, including producing guidelines on responsibility, channelization, environmentally sound collection, storage, transport, dismantling and recycling centres, renewal and random sampling of EEE for parameter testing in accordance with guidelines under the Restriction of Hazardous Substances (RoHS) Directive. India's RoHS Directive places restrictions on the same six substances with the same maximum concentrations as the analogous European Union Directive, but the scope of the products is different.[21]
- E-Waste (Management and Handling) Rules, 2011 (S.O 1035(E)).[22] These rules apply to any producer or consumer participating in the manufacture, sale, purchase and processing of EEE or components thereof and to e-waste collection, dismantling and recycling centres. They do not apply to batteries or radioactive waste.

Producers of electrical and electronic devices are responsible for:

- the collection of e-waste generated during the manufacture of EEE and its subsequent recycling or disposal;
- the collection of end-of-life EEE, based on the principle of EPR and ensuring that such e-waste is taken to registered recycling centres;
- the creation, as an individual or collective initiative, of collection or recovery centres with producer responsibility organization systems;
- the financing and organization of a cost-covering system for the environmentally friendly management of e-waste generated in the production of their own products and historical waste existing at the date of entry into force of these standards. The producer can choose to establish this system independently or as part of a collective system.
- Guidelines for Environmentally Sound Management of e-Waste, 2008.[23] These guidelines are reference documents for the management, handling and disposal of e-waste. While the document provides general guidelines and schemes, specific methods for the treatment and disposal of waste should be developed to reflect the risks associated with the waste type in question. These guidelines set the basic level to be achieved in e-waste management. The Ministry of Environment and Forests (MoEF) or the CPCB may prescribe stricter standards as necessary.
- E-Waste Policy of Tamil Nadu 2010[24] The Government of Tamil Nadu seeks to effectively address the growing problem of e-waste with the contribution and cooperation of all stakeholders. To this end, it has introduced the following action plan for compliance with RoHS regulations for products manufactured in Tamil Nadu and sold in India:
  - objectives are to be set to reduce the use of hazardous substances in EEE;

- detailed information on hazardous EEE components is to be provided with product information;
- in the case of a reduction in hazardous substances used in EEE, product information is to be updated accordingly;
- only products compliant with the European Union RoHS Directive are to be imported or allowed entry onto the EEE market.

3.1.5 Standards and certification

According to its website, Attero seeks to improve its processes and sustainability by meeting the requirements of the following standards and certifications:[25]

- UEPPCB e-waste recycling authorization: Attero has been authorized by the Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) to recycle e-waste under the E-Waste (Management and Handling) Rules, 2011.
- MoEF authorization for on-site recycling of e-waste: Attero has received site approval for the operation of its e-waste management plant from MoEF under the Energy Information Administration (EIA) Notification of 2006.
- ISO 14001:2004: ISO 14000 is a standard primarily related to environmental management and addresses what an organization does to minimize the negative effect of its operations on the environment and to comply with legal, regulatory and environmental requirements. Certification under ISO 14001:2004 states that Attero works to minimize any detrimental environmental effects arising from its operations, is in compliance with all necessary laws and regulations and is continuously working to improve its environmental performance.
- ISO 9001:2008: The ISO 9000 family of standards is primarily concerned with quality management systems and deals with what an organization does to ensure that the quality of its products and/or services meets the expectations of consumers and other interested parties, while complying with all legal and regulatory requirements related to the products. In essence, Attero ISO 9001 certification states that it is actively working to meet both consumers' quality expectations and regulatory requirements, while seeking continuously to improve consumer satisfaction and performance.
- OHSAS 18001:2007: The Occupational Health and Safety Assessment Services (OHSAS) 18001 specification sets the requirements for occupational health and safety management systems to help measure organizations, control risks associated with occupational health and safety and improve performance. This British standard was developed to be compatible with ISO 14001 and ISO 9001 and to promote the incorporation of the environment, quality and occupational health and safety management in organizations.
- UNFCCC-approved for awarding of carbon credits: Attero is the first electronic asset management company to be approved by the United Nations Framework Convention on Climate Change (UNFCCC), which grants carbon credits for the recycling of e-waste.

As mentioned under the section on *applicable regulatory framework* above, the EPR principle is included in the E-Waste (Management) Rules, March 2016, which establish guidelines for the implementation of EPR, stating that each producer must submit an application for EPR authorization under the 2016 E-Waste (Management) Rules. The sale or marketing of EEE by any producer without EPR authorization will be deemed in violation of these Rules.[26]

3.1.6 Refineries and WEEE Managers/Operators

It is important to know whether the city where the initiative is implemented is home to refineries and WEEE managers/operators. The WEEE Recycle project, establishing e-waste channels to enhance

environmentally friendly recycling, provides information on existing refineries and e-waste collection centres in India.

The project aims to improve e-waste management in India through by involving producers and recyclers (formal and informal), small and medium-sized enterprises (SMEs) and other stakeholders in the value chain. According to its website, the following 20 e-waste collection centres, located in the regions of Delhi, Pune and Bangalore, cover the whole of India:[27]

Regions	Collection centres	Website
Delhi	Earth Sense Recycle Pvt. Ltd.	
	Greenscape Eco Management Pvt. Ltd.	
	SIMS Recycling Solutions Pvt. Ltd.	www.simsmm.com www.apac.simsrecycling.com
	Attero Recycling Pvt. Ltd.	www.attero.in
	Green E-waste Recyclers Pvt. Ltd.	http://greenewasterecycler.tradeindia.com/products.html
	HRA e-waste Pvt. Ltd.	https://www.indiamart.com/hra-ewaste-limited/
Pune	ECO Recycling Limited	
	Earth Sense Recycle Pvt. Ltd.	
	Hi-Tech Recycling India (P) Ltd.	www.hitechrecycling.in
	SIMS Recycling Solutions	www.simsmm.com
Bangalore	Eco-Birdd Recycling Company Pvt Ltd	www.ecobirddrecycling.com
	EWaRDD & Co.	www.ewardd.com
	Ash Recyclers	www.ashrecycler.com/
	New Port Computer Services (India) Private Limited	www.newportcomputers.com
	E-R3 Solutions Pvt. Ltd.	www.er3solutions.org
	Tech Logic	www.e-wasterecyclers.com
	E-Parisara Pvt. Ltd.	www.ewasteindia.com
	Surface Chem Finishers	
	Nishanth Technologies	https://www.justdial.com/Belgaum/Nishanth-Technologies-Hanuman-Nagar-Belgaum/9999PX831-X831-100609102904-D7E9_BZDET
	SIMS Recycling Solutions	

Source: e-Waste collection centres in India

3.1.7 Main activities of the initiatives

The purpose of this section is to provide a deeper understanding of Attero activities. To that end, it is necessary to know the quantity and type of material received; how it arrives at the establishment

and how it is processed; the type and conditions of output for different material and components; what activities the initiative undertakes in the areas of disposal and recycling, donations, education, awareness-raising and dissemination through various media; and any additional information regarding research, teaching, innovation and outreach.

3.1.8 Categories of WEEE/EEE Processed

Of the ten categories covered by European Union Directive 2002/96/EC,[28] Attero processes the following:[29]

- IT and telelcommunication equipment;
- consumer equipment;
- electrical and electronic tools.

3.1.9 Input of Material at the Plant

According to its website, in order to maximize the recovery of electronic material, Attero has collection centres in 20 cities across India. This network offers a significant competitive advantage with the ability to manage reverse logistics for all electronic assets, from end-of-life material to renewable electronics and excess inventory.

Attero also organizes promotional campaigns on e-waste collection to raise public awareness of the hazards of this type of waste,[30] reaching out to residences, educational institutions and corporate organizations. During events, electronic products are collected and transported to Attero recycling plants in different cities across India.

The company works with the informal sector, trying to generate a safe and organized waste collection network, and provides training to facilitate responsible work with and management of hazardous materials.

Attero has created the Clean e-India Initiative to provide a programme for the return of old electronic devices. The return programme is designed to involve stakeholders in the life cycle of electronic devices, from manufacturers to the informal sector, where most e-waste ends up. Attero has worked closely with the informal sector to establish an organized e-waste collection network for old consumer electronics. It also provides training to workers in the informal sector to facilitate the adoption of environmentally friendly techniques for e-waste disposal and recycling. The programme proposes improvements that will benefit all stakeholders, from manufacturers to the informal sector, making them part of the collection chain for disused electronic devices.

3.1.10 Material Processing

Once WEEE has entered the plant, Attero performs the following processing activities:[31] [32]

- classification
- gathering/storage
- weighing
- activity recording/tracking
- reuse
- repair
- refurbishment
- recycling

- recovery
- dismantling
- destruction/grinding
- decontamination
- functional testing/stress testing/performance testing
- safe data deletion.

According to the company, Attero daily operations involve the use of state-of-the-art recycling technology, ensuring that e-waste is processed in a highly efficient and environmentally friendly manner with a reduced carbon footprint. It has a high tech recycling plant for the extraction of valuable resources, such as precious and semi-precious metals.

It owns the largest electronic restoration and repair facilities in India, with advanced technology to extend the lifespan of devices and promote reuse. To that end, Attero has created an e-commerce platform called Gobol.in[33] that serves as a dedicated consumer retail channel for the direct sale of refurbished products.[34]

Attero repairs EEE for reuse by consumers. Its exhaustive process involves inspection, renovation, refurbishment and packaging, during which electronics undergo stringent quality controls to identify functional defects and cosmetic imperfections, which are then corrected by highly qualified technicians. Full functionality is restored using state-of-the-art equipment under "clean-room" conditions.[35] Data sanitization[36] and destruction processes comply with recent international standards to ensure complete data security. The services cover all digital data stored on various media, such as PC hard disks, CD/DVD drives, USB drives, memory cards, SD cards, magnetic tapes, SSDs, SIM cards, internal memory of mobile devices and much more. Refurbished products undergo a rigorous quality verification process to ensure adequate functionality. Once all tests have been passed, the appearance of restored products is improved, stickers are applied to show that the product is a restored article, and the product is finally packaged for sale.

3.1.11 Output of Material from the Plant

Attero sells its products either as low-cost reconditioned equipment or as raw material resulting from its refining process. To promote the reuse of recycled items among consumers, Attero uses its e-commerce platform, Gobol.in, selling products under the Gobol brand.

It also provides an e-commerce platform called *Attero-Bay* (www.atterobay.com/), offering product resale services to consumers for mobile phones, smartphones and tablets. This platform promotes the recycling and reuse of electronic devices by helping consumers to sell their own appliances.

3.1.12 Other activities

The Attero website contains information on activities related to the concept of corporate social responsibility through the donation of equipment, education, awareness-raising and dissemination activities through various media and additional information related to research, teaching, innovation and outreach.

Attero has created the Clean e-India initiative to provide a programme for the return of old electronic devices and promotion of awareness on e-waste. Attero has worked closely with the informal sector to establish an organized e-waste collection network for old consumer electronics. It also provides training to workers in the informal sector to facilitate the adoption of environmentally friendly techniques for e-waste disposal and recycling. The programme promotes improvements that will benefit all stakeholders, from manufacturers to the informal sector, involving them in the collection chain for disused electronic devices and providing training to ensure that work is environmentally responsible

and that the community benefits from the environmentally friendly management of e-waste and the prevention of pollution. Attero was recognized by NASA as an innovator in the development of technologies to address a wide range of problems.

3.1.13 Distinctions received by the initiative

Various initiatives at the global level fulfil sustainable development objectives directly or indirectly, leading to awards, mentions, distinctions or other forms of recognition for their activity. They are held up as models of excellence for other international initiatives. Attero is one such example and has received the following distinctions[37]

Awards

- TiE50 2012, awarded by: TiE50 Energy/Cleantech Award 2012
- The Young Turk of the Year Award. The Golden Peacock, awarded by: the CNBC-TV18 India Business Leader Awards 2013. Golden Peacock Awards Secretariat (GPAS)
- Gold Stevie 2012, awarded by: The Stevie® Awards.

Acknowledgements

- Technology Pioneer by the World Economic Forum in 2012, awarded by: the World Economic Forum Technology Pioneers
- The top Global Cleantech 100 Company, awarded by: Cleantech Group, USA
- NASA LAUNCH: Beyond Waste Innovators 2012, awarded by: NASA and its partners at LAUNCH, recognizing Attero as one of the nine leading innovators in the development of technologies and programmes to address a wide range of problems.

Mentions

- Limca Book of Records, mentioning Attero as the only e-waste recycling company that has metal refining processes, completes full processing of e-waste and is among the few recyclers of electronic residues on a global scale.

3.1.14 Conclusions

From recycling to refining metals, Attero provides an important solution in India in the form of a high tech service with a comprehensive collection system, comprising 20 collection centres throughout India.

Attero carries out its processes using advanced technology and with a great degree of environmental responsibility, according to company information and based on compliance with regulations.

Attero takes into account the whole life cycle of electronic equipment and is responsible for the collection, transfer, recycling, reconditioning and sale of reassembled products. In addition, it conducts promotional campaigns and training for the informal sector, disseminating knowledge to improve working procedures. Attero achieves all this thanks to the great support it receives from investors and its own businesses.

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Chapter 4: E-waste management initiatives in the Africa region

4.1 Hewlett-Packard e-waste management in South Africa

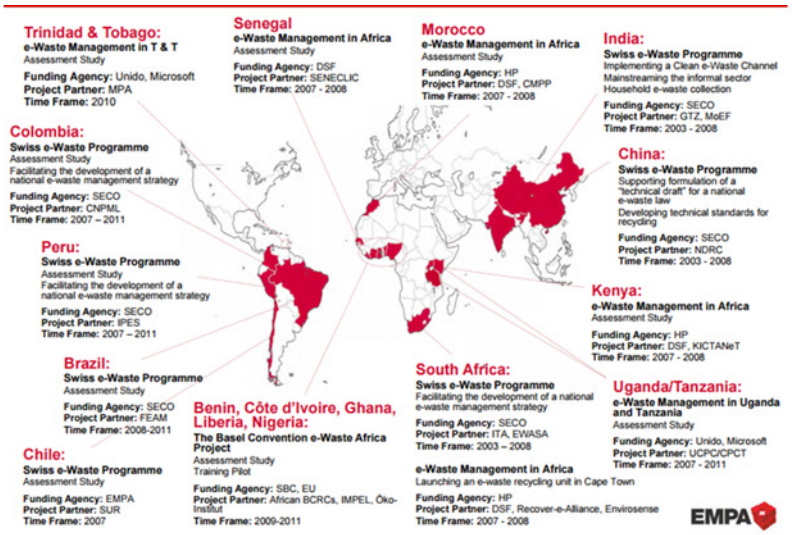
Although China and India were considered the traditional landfills sites for global e-waste, since 2005 studies have been exposing the illegal export of e-waste to African countries.[1]

As a direct response to this trend and in line with extended producer responsibility (EPR), the e-Waste Management in Africa project was launched by Hewlett-Packard[3] in 2007 in partnership with the Global Digital Solidarity Fund (DSF)[4] and the Swiss Federal Laboratories for Materials Science and Technology (Empa),[5] with the support of the e-Waste Association of South Africa (eWASA)[6] and the Southern African E-Waste Alliance (SAEWA).[7.]

This partnership has been funding the development of a pilot project in Cape Town, Western Cape Province, South Africa, since February 2008, implementing a national e-waste strategy and supporting the start-up of a low technology/highly labour-intensive material dismantling and recovery facility (MRF) for the pre-processing of e-waste.[8]

The project, recognized by Empa, actively supports the development of practical, socially just and environmentally acceptable local e-waste management solutions.

Figure 14: Empa and WEEE at the global level



Source: Empa and WEEE at the global level

The objectives of the initiative are to:

- Test the feasibility of an integrated e-waste management system, maximizing the potential for renewal, repair, reuse, dismantling and recycling of equipment, with the environmentally friendly disposal of residual e-waste.
- Promote awareness among and provide training and education to individuals from disadvantaged social sectors as a means of creating entrepreneurial opportunities in technical maintenance, dismantling and waste-to-art.
- Serve as a model for other initiatives in developing countries.

Material recovery facility

The MRF is located in Maitland, Cape Town. Its purpose is to perform waste testing and manual dismantling of non-toxic e-waste components. The MRF is divided into three distinct working areas: testing/refurbishing, dismantling and waste-to-art production sections. For more information, consult the *main activities of the initiatives* section below.

4.1.1 Source of financing and investors

The e-Waste Management in Africa initiative is registered as a non-profit organization. It was created with funding from Hewlett-Packard, one of the largest ICT companies in the world, based in Palo Alto, California. In addition, it has support and financing at the international level from the following partners and collaborators:

DSF Digital Solidarity Fund 數碼共融基金	Digital Solidarity Fund (DSF), dedicated to supporting digital inclusion initiatives organized by NGOs.
Empa Materials Science and Technology	Swiss Federal Laboratories for Material Science and Technology (Empa), Institute of Interdisciplinary Research
eWASA e-Waste Association of South Africa	e-Waste Association of South Africa (EWASA)
Southern African E-Waste Alliance SAEWA	Southern African E-Waste Alliance (SAEWA)

Figure 15: Launch of the MRF in Cape Town, South Africa in March 2008

Source: © Empa/Switzerland,

4.1.2 Population and e-waste levels in the region

Africa has an approximate population of 1.27 billion. South Africa has some 56 million inhabitants and Cape Town around 3.7 million.[9]

The amount of e-waste generated in Africa in 2016 was 2.2 million tonnes in total and 1.9 kg per inhabitant. For its part, South Africa generated 321 kt in total, or 5.7 kg per inhabitant.[10]

Table 6: Overview of e-waste in South Africa

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	55.62	IMF WEO
Purchasing power	USD per inhabitant	2012	11 302	IMF WEO
EEE put on market	kg per inhabitant	2012	9.2	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	473	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	5.7	*The Global E-waste Monitor 2017*
	kilotonnes	2016	321	*The Global E-waste Monitor 2017*

Source: Based on StEP Intitiative information and *The Global E-waste Monitor 2017*.

4.1.3 Human resources involved

The initiative can be classified as medium-sized. It was established with a workforce of 24 people: 16 to carry out operational work, and eight in management positions. The workforce is distributed in the areas shown in Table 7.[11]

Table 7: Staff of e-Waste Management in Africa initiative

Area	Number of persons assigned
IT testing and repair	2
TV and home appliance testing and repair	2
Equipment dismantling	5
Sub-dismantling	1
Waste-to-art development and manufacturing	3
Marketing and project management	2
Coordination of daily operations	1

The personnel performing operational work come from the informal sector and are trained to carry out activities in their assigned area. The following images show aspects of the daily tasks done by workers, young people and women.[12]

Figure 16: Dismantling, testing, repair and refurbishment

Source: © Empa/Switzerland

4.1.4 Applicable regulatory framework

It is important to take into account the legal and statutory framework in the region and its impact on the initiative studied.

At the international level, the following Conventions have been considered in Africa (for further information see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal: on 18 July 2014, 14 regional and coordinating centres were established under the Basel Convention, including in South Africa. The centres deliver training and technology transfer regarding management of hazardous and other waste and the minimization of its generation, so as to assist and support parties in the implementation of the Convention[13]
- Stockholm Convention on Persistent Organic Pollutants: South Africa is one of seven centres nominated for the Stockholm Convention[14]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade: South Africa acceded to the Rotterdam Convention in 2002. [15]

At the national level, South Africa lacks legislation on e-waste. It does, however, have laws on hazardous substances and waste and their management and disposal, based on other laws governing issues such as the environment, water, air, waste, hazardous substances and health and safety.[16]

As a member of eWASA, the initiative can offer clients a safe disposal service for equipment, in compliance with the ISO 14000 standard.

4.1.5 WEEE managers/operators and refineries

Through eWASA, e-waste can be managed in accordance with the EPR principle and current regulations. eWASA was established in 2008 to oversee the establishment of a sustainable e-waste management system for the entire country.

4.1.6 Main activities of the initiatives

The MRF performs e-waste testing and manual dismantling of non-toxic e-waste components. The facility is divided into three working areas: testing/refurbishing, dismantling and waste-to-art. The MRF has a total surface area of approximately 300 m^2.

The e-Waste Management in Africa Initiative processes four of the ten categories specified in European Union Directive 2002/96/EC:[17]

- large household appliances
- small household appliances
- IT and telecommunication equipment
- consumer equipment.

The integrated management of WEEE offered for these categories comprises the following services:

- testing
- repair
- refurbishment
- dismantling
  - for external industrial recycling
  - separation of equipment (mainly computers, printers, monitors and appliances)
  - extraction and temporary, safe storage of CRT
  - removal of labels and metals from plastic wrap
  - removal of plugs and connectors from cables
- waste-to-art, as shown in the images below:

Figure 17: Waste-to-art product development and manufacturing

Source: © Empa/Switzerland

These activities are mostly performed exclusively by the initiative, but others, such as collection and classification, education and awareness raising, are conducted jointly with partners.

Since the beginning of the project, the collection, testing, refurbishment and dismantling of electronic equipment has been limited to manual processing, in order to maximize the value of recovered materials, while excluding any physical crushing or mechanical granulation that might lead to the creation of a hazardous working environment. These activities ensure that large volumes of materials and components are eliminated or recycled, significantly reducing the associated waste destined for landfill when compared with automated processes. Approximately 150 t of material is processed annually.

WEEE enters the working sector variously, as collection is performed with the support of collaborating partners and there are multiple collection points in different locations across the region. Once items have been processed, final products are sold and waste is transferred to managers/operators. One of the partners in this case is eWASA. Staff are trained to repair, refurbish and dismantle WEEE in order to cover their assigned working area. Training is provided free of charge and is considered a requirement for the proper performance of activities.

4.1.7 Conclusions

The initiative emerged as a response to the country's WEEE situation and could be used as a model for other African countries facing similar problems. It was launched by Hewlett-Packard, a private company, as parts of its EPR undertaking and emerged as a corporate social responsibility project. It has received financial support from national and international partners, but its goal is to be self-financing. In South Africa, the initiative provided funds in early 2008 to support the operation of the MRF in Cape Town until the end of 2008, by which point it planned to be self-sufficient.

The initiative is among those recognized worldwide by Empa. The project actively supports the development of practical and socially and environmentally acceptable e-waste management solutions. It addresses the problem of e-waste through the collection, dismantling, refurbishment and sale of items and even the production of pieces of art created from what would otherwise be considered waste.

Staff performing operational work come from the informal sector and are trained to carry out activities in their assigned area. The initiative is not operated by the formal sector, agencies or universities. In addition, the initiative carries out promotional campaigns and training for the informal sector as a means of obtaining trained staff.

Finally, through African IT WEEE pilots and a number of desk studies, Hewlett-Packard has assessed electronic recycling conditions and tested methods to improve recycling processes and equipment in its search for a financially and environmentally sustainable solution.[18]

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Chapter 5: E-waste management initiatives in the Americas region

This section presents selected initiatives in the Americas region:

1. Computadores para Educar (Colombia)
2. Chilenter (Chile)
3. Programa E-Basura (Argentina).

5.1 Computadores para Educar, Colombia

During an official visit to Canada in 1999, the then Colombian president, Andrés Pastrana Arango, had the opportunity to see the Canada Computers for Schools programme and its benefits. Following the visit, he requested the creation of a similar programme in Colombia, entrusting its development to the Ministry of Information Technologies and Communications, the Ministry of National Education and the National Learning Service (SENA).[1] The *Computadores para Educar* (Computers to Educate) programme was created as a non-profit association in 2000 and launched on 15 March 2001 to collect disused computers from public and private companies for refurbishment and subsequent delivery, at no cost, to public schools as educational support. Decree 2324 of 2000 (9 November) and Presidential Directive 02 of 2001 (11 May) complemented the political framework and facilitated the development of *Computadores para Educar*.

In July 2000, the first reconditioning centre was inaugurated in a warehouse in Corferias, Bogotá, with a further four opened in Barranquilla, Cali, Medellín and Cúcuta between May 2001 and January 2002. The reconditioning centres in Bogotá, Cali and Medellín are still in operation at the time of writing. *Computadores para Educar* is currently aligned with the policies and programmes of the Colombia Ministry of National Education, seeking to bridge the digital divide in the public education sector.

Computadores para Educar has three strategic objectives:

- access to ICTs;
- capacity building in the use of ICTs;
- environmental sustainability.

The programme delivers computers to educational and cultural centres and public libraries, while also providing training for teachers to develop ICT skills so that computers and tablets can truly support and enhance the quality of education and contribute to new learning opportunities. Parents are also trained to support the process of ICT uptake in their environments. Additionally, *Computadores para Educar* undertakes the responsible environmental management of ICT devices through the collection and dismantling of obsolete computers, valorization of reusable material, and sound management of e-waste. The programme has served as a model for other countries in the region.

5.1.1 Source of financing and investors

State financing for the programme is drawn from the Information and Communications Technology Fund. In addition, the Ministry of Information Technologies and Communications maintains close coordination with other programmes, such as the *Estrategia de Gobierno en Línea* [Government Online Strategy] and Compartel, ensuring links and synergies between *Computadores para Educar* and other ICT projects.

Computadores para Educar is supported by private companies and other bodies, such as 3com, AC Consultores, Andi, Acis, Arthur Andersen, the Chamber of Commerce of Barranquilla, Colomsat,

Compaq, the National Coffee Growers Federation, the Starmedia Foundation, Hewlett-Packard, IBM, Intel, Microsoft, Saferbo, Sun Microsystems and Unisys.

5.1.2 Population and e-waste levels in the region

The Americas have a population of more than 1 billion. Colombia has approximately 49.4 million inhabitants, the state of Cundinamarca 2 762 800 and the city of Bogotá 8 080 734.[2]

The amount of e-waste generated in the Americas in 2016 was 11.3 million tonnes in total, or 11.6 kg per inhabitant. Colombia generated 275 kt in 2016 or 5.6 kg per inhabitant [3]

Table 8: Overview of e-waste in Colombia

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	48.75	IMF WEO
Purchasing power	USD per inhabitant	2012	10 729	IMF WEO
EEE put on market	kg per inhabitant	2012	9.7	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	453	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	5.6	*The Global E-waste Monitor 2017*
	kilotonnes	2016	275	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*.

The report *eWaste in Latin America: Statistical analysis and policy recommendations* of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) indicates that the amount of e-waste generated in Colombia in 2018 will be 341 kt in total, or 6.8 kg per inhabitant.[4]

According to the programme information, *Computadores para Educar* processed 489.3 tonnes of waste in 2016.

5.1.3 Human Resources Involved

The initiative can be classified as a large company with more than 50 employees[5] in various areas, including its planning advisory office, technological solutions management and contracting management. Staff are public salaried employees.

5.1.4 Applicable regulatory framework

It is important to take into account the legal and statutory framework and its impact on the initiative surveyed.

At the international level, the following Conventions have been considered (for further information see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, signed on 22 March 1989 and ratified on 31 December 1996; entered into force on 31 March 1997[6]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed on 11 September 1998 and ratified on 3 December 2008; entered into force on 3 March 2009[7]
- Stockholm Convention on Persistent Organic Pollutants, signed on 23 May 2001 and ratified on 22 October 2008; entered into force on 20 January 2009.[8]

At the national level, the following regulations apply:[9]

- Law 99 of 1993, establishing a general environmental law
- Law 1672 of 2013, setting national policy on WEEE management
- Decree 1609 of 2002, regulating the handling and transport of dangerous goods by road
- Decree 4741 of 2005, partially regulating the prevention and handling of waste or hazardous waste generated in the framework of integral management
- Lamp Takeback Agreement, November 2008
- Resolution 1512 of 2010, establishing a national system for the selective collection and management of waste computers and/or peripherals
- Decree 1076 of 2015, regulating the environment and sustainable development sector
- Decree 1079 of 2015, regulating the transport sector.
- At the local/municipal level, the initiative has an environmental operating licence.

5.1.5 Standards and Certifications

Computadores para Educar follows Partnership for Action on Computing Equipment (PACE) guidelines[10] to promote the environmentally responsible management, repair/rehabilitation, recycling and disposal of used and end-of-life computing equipment.

In addition, the programme has been undertaking its activities in line with quality requirements since 2009, achieving certification under the ISO 9001 and NTCGP 1000 technical standards as a programme that meets the highest standards in its services. These certifications were ratified in 2013 and 2016 by SGS COLOMBIA.[11]

5.1.6 WEEE managers/operators and refineries

The WEEE managers/operators in Colombia are as follows:

- C.I. RECYCLABLES S.A.S., a company dedicated to the management, commercialization and final disposal of industrial excesses and hazardous waste[12]
- Lito S.A., an organization dedicated to the comprehensive management of industrial surpluses and hazardous waste[13]
- Gaia Vitare, environmental engineers dedicated to the comprehensive management of special and hazardous waste, including e-waste[14]
- GecoRaee, a leading and dynamic waste recycling company dedicated to helping companies and individuals with the safe and environmentally friendly disposal of computers and all kinds

of electronic items and components, such as televisions, mp3 players, cameras, cables, power transformers and batteries[15]

- PROSARC S.A., a private public services company dedicated to providing environmentally friendly solutions, guaranteeing high standards of quality and safety in all value-chain processes[16]
- Megaserviciosplus, dedicated to the processing and recycling of solid and liquid waste, establishing suitable environmentally friendly processes based on current legal regulations, using technology adjusted to meet quality requirements and satisfy clients and supported by a highly qualified team. The company complies with occupational health and safety policies.[17]

5.1.7 Main activities of the initiatives

Of the ten categories of WEEE covered by European Union Directive 2002/96/EC, *Computadores para Educar* processes category 3 (IT and telecommunication equipment).

The programme has reconditioning centres to receive disused computers from individuals, public entities, private companies, organizations and international bodies. Once received, the equipment is subjected to the processes described below to ensure the optimum aesthetic and technical condition for reuse at educational establishments covered by the programme that includes: checking, classification, repair, cleaning, storage, weighing, refurbishment, dismantling, valorization, and software updates.

While the equipment is being reused, *Computadores para Educar* provides corrective and preventive maintenance services to ensure normal operation. Once it has reached the end of its second life cycle, i.e. after four years, the programme collects the equipment and transfers it to the National E-waste Recycling Centre (CENARE). There, it is manually disassembled or demanufactured, involving the separation, cleaning and classification of parts and the recovery of some ferrous and non-ferrous metals, as well as plastics and clear glass.

The recovered material, such as plastics, metals, printed circuits, glass, copper and other parts, e.g. rubbers and acetates, is sold by public auction for subsequent use, thereby ensuring environmentally friendly recycling, promoting energy efficiency, reducing the need to mine new material and helping to shrink the carbon footprint.

Material containing, *inter alia*, heavy or rare metals is considered potentially hazardous and is outsourced to entities with an environmental permit for appropriate treatment.

Refurbished equipment is delivered free of charge to Colombian schools, official public schools, cultural entities and public libraries most in need, thereby reducing digital, social and regional divides.

According to *Computadores para Educar*, CENARE focuses only on environmental goals.

5.1.8 Other activities performed

Computadores para Educar carries out various social activities. In addition to refurbishment and e-waste management, it has a low-cost environmental educational robotics strategy. This involves the recovery of electrical, electronic and mechanical components from the dismantling of obsolete computers and electronic surpluses for the subsequent creation of robotics laboratories and kits that help students to learn about various aspects of science and technology. It facilitates the assimilation of basic concepts through hands-on experience designed to teach students to resolve day-to-day problems through logical thinking and innovation.

Figure 18: Social activities

Source: Computadores para Educar ©

Computadores para Educar has also developed a strategy for educational innovation and the use of ICTs for learning (ETIC@), which it considers fundamental to improving the quality of education and reducing social and regional divides in the country.

Figure 19: Use of ICTs for learning

Source: Computadores para Educar ©

Capacity building is integral to this approach and to ensuring the benefits of *Computadores para Educar*. Training is offered free of charge to teachers, managers, librarians, and officials of cultural entities as part of its train-the-trainers programme.

The ETIC@ strategy is a commitment to fostering the development of skills and initiatives to allow any official educational establishment, rural or urban, to strengthen their capacity to provide a high-quality education that meets the expectations and demands of modern society.

The programme contributes to the development of both technical and technological competences, as well as pedagogical, communicative, evaluative and attitudinal skills, referring to the Ministry of National Education teacher training programme and UNESCO guidelines for teacher training in ICT, developed between 2008 and 2011.[18], [19]

5.1.9 Distinctions received by the initiative

The initiative pursues the objective of contributing to the development of responsible environmental waste management, leading to recognition by several entities.

Awards

- WSIS PROJECT PRIZE 2012, recognizing the world's best practices in the *Access to information and knowledge* category, awarded by the World Summit on the Information Society, held in Geneva in 2012.
- ORBE PRIZE for Environmental Initiatives, granted by the Franco-Colombian Chamber of Environmental Innovation (CCFCI) and Portafolio.

Figure 20: Celebrating responsible environmental waste management prizes

Source: Computadores para Educar ©

5.1.10 Conclusions

Computadores para Educar is an effective initiative that gives children and young people better access to technological tools in their learning environment, helping to create a culture of innovation and fostering the development of skills based on scientific and technological training.

The programme is complemented by a political and legal framework appropriate to its implementation. It is aligned with the policies and programmes of the Colombia Ministry of National Education, seeking to bridge the digital divide by making ICTs accessible to educational communities, especially in the country's public education centres, and by providing computers and training teachers to maximize use and benefit. *Computadores para Educar* receives State funding for its operations and is supported by private sector companies.

The initiative operates in an environmentally responsible manner, setting a benchmark for the recycling of e-waste in the public sector institutions of Latin America through the collection and dismantling of obsolete computers, and valorization of useable material. The final disposal of e-waste is carried out by authorized managers/operators.

The programme contributes to the development of technical and technological competences and pedagogical, communicative, and evaluative skills, referring to the teacher training initiative of the Colombia Ministry of National Education.

5.2 Chilenter, Chile

Chilenter was founded on 8 August 2002 by Luisa Durán de Lagos, then First Lady of Chile, with the aim of bridging the digital divide in the country. She was looking for ways to give large numbers of discarded computers a second life by collecting and

repairing them and subsequently delivering them to technologically isolated educational establishments and social organizations.

Chilenter is the only non-profit organization in Chile dedicated to the recycling and recovery of e-waste and to the refurbishing of donated computers that can have a second useful life at educational establishments and social organizations.

Chilenter belongs to the Network of Foundations of the Social and Cultural Directorate of the Office of the President of Chile. It receives disused technological equipment from companies and individuals and refurbishes equipment that meets certain standards for donation to schools and social organizations. Equipment that does not meet the standards is recycled and its parts and pieces valorized at the national and international levels.[20]

5.2.1 Source of financing and investors

The organization is financed through the Network of Foundations of the Social and Cultural Directorate of the Office of the President of Chile. Since its inception in 2002, numerous collaboration agreements have been signed with different organizations and companies. In 2015, for example, Chilenter formed a partnership with local authorities, allowing local people access to alternative recycling options for their disused computer equipment.

In 2014, seven agreements were signed with public and private organizations, seeking to bring technologies closer to the most vulnerable social sectors while caring for the environment recycling and recovering e-waste.[21]

Chilenter partners include:

CODELCO	A Chilean-owned company and the world's leading copper producer. A global leader in ore reserves and a driver of national development[22]
Fundación PRODEMU Promoción y Desarrollo de la Mujer	Dedicated to delivering tools to women for the full development of their autonomy and leadership and the exercise of their rights through training at the national level[23]
FUNDACIÓN ARTESANÍAS DE CHILE CRAFTS	Private non-profit entity working to preserve national cultural identity and create opportunities for socio-cultural and economic development for traditional craft workers, understanding that a craft is a productive activity that gives sustenance to many families[24]
Servicio Nacional del Adulto Mayor Ministerio de Desarrollo Social Gobierno de Chile	Created to contribute to improving the quality of life of the country's elderly population[25]

SENAME Ministerio de Justicia y Derechos Humanos Gobierno de Chile	Created to contribute to the promotion, protection and restitution of the rights of vulnerable children and adolescents, as well as to promote social responsibility and the reintegration of adolescents who break the law, through programmes implemented directly or through collaborating organizations[26]
SERVICIOS COMPUTACIONALES GLOBAL	Provides IT-related services[27]
Teleton	Non-profit institution dedicated to the rehabilitation of children and adolescents with motor disabilities, emphasizing improvement in quality of life, the promotion of their dignity as individuals and development of their capacities, and social inclusion[28]

5.2.2 Population and e-waste levels in the region

The Americas have a population of more than 1 billion. Chile has approximately 18.5 million inhabitants and Santiago de Chile has 7.7 million. The commune of Quinta Normal, where the initiative is located, has a reported 101 737 inhabitants.[29] The amount of e-waste generated in Chile in 2016 was 159 kt in total, or 8.7 kg per inhabitant.

Table 9: Overview of e-waste in Chile

Subject	Unit	Year	Amount	Source
Population	inhabitants in millions	2018	18.19	IMF WEO
Purchasing power	USD per inhabitant	2012	18 354	IMF WEO
EEE put on market	kg per inhabitant	2012	11.9	UNU-IAS SCYCLE (2015)
	kilotonnes	2012	206	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	8.7	*The Global E-waste Monitor 2017*
	kilotonnes	2016	159	*The Global E-waste Monitor 2017*

Source: Based on StEP Intitiative information and *The Global E-waste Monitor 2017*.

The report *eWaste in Latin America: Statistical analysis and policy recommendations* of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) suggests that the amount of e-waste generated in Chile in 2018 will be 206 kt in total, or 11.2 kg per inhabitant.

Since 2009, Chilenter has managed more than 1 400 t of e-waste, including processors, RAM, printers, CPUs, cables, printed circuits, and DVD and CD players, leading to the recovery of precious metals and components and the safe disposal of hazardous waste through authorized companies.[30]

5.2.3 Human Resources Involved

The initiative can be classified as a medium-sized enterprise, with 30 to 40 salaried employees.[31]

In addition, Chilenter works with students from various schools. They are in charge of recycling equipment arriving at its warehouse in La Granja and are mainly from technical high schools in the south of Santiago. They are provided with support for transport to and from their homes and, upon completion of their work for Chilenter, are given certificates by the Chilenter Foundation. The students normally work for about four hours a day, with the incentive of participating in learning experiences at companies linked to the project.[32]

5.2.4 Applicable regulatory framework

It is important to take into account the legal and statutory framework and its impact on the initiative surveyed.

At the international level, the following Conventions should be considered (for further details see Chapter 1 of this report):

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, signed on 31 January 1990 and ratified on 11 August 1992; entered into force on 9 November 1992[33]
- Stockholm Convention on Persistent Organic Pollutants, signed on 23 May 2001 and ratified on 20 January 2005; entered into force on 20 April 2005[34]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed on 11 September 1998 and ratified on 20 January 2005; entered into force on 20 April 2005[35]
- OECD[36] Guidelines: since 2010 WEEE must be managed in accordance with the guidelines of the Organisation for Economic Co-operation and Development (OECD).[37], [38]

The StEP Initiative lists the following regulations that apply at the national level:[39]

- Reporting Requirements for Producers of Priority Products, Resolution, 2017[40]
- The objective of these requirements is to reduce the generation of waste and promote its reuse, recycling and recovery by establishing EPR and other waste management instruments in order to protect human health and the environment.
- Framework for Waste Management, Extended Producer Responsibility and Promotion of Recycling, Law 20.920, 2016[41] [42]
- The objective of this law is to reduce the generation of waste and promote its reuse, recycling and recovery by establishing EPR and other waste management instruments in order to protect human health and the environment.
- Promotion of Electronic Waste (e-Waste) Recycling, Senate Resolution, 2008 [43], [44,]
- The objective of this regulation wais to promote the recycling of electronic e-waste[45].
- Sustainable Management of Waste Computer Equipment, Public–Private Voluntary Agreement, January 2010[46,]
- The objective of this agreement is to establish a public–private framework for the sustainable management of waste from computer equipment[47]
- Sanitary Regulation of Hazardous Waste (DS 148).

5.2.5 Standards and Certifications

Whenever companies, institutions or private individuals donate material, Chilenter issues a certificate stating that Chilenter is an authorized recipient in accordance with Resolutions 021602 of 19 April 2011 and 1686683 of 13 November, issued by the Ministry of Health Secretariat for the Metropolitan Region.[48]

Chilenter has been authorized as an environmentally sustainable waste manager since 2009, incorporating the principal international and national guidelines for e-waste management and avoiding and minimizing waste generation through the reconditioning of computers, valorization of components and sound waste processing.[49]

The region implements Law 20.920, which establishes a framework for waste management, EPR and the promotion of recycling as the national recycling framework. It sets out guidelines on EPR and requires that producers of priority products (lubricating oils, EEE, batteries, containers, packaging and tyres) assume responsibility for the organization and financing of waste management for products sold in the country.[50]

5.2.6 WEEE managers/operators and refineries

Chilenter became an environmentally sustainable manager of e-waste in 2009. Other WEEE managers/operators are listed below:

Collector	Website
DEGRAF Reciclando por un mundo mejor	www.degraf.cl/
RECYCLA CHILE S.A. INNOVACIÓN EN MEDIO AMBIENTE	www.recycla.cl/
CHILERECICLA	www.chilerecicla.com/
MIDAS RECICLAMOS FUTURO®	www.midaschile.cl/
HIDRONOR GESTIÓN Y TRATAMIENTO DE RESIDUOS	www.hidronor.cl/

5.2.7 Main activities of the initiatives

Of the ten categories of WEEE covered by European Union Directive 2002/96/EC,[51] Chilenter processes category 3 (IT and telecommunication equipment).[52]

Chilenter is not responsible for collection and transport logistics. Donors must deliver waste to its facilities by prior arrangement.

After years of work, however, Chilenter has established two e-waste collection points, in coordination with other institutions, in order to make the recycling of disused electronic devices accessible to the public. Chilenter is responsible for managing these collection points, through initiatives with Universidad Mayor and the Estación Mapocho Cultural Centre. The first is at the administrative offices of Universidad Mayor San Pío X location for the collection of mobile phones, tablets, chargers, keyboards, mice, CDs, routers, hubs and switches. The Estación Mapocho Cultural Centre hosts a collection point for mobile phones and chargers.[53]

A charge is levied for certain equipment, but public bodies and the general public may deposit up to five pieces of equipment for free.

The following equipment is received free of charge:

- computer equipment: desktop computers, notebooks, mobile phones, servers, switches, routers, firewalls, hubs, modems, media converters and telecommunication equipment (VPN, storage, etc.)
- computer peripherals: LCD monitors, pen drives, cables
- components: RAM, processors, motherboards, daughterboards, video interface cards, network interface cards, sound interface cards, hard disks, floppy disks, CD-DVD readers and power supplies
- other equipment: projectors, telephone switchboards and telephone extensions.

A charge is made for receiving the following equipment:

- computer equipment: CRT monitors
- other equipment: fixed and wireless telephone sets, photocopiers, screens, video and teleconferencing equipment, multifunction printers, time clocks, etc.
- others: toners and cartridges
- computer peripherals: keyboards, mice, scanners, UPS, barcode and magnetic readers, plotters, other USB devices (cameras, HD, audio equipment).

Once WEEE arrives at the plant, the material is processed manually.

The comprehensive management of WEEE offered by Chilenter comprises the following services[54]

- classification
- storage
- weighing
- reuse
- repair
- recycling
- reconditioning
- recovery
- dismantling
- valorization.

An unprecedented recycling scheme was launched in Chile for the responsible management of old cathode ray tube (CRT) computer screens and associated e-waste. A total of 31 250 CRT monitors were dismantled for export to Belgium, where 250 t of CRTs, considered highly dangerous to health

and the environment, were recycled for their lead content. In addition, precious metals, such as gold, platiniumand silver, contained in monitor components were extracted for reuse.

Chilenter recycles and valorizes e-waste, reconditioning and lending computers to educational establishments and social organizations. Recovered materials are sold locally, exported or sent elsewhere for final disposal.

Chilenter began exporting certain components in 2009 and has completed 17 such exports to date. In 2015, it exported more than 5 t of motherboards for recycling and reuse to the city of Antwerp, Belgium. In 2014 alone, Chilenter exported two consignments comprising 35.67 t of waste for recovery, including 4.6 t of medium-grade printed circuit boards and 4.7 t of high-grade printed circuit boards.

5.2.8 Other activities

The Chilenter website contains the following information regarding corporate social responsibility activities, including equipment donations, education and promotional activities in various media forms.

Chilenter has conducted a large number of awareness-raising events, collection campaigns, training activities and media outreach, including:

- **Environmental education:** Chilenter has contributed to education and the use of technology for over 13 years through the development of electronic recycling workshops designed for middle-school students. These workshops provide information on e-waste management and recycling methods in order to show how such waste is recovered and recycled properly.[55]

- **TransformArte**: Almost half a ton of components from disused computers, including motherboards, cables, fans and processors, have been converted into 23 innovative sculptures by Chilean artists. TransformArte 2 is an initiative of the Chilenter Foundation and the Social and Cultural Directorate of the Office of the President of Chile. It is open to the public, free of charge, at the Anahuac Cultural Centre. TransformArte 1 was held in various locations from 2014 to 2016 and attracted more than 80 000 visitors. On the back of such popularity, TransformArte 2 was inaugurated at the Estación Mapocho Cultural Centre.[56]

- **Senior citizens:** While Chilenter activities initially centred on students, since 2014 it has expanded its focus to cover social organizations, specifically those dedicated to the elderly. Rather than being given PCs to take home, the elderly are invited to attend laboratories and workshops without fear as a way of learning about technology and becoming digitally literate, while also offering greater human interaction, online and in person.[57]

5.2.9 Distinctions received by the initiative

Various initiatives at the global level fulfil sustainable development objectives directly or indirectly, leading to awards, mentions, distinctions or other forms of recognition for their activity. They are held up as models of excellence for other international initiatives. Chilenter is one such example and has received the following distinctions:

Awards

- Best Collaborative Economy Initiative at the APEC O2O Summit 2016[58]
- Best Social and Educational ICT Project by the Chilean Association of Information Technology Companies (ACTI) in 2012.[59]

5.2.10 Conclusions

Chilenter belongs to the Network of Foundations of the Social and Cultural Directorate of the Office of the President of Chile. It was established as an environmentally sustainable waste manager in 2009, incorporating the principal international and national guidelines for e-waste management and avoiding and minimizing waste generation through the reconditioning of computers, valorization of components and sound waste processing. Each activity is governed by the principle of the three Rs: reduction, reuse, and recycling, as well as responsibility.

Chilenter works to facilitate access by children, adolescents and the elderly to technological tools. It is complemented by a political and legal framework appropriate to its implementation and is aligned with the policies of the Office of the President of Chile, seeking to increase the reach of ICT and bridge the digital divide in the public education sector. Chilenter receives financing for its operations.

Chilenter ensures the environmentally friendly management of e-waste through the collection and dismantling of disused computersand the valorization of useable material. The final disposal of e-waste is carried out by authorized managers/operators.

Chilenter sells and exports part of its products, while it delivers reconditioned equipment to schools in Chile free of charge.

5.3 E-Basura Programme, Argentina

Given the increasing amounts of e-waste and lack of solutions, the *E-Basura* Programme[60] emerged in 2009 as an initiative of a group of teachers and students at the National University of La Plata (UNLP) School of Computer Science.[61] As professionals in computer science and ICT, they seek to solve environmental problems, social inequalities and a lack of access to technology and education in broad sectors of society.

In order to reinforce UNLP commitment to society, an outreach project was launched to solve the problem of e-waste, focusing on the social, environmental and educational aspects.

E-Basura is the only such university initiative in the Americas region dedicated to reconditioning viable computers arriving at its computer reconditioning centre for subsequent donation to educational establishments, social organizations and public welfare institutions throughout Argentina. In addition, *E-Basura* offers courses in PC assembly and repair, academic internships, and professional work experience.

It was set up in 2009 as a project of the UNLP School of Computer Science, which then consolidated it as the *E-Basura e Informática Verde* [e-waste and green computing] programme in 2014, ensuring links with university teaching and the commitment to achieving the sustainable development goals

through the use of ICTs and taking a holistic view of information technology and the environment. It became a university programme in 2017, by decision of UNLP.

The goals of *E-Basura* are:[62]

- Awareness raising and education at UNLP and throughout the country on the risks of failing to process WEEE.
- Promoting reuse of operational e-waste in order to extend the life of computer equipment.
- Providing access to technology by donating computer equipment to the most disadvantaged sectors of society (institutions, social organizations, community kitchens, schools, libraries and other public and non-profit entities) to bridge the digital divide and contribute to social equity.
- Contributing to final safe disposal, avoiding burning and dumping.
- Generating activities and partnerships with companies that minimize the ecological impact of WEEE.
- Promoting corporate social responsibility by looking for partnerships to promote the initiative and further its social benefits.

E-Basura receives disused technological equipment from UNLP departments, private companies, public institutions, agencies and individuals. It refurbishes equipment that meets certain standards for subsequent donation to schools and various social organizations. Equipment that does not meet these standards is sent to authorized operators for final disposal.

5.3.1 Source of financing and investors

Funding for the programme comes from UNLP, which devotes a small amount of funds to subsidized outreach projects.

It is supported by UNLP School of Computer Science, the Higher Centre for Information Processing (CeSPI) — the UNLP computing centre — and the Laboratory of Research in New Information Technologies (LINTI) to cover some scholarships and internships.

In 2012, it received premises from the Buenos Aires provincial government to house its reconditioning centre, where UNLP students receive disused equipment from individuals and private and public companies and perform their daily work of recovering and restoring PCs for donation and reuse.

Since its inception in 2009, *E-Basura* has entered into numerous collaboration agreements with various organizations and companies, including an institutional collaboration agreement with the Buenos Aires provincial government to process its assets.

5.3.2 Population and e-waste levels in the region

The Americas have a population of more than 1 billion. Argentina has approximately 44.6 million inhabitants, the province of Buenos Aires 16.7 million and the city of La Plata, where the initiative is located, approximately 827 100.[63]

According to the StEP Initiative, the amount of e-waste generated in Argentina in 2014 was 292 kt in total, or approximately 7 kg per inhabitant.[64] The amount of e-waste generated in Argentina in 2016 was 368 kt in total, or 8.4 kg per inhabitant.

Table 10: Overview of e-waste in Argentina

Subject	Unit	Year	Amount	Source
Population	total inhabitants in millions	2018	43.60	IMF WEO
Purchasing power	USD per inhabitant	2012	18 205	IMF WEO
EEE put on market	kg per inhabitant	2012	8.5	UNU-IAS SCYCLE (2015)
	kilotonnens)	2012	348	UNU-IAS SCYCLE (2015)
E-waste generated	kg per inhabitant	2016	8.4	*The Global E-waste Monitor 2017*
	kilotonnes	2016	368	*The Global E-waste Monitor 2017*

Source: Based on StEP Initiative information and *The Global E-waste Monitor 2017*.

The report *eWaste in Latin America: Statistical analysis and policy recommendations* of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) predicts that the amount of e-waste generated in Argentina in 2018 will be 343 kt in total, or 7.8 kg per inhabitant.

Since 2009, *E-Basura* has managed more than 200 t of disused electronics, such as CPUs, computers, notebooks, tablets, servers, monitors, printers, keyboards, speakers, processors, RAM, cables, printed circuit boards and DVD/CD players. This has allowed the recovery of components and the safe disposal of residual waste through authorized companies.

5.3.3 Human resources involved

The initiative can be classified as medium-sized, with around 20 staff among teachers, university students, researchers, graduates and non-teachers. Some work is done on a voluntary basis, others receive scholarships or internships for their work, covered from funds provided by the School of Computer Science,[65] CeSPI,[66] LINTI[67] or UNLP itself.

The team comprises UNLP students, teachers, graduates and coordinators from a wide range of disciplines, representing UNLP schools of computer science, legal and social sciences, journalism and social communication, humanities and educational sciences, fine arts, engineering, natural sciences, and museums, and economics.

Ten people, mainly UNLP students, work four hours a day at the computer reconditioning centre.

5.3.4 Applicable regulatory framework

It is important to take into account the legal and statutory framework and its impact on the initiative surveyed.

At the national level, there is a lack of specific regulation on comprehensive WEEE management. Dedicated government initiatives have been scarce and several bills on WEEE management at the national level have failed to pass through parliament.[68] Currently, however, the Government is working on a decree, and several bills were proposed in 2016.[69] In addition, Argentina has assumed international and regional commitments regarding the treatment of waste, including e-waste.

At the international level, the following conventions have been considered (for further information see Chapter 1 of this report)

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, signed on 28 June 1989 and ratified on 27 June 1991 through Law 23.922;[70] entered into force on 5 May 1992.[71] The Basel Convention applies when waste is subject to transboundary movements for disposal or recovery
- Stockholm Convention on Persistent Organic Pollutants, signed on 23 May 2001 and ratified on 25 January 2005; entered into force on 25 April 2005[72]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed on 11 September 1998 and ratified on 11 June 2004; entered into force on 9 September 2004[73]
- Southern Common Market (MERCOSUR) Agreement on the Environmental Management of Universally Generated Special Waste and Post-Consumption Responsibility. The First Extraordinary Meeting of Ministers of the Environment was held in March 2006, in Curitiba, Brazil.[74]

At the national level, in the absence of a dedicated law, the following legal framework applies:

- Constitution, Article 41, which stipulates that all inhabitants enjoy the right to a healthy and balanced environment fit for human development and that the authorities must ensure that this right is upheld and provide environmental information and education. Article 41 also prohibits hazardous or potentially hazardous waste from being brought into the country
- Law 24.051 on Hazardous Waste,[75] regulating the generation, handling, transport, processing and final disposal of the types of hazardous waste listed in Annex I to the Law, which is identical to Annex I to the Basel Convention
- Resolution 522/16: National Strategy for the Sustainable Management of Universally Generated Special Waste.[76]

In addition, some provinces have introduced their own regulations. The StEP Initiative lists the following:

- Law 14321/2011 on the sustainable management of WEEE, Buenos Aires province
- Resolution No. 101/11 approving the certification programme for the sustainable management of WEEE, Buenos Aires province
- Decree 627/2011 on the management of WEEE from public offices, Buenos Aires city
- Law 2807/2008 on the management of WEEE, Buenos Aires city
- Decree 705/2011 implementing WEEE Management Law 2807/2008, Buenos Aires city.

The provinces of Chaco, Santa Fe and Chubut also have WEEE regulations.

The drawback to having such a large number of regulations is that, while preventing Argentina from becoming an e-waste disposal site, it hinders the launch of local initiatives and includes regulations preventing the disposal of e-waste at, for example, sites of State institutions.[77] The situation is made more complex by the fact that few provinces have regulations, and that there are few operators in the country.

5.3.5 Standards and certification

E-Basura is a medium-sized initiative that seeks to improve its processes and sustainability by fulfilling the requirements of the following standards, certifications and guidelines at its computer reconditioning centre:

- Following each deposit of equipment by companies, institutions or individuals, *E-Basura* issues a receipt for the equipment. Whenever it donates equipment, it issues a receipt itemizing all equipment for ease of traceability and control
- In its daily operations, *E-Basura* refers to the PACE[78] guidelines to promote the environmentally responsible management, repair, rehabilitation, recycling and disposal of used and end-of-life computer equipment. These guidelines include: Guideline on environmentally sound testing, refurbishment and repair of used computing equipment; Guideline on environmentally sound material recovery and recycling of end-of-life computing equipment; Glossary of terms; Report with ESM criteria recommendations; Report on strategies, actions and incentives to promote environmentally sound management of end-of-life-computing equipment; and Manual on steps to establish and implement environmentally sound management for used and waste computing equipment
- *E-Basura* also applies the guidelines and documentation of the Regional Platform of Electronic Waste in Latin America and the Caribbean (RELAC)[79]
- *E-Basura* incorporates ITU recommendations into its operations
- *E-Basura* has a trademark granted by the National Trademark Office, as provided in Resolution I.N.P.I. P-341/13, in accordance with the Digital Signature Law, No. 25.506 (2013).

5.3.6 WEEE managers/operators and refineries

The following WEEE managers/operators can be found in the province of Buenos Aires:

- Silkers S.A.:[80] offers sorting services, temporary collection, recovery and recycling of base materials. It prioritizes the recycling of WEEE and components thereof, recovering important natural resources and minimizing environmental damage. In addition, it offers WEEE removal. It is authorized to operate in the province of Buenos Aires
- Industrias Dalafer S.A.:[81] carries out WEEE management for appliances such as batteries, mobile phones, computers, etc., which may involve delivery or removal from the organization and transport to the plant. It is authorized to operate in the province of Buenos Aires
- Grupo Pelco:[82] provides industrial waste management, valorization of solid waste, recycling and recovery of WEEE. It is authorized to operate in the province of Buenos Aires
- Scrap y Rezagos SRL:[83] represents an end-to-end solution for large and small companies interested in the proper management of their disused EEE. It offers all the necessary services, including recycling, reuse and final disposal, and specializes in computer equipment, telecommunication and consumer electronics. It offers delivery, purchase and exchange of WEEE. It is authorized to operate in the city of Buenos Aires.

Argentina does not have refineries. All managers/operators must be able to export and to operate under the Basel Convention.

5.3.7 Main activities of the initiatives

Of the ten categories covered by European Union Directive 2002/96/EC,[84] *E-Basura* processes the category 3 (IT and telecommunication equipment).[85] *E-Basura* has a single collection point at its base of operations. It is not responsible for transport. Donors must bring the WEEE themselves, by prior arrangement, to its facility in Tolosa. WEEE is received through voluntary collection campaigns and

as project donations. In exceptional cases, where the amount of WEEE justifies it, a transport service may be hired to bring waste to the facility. Once the disused EEE/WEEE is at the reconditioning centre, processing activities are carried out. The WEEE management it offers comprises the following services:

- classification;
- collection/storage;
- activity log/tracking;
- testing;
- reuse;
- reconditioning;
- repair;
- recovery;
- functional/stress/performance testing.

Figure 21: E-Basura Programme e-waste work area

Source: *E-Basura* Programme ©

E-Basura receives computer equipment from companies, institutions and individuals on a daily basis. After the equipment has been restored, including the installation of free software, it is subjected to stress tests to detect faults before it is given away. Finally, the computers leave the reconditioning centre for donation or are picked up by the beneficiary, as the initiative does not have its own means of transport.

The objectives of the programme are not only to bridge the educational and digital divides and promote social inclusion, but also to encourage art, robotics and the reuse of components and to promote work among its students, as well as interaction among different UNLP schools and research into WEEE.

The beneficiary institutions must be non-profit public organizations that can justify their social purpose.

These include:

- community kitchens
- community centres
- kindergartens
- primary schools
- middle and technical high schools
- rural schools
- special schools
- libraries
- museums
- hospitals
- dispensaries
- health centres.

At the time of writing, *E-Basura* does not sell any equipment or components.

Residual e-waste that *E-Basura* cannot use is sent for safe disposal through authorized managers/operators. It has signed collaboration agreements with companies such as Silkers, Dalafer and Scrap y Rezagos, which remove residual waste on a monthly basis, free of charge.

5.3.8 Other activities

The objectives of the programme are not only to bridge the educational and digital divides and promote social inclusion, but also to encourage art, robotics and the reuse of components and to promote work among its students, as well as interaction between different UNLP schools and research into WEEE.

The relationship between research, teaching, innovation and outreach has helped to integrate the e-waste problem and social requirements into university research and teaching. Research targets specific problems and its outcomes are used to train human resources on specific subjects. The teaching aspect allows for the incorporation of the concepts of WEEE and "green IT" into the Computer Science and Systems degree programme, fostering student innovation.

With regard to corporate social responsibility activities, through equipment donations, education campaigns, awareness raising and dissemination of information on activities in various media, as well as additional information related to research, teaching, innovation and outreach, the following information applies:

Donations to indigenous peoples

Contributing to the digital literacy of broad social sectors, including through community kitchens, (Note) and indigenous peoples of Argentina. UNLP students participate in donations.

(Note): Community kitchens and snack bars in the neighbourhoods of Argentina were a measure to solve the problem of hunger faced by children and young people and proved very popular, particularly among women. Subsequently, school support activities and workshops were added.

Humanitarian aid

E-Basura has reached several provinces of Argentina with support from institutions and companies, as it does not have its own means of transport.

This example shows a humanitarian aid trip to rural schools and dispensaries (Note) located in Argentina's almost impenetrable Chaqueño forest. Entry is only possible in 4×4 trucks.

(Note): Dispensaries are establishments intended to provide medical assistance or treatment, usually free of charge, to patients whose illness does not prevent them from leaving home.

Social awareness and environmental education

Social awareness and environmental education activities are fundamental to the initiative that works to build awareness and promote behavioural change among participants.

Activities include different types of conferences and events, e.g. congresses, environmental days, exhibition stands, shows and campaigns for collection of equipment, talks in primary and secondary schools, and training courses for university students.

Awareness campaigns and equipment collection

Since 2010, awareness campaigns and the collection of obsolete equipment have been carried out annually. In 2012 and 2014, the campaigns were organized with the support of the Undersecretariat for the Modernization of the State of the Province of Buenos Aires. In addition, *E-Basura* has carried out collection campaigns for mobile phones since 2015.

School talks

Children and young people are key to raising awareness, which is why *E-Basura* gives talks at schools and science fairs and organizes visits to the reconditioning centre and the School of Computer Science, where children are invited to participate in special events.

Participation in events, conferences and congresses

To reach the rest of society, *E-Basura* participates in a large number of different events – 178 so far. The outcome is published in scientific journals and in congresses at the international level. The events are attended by university students.

Training in PC assembly and repair

These courses are given free of charge to the most disadvantaged sectors and to students of technical schools, including UNLP itself.

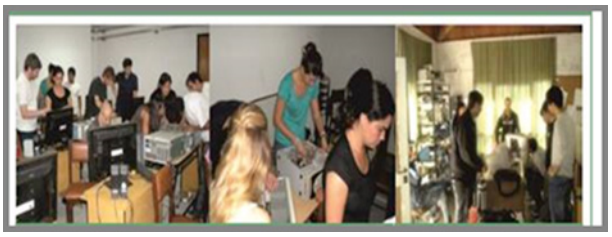
The courses promote social inclusion and work experience and improve quality of life among young people and adults.

The courses include vocational training of varying complexity and short-term academic internships. Courses are adapted to the socio-cultural environment and provide students with instruction on environmental care. Students receive certificates following the course.

Training takes place at the reconditiong centre and at the institutions involved.

Courses are given to students of technical secondary schools and the UNLP School of Computer Science. They are also given under academic internships (last year of secondary school), the Youth Inclusion Project (World Bank 2012) and the UNLP Vocational School.

Students with certain disabilities, such as visual impairment, reduced mobility and autism, have also participated with their support workers.



Dissemination of information

The dissemination of information in various media is fundamental to social awareness. Since its inception, *E-Basura* has made more than 200 media appearances, including on radio and television and in newspapers and documentaries.

It also disseminates information through its website and social media feeds.

5.3.9 Distinctions received by the initiative

Various initiatives at the global level fulfil sustainable development objectives directly or indirectly, leading to awards, mentions, distinctions or other forms of recognition for their activity. They are held up as models of excellence for other international initiatives. *E-Basura* is one such example and has received the following distinctions:

Awards

- Digital Inclusion 2009, first prize — Awarded by the National Programme for the Information Society (ISP) of Argentina by the Ministry of Communications under category C for non-governmental and/or university outreach initiatives performing activities aimed at reducing the digital divide. This award seeks to identify and encourage good practices in activities related to digital inclusion
- World Bank Contest 2012, first placed project — Selected from 45 proposals from 30 countries. The project, co-directed by young employees of the World Bank, concerns technical training in PC repair for young people to improve their job prospects and social inclusion
- WSIS Prizes 2016, C7. ICT Applications: E-Environment — Awarded by ITU, UNESCO, the United Nations Conference on Trade and Development (UNCTAD) and the United Nations Development Programme (UNDP) during the World Summit on the Information Society (WSIS), 2–6 May 2016 in Geneva.

Distinctions, recognition, etc.

- Declared to be of provincial interest by the government of Buenos Aires province (Resolution 31 of February 7, 2012).
- Presented before the Argentine Chamber of Deputies on 7 November 2012 for declaration of national interest.
- Granted premises by the Buenos Aires provincial government, April 2012.
- Selected in calls for university outreach projects since 2010.
- Included in UNLP strategic plans 2010–2014 and 2014–2018.
- Selected to participate in the MERCOSUR ECONORMAS Project, aimed at promoting sustainable production and consumption and good environmental practices, 2013–2014.
- Received a mention from MERCOSUR ECONORMAS for having participated in the implementation of good practices in environmental management and cleaner production, undertaken with SMEs in the WEEE sector in Argentina, 2014.
- The initiative was one of three candidates from Argentina for the UNESCO–Japan Prize on Education for Sustainable Development, 2017.

5.3.10 Conclusions

E-Basura is an organization under the umbrella of the National University of La Plata. Established in 2009 to provide a solution to the regional WEEE problem, *E-Basura* promotes the principle of the three Rs: reduce, reuse, recycle. In addition, it provides children, young people and adults with improved access to technological tools.

The relationship between research, teaching, innovation and outreach has helped to incorporate WEEE as an environmental problem and social requirement into UNLP research and teaching. The concepts of WEEE and “green IT” have been similarly integrated into the computer science and systems degree programme, encouraging outreach activities that foster student innovation.

E-Basura actively participates in social environmental activities and campaigns aimed at promoting and raising awareness of the origin and problem of WEEE, including the campaigns *Doná la vieja computadora que ya no utilizás* [Donate the old computer you don't use anymore] and *Tomate el medio ambiente en serio y traé tu viejo celular* [Take the environment seriously and bring in your old cell phone]. In addition, it supports the most vulnerable sectors of society through training and donations.

E-Basura prioritizes the preparation of ICT sector WEEE for reuse, thereby facilitating access to new technologies for low-income social sectors and the use of technology by greater numbers of people. To that end, it carries out the necessary operational tests and removes personal data to maintain donor confidentiality. Free software is installed to avoid software piracy.

The staff is made up of university students who are trained by university lecturers to repair, refurbish and dismantle WEEE and given vocational courses to cover the assigned area. Training is free of charge.

Team members frequently hold public seminars and training events, participate in congresses, and produce publications at the national and international levels. In addition, they perform important training and dissemination activities, including environmentally friendly PC assembly and repair courses, which are crucial to improving educational quality and bridging the country's social and digital divides. In this regard, the provision of training to all social sectors is one of the key benefits offered by *E-Basura*.

E-Basura has a significant media presence, having been visited by different media outlets, including television, radio and print media. Its facilities are also visited by primary and secondary school students.

The initiative has offered advice to various organizations and given talks and environmental training courses to companies, associations and educational centres.

E-Basura has a working partnership with the authorities, having agreed with the Buenos Aires provincial government in 2016 to collaborate in the reuse of EEE with the objective of minimizing waste generation, promoting a circular economy and maximizing reuse and re-marketing of waste.

The project does not just contribute to solving a social, educational and environmental problem: it also brings university students into closer contact with other social realities and complements their professional training. The goal is for students to give back to society some of what society has invested in them through public and free universities, such as UNLP.

E-Basura is a source of innovation in the region, facilitating the discussion of environmental protection from the point of view of technology and encouraging university research aimed at mitigating the adverse effects of e-waste through innovative solutions that contribute to attaining the Sustainable Development Goals.

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Chapter 6: Summary, conclusions and recommendations

6.1 Summary of the initiatives

Different types of e-waste management initiatives were researched around the world, in the Africa, Americas, Asia-Pacific, CIS, and Europe regions. These initiatives display very different characteristics in the way they are managed and how they operate. Private enterprises pursue an essentially economic purpose, government agencies a social and environmental purpose, public–private partnerships a social, economic and environmental purpose, and universities a social, educational and environmental purpose. However, if more initiatives were researched, more combinations and ways of creating them might be found.

Financing

Most of the e-waste initiatives studied in this report have external sources of financing. In some cases they have the support of international and/or governmental agencies. It can also be noted that, once the EEE/WEEE has been processed, each initiative markets different materials and components according to the specific economic, social and political conditions of its country or region, as part of its financing mechanism. Most of the initiatives described sell some components, such as plastics, metals, glass, copper, printed circuits, parts/pieces, repaired equipment, mobile phones or batteries, on the local market. The sales of components and equipment on the local market is a direct source of income for these initiatives that can help improve their processes, cover operating costs and ensure continuity of service in the future.

The value of materials on the market depends to a great extent on prices in the international market, the costs associated with operations and the volume processed. Each initiative must therefore adapt to its region and to the international context. In addition, the management schemes applied in each country, which are described in Chapter 1 (Legal framework) above, must support the initiative, contribute to a common fund to cover the costs of collection and disposal of WEEE, or pay for the service using funds from tax collected. This will depend on each country's regulations.

In Europe, private organizations play the lead role in managing and financing e-waste centres. In developing countries, however, it was observed that support for e-waste centres was provided by a mixture of private sector bodies, governments, foundations and various international programmes and organizations. This support is an important feature for the continuity and achievements of any initiative that does not pursue purely economic goals, as in the case of universities, foundations or civil society organizations.

Human resources

Human resources play a fundamental role, as does the way in which the plant operates. Manual processing requires more skilled labour than mechanical processing, but production is less. In most of the initiatives, the source of labour was employees, but in others labour was sourced from the informal sector. It is important for developing countries to build capacity in the informal sector through technical training.

In the case of the National University of La Plata, in Argentina, this involved students, teachers, researchers, volunteers, outreach workers and others. In this specific case, there is an interrelation between teaching and research, which results in enriching and innovative activities focused on contributing to solving the problem of e-waste.

Regulatory frameworks and standards

As for the regulatory framework, most of the initiatives researched are covered by specific legislation on WEEE and EPR.

Most initiatives seek to improve their processes and sustainability by applying international standards, certifications and guidelines. Private companies are generally certified as operators and exporters of e-waste, in view of the nature of their operations, their larger size and volume of scrap handled, and their greater number of employees. Countries where these initiatives operate have several authorized managers/operators. This is not the case for refineries, as not all regions have one: for example, the American region has to export to refineries in Europe, in compliance with the Basel Convention, through an authorized manager/operator.

The various initiatives around the world mostly contribute, either directly or indirectly, to meeting the Sustainable Development Goals, as a result of which many of them have received awards, mentions, distinctions or other recognition for their activity. They serve as an example to other international initiatives. Of the initiatives researched, those in the Asia-Pacific and the Americas region (Chile, Colombia and Argentina) had received the most awards: both *Computadores para Educar*, from Colombia and *E-Basura*, from Argentina, have received WSIS Prizes from the World Summit on the Information Society, in 2012 and 2016, respectively.

Activities performed by the initiatives

It is clear that private companies process the most categories of e-waste, as defined in European Union Directive 2002/96/EC. Other initiatives deal only with category 3 (IT and telecommunication equipment).

Materials arrive at reconditioning plants or centres in many different ways. Some initiatives have a single point of collection, while others, especially private companies or associations, have multiple collection points at various locations around a city. Some charge for pick-up services; others provide them free of charge. In the case of Chile, Chilenter charges for receiving certain types of materials, such as cathode ray tubes; however, they also receive components from retailers and service centres through reverse logistics, from donations, by purchase, or by involving the informal sector or scrap workers in the logistics chain.

Once e-waste has entered a facility, each initiative processes the material differently, according to the nature of its operations. These activities mainly include sorting, collection/storage, weighing, logging, tracking/testing, reuse, repair, reconditioning, recycling, recovery, dismantling, destruction/grinding, decontamination, valorization, functionality/stress/performance testing, and secure data erasure. The type of activity varies according to the focus of the initiative: commercial initiatives generally include dismantling, destruction/grinding, decontamination and recovery, while those of a more socially oriented nature usually include reconditioning activities, functionality/stress/performance testing, donation/sale and secure data erasure.

It is important to note that processing mechanisms vary among regions. Developed countries have very different working conditions from developing countries. In Europe, private companies are geared towards automated and semi-automated recycling processes, while in Latin America and developing countries recycling companies and organizations focus on reuse and refurbishing through manual operations. It is important to note that in manual processing, higher percentages of precious metals are obtained, guaranteeing homogeneous classification (e.g. better quality of gold), while automated processes yield a wider mixture of materials but a lower quality of precious metals.

Once the e-waste has been processed in the plant or operating centre, each initiative performs different tasks, depending on its operations, that allow an outflow of components and materials from the establishment. These activities range from social actions, such as donations, to selling on the local market, or on international markets through sales and exports.

Treatment of e-waste materials and components

Regarding the final safe disposal of e-waste, it was observed that in some cases this is undertaken by the initiatives themselves, if they are certified, while in others it is carried out by other managers/operators, as is the case for initiatives in the Americas. It is important for all countries to promote

adequate legal frameworks and incentives to encourage authorized managers/operators to establish operations in areas where such initiatives exist.

Social aspects

An integrated approach is needed to solving the problem of e-waste, focusing not only on the sustainable development aspects (environmental, social, economic and cultural) but also on actions to improve the entire management cycle. It is of fundamental importance for activities associated with research and investigation into new lines of action and improving the e-waste process to be carried out, and for WEEE issues to be incorporated into education programmes. Social activities aimed at raising awareness of e-waste issues are important in addressing social problems. In this respect, we find different activities in the various initiatives surveyed. Some include lectures and training seminars on environmental issues for the community. Associations, foundations and programmes tend to be more oriented towards social aspects and training, although they take other factors into consideration as well.

Education and training is a very important component as it improves people's quality of life and also contributes to achieving the SDGs. One of the activities commonly included in e-waste initiatives is training people to repair, recondition and dismantle computer equipment. This activity was present in almost all the cases surveyed, but it was often provided only to the employees of each initiative rather than as part of a social activity.

Some initiatives offered educational training only to students in primary, secondary and technical schools. Others featured training for students from socially disadvantaged groups, the informal sector and cooperatives. The most comprehensive approach was observed in Argentina, where training was also provided for students with disabilities and students in higher education. This case stood out among all the initiatives, as the students involved will enter the professional world with clear social and environmental training and a focus on the SDGs.

It was observed that initiatives provide training free of charge and offer it to both men and women. The age range of the beneficiaries varied depending on the region; 18 was a standard age to begin technical training. Associations, foundations and programmes are more oriented towards fulfilling an educational role and tend to include activities from earlier ages. The Chilean initiative includes training for the elderly.

Finally, disseminating information on the activities performed by each initiative plays a fundamental role because it makes it possible to raise awareness, sensitizing and educating society on the importance of proper, sound management of e-waste. Broadcasting was observed to be the medium used most often by the initiatives, but most initiatives and programmes have their own websites and social media feeds. The most comprehensive approaches were found in the American region, with the development of and participation in events, awareness-raising campaigns, collection campaigns, and a wide range of journalistic coverage in multiple media. In the specific case of the National University of La Plata, the publication of scientific papers and the participation of university students in congresses and scientific events was also a distinctive feature.

Most of the initiatives analysed make it possible, directly or indirectly, to achieve several of the 17 Sustainable Development Goals (SDGs). The list below shows the linkage between e-waste management and attaining the SDGs.

6.2 WEEE management system contributions to achieving SDGs

SDGs	Achievements that could be made directly or indirectly by initiatives
	Programmes/initiatives that focus on the most disadvantaged and low-income sectors and provide a tool to improve their social inclusion and employability.
	Programmes/initiatives that provide tools to improve education, social inclusion and employability are an indirect means of achieving this goal.
	Rescuing equipment from inadequate final disposal guarantees a healthy life for the whole of society. The donation of recovered equipment and vocational training also contribute to the well-being of people and improve their self-esteem, regardless of age.
	Providing access to technology enables access to more and better educational services, resulting in more inclusive and equitable education. Education and environmental awareness of WEEE issues also contribute to high-quality education. If, in addition, training reaches society with the aid of students and university teachers, the quality of these students' education improves while they help their neighbours, further encouraging education.
	Programmes/initiatives that promote participation by everyone in society, regardless of gender, age or social status. This equality of opportunity in employment or training promotes empowerment and personal development.
	Correct recycling techniques and proper disposal prevent water, air and soil contamination.
	Correct configuration of recovered and donated equipment contributes to reducing the release of CO_2. E-waste plants that promote compliance with standards and use alternative energy for their operations, or that promote partnerships for the provision of affordable energy, will indirectly contribute to fulfilling this objective. Public education plays a fundamental role in reducing energy consumption and waste generation.
	Access to technology and education improves people's ability to pursue decent work. Vocational training would open the doors to economic growth. The sale of repaired parts and equipment could be a source of economic income for people in a circular economy model. In addition, these initiatives create job opportunities and produce trained employees.

SDGs	Achievements that could be made directly or indirectly by initiatives
	Innovation in the reuse of parts and components from electronic scrap could be exploited to reduce the volume of e-waste.
	Access to ICTs for vulnerable or less-resourced sectors of society drastically reduces social, cultural and digital inequalities. Providing access to technology enables access to more and better educational services, which in turn makes the labour market more inclusive and equitable.
	Access to information technology contributes to the creation of smart cities that take account of environmental protection through correct final disposal of WEEE, meeting social, environmental, economic and cultural aims.
	Achieved through awareness-raising and educational campaigns.
	Achieved by applying the three Rs rule (reduce, reuse, recycle): reuse comes before recycling, with lower energy consumption, less generation of waste and correct final disposal of WEEE.
	Ensuring correct final disposal and preventing WEEE from being dumped in seas and oceans indirectly contributes to the protection of underwater life.
	Rescuing equipment from inadequate final disposal contributes to avoiding contamination of water, air, land and the life of terrestrial ecosystems.
	Donating equipment to non-profit and public good institutions promotes solid institutions and social justice. Education plays a fundamental role.

SDGs	Achievements that could be made directly or indirectly by initiatives
	Most WEEE programmes/initiatives promote public–private strategic alliances to find solutions, indirectly contributing to mitigating climate change and achieving the SDGs.

6.3 Conclusions

As noted throughout this report, the pollution caused by e-waste and the associated toxicity risks have become a problem for human health and the environment. Important considerations in analysing WEEE management are the relationships among the actors involved and the definition of responsibilities throughout the chain from generation, transport, storage, reconditioning, commercial and social recovery, reuse, recycling and treatment, up to final safe disposal.

On the one hand, in the private sector we have the technology industry (with its manufacturing and its waste) and the recycling industry itself, including repair, recycling and final disposal activities. On the other hand, there are different types of organizations working on reuse of computing equipment, digital appropriation of ICTs, environmental rights, social inclusion and the reduction of the existing educational and digital divide that gives rise to serious inequalities and lack of opportunities for large sectors of society.

In this context, civil society must also play an important role: millions of consumers, including companies, agencies and institutions around the world, must take responsibility for their own e-waste and commit to compliance.

Governments play a fundamental role as promoters of regulations and controls, and must in turn support actions and initiatives that benefit society as a whole.

On the other hand, we find international organizations fighting for environmental protection. They play a major role, obtaining financing, support and synergies for those initiatives that provide solutions at global level.

Moreover, recovery, reuse and recycling must be planned strategically in order to maximize the huge potential of non-renewable natural resources and to generate employment through the valorization of multiple sources of elements and components in a circular economy model.

Tackling the problem of e-waste from different angles and perspectives allows other benefits for sustainability, in addition to environmental benefits, to be achieved and contributes to bridging the digital divide by providing technological resources such as computers and connectivity, leading to social inclusion and economic, educational and cultural benefits for different sectors of society and governments themselves.

E-waste is also addressed by international organizations. This has led to the creation of various international standards, initiatives and programmes to tackle the largest and most socially and environmentally problematic waste streams facing the world today.

As evidenced in this report, the impact and benefits achieved by these initiatives are clear:

Environmental	Reducing environmental pollution, reducing health problems, caring for natural and non-renewable resources, promoting reuse, reducing the amount of e-waste, promoting safe final disposal, reducing greenhouse gases, reducing consumption of energy and generation of toxic waste at the manufacturing stage, creating a sustainable development scheme, etc.
Cultural	Increasing digital literacy, reducing the digital divide, creating social awareness of the problem, raising awareness within the university community and among students, improving education, favouring activities that safeguard the environment and human health, contributing to competitive advantages, generating cultural benefits to local and national governments
Social	Producing changes in society, liberating spaces, reducing the social gap, encouraging people into work, increasing corporate social responsibility, improving quality of life, expanding access to technology and knowledge, encouraging training for cooperatives and the informal sector, fostering the legal framework, generating social benefits to local and national governments
Economic	Encouraging the generation of raw material, reverse mining, redistribution of equipment, reuse of parts, reducing energy consumption and toxic waste, reducing environmental remediation costs, creating new training schemes for cooperatives, providing employment opportunities and improving the quality of jobs, generating models to be replicated, generating economic benefits to local and national governments

6.4 Recommendations

As a final result, we have formulated some recommendations for the development and implementation of a WEEE management initiative. This is not an exhaustive list, as that would constitute an entire report in itself, but some guidelines extrapolated from the initiatives surveyed in this report. They can be grouped as follows:

Environmental and operational work

- The type of WEEE to be processed must be defined. Although computer and telecommunication equipment is the most profitable segment in the market, solutions need to be promoted for all six categories[3] covered by the 2012 European Union WEEE Directive (Directive 2012/19/EU).[1] This should be done through public–private partnerships.
- Human resources play a fundamental role in the type of operations a plant undertakes. The initiative must have personnel capable of carrying out their work. All human resources must be well trained so that processes are carried out in a safe and appropriate manner. With manual dismantling, for example, smaller volumes of e-waste are processed, but because components, metals or other materials are not mixed as much as in automated processing, precious metals (e.g. gold) and other materials can be recovered more eficcientrly, thus actually increasing the volumen and purity of the materials recovered..

[3] In accordance with Directive 2012/19/EU, six categories are to be used as of 15 August 2018 (Annex III). Between adoption of the Directive and 14 August 2018, ten categories similar to those defined in Directive 2002/96/EC were in use (Annex I): 1. Large household appliances; 2. Small household appliances; 3. IT and telecommunication equipment; 4. Consumer equipment and photovoltaic panels; 5. Lighting equipment; 6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools); 7. Toys, leisure and sports equipment; 8. Medical devices (with the exception of all implanted and infected products); 9. Monitoring and control instruments; 10. Automatic dispensers.

- The way in which equipment arrives at the plant or reconditioning centre must be profitable for the initiative. All logistics for transporting equipment are complex and expensive, so the options must be evaluated to determine which is best. For example, having multiple collecting points distributed at different locations fulfils a social purpose and raises awareness, but the initiative should take into consideration sustainable funding mechanisms for implementing this approach. Another option is for the informal sector to participate in the reverse logistics chain. This should be supported by governments for implementation in certain regions.
- Recovery, reuse and recycling should be strategically planned to take advantage of the huge potential of non-renewable natural resources, the recovery of precious metals and rare earth elements, and the generation of employment through the valorization of different streams of elements and components in a circular economy model.
- The initiative should base its approach on the three Rs rule (reduce, reuse, recycle) and the circular economy model. Reuse should be prioritized over recycling, or at least considered.
- Reconditioning and refurbishing activities should include functionality/stress/performance testing so that equipment can be certified.
- For reconditioning and refurbishing activities for the ICT sector, the initiative must incorporate procedures for the secure destruction of information contained in the storage media, in order to protect the personal data of users, by means of physical destruction and/or secure erasure.
- The method for processing the equipment received (manual, semi-automated or automated) should be determined by the initiative in order to make it as profitable as possible. For example, manual processing is a good option in Latin America and other countries where the cost of labour is low.
- For all reusable or recyclable material processed in the plant, sale on the local market should be considered in addition to exporting to the international market. Donations of refurbished equipment should also be part of the social and beneficial approach integrated into the initiative. Commercialization will provide continuity over time and enable the initiative to pay salaries, operating expenses and logistics expenses, as well as maintaining social and educational activities.
- The sale of materials such as plastics, metals, glass, copper, etc. will depend to a great extent on their prices in the international market, costs associated with operations and the volumes processed. Each initiative must adapt to its environment.

Social, educational and cultural

- The development of initiatives for e-waste management should, besides pursuing economic goals, also include social, environmental, educational and cultural goals.
- The initiative must be seen as a source of training, employment and inclusion for the informal sector.
- The initiative should envisage donating refurbished equipment, such as computers and tablets, in order to help the most vulnerable groups in society, achieve educational and cultural goals, bridge the digital divide, reduce the social gap and foster activities associated with the arts, robotics and research, among other things.
- Education and training is a very important component as the initiative can improve people's quality of life and contribute to achieving the SDGs. It should include social awareness activities.
- It is important for the initiative to offer technical capacity-building courses in repairing, reconditioning and dismantling equipment for external people, not just its own staff. It should take into account the most vulnerable sectors of society and promote gender equality, inclusion and employment. Environmental aspects of WEEE should be considered in developing such courses.

- The initiative should carry out training activities for pupils in primary, secondary and technical schools, students from disadvantaged social sectors, people with disabilities, the elderly and the informal sector, among others.
- It is important to provide training activities and courses free of charge. This will require economic support from governments, partners and international organizations, given the associated costs.
- Public awareness plays a fundamental role for any type of initiative. It makes it possible to sensitize and educate society, making the problem of e-waste and the activities of the initiative well known to the public through the use of mass media, such as television, social media, websites, newspapers, etc.
- Initiatives should improve their processes and sustainability by applying standards and seeking certification, as well as incorporating international organizations' standards into daily operations.
- It is of fundamental importance that the initiative works continually to improve its processes and to research different lines of action in the search for solutions to the problem of WEEE. This could be achieved through partnerships with universities.
- Linking the themes of WEEE, social activities and innovation at universities will encourage new solutions. In addition, it will motivate students to become involved in the professional world with a clearer social and environmental orientation and with a focus on the SDGs.

Economic support, financing and partners

- The initiative must seek external financing to support activities that encourage environmental benefits and contribute to the achievement of the SDGs. This is crucial to the continuity of actions and scope of the objectives set. It must also seek support from international and governmental organizations.
- The initiative must be well planned so as to contribute to achieving several of the 17 SDGs, directly or indirectly (covered in detail above). This emphasizes the importance of such initiatives and how crucial they should be to governments and international organizations in contributing to sustainability and providing a wide range of benefits society.
- The initiative should take a multistakeholder approach. Communication among all actors involved (governments, private companies, organizations and society) must be encouraged, and responsibilities must be very well defined throughout the WEEE management chain. Governments have a fundamental role as promoters of regulations and controls, but must also support actions and initiatives that benefit society as a whole. International organizations fighting for environmental and protection rights must play a major role in mobilizing financial support and synergies for initiatives that provide solutions on a global scale.
- The promotion of awards and recognition from governments and international organizations is important. Although it is not a requirement for initiatives to receive awards, mentions, distinctions or other recognition for their activity, doing so highlights excellence, as well as serving as a model for other similar initiatives.
- It is important to include the topic of recycling WEEE in college and university programmes. Academia plays an important role. The participation of students, teachers, researchers, volunteers and outreach workers will allow linkages between teaching, research and university outreach, which is an enriching and innovative way of helping to solve the problem of e-waste.

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Appendix: Model for a waste electrical and electronic equipment management centre

Waste electronic and electrical equipment (WEEE) has been on the agenda of governments, industry and non-governmental organizations for more than 20 years. Unfortunately, despite all the efforts made, countries still struggle with the development and implementation of take-back and collection systems, irrespective of whether it falls to governments or other organizations to deal with the legal, technical and economic aspects of e-waste treatment. Since the material composition of electronic and electrical products varies widely, a large proportion of WEEE is not being collected or treated in an environmentally friendly or health-friendly manner.

Today, information and communication technologies (ICTs) have become a key tool for achieving the Sustainable Development Goals (SDGs). At the same time, more electrical and electronic devices are being discarded prematurely in order to acquire the latest update, rapidly increasing the volumes of end-of-life and near-end-of-life equipment around the globe. This waste requires environmentally sound management owing to the hazardous substances, rare metals and elements it contains, which, if not properly treated, are potentially harmful to both the environment and human health. It is important to understand that the management, treatment and final disposal of this type of waste must be carried out in a responsible manner.

It is therefore of the utmost importance to develop, establish and implement a recycling model for WEEE that meets the needs of individual countries and regions. This recycling model should be aligned with the principle of circular economy through the application of international standards, as well as the promotion of public–private partnerships at national and international level. Looking forward, the model for a waste electrical and electronic equipment management centre presented here also aims to contribute to the development of future sustainable and smart cities.

Waste electrical and electronic equipment management centre (WEEEMC)

A WEEEMC should be able to address the problem of e-waste in a holistic way, rather than focusing solely on sustainable development aspects (environmental, social, economic and cultural). It should engage in research-based activities to improve management processes; teaching and awareness-raising; innovation; and problem-solving in line with the needs of society.

From an environmental, social, economic and cultural perspective, a WEEEMC must be able to provide solutions to:

- the environmental problems caused by WEEE, by reducing e-waste volumes through recycling methods and ensuring final safe disposal;
- social problems, by establishing reconditioning and training centres that can provide people with work;
- cultural problems, by undertaking awareness-raising activities, environmental education and dissemination of information;
- economic problems, by selling certain raw materials and components, along with reconditioned equipment, in a circular economy model.

Moreover, at an educational level, the waste electrical and electronic equipment management centre should also consider:

- undertaking activities associated with researching new lines of action and improving management processes for disused WEEE;
- incorporating the subject of e-waste management into curriculums at all educational levels, including in universities;
- carrying out social activities aimed at solving problems in the most vulnerable sectors of society;

- promoting innovation to find new solutions to new e-waste challenges.

Activities

A waste electrical and electronic equipment management centre should be able to perform the following types of activity:

Group 1: Activities in this group are those that seek to adapt the initiative to national and international regulatory frameworks and ensure continuous improvement. Furthermore, these activities should further the implementation of international standards, best practices and guidelines developed by different international organizations dealing with WEEE, including within the United Nations family.

Group 2: This group of activities corresponds to the tasks associated with input of elements into the plant, in compliance with national and international WEEE regulations. The following processes should be covered: reception, collection, classification, storing, testing, disassembling, repair, discarding, valorization and decontamination.

Some of the activities that may be carried out are: responding to requests from the community, institutions, organizations and companies made through an online form in which all the necessary information on the equipment delivered, such as type and quantity, can be provided; coordinating what equipment will be received and when, depending on warehouse availability and operating strategy; receiving disused EEE and WEEE in the loading/unloading area; weighing; issuing a receipt specifying the type, quantity and weight of equipment received and information on the donor or organization; making a digital inventory; storing the material; classifying the elements/components/equipment received; performing analysis and preliminary tests on the components/equipment; sending faulty equipment to the repair sector; repairing systems and components that meet minimum conditions for life cycle extension; sending equipment and components with irreparable faults to the dismantling sector for recovery and valorization; and delivering unusable items to the scrap sector to be removed by the operator for final safe disposal. A circular economy model should be applied.

Group 3: The tasks in this group of activities all relate to reconditioning computers and components from the ICT sector, which will then be donated or sold. Activities in this group must include, at a minimum, assembly and repair of equipment; component testing; installation of operating systems and applications; running stress tests; secure data erasure to protect user privacy; cleaning equipment; labelling in accordance with WEEE standards; and registration in stock control systems.

Group 4: This group of activities focuses on research into the recovery of various types of materials and the reuse of parts and components in a circular economy model. Activities in this group should include, as a minimum, alternatives for reuse and recycling; applying innovation; defining new processes and procedures in line with new reuse and recycling options; performing laboratory tests; carry out training and awareness raising; and writing reports and activity logs.

Group 5: This group covers environmental education and awareness raising, which should involve all sectors of society. Activities in this group must include, at a minimum, organizing and participating in awareness-raising events; organizing campaigns for the collection of obsolete equipment; coordinating student visits to refurbishment centres or plants; and publicizing activities through various news media, including websites and social media.

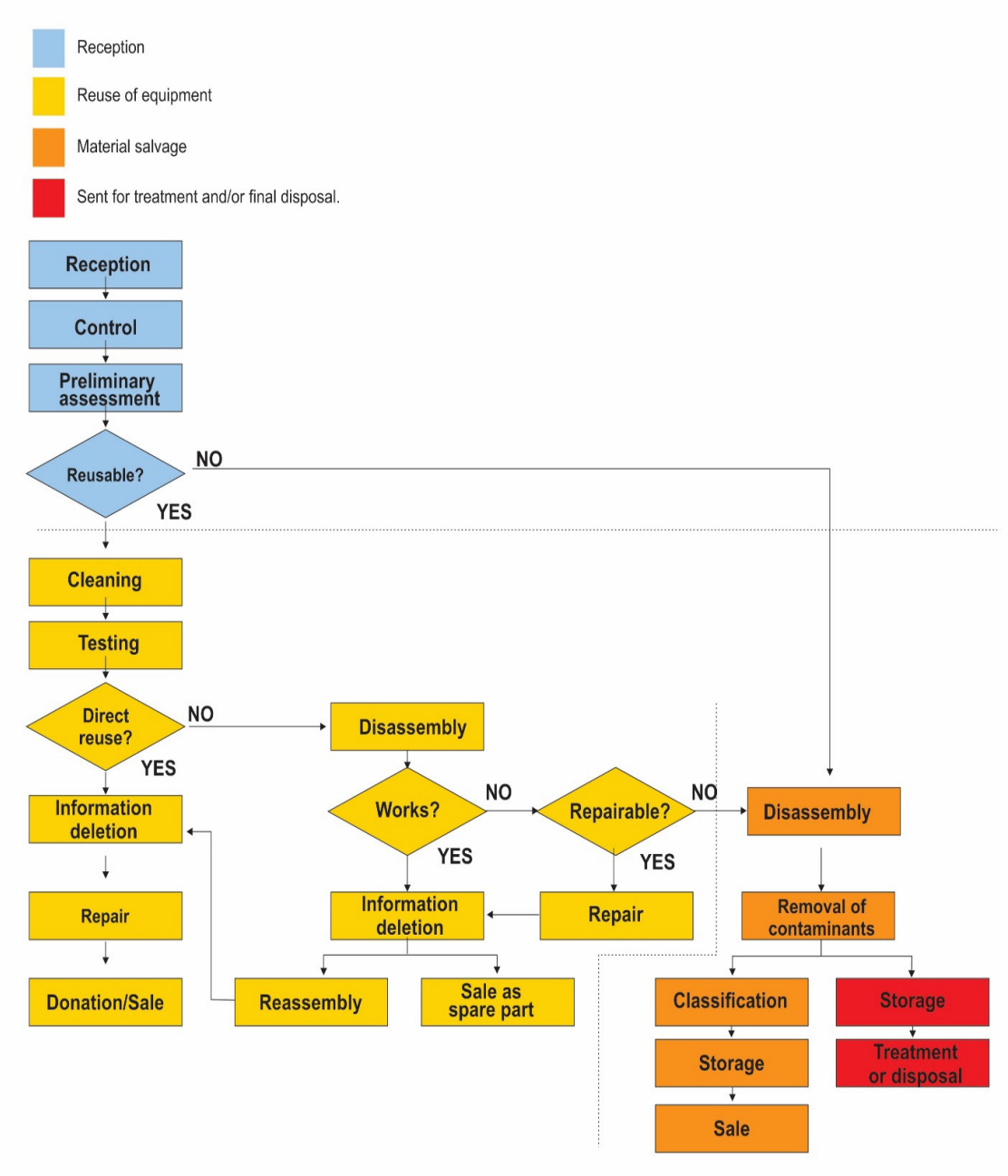
Group 6: Activities in this group cover the social element, through the donation of refurbished ICT equipment to various organizations to contribute to reducing the digital divide. It also involves offering vocational training to improve the employability of the most vulnerable sectors of society and training university students. The WEEEMC should seek to implement a social model for the circular economy with training for the informal sector and potential certification.

Group 7: This group of activities should include evaluating how the WEEEMC functions; analysing progress and achievement indicators, in a process of continuous improvement (Plan–Do–Check–Act); and preparing regular management reports.

Process diagram

This diagram describes the basic processes to be performed by a WEEEMC. ITU standards and best practices should be followed. Research, training, awareness-raising, innovation, social assistance and dissemination of information should run in parallel to all the processes involved.

Figure A: Basic process diagram



Source: Orellano Peinado, Federico. *Reutilización y reciclado de equipos informáticos y de telecomunicaciones*. https://issuu.com/forellanopeinado/docs/estudio_de_los_aspectos_propios_de_la_construcci_n

Progress and achievement indicators

Qualitative and/or quantitative values are expected for at least some of the following indicators of achievement:

- quantity of equipment/components/material received (units/kg/tonnes);
- quantity of equipment/components/material recovered;
- quantity of equipment/components/material valorized;
- quantity of equipment/components/material donated;
- number of beneficiaries of donations;
- level of participation/cooperation by agencies, public/private/international sector and the public;
- quantity of WEEE sent to final disposal (units/kg/tonnes);
- number of events (organization/participation);
- number of students/cooperatives/informal sector workers trained, economic indicators, research indicators, etc.

Elements necessary for set-up

The following list covers some of the factors that must be taken into account in setting up a WEEEMC:

Infrastructure
Warehouse to deploy recycling unit
Basic machinery – load-carrying and weighing equipment
Loading boom/forklift
Weighing scale for raw material
Compacting machine
General purpose crushing machine
Extractor
Metal shelving
Pallets
Equipment for repair and dismantling and basic tool kit
Portable vacuum cleaner
Compressor
Hardware spares (RAM, drives, etc.)
Medium sized screwdrivers, 5 mm diameter (flat and Phillips)
Voltage tester
Flat toe clip (125-150 mm)
Cable cutter (pliers) (approx. 150 mm)

Clamp for network connectors (RJ 45/11)
Cable tester (LED type) for RJ-45 network cables
Digital multimeter (890G)
Motherboard PCI/mini PCI/LPC tester
Power supply tester with LCD display
Miner flashlight (and batteries)
Plastic toolbox (reinforced)
Brushes
Isopropyl alcohol
Cleaning foam and detergents
Multi-purpose parts organizers
Plastic seals bag
Big bag separation pockets
Anti-static and insulation bags
Film roll
Cardboard boxes (x dozen)
Maintenance tools – various
Safety and environmental protection kit
Masks
Chinstraps
Goggles
Gloves
Helmets
Back support belts
Ear protection
Work clothes (shirt, trousers, various)
Work boots with steel tip
First aid box
Anti-static wristband
Plastic containers
Dry chemical powder fire extinguishers ABC under pressure, 5 kg
Carbon dioxide (CO2) fire extinguishers, 3.5 kg capacity

Computer and telecommunication equipment
Computers
Servers
Multifunction printer
Laser printer
Fixed telephones
Photographic camera
Projector
Digital screen
Router/switch
Safely deleted HW or software
Security system (sensors and sirens)
Barcode system and software
Furnishings
Central heating with forced circulation
Air conditioning unit (hot and cold)
Desks
Desk chairs
Work benches
Wooden work tables (3 m x 1 m)
Tables for training classroom
Chairs for training classroom
Whiteboards (1.40 m x 0.90 m)
File cabinets
Water dispenser
Refrigerator
Portable stovetop
Microwave oven
Utilities and monthly expenses
Employee insurance
Fire and theft insurance
Local taxes

Electricity, gas and water
Internet and telephone
Logistics expenses
Transportation expenses
Cleaning service
Maintenance service
Other monthly expenses
Dissemination (multiple media)
Teaching material for students (paper, toner, etc.)
Travelling and mobility for teachers
Refreshments for students
Receipts
Software
Bibliography
Human resources
Management staff
Chief of plant and chief of trades
Administrative and accounting staff
Institutional communication staff
Loading and unloading staff
Specialized technical staff
Technical staff
External consultant
Environmental specialist
Cleaning and maintenance

The WEEEMC concept is intended to be of use in establishing pilot plants in a way that contributes directly to tackling the problem of e-waste facing cities, in line with the SDGs.

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