Sustainable management of waste electrical and electronic equipment in Latin America

BASEL CONVENTION

CRBAS
Centro Regional Basilea
para América del Sur

UNITED NATIONS

ECLAC

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

Regional Bureau for Sciences
in Latin America and the Caribbean

UNIDO

UNITED NATIONS
UNIVERSITY
UNU-VIE SCYCLE
Sustainable Cycles Programme

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

World Health
Organization

1956 2016
CCITT / ITU-T

ITU

Sustainable management of waste electrical and electronic equipment in Latin America

Acknowledgements

Legal Notice

Disclaimer

Executive summary

This study was carried out to determine the current status of the management of waste electrical and electronic equipment (WEEE or e-waste) and used electrical and electronic equipment (EEE) in Latin America and to define the guidelines for a roadmap that would ensure the environmental sustainability of e-waste management in the region. Latin American countries should promote the technological implementation of appropriate management tools, technical standards of e-waste management, efficient regulatory frameworks and sustainable business models. This work should include the participation of stakeholders from the information and communication technology (ICT) sector, industry, the health sector, academia (especially those who study the environment and technology), civil society organizations, non-governmental organizations (NGOs) and society in general.

The first part of the report provides an overview of the management of e-waste in Latin America and presents definitions and general principles of waste management at the global level, including processes and technologies. It also introduces policies, strategies and regulatory frameworks from other regions that have been developing sustainable e-waste management solutions for many years.

The report analyses the environmental impacts and health effects associated with inadequate management of e-waste in order to identify risks and opportunities. Policymakers in the region should consider these risks and opportunities when designing new policies and regulations for waste management. The report also describes the roles of the different stakeholders in the management of EEE throughout its life cycle, until it becomes e-waste.

The subsequent sections include a case analysis of the regulatory framework implemented in each Latin American country. This report also provides an overview of the challenges faced by the region and the ICT industry that may impede environmentally sustainable e-waste management in the medium and long term. Further, this study stresses the importance of the implementation of technical standards developed by the International Telecommunication Union (ITU) to facilitate the proper management of e-waste and to respond to the growing concerns in the ICT sector and the public.

The report concludes with recommendations for the establishment of a roadmap to ensure environmental sustainability for regional and national e-waste management in Latin America. This includes the need to promote models that prioritize reuse and recycling together with building effective partnerships that bring together all stakeholders to the fullest extent possible.

The countries selected for this study are Argentina, the Plurinational State of Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and the Bolivarian Republic of Venezuela on account of their comparatively uniform legislation in the region. Additionally, some of these countries carry out e-waste management with general and/or analogous rules, which lack specificity to address the problem of e-waste that now deserves and demands special treatment and specific regulation.

This study has been carried out in collaboration with several organizations working towards the sustainable management of e-waste worldwide. These organizations include, among others, the ITU, the Secretariat of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the World Health Organization (WHO), the World Intellectual Property Organization (WIPO), the United Nations Industrial Development Organization (UNIDO), the United Nations University (UNU) and the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Table of Contents

1. Introduction

The importance of information and communication technology (ICT) in the economic, productive and social development of countries is indisputable. These technologies are a key element of the new economic model largely based on knowledge and the information society.

ICTs directly contribute to the wellbeing of people and their integration into society. Limited access to ICTs and their non-uniform use results in social stratification based on access to information.

Recent years have seen an important expansion of the ICT sector. In 2013, the penetration of mobile telephones in Latin America and the Caribbean reached 114.5 per cent of the population; the penetration of fixed broadband reached 9 per cent; and mobile broadband increased to 24 per cent. Moreover, there has recently been a strong growth of Internet use in the region, and the users already represented 46.7 per cent of the population in 2013. (ITU-ECLAC, 2013)

All this implies a steady growth in global production and sale of electrical and electronic equipment (EEE), particularly those related to ICT–computers, printers, cell phones, fixed phones and tablets. The increasing demand for EEE, however, becomes a source of waste. Waste EEE is also known as WEEE or e-waste.

In the last two decades, legislators, producers and recyclers have established "specialized treatment and recovery systems" in some countries to collect e-waste from the final owner and process it in treatment facilities suited to that purpose. However, despite these efforts, data collection and technical processing of e-waste is uncommon, and most countries do not yet have these management systems in place. There is a large amount of e-waste that is neither collected nor treated in an environmentally friendly way. Additionally, e-waste is still shipped from developed to developing countries. Often, the e-waste transferred to developing countries is processed by basic and inefficient techniques to extract materials and components. (UNU, 2012)

With increasing gross domestic product, world consumption of EEE accelerates, and its waste streams grow. In Europe alone, the current amount of e-waste generated is about 12 million metric tonnes (Mt) per year. This is expected to increase in the coming decades at a rate of at least 4 per cent annually–a rate about three times faster than the growth of municipal waste. (UNEP, 2013)

As the consumption of EEE increases, the problem of e-waste gains importance. In this regard, the Solving the E-waste Problem (Step) Initiative, hosted by the United Nations University (UNU), calculates that the volumes could grow by 500 per cent in the next decade in some countries, reaching 48 million Mt globally in 2017, of which 4,5 million Mt is predicted to come from Latin America. (Baldé et al., 2015) E-waste requires proper treatment to manage these increasing volumes, and managing this treatment poses one of the greatest challenges for the region in the coming years.

According to the UNU, the Americas generated 11.7 Mt of e-waste in 2014. The three countries with the largest generation of this waste stream were the United States (7.1 Mt), Brazil (1.4 Mt) and Mexico (1.0 Mt). In Latin America, around 3.8 Mt of e-waste was generated in 2014, with Brazil (52 per cent), Argentina (11 per cent), Colombia (9 per cent) and Venezuela (9 per cent) being the countries that generated the main volume of e-waste. In relative terms, Chile (9.9 kg/inhabitant) leads the region in its volume of e-waste generated per capita, followed by Uruguay (9.5 kg/inhabitant) as seen in Table 1 and described in detail in Annex 1.

Table 1 – Statistics of e-waste in Latin America, 2014

Country	e-waste in kg / person	Total e-waste generated (in kilo tonnes)
Argentina	7.0	291.7
Bolivia (Plurinational State of)	4.0	44.7
Brazil	7.1	1,411.9
Chile	9.9	176.2
Colombia	5.3	252.2
Ecuador	4.6	72.9
Peru	4.7	147.6
Paraguay	4.9	34.2
Uruguay	9.5	32.4
Venezuela (Bolivarian Republic of)	7.6	232.7
Guyana	6.1	4.7
Surinam	8.5	4.7

Source: (Baldé et al, 2015)

There are additional challenges associated with e-waste management besides those mentioned above. In general, EEE products have relatively short durations of usage due to rapid innovations resulting in the generation of new products with lower prices and increasingly shorter life cycles. The products are sophisticated and contain a wide range of materials, but sometimes, they are manufactured using methods that prevent its separation. At the same time, many of the hazardous components of these products cause environmental and health problems if handled inappropriately at their end-of-life (EoL) stage. This mishandling often occurs in developing countries, where the recycling methods used are insufficient or deficient.

This situation is accompanied by a significant and uncontrolled transboundary movement of e-waste, for which the final destination is unknown, and the applied treatment options are questionable. According to the Step Initiative, e-waste is one of the largest waste streams on Earth, and it carries significant social and environmental implications. (Step Initiative, 2014) Even though the transboundary movement of e-waste from developed to developing countries has been addressed under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal since 1992, illegal shipments of e-waste are still prevalent. The European Union and 182 states are parties to the convention, but a few countries, such as Angola, Haiti and the United States, have not ratified it. (Basel Convention, 2015)

The management of e-waste is one of the greatest challenges faced by the ICT sector. This stream requires sustainable management of products at the end of their useful lives due to the environmental, social and economic implications associated with it. It is important to understand that these wastes are heterogeneous and have specific characteristics. Therefore, its management, treatment and disposal must be carried responsibly. In general terms, this report describes the basic principles of sustainable management of e-waste that already exist and are applicable to the region.

With respect to regulatory frameworks, most Latin American countries do not have specific regulations for e-waste in place. Among the 10 countries analysed in this study, there are *ad hoc* regulations only in Colombia, Peru, Brazil and Ecuador. Thus, one of the challenges in the region is the establishment of effective and specific regulatory frameworks for e-waste, which in turn enables the development of specialized treatment and recovery systems on the national and regional level.

In Latin America, all countries have ratified timely binding international instruments, such as the Basel Convention and the Stockholm Convention on Persistent Organic Pollutants (POPs). However, it is necessary to continue working on sustainable models of e-waste management. This report aims to shed light on the challenges faced by each country in the region to ensure sustainability in the medium and long term.

This report attempts to present recommendations and resolutions from international organizations and conventions, so that each country can evaluate the possibility of implementing such instruments in future regulations in this area. The Recommendations developed by the ITU are an example of technical standards used for the management of e-waste.

Furthermore, this study aims to present the current status of e-waste management in Latin America and determine the guidelines for a roadmap that would ensure environmental sustainability in the region.

2.   Management, treatment and final disposal of e-waste

This section describes the general concepts of e-waste, its fundamental technical definitions and the main sources of its generation. Additionally, this section provides an overview of technological and environmentally sustainable alternatives that are available for proper e-waste management at the global level. It also describes some examples of policies and strategies that many countries have adopted in order to promote sustainability in the management of e-waste. The introduction includes examples of regulatory frameworks in other regions, such as Europe's WEEE Directive.

2.1   Environmental sustainability in e-waste management

According to the Step Initiative, e-waste constitutes one of the largest waste streams on Earth with significant social and environmental implications. (UNU, 2013) Therefore, it is important to understand that e-waste is a unique waste stream of concern whose management, treatment and disposal must be done in a sound manner.

It is important to define the concept and its associated terms clearly in order to understand the best ways to manage it.

In 2009, Luciano Morselli defined EEE as "Any device that for functional reasons is dependent on electric currents or electro-magnetic fields in order to work properly. It becomes WEEE when its owner disposes of it, tries or needs to discard it". (Morselli et al, 2009)

In 2014, the Step Initiative defined electrical and electronic equipment (EEE) as "any item from homes or businesses that contains circuits or electronic components and a power source or batter". Step also established that the term e-waste covers "all types of electrical and electronic equipment and parts 'discarded' by its owner as waste without the intention of re-use". Step emphasizes the term "discarded" to distinguish between an item or product that can be reused from waste.

According to the European Directive 2012/19/EU, EEE products "are those that run on electric currents or electromagnetic fields and are intended for the use with a voltage rating not exceeding 1000 V alternating current (AC) and 1500 V direct current (DC); are also those apparatuses necessary to generate, transmit and measure such currents and fields".

Categories of e-waste

EEE products have been categorized into various groupings by pieces of national legislation taking into account their original purpose, size, composition and/or weight. Internationally, the suggested classification has been used as a reference by the 2002 European Directive reflected in Table 2.

Table 2 – Classification of EEE – European WEEE Directive

1. Large household appliances, such as large cooling equipment like refrigerators, freezers, or equipment for cookers, microwave ovens, etc.
2. Small household appliances, such as cleaning equipment like vacuum cleaners and irons.
3. Information technology (IT) and telecommunication equipment, personal computers, laptops, printers, photocopiers, telephones, cell phones, modems, routers, tablets, data processing management equipment, etc.
4. Consumer electronics, such as radios, televisions, video cameras, musical instruments, etc.
5. Lighting equipment, fluorescent lamps, compact fluorescent, excluding incandescent lamps for homes.
6. Electrical and electronic tools (except fixed industrial tools of great significance) like crushing equipment for coatings.
7. Toys or sporting and leisure equipment, video consoles, trains, electric cars, etc.
8. Medical devices (with the exception of all implanted and infected products), such as cardiology equipment, radiotherapy, dialysis, etc.
9. Monitoring and control instruments, such as smoke detectors, thermostats, control panels, etc.
10. Vending machines for drinks, automated teller machines (ATMs), etc.

Source: (EU WEEE Directive 2002/96/CE, 2002)

The European Directive states that from 2018 onward, all EEE should be grouped into six general categories, as described in Table 3. The United Nations University recognizes these e-waste categories as valid for international use.

Table 3 – Classification of EEE

1. **Heat exchange equipment**: Refers to refrigeration and freezing, such as refrigerators, freezers, air conditioners or heat pumps.

2. **Screens, monitors**: Typical devices include televisions, monitors, laptops, notebooks and tablets. Any device area larger than 100 cm^2.

3. **Large equipment**: Typical equipment includes washing machines, clothes dryers, dishwashers, electric heaters, large printers, photocopiers and photovoltaic panels. (External dimension more than 50 cm).

4. **Lamps**: Typical equipment includes vertical fluorescent lamps, compact fluorescent lamps, high-pressure discharge lamps and light emitting diodes (LEDs). (Including categories 1-3)

5. **Small equipment**: Typical equipment includes vacuum cleaners, microwave ovens, ventilation apparatuses, toasters, electric kettles, electric shavers, scales, radios, video cameras, electrical and electronic toys, small electric and electronic tools, small medical devices, small tools for monitoring and control. (Including categories 1 to 3 and 6. External dimension up to 50 cm).

6. **Small ICT**: Typical devices include cell phones, global positioning systems (GPS), pocket calculators, routers, personal computers, printers and telephones.

Source: (UNU, 2015) and (EU WEEE Directive, 2012/19/EU, 2012)

The characteristics of each of these categories will determine the best treatment process and disposal for their respective equipment after EoL. The logistics of collection, management and recycling of this equipment should be carried out according to its characteristics.

E-waste can come from household, professional, industrial, institutional or other uses. Its generation depends on several factors, including the useful life of the equipment (e.g., computers, televisions, etc.), the need for renewal of the equipment by users (e.g., mobile phones) and major technological changes (e.g., the global system for mobile communications (GSM) to the universal mobile telecommunications system (UMTS) mobile telephony). For example, according to Step Initiative and the Massachusetts Institute of Technology (MIT), the average lifespan of a mobile phone is estimated at three to five years. (GSMA, 2014) This use should be taken into account as it highly contributes to the rapid growth of e-waste globally.

Sustainable management of e-waste

The majority of the e-waste and its components are recycled or reused by formal or informal programmes, depending on the recycling capacities of the country where the e-waste is generated. If e-waste is properly managed, business opportunities can be created to meet the need for reconditioning of equipment and recovery of raw materials. Governments, non-governmental organizations (NGOs) and the ICT sector consider e-waste management a tool and opportunity for sustainable development. (ITU, 2014)

E-waste is a complex mixture of hazardous and non-hazardous materials that requires specialized processes of collection, transportation, segregation, treatment and disposal. It is important to be familiar with the life cycle of EEE to understand its potential environmental impacts. Figure 1 describes the life cycle of EEE and the processes it undergoes once it becomes e-waste.

Figure 1: Life cycle of e-waste

Source: (ILO, 2012)
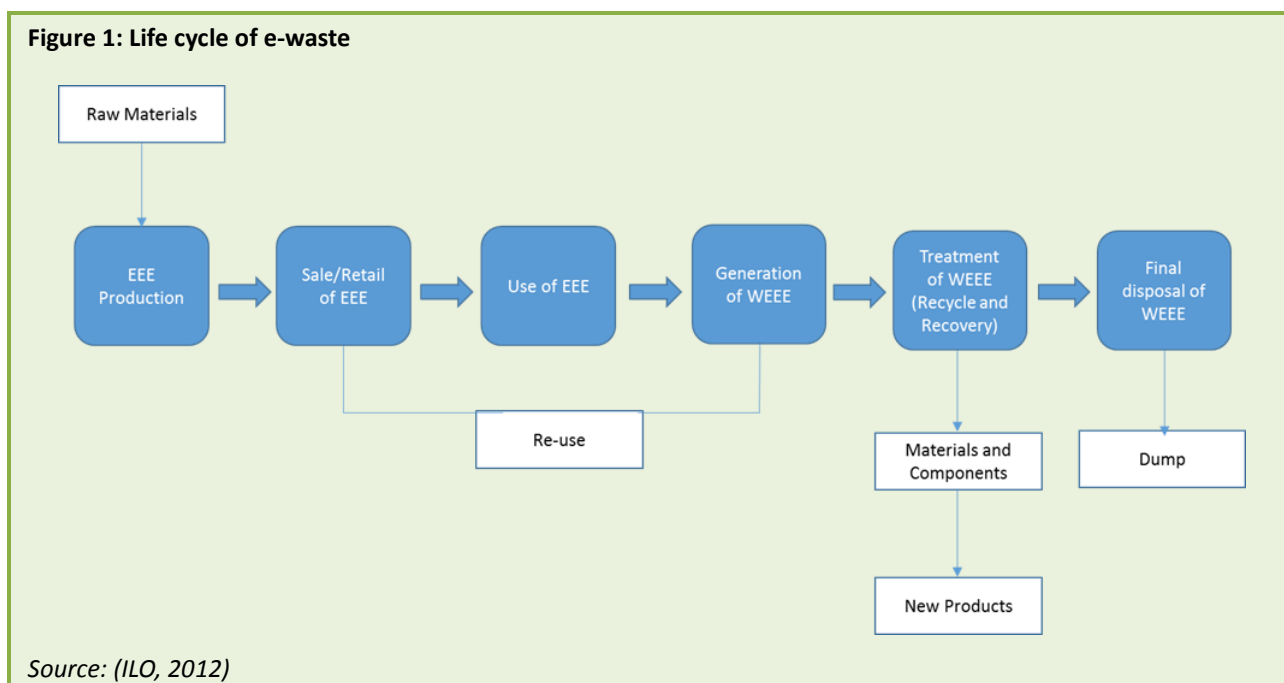
In 2013, ITU published the Toolkit on Environmental Sustainability for the ICT Sector, which addresses the importance of the management of EEE at EoL. It includes e-waste–specifically ICT equipment. The report proposes that if the equipment does not meet the ICT needs of its initial user, it should not be assumed that the appliance is in poor condition or obsolete; it could be useful to another person. The EoL principle suggests that it may be possible to extend its life by reusing the item by other users or for other purposes. Furthermore, the principle also stresses that the component parts and materials can be recovered or recycled at the end of a product's useful life. (ITU, 2013)

In Table 4, there are some basic principles and definitions of environmental sustainability for the management of e-waste. The main aim of EoL management is to extend the use of the component materials through recovery or recycling.

Table 4 – Terminology and management processes of e-waste

Reuse: Extension of the end of life of equipment or component parts to be used for the same purpose for which they were originally conceptualized; this may or may not include a change in ownership of the equipment. This process aims to promote optimal use of available resources, but social or environmental risks associated with poor management should be taken into account.

Dismantling and segregation: This involves careful manual separation of the parts and components of a piece of equipment in disuse. It is suggested that this activity be carried out by authorized recycling companies that specialize in reconditioning.

Recycling and recovery: This process involves the recovery of devices, components and material. The dismantling can be manual or semi-manual. The recovery of materials is part of the WEEE recycling process, especially for metal recovery, which requires specialized facilities and investment.

Refurbishment: This is any process that allows re-utilization of EEE that was previously WEEE. It includes changes in hardware and software.

Final disposition: In the process of final disposal of waste or materials, non-recoverable materials can be disposed of in controlled landfills (dumps) or by incinerating.

Source: (ITU, 2013)

The principles of reduce, reuse and recycle (3Rs) should also be taken into account for the proper management of e-waste in order to minimize the generation of waste throughout its life cycle by employing innovative and efficient processes and technologies. Reuse is an alternative that should include the implementation of a proper collection and refurbishment process. Reusing products has its limitations; it can only temporarily extend the life of the equipment.

Thus, for any decision regarding extension of the lifespan of ICT equipment and other obsolete or inoperative e-waste for material recovery, recycling should be considered. These recycling processes should be carried out using environmentally sustainable management methods and technologies. Some ICT equipment, for example, require specific methodologies and specialized recovery processes that often can only be performed by skilled operators and recycling companies using specialized equipment. (ITU, 2013)

Recycling and recovery of e-waste

The process of recycling of e-waste enables the recovery of metals and/or scarce materials that serve as raw material for the production of EEE. In the report "Recycling: from WEEE to Resources", the United Nations Environment Programme (UNEP) and the Step Initiative emphasize the importance of recycling as a means to contain environmental pollution by controlling hazardous materials contained in e-waste. The study explains that modern electrical appliances may contain up to 60 types of different elements–some of them valuable, others hazardous and some both. Thus, EEE represents the largest source of consumption–and therefore demand–for many of the world's precious and specialized metals. (Step Initiative, UNEP, 2009)

The e-waste recycling chain consists of three activities: collection; classification/dismantling and pre-processing (including sorting, dismantling and mechanical processing); and final processing. The chain, described in Figure 2, often results in separate components or fractions of materials that can re-enter the market for reuse and/or as a source of feedstock for other processes. (UNEP, Step Initiative, 2009)

Figure 2: E-waste recycling chain

WEEE → Collection → Dis-mantling → Pre-processing → End-processing → Recycled metals

Separated components & fractions

Re-use

Handling of final waste

Source. (UNEP, Step Initiative, 2009)
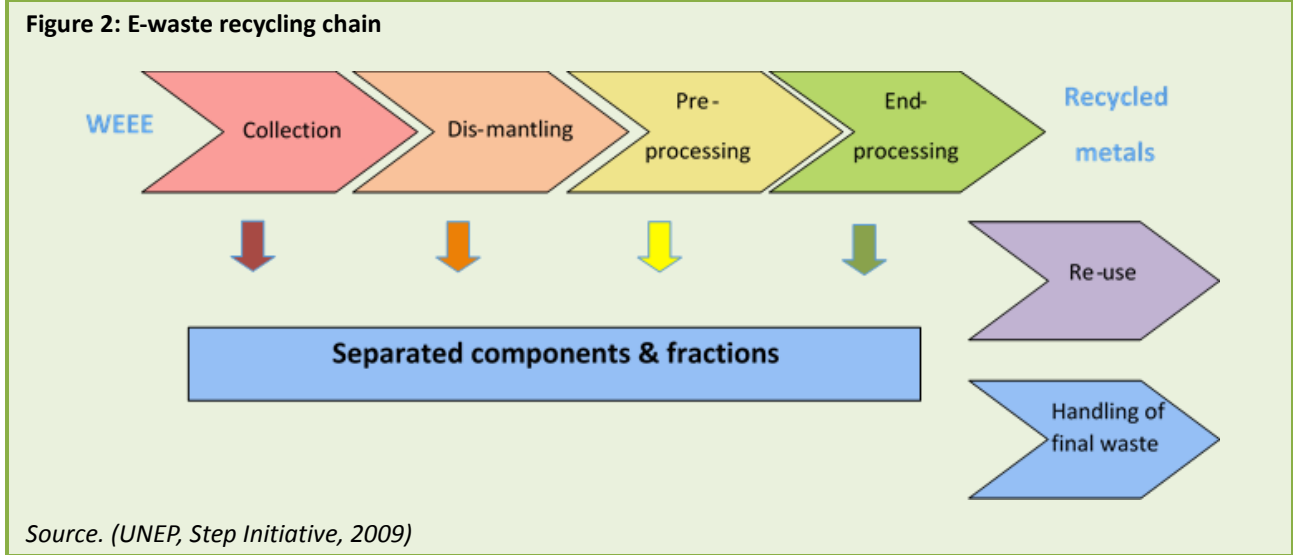
Formal versus informal recycling

E-waste recycling processes are developed either formally or informally. One part of the waste stream is transported to developed countries for controlled recycling, but another part is sent (often illegally) to developing countries, such as China, India, Ghana and Nigeria, for reuse and recycling. In these countries, e-waste is recycled informally by workers that obtain valuable materials by using rudimentary techniques, which causes pollution and affects public health. Additionally, in these countries, there is insufficient technological capacity to treat high amounts of waste that are further added to the existing amount of the local production. (ILO, 2012)

This informal activity does not involve acceptable recycling methods, but it instead involves methods that prioritize obtaining materials with value. The recycling of valuable elements like copper or gold has become a source of income in the informal sector of developing countries or countries with emerging economies.

Increased recycling activities due to the limited availability of natural resources have introduced the concept of "urban mining", or the activity of treating electronic waste to recover metals and other components with the aim of reusing them. While this activity could be quite lucrative and productive in countries where an industry has already been established around it, risks to the health and the environment from uncontrolled and informal processes should be taken into account. (Step Initiative, 2012)

It is important to introduce principles of environmental sustainability within these processes of re-use, recycling and disposal of e-waste globally and in Latin America. These principles must be accompanied by state policies and regulatory frameworks that promote sustainable processes.

2.2 Global, regional and national policies for e-waste management

International environmental law evolved in the early 1970s after the environmental crisis that appeared in the post-industrialization period. The Stockholm Conference (1972), convened by the United Nations General Assembly, opened the international discussion about the environment. In this first summit, the Stockholm Declaration, which established basic environmental principles and implementation, adopted an action plan that led to the creation of the UNEP.

In 1992, the Rio Conference took place. Considered to be the most important milestone for the development of international environmental law, the conference hosted participation from 176 states and more than 1,200 governmental organizations and NGOs. Among the most important results of the conference were the development of two international Conventions (Climate Change and Biodiversity), a Programme of Action (Agenda 21) and the Rio Declaration, which established the guiding principles for environmental protection.

There are principles in international law that are applicable to waste, such as the principles of source reduction, proximity, integrated life cycle and extended producer responsibility (EPR). The latter is particularly important in the case of e-waste. It is a public policy principle that promotes environmental improvements for the full life cycle of products, extending a manufacturer's responsibilities through the product's entire life cycle, with a focus on recovery, recycling and disposal.

The agencies involved in the chain of the product life cycle should take environmental considerations into account as a holistic process. However, in practice, the production and the management for a product after EoL are separate. This is reflected in the legislation that provides, on one hand, a set of rules governing the production, and on the other hand, rules regarding waste management, thereby separating the responsibilities of production and management.

Similarly, the Organization for Economic Co-operation and Development (OECD) defines EPR as an approach to environmental policy that includes a producer's material and/or financial responsibility in relation to a product, extending the stages of its life cycle for post-consumption. (OECD, 2000) Policies concerning EPR have two key characteristics. Firstly, they transfer responsibility to the producer (collection, treatment and reusing and recycling), and they thus displace the responsibility of municipalities. Secondly, they provide incentives for producers to incorporate environmental considerations in the product design. Thus, the life cycle of e-waste is extended, and various stakeholders become involved in the process, ranging from the production companies, distributors, retailers, consumers (e.g., enterprises, private households and governmental institutions) to companies that treat, recycle and dispose of e-waste, including transportation companies in each of these phases.

Likewise, there are several international initiatives that have been created to promote recycling, reuse and recovery of e-waste, among others:

- In 2002, during the 6th meeting of the Conference of the Parties to the Basel Convention, the Mobile Phone Partnership Initiative (MPPI) was developed with the signing of a Declaration by 12 manufacturers entering in partnership with the Basel Convention in collaboration with other stakeholders to develop and promote environmentally sound management of mobile phones at EoL. (Basel Convention 2002) In July 2005, three other telecommunication operators joined the partnership by signing the above-mentioned corresponding Declaration. MPPI developed guidelines on awareness-raising, design considerations, collection of used and EoL mobile phones, transboundary movement of collected mobile phones, refurbishment of used mobile phones, material recovery/recycling of EoL mobile phones and an overall guidance document on the environmentally sound management of used and EoL mobile phones which was finally adopted by the Conference of the Parties in 2011. Following the success of MPPI, parties to the Basel Convention founded the Partnership for Action on Computing Equipment (PACE) to address the challenges related to computing equipment. (Basel Convention, 2010) PACE developed guidelines on environmentally sound testing, refurbishment and repair of used computing equipment and on the environmentally sound material

recovery and recycling of EoL computing equipment. An overall guidance document on the environmentally sound management of used and EoL computing equipment is currently under development.

- The Step Initiative, as previously mentioned, was created in 2007 to jointly resolve the problem of e-waste on a global scale. It is led by the United Nations University, and it was established in order to build an international platform between stakeholders, including, country representatives, and representatives from producer groups, recyclers, refurbishers, academia, NGOs and international organizations for the exchange of information about e-waste management systems to increase and coordinate worldwide efforts for sustainable management of e-waste.

- The National Administration of Electronic Products (National Electronics Product Stewardship Initiative (NEPSI)) is a multi-stakeholder dialogue that aims to develop a framework for a national e-waste management system in the United States. The dialogue includes representatives from electronic product manufacturers, traders, state and local governments, recyclers, environmental groups and others.

- The Swiss E-waste programme SECO/Empa was developed from 2003 to 2011 by SECO (State Secretariat of Economic Affairs, Switzerland) and implemented by the World Resources Forum and EMPA (Swiss Federal Laboratories for Materials Science and Technology) in cooperation with partners and local authorities among others to assess and improve e-waste recycling systems in different parts of the world, including Latin American countries such as Peru and Colombia, by system analysis and exchange of knowledge about recycling techniques and frameworks.

2.3 International legal frameworks applicable to the management of WEEE

Within the international regulations applicable to WEEE, there are global instruments that apply indirectly to this type of waste, such as the Basel Convention, the amendment to the Basel Convention that bans the export of hazardous waste, the Montreal Protocol, the Stockholm Convention and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.

There are also other policy instruments used to stimulate greater accountability and strengthen the responsibility of producers, including those of waste management. As a result, a regional policy emerged as Directive 2002/96/EC of the European Parliament and the Council of 27 January 2003 and its subsequent amendments Directive 2003/108/EC of the European Parliament and of the Council of 8 December 2003, which included an article referring to the relative funding of WEEE from private households. The latter was one of the first special rules on the treatment of WEEE. (EU WEEE Directive 2002/96/EC, 2002)

The aforementioned Directive was revised for a better understanding and application in the Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on WEEE. The previous Directive was repealed in February 2014. (EU Directive WEEE 2012/19/EU, 2012) This Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts resulting from the generation and management of e-waste. It also aims to reduce the volume of e-waste going to landfill. Additionally, this directive aims improve the environmental performance of all operators involved in the life cycle of EEE. These operators include producers, distributors, consumers and, above all, operators directly involved in the collection and treatment of e-waste.

There is an EPR defined in the Directive related to ecological product design, collection of old equipment, systematic treatment of hazardous components as well as refurbishing and recycling of usable components. The Directive requires the producers to recycle 45 per cent of sold appliances by 2016 and 65 per cent by 2019.

The same European Directive has served as a reference in formulating various projects in Latin America. Currently, all Member States of the European Union (EU) have a legislation on e-waste management. This is also a goal for Latin America.

In addition to political and business actors, the general public should also address the problem of e-waste. Environmental education serves to teach consumers to take responsibility for the e-waste they produce. Likewise, the media can strengthen consumer awareness regarding the management of e-waste as an important part of the life cycle of consumer appliances.

3.   Environmental pollution and impact on health

Latin America is not unfamiliar with the emerging problem of pollution caused by e-waste. As previously mentioned, in 2014, 42 million tonnes of e-waste were generated worldwide, of which about 8.6 per cent came from the region. The details of the generation of e-waste in Latin America are described in Annex 1. (Baldé et al., 2015)

The recycling of e-waste to obtain items such as gold and copper in the informal sector often illegally provides opportunities for vulnerable sectors. These processes directly and indirectly affect the health of vulnerable populations, including the workers themselves, children and pregnant women. Hazardous exposure for workers in the e-waste recycling sector and their families may arise from the type and quantity of e-waste, processing time and the methods employed.

Toxic substances from e-waste can move into the ecosystem through multiple routes, including water, air and soil, where they can enter the food chain leading to indirect exposure. The extent to which e-waste contamination contributes to adverse health effects is difficult to determine. However, the negative effects on health are noted to be more significant for communities living in areas where informal recycling takes place. (Environmental Health Perspectives, 2015).

The legal and regulatory framework for e-waste management is non-existent in most Latin American countries, and where it exists, it does not include explicit provisions for the protection of health. In general, recycling activity is dominated by the informal sector. (WHO, 2014)

E-waste and artisanal recycling processes (which may include combustion) are a source of environmental exposure to a mixture of compounds of known toxicity, such as lead, mercury, cadmium, chromium, polychlorinated biphenyls (PCBs), brominated flame retardants and polycyclic aromatic hydrocarbons, as well as unintentional persistent contaminants, such as dioxins and furans, among others. These compounds are a source of pollution and also a risk to human health if improperly managed.

Globally, several studies have highlighted the negative effects of exposure of high levels of the above-described compounds on working adults, pregnant women and children. The number of studies related to these exposures has increased with cytogenetic alterations in cell function and adverse health effects, including impairment of the immune, cardiovascular, gastrointestinal and endocrine systems, perinatal complications, such as premature delivery, restricted intra-uterine growth, reduced neonatal lung function and neurobehavioral changes in the childhood. However, the restrictions on the number and the design of the studies prevent an accurate estimation of doses and effects of specific exposures.

In addition to toxic exposure, informal recycling of e-waste can cause lacerations when components are dismantled (children are often utilized for these tasks due to the small size of their hands) or burns when acid baths are used to separate substances of commercial interest.

In the Central American regions of the Andean Altiplano and the American Southern Cone, exposure occurs mainly in the areas of greater social vulnerability, which are not always accounted for, as their geographical distribution may be dispersed. This makes monitoring and controlling the activity difficult and increases the risk of human exposure. Many of these workers function in unprotected conditions while recycling, dismantling and burning WEEE. In many cases, waste recycling represents the largest source of family income. (Restrepo et al., 2010)

For example, e-waste recycling in Uruguay–particularly cable burning to obtain copper–is a source of lead exposure for children living in the vicinity of the burning point. The casuistry of the Environmental Paediatric Unit of Uruguay found that 24 per cent of children had lead levels in their blood above 5 µg/dl (micrograms per decilitre). The source of exposure was a burning point in the children's immediate vicinity.

Children can also be exposed in different ways, such as by dwelling in homes where recycling or manual WEEE dismantling is performed; living or studying alongside land contaminated by such activities; doing informal work; their parents defiling of the home environment through their exposure at work; or through contact with the hands or work clothes of parents who work in informal recycling. When recycling is done informally, there is no protection for workers or their families. Adult workers should have access to effective protection equipment, and children should not do this work or be exposed to environmental pollution resulting therefrom.

Urban settlements exist in Latin America where many generations of families live for decades in places where the land was filled completely or unevenly with industrial waste making the area a source of electronic waste contamination in some cases. It is important to note that in countries that have yet to implement selective collection of recyclable waste, e-waste is mixed with domestic waste deposits. In these countries, there is frequent open burning of waste, which has the potential to expose those living nearby to toxic fumes.

The World Health Organization (WHO), in coordination with its collaborating centres and international network, defined areas that require immediate attention. These areas identified include: promoting research on the effects of e-waste and policy options; introducing interventions that protect the health of vulnerable populations; and training key agents involved in various levels of decision-making, especially in the health sector, to support regulatory processes and interventions around the issue of e-waste in all countries.

Decision-makers in each country's health field must recognize e-waste as a potential risk to public health, and they should coordinate with other sectors to ensure the regulation of e-waste recycling activities and the protection of those that come into direct and indirect contact with the waste stream.

4. Analysis of the political and regulatory context for e-waste in Latin America

In the last few years, there have been several analyses of the legal and regulatory frameworks of e-waste in Latin America. While most of them identified the existing legal loopholes, this study goes further. It addresses critical issues in the regulatory context of e-waste in Latin America such as the existence of specific regulations and models of governance for implementation. The analysis has been conducted in collaboration with the governmental representatives from the region's countries.

This analysis also includes a country-by-country evaluation of ad hoc e-waste public policies and inter-institutional cooperation mechanisms with actors in the ICT sector and those involved in the management of e-waste. Furthermore, it explores whether countries have the institutional and technical capacity to manage and dispose of this type of waste. The analysis also addresses issues such as EPR to explore if they are integral to the responsible management of e-waste at the national level. Additionally, it reports whether or not these countries have ratified the Basel Convention in due time and it addresses each country's unique challenges and their respective plans to overcome them in the near future.

It is important to mention that there are several international initiatives focused on the definition and enhancement of appropriate legal frameworks around e-waste in Latin America. One of them is from the United Nations Industrial Development Organization (UNIDO), which is developing a project entitled "Strengthening of National Initiatives and Enhancement of Regional Cooperation for the Environmentally Sound Management of Persistent Organic Pollutants (POPs) in e-waste in Latin American countries". The countries included in the project are Argentina, Bolivia, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Peru, Uruguay and Venezuela. This project will be funded by the Global Environment Facility (GEF), national agencies and the private sector. The project aims to provide technical assistance on policies, operations, legislation, technology and awareness on the subject. At the national level, it will help to strengthen policies and the training of technicians and public officials, as well as the development of information and awareness on the subject. UNIDO is expected to strengthen the existing infrastructure at the regional level to promote regional cooperation, information exchange systems, knowledge management and harmonization of the key aspects of the e-waste policies. (UNIDO, 2014)

Another important initiative in the region is conducted by the Global System for Mobile Communications Association in Latin America, GSMA Latam. This industry body has analysed the impact of the regulatory framework of e-waste on the environmental sustainability of waste management in the telecommunication sector. The current status of the e-waste legal framework applicable to mobile operators is described in Annex 3. (GSMA, 2014)

4.1 Argentina

In Argentina, national regulations pertaining to the legislation of e-waste are currently dispersed and unstandardized. The regulatory framework must be strengthened. In this regard, it is noteworthy that the country's congress discussed an important draft national law on the management of this waste stream. However, this draft national law lost its parliamentary status in late 2012.

In 2011, the Provincial Legislature applied Law No. 14.321 that established a set of guidelines, obligations and responsibilities for the sustainable management of e-waste in the Province of Buenos Aires, and it is mentioned in the Regulatory Decree N.2300/11.

Law No. 2807 establishes measures to enable the sustainable management of EEE which has been discarded and declared as non-patrimonial property within the executive power of the Autonomous City of Buenos Aires only.

The country's constitution protects the right to a healthy environment in accordance with the provisions of the Basel Convention, which Argentina has ratified as described in Annex 2. At the same time, the constitution stipulates in Article 41 that "all citizens have the right to a healthy and balanced environment suitable for human development", and that "the authorities shall provide for the protection of this law and environmental information and education". The Article also states, "it is prohibited to bring in waste that are dangerous or potentially hazardous into the country".

The current legal framework applicable to the subject of waste is Law No. 24.051 on Hazardous Waste, which regulates the generation, handling, transportation, treatment and final disposal of hazardous wastes listed in Annex I of the act in accordance with the precepts by the Basel Convention, which applies in situations where waste is subjected to transboundary movements for disposal or recovery.

It is important to note that Argentina is part of a regional and international initiative Agreement of the Southern Common Market (Mercosur). The country allocated a part of the financing granted by the initiative to study and establish good practices in the area of e-waste management.

Recently, Argentina's Ministry of Energy implemented through Resolution No. 48, April 2015, the incentive programme "Renovate", which promote entities that sell appliances with a single payment of financial compensation. This will allow them to deliver new appliances to the user for a promotional price. On their side, traders should ensure the removal of the aftermarket goods from the consumers' homes and their subsequent transfer to e-waste operators for decontamination, dismantling and destruction at no cost to the consumer.

As for public policies, the legislation is limited and unspecific. As a result, there is no national system that ensures the appropriate environmental management of e-waste in Argentina. The heterogeneity of the regulatory frameworks limits the potential and reduces the impact by the other actors in the absence of institutional programmes whose clear role would be to encourage the proper management of e-waste.

It is important to highlight the work of the National Institute of Industrial Technology (INTI), which has solid initiatives, including the National Programme for Management of Waste of Electrical and Electronic Equipment, a joint project of municipalities and civil society that includes the building of e-waste processing plants that could eventually be managed by work cooperatives. This institute, with the cooperation of the Secretariat for Solidarity Economy of the Municipality and Nodo TAU, developed a project for recycling and reconditioning e-waste that should be managed by a cooperative. Nodo TAU is a non-profit civil society association of professionals from the ICT sector, educators and social activists dedicated to facilitating access to new information technologies for community organizations in the region.

Argentina has undertaken international and regional commitments regarding the treatment of waste, including e-waste. These are the Basel Convention and the Southern Common Market (Mercosur) Agreement. Additionally, there are specific and concrete initiatives undertaken by the national government, which consist of campaigns and seminars. There is also a programme led by the Ministry of Education for recycling computers for use in public schools. The school project has a repair and recycling workshop component meant to create job opportunities.

As for the recycling industry, the country relies on associations and organizations that assume this task for economic purposes with a commitment to sustainable development and environmental protection. Some foundations offer training programmes to urban recyclers to improve the quality and specialization of e-waste management.

The major challenges facing Argentina are the lack of relevant information for the public, as well as users' and other sectors' lack of awareness of the integrated management and disposal of these wastes. Argentina has conducted training, informational workshops and other measures to overcome these challenges.

4.2   Plurinational State of Bolivia

Bolivia has no specific regulations regarding e-waste. However, it has developed a working group with representatives from the public and private sectors aimed at developing specific technical standards for sound e-waste treatment at the national level.

Currently, the country has no formal recycling initiatives, although its government has carried out several recycling campaigns to raise awareness about the management of waste. There are several associations and private companies engaged in the disposal of e-waste operating in La Paz, Cochabamba and Santa Cruz. The private companies that work in this field, despite their efforts in e-waste management, lack adequate technology, and the management is mainly based on the storage and subsequent manual dismantling of e-waste. This has led to an exponential increase in the informal treatment of printed circuit boards and e-waste disposal.

Currently, Bolivia does not have public policies on e-waste. However, at the governmental level, the country established a joint working group called the Ministry of Environment and Water and the Ministry of Production Development and Plural Economy to meet the challenge of e-waste management. This inter-ministerial work favours the eventual development of state policies and training programmes. The ICT sector is expected to be more active in Bolivia, in order to cover the legal gaps in the management of e-waste.

The EPR principle is applied in the absence of legislation related to the sector. The application of this principle is expected to become more relevant in the near future for the Plurinational State of Bolivia, which has signed the Basel Convention (see Annex 2).

One of the greatest challenges Bolivia faces is the absence of rules, regulations and strategies for the proper management of e-waste. It is necessary to strengthen national initiatives and the capacities in the installation and infrastructure of e-waste dismantling and recycling. Bolivia actively participates with UNIDO on the "Strengthening National Initiatives and Improving Regional Cooperation for the Environmentally-Sound Management of POPs in Waste of Electrical and Electronic Equipment (WEEE) in Latin America" project, which serves as a baseline for development work of other related projects.

4.3   Brazil

Brazil has a national law called the "Law of the Garbage", which states that everyone has a responsibility concerning the generation of e-waste. This responsibility applies to manufacturers, traders, government officials and consumers.

In the specific case of e-waste, Federal Law No. 12.305 was approved on 5 August 2010 by the National Solid Waste Policy, where it has been carried out to ensure proper treatment of e-waste. Moreover, State Law No. 13.576 (enacted in July 2010) was enacted in the City of São Paulo for the establishment of rules and procedures for the correct and proper recycling, management and disposal of e-waste. Brazil signed the Basel Convention in 1993 through Decree 875/1993.

The Brazilian regulatory frameworks include the principle of shared responsibility (PSR) regarding EEE's life cycle. These frameworks also recognize solid waste as reusable and recyclable waste, considering it as an economic asset whose value is also social, as it has been deemed a generator of income and jobs. (Ministry of Water Resources and Urban Environment, 2014)

The above-mentioned regulations also include instruments aimed at creating national policies and action plans for e-waste and solid waste in general. In addition, they include guidelines for selective collection, and also highlight the importance of reverse logistics systems.

Brazil has specialized companies that manage e-waste. Once collected, discarded devices go through a process of reverse logistics, where each component part is dismantled, removed and then individually classified. The recycling companies process the recycled materials to obtain raw materials such as plastics, iron, aluminium, wires and cables. Generally, hazardous substances are neutralized through specific chemical processes.

During the recycling process, some materials, such as monitors, cathode ray screens or cathode ray tubes (CRTs) are recovered. Some types of batteries and mercury lamps necessitate a difficult or expensive process of decontamination, and they are also locally managed.

Brazil's regulatory framework also includes other binding instruments, such as Regulatory Decree No. 7404 of 201 and Law No. 9605 of 1998, which dictate that criminal and administrative penalties will be eventually applied as a result of environmentally damaging behaviours and activities. Locally, the State of Rio de Janeiro has Law No. 4.191 of September 2003, which provides for the state policy of solid waste and other measures.

Decree No. 40.645 of 2007 mandates the separation of recyclable waste that has been discarded either directly or indirectly by state agencies and entities and assigns this waste to recycling associations and cooperatives, among other measures. Similarly, Law No. 12.30 of August 2010 institutes the National Policy on Solid Waste, and it modifies Law No. 9.605 of 12 February 1998.

4.4   Chile

Chile does not have specific legislation for e-waste management. Currently, the Sanitary Regulation on Management of Hazardous Wastes requires e-waste to be treated as hazardous waste. There is an on-going debate at the Chilean Congress on a draft general law on waste management that introduces, among other things, EPR for EEE. This draft states that the organization in charge of e-waste regulation is the Ministry of Environment. It also establishes the responsibility of producers of priority products to inform customers about the products they put on the market, including their collection process and valuation.
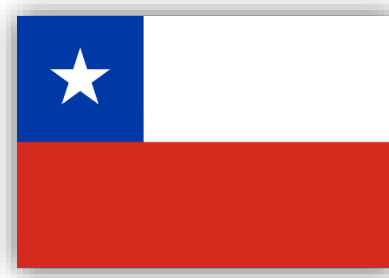
With regard to the stakeholders involved in e-waste management, Chile has three authorized companies and reconditioning programmes that manage this waste stream. These companies are involved in EEE dismantling, the subsequent delivery of recyclable components abroad and sending the other components to their final disposal process. If these are hazardous waste, they are sent to a secure landfill. The reconditioning programme also restores the used EEE for reuse. This programme was designed a few years ago with the aim of bridging the digital divide.

One important aspect in the implementation of EPR is the management of information. Within this scheme, Chile recently enacted the Regulation on the Pollutant Release and Transfer Register (PRTR) (approved and published in May 2013). It consists of an easily accessible database for the general public, which is designed to capture, collect, organize, store, analyse and disseminate information on emissions, waste and transfers of pollutants that are generated in industrial or non-industrial activities or transferred for recovery or disposal. On this record, there will be systemized information classified by the type of source or group of sources, the nature, flow and concentration of pollutant emissions that are subject to standardization on emission. (Platform RELAC, 2015)

Additionally, the register will include the statement or estimate of emissions, waste and transfers of those contaminants that are not regulated by an emission standard, a decontamination plan or other current regulations. This register will be applicable when these emissions correspond to diffused sources or in case these emissions are treated, based on international agreements signed by Chile. The estimates will be done by the Ministry of Environment through the information provided by the various bodies of the State Administration. Additionally, the register will record the nature, volume and destination of solid waste generated by those establishments, in accordance with the provisions of the regulation.

The PRTR in Chile has proposed the completion of various objectives that are described below:

a) To facilitate access to information regarding emissions, waste and transfers of pollutants;

b) To promote awareness for the general public;

c) To establish a support tool for the adoption of public policy and regulation;

d) To establish a tool that favours the design of environmental management policy aimed at reducing pollution and moving towards sustainable development;

e) To provide the people involved in regulated e-waste recycling with information on emissions, waste and transfers of pollutants;

f) To seek to generate better environmental management of emissions, waste and transfers of pollutants from the industry and municipalities; and

g) To create the Single Window System as the only form of access and reporting in order to concentrate the reported information in a database, allowing the approval and facilitation of the delivery of information from the required stakeholders.

Additionally, this draft general law on waste elaborates that in the PRTR, the information given below should be included in the enactment of the principle of EPR:

a) Producers of priority products;

b) Authorized management systems;

c) Distributers or marketers of priority products, where appropriate;

d) Authorized agencies;

e) The compliance with collection and valuation goals; and

f) And any other information that is stated in this regulation.

Currently, if any stakeholder wishes to develop a waste recycling project or activity, they need a health authorization granted by the Regional Sanitary Authority. Additionally, the project must be evaluated preventively through the System of Environmental Impact Assessment (SEIA), an agency under the Ministry of Environment. The final permission is from the Environmental Qualification Resolution (EQR), which is enforceable by the Superintendent of the Environment.

Chile has ratified the Basel Convention (see Annex 2).

4.5   Colombia

The Republic of Colombia has a specific law on the integrated management of e-waste. Law No. 1672 was published in 2013, and it sets guidelines for the adoption of a public policy for the integrated management of e-waste generated in the country's territory.

For the purposes of the application of this law, some guiding principles are taken into account, such as EPR and the active participation of producers, traders and users. Likewise, the law includes principles such as the creation of incentives, decentralization, innovation in science and technology, product life cycle considerations, sustainable consumption and pollution prevention. These concepts have been the main challenges in the country, and it is expected that this legislation will provide assistance in overcoming them. Law 1672 of 2013 is still under regulatory process, and it is expected to have been enacted in 2015. It includes the concept of EPR.

In addition, Resolution No. 1297 of 8 July 2010 should be mentioned, which established, among other previsions, the separation of collection systems and environmentally sound management of potentially hazardous waste, such as batteries.

There is also Resolution 1511 of 5 August 2010, which established, among other things, a separate collection system and environmentally sound waste management of bulbs. Moreover, Resolution 1512 of 5 August 2010 established, among other provisions, a separate collection system and environmentally sound waste management of computers and/or peripherals.

It is also important to mention that Colombia has approved the Basel Convention in 1996, under Law 253.

In regard to public policy, Columbia's congress established guidelines for the adoption of a policy for integrated management of e-waste. The Ministry of Environment and Sustainable Development is currently formulating the policy and certain obligations of the different public and private actors involved in the management of e-waste on the basis of compliance with these policy guidelines. Within the framework of the Policy of Production and Sustainable Consumption, some post-consumer programmes have been implemented that force producers to implement selective collection systems and environmentally sound management of e-waste.

Regarding associations dedicated to the disposal of this waste stream, there are currently collective management systems for computers and peripherals, lamps and batteries. Producers should individually or collectively implement collection schemes and environmentally sound management systems for e-waste.

Colombia does not have technology for end-processing all types of e-waste fractions. E-waste managers use neither automated nor semi-automated technologies for the disassembly and recovery of materials; the removal is done manually, and the recovered parts are exported to other countries for recycling and raw material recovery.

Manual processes for the preparation for reuse, recovery and disposal of e-waste are considered an important source of employment and business development, given the demand for the treatment of e-waste. Furthermore, the development or adoption of technologies for the recovery of highly valued commodities (precious metals, rare earths, etc.) can also encourage foreign investment, research and technological development.

Colombia's Ministry of Environment and Sustainable Development and the Ministry of Information Technologies and Communications have been working together to deal with the growing problems associated with e-waste management. Law 1672 of 2013 established obligations under the competencies of various government ministries and national entities in order to strengthen the comprehensive and environmentally safe management of e-waste. It is important to emphasize the active participation by the government (Ministry of ICTs with Computers for Education and other agencies) and the production sector (producers of EEE through the collective or individual collection systems).

Since 2008, Colombia has been receiving financial support from the Swiss cooperation SECO and the Swiss Federal Laboratories for Materials Science and Technology (EMPA) to generate statistics on e-waste. Assessment studies have been conducted to estimate e-waste generation with support from the National University of Colombia about the post-consumer waste, such as lamps and primary and secondary batteries. Some estimates of the apparent consumption of EEE in Colombia were thus derived. In spite of this, Columbia's current total generation of e-waste is still unknown.

Despite having specific legislation on the issue, Colombia still struggles with some management challenges. One challenge is the lack of technological alternatives competitive in the market against alternative disposal in secure landfills. Another is the definition of a model that allows the country to invest in the process of e-waste full recovery as a strategy to further technological and economic development. Colombia hopes to promote this combination of economic development and technological innovation, which could be a source of green jobs (skilled and unskilled labour) for the processes of reuse, valuation, disposal and recovery of raw materials of high economic value through the use of advanced technologies.

In order to solve these issues, the government plans to establish policy and regulatory instruments to adopt technical standards for e-waste management and to develop technologies for the recovery or disposal of the substances, mixtures or hazardous components of e-waste, etc. It also expects the implementation of national policies that promote and direct international cooperation, foreign investment or local investment in research, development and adoption of such technologies for the proper management of e-waste.

4.6   Ecuador

Ecuador has had national regulations for hazardous waste since the Constitution of the Republic of Ecuador published Article 15 in 2008, which prohibits the introduction of hazardous waste into the country. Ecuador ratified the Basel Convention on 24 May 1993.

The country has had an existing law of Environmental Management since 1999 and a secondary law called "Unified Text of Secondary Legislation of the Ministry of Environment". The latter established the management system of hazardous waste, which was initially based only on the responsibilities of the producers to the level of production and service sectors, as well as the managers that regulate the generation of hazardous waste.

In February 2012, the Ministry of Environment of Ecuador (MEE) established EPR in the Ministerial Agreement No. 161 on the "Regulations for the Prevention and Control of Pollution of Hazardous Chemicals, and Hazardous and Special Wastes", which amends the first system. Additionally, it establishes the framework for the National Control System of the Management of Hazardous and Special Waste, as above mentioned, by the establishment of the EPR principle (applicable to the importer), which implies the involvement of actors, such as domestic manufacturers and importers of products.

This approach covers waste generated from products of massive consumption. In particular, regarding e-waste, the MEE published in January 2013 in the Official Gazette No. 881, the National Policy on the Post-Consumer of Electrical and Electronic Equipment by the Ministerial Agreement No. 190 whose overall objective is to establish the management model of disused EEE under the principle of EPR and active participation of the state and the population. The Agreement lists e-waste as a stream of hazardous and special wastes. Therefore, the "precautionary principle", the "principle of cradle to grave" or "the polluter pays principle" are enacted through policy.

In order to meet the overall objective of establishing a post-consumer policy to manage e-waste, specific policies have been developed. These policies establish environmentally appropriate management guidelines for this type of waste, based on the applicable environmental legislation. It significantly contributes to the protection of the environment, since it reduces the environmental impact by the improper disposal of waste in dumps or landfills. Furthermore, other impacts are avoided in the case of open burning.

Ecuador has enacted Ministerial Agreement No. 191, which instructs the management of discarded cell phones. The agreement sets a target to collect 3 per cent of discarded cell phones and creates control mechanisms for importers and managers of these devices. (RECICLAMETAL, 2014) The instructions are derived from the policy set out in the Ministerial Agreement No. 190, as disused cell phones are a part of the e-waste stream. For the specific case of obsolete handsets, besides the Ministerial Agreement No. 191, the country has regulations established by the Committee of Foreign Trade (COMEX), issued as follows:

- Through Resolution No. 067 of June 2012, COMEX restricts the import of cell phones by quotas, which were distributed among 33 importers as determined in Annex I of the Resolution.

- The MEE established a cell phone recycling policy which suggests a recycling rate for calculating the quota in addition to the normal quota set out in the Resolution.

- Through Resolution No. 69 of July 2012, COMEX replaces Annex I of Resolution No.67, recalculating the annual import quotas.

- Through Resolution No. 100 of December 2012, COMEX sets the maximum additional quota that can be accessed by the importer at a rate of a 2.5 to 1.

Under the Ministerial Agreement No. 191, importers and domestic manufacturers of mobile phones have to present a plan for the management of such equipment when they are beyond their usable life cycle. Likewise, they are required to report to MEE each month on the amounts of unused and collected cell phones that are handed over to the managers, who also forward a monthly statement of management.

COMEX oversees the number of normal and additional cell phones imported. In that regulatory framework, the MEE sends COMEX data (based on data declarations), which COMEX uses to calculate the number of additional units to import over the normal import quota, taking the rate of 2.5 to 1 as a parameter, or alternatively 5:2, which means that for every five managed cell phones, the importer may bring in two pieces of equipment above the normal import quota.

As a result, between July 2013 and December 2014, 587,732 cell phone units were collected, which were delivered to managers for the separation of components, dismantling and export.

With this regulation, the country pursues its mandate to:

- Comply with the provisions of Articles 396 and 397 paragraph 3 of the Constitution of the Republic of Ecuador;

- Strengthen the country's environmentally sound management of hazardous and special wastes to combat pollution to the environment; and

- Strengthen the changing behaviour patterns of consumers, importers and manufacturers, guiding them to take more responsibility for the quality of the products they respectively consume, import and manufacture and to make them responsible for waste management in conjunction with the state.

In general terms, any person or company that generates e-waste has to deliver it to the authorized operators. Currently, the country's management companies reach the stage of primary dismantling and subsequent export of the components, which is subject to the Basel Convention. At the moment, there are nine managers who have an environmental permit for different stages of waste management (storage, transport and dismantling).

In 2015, the MEE was formulating a proposal concerning the technical standard for the implementation of EPR for obsolete EEE. These instructions shall elaborate on the management responsibility of manufacturers or importers, and as in other post-consumer policies, it will also establish an annual collection target for the country.

In turn, the country will participate as a part of the UNIDO Regional Project of E-waste Management in Latin America.

4.7   Paraguay

Paraguay does not have a specific law on e-waste; however, in its constitution, there are several items that protect the right to a protected environment and other related rights. There are issues related to protecting the environment in the following articles: "the Quality of Life" (Article 6), "the Right to a Healthy Environment" (Article 7), "Environmental Protection" (Article 8) and "the Right to Health" (Article 68).

Moreover, there are several laws, such as No. 1.561/2000 that establish the National Environmental System, the National Environment Council and the Ministry of Environment. These government agencies coordinate all matters relating to the definition, monitoring and evaluation of environmental policies.

Law No. 42/90 prohibits the import, storage and use of industrial wastes considered hazardous or toxic, and it establishes penalties for non-compliance. Paraguay also has Law No. 294/93 in its environmental regulatory framework along with its corresponding regulatory decree that mandates the completion of an impact assessment prior to all types of human activities that could potentially affect the environment.

The country has enacted the Solid Waste Act and Law No. 3956 (Gestión integral de los residuos solidos en la República del Paraguay/ Integral management of solid waste in the Republic of Paraguay), in which the Environment Secretariat was appointed as the country's enforcement authority. The Paraguayan Penal Code entered into force in 1997, by Law No. 1.160/97, which defines and punishes crimes affecting the environment. The Public Ministry created a special unit on crimes against the environment to ensure compliance with current legislation.

At the international level, the Basel Convention was adopted by the Republic of Paraguay by Law No. 567 of 1995.

The absence of legislation and the lack of specific rules for e-waste create a worrisome situation regarding the treatment of this waste stream in the country. Its relevant institutions have started to focus more closely on this issue in order to find solutions to associated problems. One of these problems is the general public's lack of awareness concerning the proper disposal of waste in Paraguay.

The country's main solid waste landfill, Cateura, covers collection for the city of Asunción and other surrounding cities, and it is in the process of being optimized. Due to increased media visibility as a result of this situation, the population has been made more aware of the importance of waste management.

In the studies available on the type and volume of generated waste in the country, the presence of e-waste is not specifically mentioned. It is understood that e-waste, in general, is assimilated into solid waste in Paraguay.

In 2002, Paraguay's Ministry of Planning stated that the management of solid waste requires major improvements. The average generation rate of urban solid waste in the country ranges from 0.5 kg to 1.8 kg per person per day. According to a 2008 report by the General Directorate of Statistics, Surveys and Censuses (DGEEC), the portion of the urban population with access to residential garbage collection services had risen from 57 per cent in 2002 to 58.6 per cent in 2008. The collection activity was conducted by municipalities in 66 per cent of these cases, while 30 per cent of the cities used the services of private companies, and in 4 per cent of the cases, there was a combination of both. As a result, it is estimated that 72 per cent of the country's solid waste is disposed of in open dumps, 24 per cent in controlled landfills and 4 per cent in controlled and manually operated landfills. This situation is probably due to the absence of sanitary landfills in the country. Thus, Paraguay's municipalities are working to establish selective and appropriate collection systems of waste and recycling programmes in the cities. (SIGRAEE, 2014)

4.8   Peru

Peru's ICT sector has an accelerated growth process, which has contributed to new social and environmental problems, including the problem of managing and controlling increasing amounts of obsolete EEE and its components, especially those from the ICT sector. The sale of EEE has increased in recent years, and it is only a matter of time before this equipment is discarded by its users and becomes waste. Technological progress means major improvements in the quality of life for the population. However, this progress has harmful, accumulating effects on the environment, such as an increase in e-waste generation, which need to be managed and treated properly.

Studies supported by the Swiss Cooperation in Peru indicate that by 2015, approximately 150,000 tonnes of e-waste will be generated, mainly comprised of used computers and communication items. (Ministry of Environment of Peru, 2014) The country has about 25.9 million cell phones and 4 million computers in use. On average, cell phones are replaced every two years, and computers (including desktops and laptops) are replaced every five to seven years. The items are replaced, either because they have completed their respective life cycles, or because the advancement of science and technology renders it obsolete, thus converting it to e-waste.

Peru has a specific regulation for the management of e-waste under the Supreme Decree N. 001-2012 by the Ministry of Environment called the "National Law for the Conduct and Management of Waste of Electrical and Electronic Equipment". This law describes the rights and obligations related to the proper waste management of these devices through the different stages of management (i.e., generation, collection, transportation, storage, treatment, reuse and disposal). It involves different actors in the responsible management process. Furthermore, it aims to improve the living conditions of the general public and mitigate e-waste management's impact on the environment and human health.

This regulation establishes the responsibilities of the actors involved in e-waste management and EEE production. It proposes cooperation among municipalities, operators of e-waste and consumers or users of EEE, so that they assume responsibility for some stages of the management as part of a system of shared and differentiated responsibility integrated into the management of solid waste.

Peru also has enacted the Solid Waste Act No. 27314 of 2000. This law applies to activities, processes and operation management from generation to final disposal of wastes, including solid wastes, generated in the all economic sectors. The law also covers deposit activity and transit of waste throughout the country.

Regarding the state public policy, the Ministry of Environment developed public campaigns to collect 21 tonnes of e-waste in 2010 and 2011 in Lima. In 2012, 14 tonnes were collected in Lima, Callao, Huancayo and Trujillo. In Arequipa, they succeeded in collecting about 22 tonnes of e-waste. The waste was recycled and treated properly by authorized e-waste operators. Additionally, two e-waste management plans for private sector entities guaranteed by the State were approved at the end of 2013. (Ministry of Environment of Peru, 2014)

Peru's government partnered with the private sector to promote and carry out a project for the management of e-waste called "Corporate Social Responsibility for the Management of Waste of Electrical and Electronic Equipment in Peru – PERU e-waste", which is a collaboration between the Ministry of Environment, the Swiss State Secretariat for Economic Affairs and the Swiss Federal Laboratories for Materials Science and Technology (EMPA). This programme aims to improve the living conditions of local populations through the organization of formal e-waste management programmes, thereby reducing the negative impacts on the environment and human health, strengthening local capacities and promoting sustainable economic activities. (Ministry of Environment of Peru, 2014)

It is important to stress that the Ministry of Environment and EMPA signed an agreement that developed the project of "Sustainable Industries of Recycling", which facilitates technical assistance to promote the management and handling of EEE, applying the EPR principle.

Finally, and in accordance with the National Environmental Policy, the axis of Integrated Management of Environmental Quality, Peru has established guidelines for solid waste. In addition, the National Environmental Action Plan has set a target that 100 per cent of e-waste should be recycled and properly disposed of from 2011 to 2021. (Ministry of Environment of Peru, 2014)

4.9   Uruguay

In Uruguay, there are no unified regulations on e-waste; however, the country has general regulations on waste and environmental protection that are used to cover possible loopholes related to e-waste management.

Regarding the existence of binding international instruments for e-waste, Uruguay ratified the Basel Convention in 1991 through Law No. 16.221. In addition, the country is home to the Coordinating Centre of the Basel Convention and the Regional Centre of the Stockholm Convention for Latin America and the Caribbean. In this regard, the country serves as a reference for the region on this topic, and it lends its services both locally and at the regional level.

Uruguay has a public framework for waste management and especially for the issue of e-waste. There are some initiatives promoted by the Central Government, the Departmental Governments and other public institutions, such as the National Agency for Research and Innovation, Plan Ceibal and the Technological Laboratory of Uruguay. However, it is necessary for the country to unify and consolidate a specific national e-waste policy.

At the moment, the country does not have any specialized associations dedicated to the disposal of e-waste, but there are some private enterprises and initiatives created for its management and collection, respectively. Uruguay has limited technologies to manage some e-waste (dismantling and recovery of non-ferrous metals) and some plans under the Basel Convention for the transboundary movement of waste. Regarding the availability of technology to treat e-waste, the country lacks adequate technologies, except for those provided for the implementation of the Basel Convention.

The participation of the ICT sector has been limited to the development of specific projects related to mobile phone, fixed phone and personal computer collection campaigns.

The EPR principle is currently applied to the management of waste, such as packaging, industrial and agro-industrial waste. It is expected that the concept of EPR will be applied for e-waste in the near future.

Some of the challenges obstructing the country's proper management of e-waste are related to the absence of coordinated management plans, limitations of scale and especially lacking public awareness on the issue. Moreover, the country has the central challenge of reaching an agreement and implementing it among the different stakeholders for a national e-waste management plan. There is a working group within the National Directorate of Environment (Ministry of Housing, Spatial Planning and the Environment) tasked with drafting a bill in the future on solids (in general), including e-waste.

Internationally, the Ministry of Industry, Energy and Mining and other agencies signed an agreement with the Finnish VTT Institute in 2014 for the development of a comprehensive project on e-waste management, which is still being finalized.

Regarding the general public, there are some awareness campaigns, which are necessary to further educate them on the subject.

4.10   Bolivarian Republic of Venezuela

Currently, Venezuela does not have any specific legislation on e-waste, but it takes the established norms related to common waste as a reference. Some refer to environmental protection and management of e-waste, such as the Constitution of the Bolivarian Republic of Venezuela (in Chapter IX on environmental rights), the Law of the Homeland Plan (whose aim is to preserve life on the planet and to save the human species) and the Law on Hazardous Substances and Waste Materials.

These regulations mention e-waste, but they do not establish specific guidelines for its management. As for the legislative position on the issue, the country is currently reviewing international standards and national laws. Venezuela is also expected to develop a legal instrument with a binding framework for the management of e-waste. The drafts of legislation on e-waste in Venezuela have to be examined based on the principle of EPR.

Venezuela's government ratified the Basel Convention through the Approving Law and signed and published in the Official Gazette No. 36.396 on 16 February 1998.

No environmental policies have been established specifically for e-waste; however, roadmaps will likely be developed to coordinate intergovernmental initiatives in the creation of environmental policy proposals aimed specifically at e-waste management.

The e-waste disposal is carried out by five private national companies that develop e-waste management activities. They perform the processes of collection, storage, treatment and dismantling of equipment, leading to reuse of recoverable materials, scrap metal, glass, plastics, etc. These companies export printed circuit boards to overseas management facilities under the Basel Convention.

Venezuela has some limitations when it comes to the availability of e-waste management technology. In line with this, the government has offered to work jointly and between government ministries to start a strategic discussion on the country's technological capacity to manage e-waste. The government expects to address the issue by including the Ministry of Popular Power for Eco-Socialism, Habitat and Housing; the Ministry of Popular Power for Higher Education, Science and Technology; the Ministry of Popular Power for Foreign Affairs; the Ministry of People's Power Industries; and the Ministry of Popular Power for Trade to review and draft legislation on this matter.

The national government has decided to implement training plans around e-waste management. Among other programmes included in the plan is the online courses from the Ministry of Popular Power for Education, Science and Technology. Venezuela expects to promote e-waste collection through educational campaigns through the public media to strengthen partnerships with the private sector for the efficient e-waste management and to expand awareness campaigns about e-waste, its environmental impact and the ability to lessen that impact with proper management.

Venezuela also participates in the UNIDO project.

5. Role of the different stakeholders for the sustainable management of e-waste

The role of different stakeholders in the sustainable management of e-waste should be determined by the life cycle of EEE. The key is to clearly define these roles to ensure environmentally sustainable e-waste management in Latin America. Listed below are some of the most important actors in the process of sustainable e-waste management.

Producers or manufacturers of EEE: One of the main responsibilities of this group is the comprehensive management and disposal of e-waste. Other responsibilities include: accepting the legal responsibility that corresponds to their manufactured items that produce environmental damage if treated improperly; detailing the composition of the devices and how they should be treated at EoL; and raising awareness among consumers about the prohibition against disposing e-waste with household waste. Furthermore, they have to: establish an e-waste collection system that is easily accessible to citizens; ensure the proper management of the devices at all stages (collection, transportation, storage, treatment, utilization and/or recovery and/or final disposal); and bear the costs of selective collection and environmental waste management. During the manufacturing of the equipment, they should introduce some eco-design standards to facilitate recycling and reuse of materials at EoL.

Consumers of EEE: Their role is fundamental, because they are the ones who decide to purchase or change the EEE item when it is replaced. While the user tries to access the latest technology, they should understand that their waste could be reused or recycled within the value chain of e-waste. The user has the responsibility to choose the correct products in order to try to extend the life of their devices to the fullest extent. Consumers should purchase devices that comply with the environmental standards to extend their life cycle and promote their reuse. These are some of the habits that can be implemented to avoid the increase of e-waste. It is also essential that users do not discard e-waste along with other household or business waste; they should instead opt to use established collection centres or places where proper treatment is applied.

Waste management entities: These are the entities responsible for the management of e-waste throughout the entire chain of management and disposal. Their role is associated with each of the functions performed at the different stages of the process: collection, dismantling, treatment and disposal. Managers are responsible for ensuring various environmentally responsible processes. This type of management includes public or private organizations involved in recycling, refurbishment and disassembly of e-waste. These organizations must be approved and formalized as a requirement for participation in the process. They should also meet the technical, environmental and quality standards established for proper e-waste management. Furthermore, they should ensure proper management procedures to maintain the original product's quality standards. Managers should meet current environmental regulations and identify the risks associated with the management of e-waste, such as environmental pollution or illegal export to other countries.

National and municipal governments: For its part, the state should establish laws to determine the producers' responsibility and their obligation to manage the equipment at EoL. Furthermore, it should encourage the reuse of EEE, inform consumers about the prohibition of discarding e-waste with household waste and, in turn, report that e-waste must be delivered to the designated collection points. It is recommended that governments devise policies for the management of e-waste, considering key aspects, such as:

- Developing a regulatory framework based on the principle of EPR whereby the most important aspects concerning e-waste are regulated. This framework should ensure compliance with the obligations and respect of the rights of each stakeholder involved in the system. It is recommended that they establish actions and appropriate sanctions against those who do not comply with the established obligations in this regard;

- Establishing policies for education, health and environment, in coordination with the private sector and civil society organizations;

- Developing actions for environmental awareness and population health;

- Promoting the creation and formalization of companies and organizations dedicated to refurbishment, recycling and disposal of e-waste by streamlining procedures that authorize its operation;

- Implementing effective measures to control smuggling, illegal import and marketing of EEE, its components and its parts;

- Improving controls of e-waste export and import in order to ensure a process of environmentally sound management; and

- Promoting research programmes and agreements that help optimize the integral management of e-waste and innovations aimed at minimizing the generation of this waste.

It is recommended that local governments collaborate with the processes involved in e-waste management to harmonize their municipal strategies and programmes when possible, especially in generating public awareness within their jurisdiction.

Distributor of EEE: The EEE distribution companies take a role of collaborating in the process of e-waste management. They should have adequate mechanisms to select manufactured products and trustworthy importers that meet the indicated requirements. Furthermore, these companies should designate the collection points taking into account criteria for volume and efficiency, and they should encourage recycling.

Other important actors in the process of e-waste management are the Sectorial Associations of the ICT sector, international organizations that specialize in e-waste and academia, among others.

6. Obstacles and challenges for the proper management of e-waste in Latin America
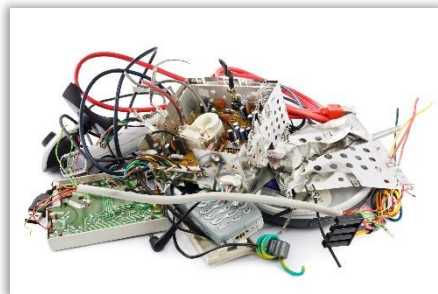
Some regional obstacles and limitations prevent the region from effectively dealing with the challenges of applying environmental policies aimed at reducing e-waste and/or reusing this waste as raw materials for new devices. These challenges have been released through a manifest by the actors in the region in recent years. In 2010, the United Nations Educational, Scientific and Cultural Organization (UNESCO) in conjunction with the Regional Platform for Electronic Waste in Latin America and the Caribbean (RELAC), mentioned some of these challenges in their publication: "Electronic waste: A Challenge for the Information Society in Latin America and the Caribbean". The publication reveals that e-waste is a challenge for the information and knowledge society. The report reaffirms the importance of encouraging initiatives to achieve sustainable management, describing it as being both an obligation and an opportunity. (UNESCO-RELAC, 2010)

In addition, this study describes experiences and challenges of the different contributors to this study regarding e-waste management.

6.1 Legal gaps for e-waste management

As described in section 4, there are environmental regulations in Latin American countries associated with the management of solid waste in general; however, few countries have passed specific legislation for e-waste management. Within this framework, there are significant gaps, such as the exclusion of the EPR principle and the lack of defined responsibilities in the process of e-waste management. One example of this has played out with some countries' telecommunications operators. These operators are not recognized as distributors of e-waste, but they have assumed the operational and financial burdens for e-waste management programmes. In fact, this should be the responsibility of the producer. (GSMA, 2014)

Another central challenge is the lack of recognition of reuse as an alternative method of e-waste management. This reduces the potential development of sustainable businesses with responsible reuse in the region. Other challenges include the lack of the export of waste and unused equipment for environmentally sound management outside the region's borders. This exacerbates internal problems, because some countries lack sufficient technological infrastructure and capacity to manage e-waste efficiently under formal and controlled processes.

6.2 Sustainable management during the life cycle of e-waste

In Latin America, the challenge is to control e-waste treatment processes at the local level and also outside the regional jurisdiction. Therefore, it is important to define voluntary or mandatory mechanisms to monitor management activities efficiently, including the e-waste services of collection, transportation, recycling, reuse and disposal.

During the collection and transportation phases, some incidents may occur, which can generate environmental risks due to mismanagement of e-waste. Examples include the temporary storage of e-waste in unsuitable conditions, leakage of e-waste and uncontrolled management processes. Therefore, it is very important that managers have adequate traceability mechanisms for these processes.

During the phases of recycling and disposal, informal recycling usually occurs due to the economic value of e-waste. In addition, illegal e-waste exports to other countries occur. According to a study on the flows of e-waste in the United States called "Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics, Analysis of Generation, Collection, and Export in the United States" developed by researchers at MIT in 2010, e-waste exports were reported as still functioning equipment in several countries in the world, including Latin America. TVs and monitors were exported to Mexico, Venezuela, Paraguay and China. Mobile phones were mainly (but not exclusively) exported to Hong Kong, the Caribbean and Latin American countries including Paraguay, Guatemala, Panama, Peru and Colombia. (Duan et al., 2013)

Therefore, it is necessary to have a policy and regulatory framework to control such activities in Latin American countries. This will ensure sustainability of e-waste management in the region.

6.3   Extended producer responsibility (EPR) – A State policy
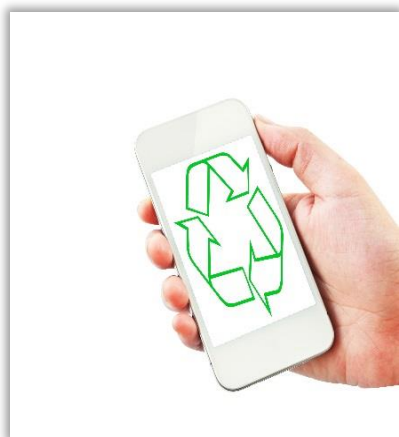
EPR is "an environmental policy in which producer responsibility for a product is extended to the state for post-consumer products of the life cycle". (OECD, 2000) The fundamental idea of the EPR principle is to provide an economic incentive for producers to consider environmental aspects when designing and manufacturing their products in order to eventually improve waste management. The principle of EPR aims to shift the responsibility (administrative, financial and/or physical) of waste management from governments or municipalities–and therefore taxpayers–to all entities that produce and sell products that are destined to become waste.

From a broader theoretical perspective, the principle of the EPR also represents a fundamental change to "the polluter pays" principle. EPR does not view the consumer who discards the waste the main responsible body for the requirements related to waste management. By contrast, the trader who makes profit from the production and sale of the product (i.e., the producer and/or distributor) is encouraged to take a prominent role.

Both the logical reasoning and economic incentive for the principle are based on the idea that producers can design products, through eco-design measures, which last longer and are easier to recycle. In this way, they reduce the cost of waste management for the recycler and consequently for the producer. EPR has appeared in regulations as early as the early 1990s in some European countries, especially regarding packaging waste, and it has been extended to the European Union (and beyond). It has become the cornerstone of different EU Directives for major waste streams, such as packaging, vehicles at EoL, e-waste, batteries and many others.

Despite the theoretical basis for principle of EPR, its use has not yet been proven to be effective on changes of the eco-design, particularly in complex cases of waste stream as modern as EEE. The implementation of EPR has yet to prove itself as a practice that helps to assign the real cost of waste management for each manufactured product to each producer. A producer who invests in a better design assumes additional costs to do so. However, there is no doubt that there are benefits from the improved design that reduce costs in waste management.

Financing waste management activities and allocating the economic responsibilities along the value chain of e-waste has proven to be a challenge both in countries with an existing waste management scheme and in countries where there are discussions about potential recovery system architectures. The manner in which all stakeholders financially contribute to the different activities varies according to the geography and proposed business models. These alternatives are described in the challenge associated with sustainable business models in the following chapters.

6.4   Lack of knowledge of e-waste management

The UNEP states that e-waste is still a new topic in developing and emerging economies. The treatment of e-waste and the recycling industry were only recently recognized and established. It has been over a decade since the national and international regulatory authorities began to develop policies (which started in 1990 in Switzerland) to address the challenge of e-waste management and treatment. In comparison to flows of traditional waste or municipal solid waste, the management of e-waste poses unique and complex challenges. (Magalini, 2015) Among these are:

•   The **heterogeneity of devices** (or appliances), in terms of size, weight, function and material composition (most of these properties change over time), which subsequently influence environmental impact at EoL;

•   The constant introduction of new products with different features, such as the change from heavy cathode ray tubes (CRT) to liquid crystal display (LCD) in TVs or the introduction of tablets. These changes are

accompanied by a progressive reduction in the average life cycle of products, which requires a **constant and continuous development of technologies for the treatment of this waste**;

- The presence or the gradual elimination of certain components or **hazardous substances** in devices-including substances that deplete the ozone layer, mercury and other heavy metals-which all require appropriate treatment;

- The **relatively high use of certain precious metals and special resources** (e.g., gold, silver, ruthenium, indium and other platinum group metals, rare and noble materials) and recovery challenges due to the "scattered" nature of low concentration elements and the technological complexity associated with the recovery of these metals in the recycling process; and

- The **diverse and large group of actors involved in several activities of the product's life cycle**, such as collection, recycling, treatment, reuse, restoration, waste disposal and export of products and fractions.

These challenges are visible in management processes and formal and informal recycling. Thus, UNEP states the future success of technological innovation in e-waste management with strong informal participation will depend on alternative business models, including financial incentives to participate in the informal sector of "safe" recycling processes. However, it also says specialized and "dangerous" recycling operations should be transferred to formal recyclers. (Step Initiative, UNEP, 2009)

6.5   *Availability and transfer of technology*

The availability of recycling technologies and specialized managers of e-waste is limited in most Latin American countries. Therefore, it is important and necessary to work with the ICT sector to identify the challenges faced by governments and stakeholders involved in the sustainable environmental management of e-waste to ensure the transfer of effective technology.

The growing economic interest in e-waste can also be seen in the innovation taking place in this field and the intellectual property (IP) protection sought in various jurisdictions on inventions and development processes in the related technological areas. The patent system provides an exclusive right to the patent holder to choose how to use the invention. In return, the patent holder must disclose the technical details of the invention in the patent application in such a way, that an expert in the field can reproduce the invention. The patent document is published, normally within 18 months after filing the patent application, and it serves as a complementary, sometimes unique source of information on available technical solutions in a given subject matter. As patent protection is territorial, it is important to identify in which jurisdictions an invention is protected; where the invention is not protected, the technical solution lies in the public domain and can be freely used. A patent owner can still have the know-how, and a know-how transfer may still make sense. In the case of an invention protected in a country, one must either acquire the patent right or have a license agreement with the patent owner to use the technical solution provided. Next to the technical information, the patent documents also contain useful legal and business information, such as the identities and affiliations of the patent applicants and the inventors, as well as the lifespan of the patent protection. Patent landscape reports group and analyse the information contained in patent documents, providing insights on key players, emerging technologies and the geographical distribution of patent protection which can help identify emerging trends, available technologies and contribute to informed decisions on research collaborations, partnerships, investments and technology transfer.

The World Intellectual Property Organization (WIPO), in collaboration with the Secretariat of the Basel Convention, prepared a patent landscape report on e-waste recycling and material recovery technologies. (WIPO, 2013) The report identifies technology trends in the area of e-waste processing and focuses on recycling technologies and material recovery for EoL mobile phones and computer equipment, grouping the identified technologies based on materials, components and processes involved. The report intended to supplement the Guidelines on Material Recovery and Recycling of End-of-Life Mobile Phones (MPPI, Mobile Phone Partnership Initiative) and environmentally sustainable material recovery and recycling of computer equipment at the end of its useful life. (PACE Initiative) (WIPO, 2013)

According to the report, the increase in related patenting activity since 2000 strongly indicates commoditization of e-waste due to the great economic value, the demand for and the scarcity of the materials involved, foremost those of rare earths and noble metals. The increased interest in the recovery of these materials is reflected in the

recent annual growth rate in patent applications related to recovery of these materials, which was the highest identified in the report.

In terms of the geographic distribution of innovation related to e-waste, the technologies described in patent applications originate mainly from Asia; most of the patent applications come from Japan, while there is also a strong increase of patenting activity in China. Little patenting activity was noted in Latin America in the report's results. Though Brazil, Mexico, Chile and Venezuela are included among the top 50 patent offices where patent protection was initially requested (office of first filing (OFF)), the number of patent applications was relatively low; 26 came from Brazil, four from Mexico, two from Chile and one from Venezuela.

Since patent protection is territorial, a patent applicant needs to choose in which countries they will seek patent protection beyond the initial country where protection is sought (OFF), the so-called offices of second filing (OSF). This choice, given the costs associated with it, is an indicator of where the applicant sees an existing or potential market for his technology. The analysis of the OSF thus constitutes an indirect analysis of the market and reflects the strategic decisions regarding existing markets and the patent applicant's potential. Among the top 50 patent OSFs, Brazil took the 13th place, and Mexico took 14th place, receiving 99 and 77 patent applications, respectively. With regards to the patent applicants who initially filed in Brazil and Chile (as OFF), the majority did not seek patent protection in other jurisdictions, showing a limited interest in foreign markets. The same approach of local patent protection was seen in most of the report's results. Japan, the United States and Germany pursued a different strategy, filing patent filing applications in multiple jurisdictions.

The report's findings were pooled and analysed according to processes, products and recovered materials related to the recycling of e-waste. Most of the technologies identified in the report related to individual components of equipment, mainly batteries and printed circuit boards. Typical processing steps include dismantling and subsequent waste separation, along with a side step of decontamination. In terms of materials, the activity in the report's results focused on non-ferrous metals (e.g., copper, nickel, etc.), plastics, ferrous metals and hazardous materials (e.g., arsenic, antimony and primarily lead). There has recently been significant growth in the extraction of rare and noble metals and recycling of mobile phones and computer equipment. This activity increase reveals the need for a market and growing interest in rare and noble metals lands. Moreover, it also reflects the industry's need for using alternative, electrically conductive materials, such as silver, especially following regulatory changes in the welding industry.

The technologies that originate from Latin America follow the general trends and findings in the report, with activities mainly concentrated on the decontamination and separation processes of recovered materials' chemical products, batteries, wiring and magnetic components, and non-ferrous metals. In the near future, the technological processes for e-waste management should be accompanied by strategic plans for patent application filings at the local, regional and international levels.

The degree of technological maturity and the availability of e-waste management can be expressed in several ways. One of these is through an analysis of the top patent applicants with complementary public information on the companies involved, including news about their products and releases. However, information related to the current technologies, technology deployment, marketed products and public information on licensing agreements and transfers of technology and knowledge receives little media exposure, and information from licensing databases is very limited. Most of this information is based on surveys of businesses, and such information is often not disclosed, because it is confidential or part of the business/competitive intelligence approach of the companies. In this sense, one of the most important conclusions to be drawn from the WIPO patent landscape report on recycling technologies is that, at the moment, there are few patents filed in Latin American countries. However, the interest in such patents is still on the rise. This reveals Latin America's potential for increased research, patent protection and use of what has not been protected by IP in Latin American countries. These unprotected breakthroughs lie in the public domain, and they are available for use in the region without requiring the acquisition of the IP rights, or the payment of royalties or licensing fees. Know-how transfer may still be required to implement these technologies locally, benefiting from the experience of the patent owners. At the same time, more research, including a market analysis and a survey for the public and private sectors, would offer a more comprehensive overview of Latin America's current situation.

The information included in the patent analysis is very important, due to the technical, business and legal data included therein, which could be key in the phase the region is going through, defining plans for sustainable e-waste management in which technology will eventually play a crucial role. Research and development in this area would be interesting to explore, as reflected in scientific publications, which would clarify whether this is an area of limited interest for research or whether there is no IP policy in place, resulting in a small number of patent applications.

Information about patents and available technologies for e-waste management should become tools that allow governments to lay the foundation for decision-making, to identify new alternatives of e-waste treatment and to enable cooperation for research, technology and know-how transfer and sharing. This information is helpful in creating synergies within Latin America (research and development, technology providers and seekers of certain technologies) and with other geographical areas that may face similar challenges. Some examples may include regions that have successfully addressed and implemented a related technology or those that have developed solutions that could serve the e-waste management needs in Latin America and promote innovation in the region.

6.6   Sustainable economic models

E-waste management through recycling or reuse models requires significant investments in logistics funds, storage, transportation, technology, advertising, etc.

UNEP cites three areas in which there are challenges obstructing the transfer of sustainable technologies and economic models of e-waste management, particularly for recycling in some emerging countries: policy and legislation; technologies and technical capabilities; and business and finance models.

As for policies and legislation, the main obstacles are "the lack of specific regulatory frameworks for e-waste management, the low priority of the issue at the country level, and conflicts within existing legislation and the lack of law enforcement". (Step Initiative, UNEP, 2009) Therefore, it is necessary to have clear legal frameworks that promote investment in new technology and efficient management processes. Regarding technology and technical capacity, the identified barriers are mainly: the lack of environmental standards, industrial safety and occupational health; the strong influence of the informal sector; the lack of optimal collection infrastructure; poor training; and the lack of awareness about environmental challenges that accompany e-waste. The barriers associated with business and finance models include: lack of industrial accountability and participation; high costs of logistics and transportation; possible exploitation of workers from disadvantaged communities; and consumers' unrealistic expectations, among others. (Step Initiative, UNEP, 2009)

From a broader perspective, there are three main actors or stakeholders who can assume financial responsibility for the management of any waste at EoL:

1. **The general public**: Because waste is a social problem that not only affects consumers but also the entire population (in terms of environmental and social impact), waste management systems should be financed by the society (that is, **taxpayers**). This is generally practiced in the case of municipal solid waste, especially when government organizations (central or local) maintain control over the operation.

2. **Holders of waste**: This case can be taken as an example of the application of "the polluter pays" principle, where the polluter is recognized as the actor responsible for disposing of their waste. This is generally practiced in the case non-domestic waste for which companies are responsible and directly billed for the management of such waste on the basis of its weight and volume.

3. **Producers**: To differing degrees, this group is linked to the implementation of the EPR principle. Although producers finance the systems, consumers should pay the costs of EoL product management through an increase in the price of the product. The internalization of the prices of products can indeed result in a reduction of producer margin sales or an increase of the sales price, resulting in an indirect financial impact absorbed by the consumers. The choice between a reduction of margin sales or an increase in the selling price is not strictly dependent on the financial model of the whole system but rather on the strategy of each producer and its product portfolio. (Magalini, 2015)

The proper treatment and disposal of e-waste requires sustainable management models that include environmental, economic and social variables. Experiences with e-waste management at the global and regional levels provide lessons. The following sections highlight examples of projects run under sustainable management models in Latin America:

Sustainable management of e-waste in Peru: Strengthening operators

This initiative was developed in 2012 by Peru's Technical Support Committee to implement the country's National Regulations for e-waste Management. The initiative is chaired by the Ministry of Environment with the technical secretariat of IPES - Promoción del Desarrollo Sostenible (IPES- Promotion of Sustainable Development) and the National Society of Industries. Additionally, it receives technical support from the Swiss Cooperation and the Swiss Federal Institute Laboratories for Materials Science and Technology. The initiative also counts on the participation of 60 representatives of the state, ICT companies, waste management operators and the civil society. This platform carries out several activities and highlights awareness and communication campaigns about e-waste collection (public and private); the development of e-waste management plans; technical ways to strengthen operator support by sector; policy development; and the development of studies and diagnostics. Results of this initiative include the approval of the National Management Regulations and Management of e-waste, the Peruvian Technical Standards 900:064 - 900:065 for e-waste management and Directive 003-2013/SBN–Procedures for proper management of the State Movable Property classified as e-waste furniture–for the proper management of e-waste in the public sector, among others.

Through this initiative, Peru has five operators registered to carry out e-waste management at the national level. These companies created and formalized jobs by meeting occupational safety and health for their employees. Similarly, they fostered management processes to improve their infrastructure and technical capacity through the use of hydraulic compaction technologies, disassembly using pneumatic systems, etc. Finally, these operators worked to enhance their internal processes to manage waste through computerized accounting systems or through the implementation of traceability systems for e-waste management and the development of external management audits.

More information: http://www.raee-peru.pe
Source: (WEEE-Peru, 2015)

Sustainable management of disused mobile phones in Colombia

This initiative was established by the leadership of the Ministry of Environment of Colombia in 2007 as part of the first round-table discussions for the preparation of e-waste legislation. The mobile phone industry, manufacturers and mobile operators through the Mobile Industry Association of Colombia (Asomóvil) anticipated and volunteered to implement waste management schemes for mobile phones with an approach similar to those used by programmes in European countries.

This initiative, implemented through a programme called "Recycle your mobile or cell phone and communicate with the Earth", began as a public-private initiative with manufacturers and telecommunication industry operators. The project aimed to collect, manage and treat waste from discarded phones, cell phones, accessories, batteries, boards, network equipment and other mobile operator equipment. The programme was implemented in more than 30 cities around Columbia, and it included the appointment of a single contractor for the entire waste management chain of collected e-waste. The company in charge of the programme, Belmont Trading, responsibly managed more than 185 tonnes of e-waste between 2007 and 2014, including cell phones, accessories and batteries. The management process is controlled and developed through quality processes keeping in mind environment and occupational health.

Among the actors who made this project successful, the state stepped in as the leader of the initiative in cooperation with the private sector. In addition, one of the successes of the campaign was the effectiveness of communication, the long-term vision and the scope of the general public's education achieved on the topic. Management costs were assumed by the manufacturers, and mobile operators facilitated their distribution networks for the collection of unused equipment.

More information: http://www.gsma.com/latinamerica/ewaste-colombia-2015
Source: (GSMA-LATAM, 2015)

Sustainable management of large household appliances in Argentina: RENOVATE programme

The RENOVATE programme, launched in March 2015, is led by the Secretary of Energy of Argentina. It aims to reduce energy consumption in the residential sector, reaching almost 33 per cent of total consumption in the country, by replacing used appliances (refrigerators and washing machines) with new ones. The programme is the result of the Resolution 48/2015, which aims to encourage domestic production and the marketing of appliances that ensure efficient energy consumption in order to stimulate demand in the market and to accelerate replacement of assets that generate increased energy consumption.

The programme also aims to encourage entities that sell appliances by offering compensation for a single piece of equipment. In return, the beneficiary organizations must ensure the removal of old household equipment from the consumers' households and its subsequent transfer to e-waste operators for decontamination, dismantling and destruction.

In April 2015, RENOVATE collected nearly 3,000 low energy efficiency units for replacement with more modern and efficient equipment. This new equipment is assured for recycling and disposal.

More information: https://www.elclimalohacesvos.gob.ar
Source: (Secretary of Energy Argentina, 2015)

All the described challenges in this section stress the need for Latin American countries to work together to ensure environmental sustainability of e-waste management in the region. The actors in the e-waste value chain have legal and technological tools as well as policy instruments to transform these challenges into opportunities.

7. Implementation of international standards in the region

The sustainable management of e-waste is usually accompanied by proper processes and technical standards that guarantee traceability during management. There are several sectors in e-waste management that establish processes and management mechanisms to properly manage this type of waste. They usually provide assistance on specific policy guidelines or regulatory frameworks. However, there is another set of procedures called "technical standards" or simply "standards" that can be used by various actors to get the same result of management on a voluntary basis.

ITU, the specialized agency of United Nations for ICT, has been working on developing international standards for environmental sustainability of ICTs for several years now. With regard to the work conducted by ITU, standards for the proper e-waste management have been highlighted in Section 7.1.

7.1 Need for international standards

The responsible management of e-waste requires management-based process and an understanding of the EEE life cycle. As previously states, there are technical standards to facilitate this management, which constitute an important tool for actors of e-waste management in the absence of specific legal frameworks. Countries and companies can improve management processes and learn from past experiences by using these technical standards. Thus, in the specific case of Latin American countries where there is work on e-waste programmes and regulatory frameworks, the standards may become important reference guidelines.

The Step Initiative highlights the importance of standards for proper e-waste management in its document, "Recommendations for Developing Standards for Collection, Storage, Transport and Treatment of E-waste". The report mentions, for example, that standards focused on e-waste recycling should maximize the quantity, quality and value of recycled materials, while simultaneously minimizing or eliminating the processes' and materials' impacts on human health and the environment. (Step Initiative, 2014) In the same study, Step describes a variety of standards associated with e-waste management in the value chain, such as the R2 standard (responsible recycling standard), which establishes guidelines for the responsible management of electronic materials throughout the process of recycling, which prohibits illegal exports and guarantees the process of secure recycling. However, the study shows that, in spite of the efforts of the e-waste management industry to develop standards, there are still no technical standards in global use.

In this regard, it is important to recognize the need for technical standards for e-waste management in collaboration with various actors within the formal standardization processes that guarantee widespread use.

7.2 Work of ITU-T

ITU's Telecommunication Standardization Sector, through its Study Group 5 on "Environment and Climate Change", has a mandate to develop international standards and guidelines for the sustainability of ICT and the environment. During the World Telecommunication Standardization Assembly (WTSA-12), held in Dubai in November 2012, Resolution 79 was approved on the "Role of telecommunications/technology information and communication in the treatment and control of WEEE, and methods for processing". This Resolution defines WEEE as a priority issue for the entire ICT sector and recognizes the importance of WEEE management to prevent impacts on human health and the environment, especially in developing countries. Resolution 79 mandated Study Group 5 to carry out the standardization processes of WEEE management. (ITU, 2012)

In this regard, ITU works with governments, companies from the ICT sector, academia and other expert agencies dealing with WEEE management to develop international standards and guidelines in this area. Additionally, ITU has a longstanding objective to identify standardization gaps that enable the creation of new technical standards for the environmental sustainability of ICT globally.
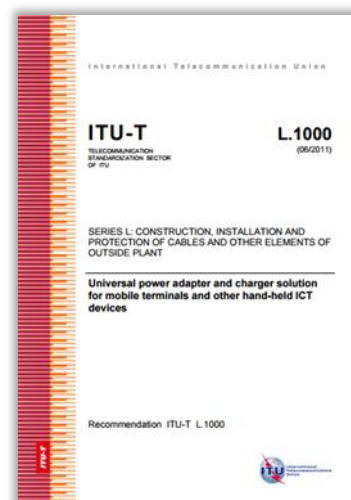
Among the efforts carried out by ITU-T Study Group 5, a number of important new international technical standards should be highlighted, such as Recommendations ITU-T L.1000, ITU-T L.1001 and ITU-T L.1100. These Recommendations, described in Table 5, focus on the efficiency of EEE manufacturing processes to avoid the future generation of WEEE at the end of its useful life.

Table 5 – ITU-T Recommendations on WEEE/e-waste

Recommendation	Scope
Recommendation ITU-T L.1000 (Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices)	Technical specifications for a universal charger compatible with a wide range of electronic devices, especially mobile phones. This global Recommendation expects to eliminate the generation of 82,000 tonnes of unnecessary chargers and the reduction of 13.6 million tonnes of CO_2 production.
Recommendation ITU-T L.1001 (External universal power adapter solutions for stationary information and communication technology devices)	Technical specifications for a universal power adapter (UPA), which is designed to be used with the majority of fixed ICT devices. This Recommendation will substantially reduce the number of manufactured power adapters.
Recommendation ITU-T L.1100 (Procedure for recycling rare metals in information and communication technology goods)	Basic guidelines regarding the importance of recycling rare metals and the procedures applied to preserve them. This Recommendation lists the points that should be considered in all phases of the recycling process, and it provides guidelines on how organizations can report in an accurate and transparent way on the recycling of rare metals.
Recommendation ITU-T L.1010 (Green battery solutions for mobile phones and other hand-held information and communication technology devices)	Defines a minimum set of parameters necessary to identify green battery solutions that should be considered by developers/manufacturers to reduce the future environmental impact of battery use. The provision of so-called green batteries is to extend the lifetime of handsets, reduce global resources consumption and preserve the environment. The compliance in terms of supporting green information and communication technology (ICT) efforts will be considered including the use of scarce resources, recycling and reuse. The existing environmental schemes available in different regions and international standards will be considered.
Recommendation ITU-T L.1101 (Measurement methods to characterize rare metals in information and communication technology goods.	Provides reference characterization procedures for efficient recycling of rare metals by using XRF and ICP-MS measurement methods.
Recommendation ITU-T L.1400 (Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies	Presents the general principles on assessing the environmental impact of information and communication technologies (ICT) and outlines the different methodologies that are being developed: • Assessment of the environmental impact of ICT goods, networks, and services • Assessment of the environmental impact of ICT projects • Assessment of the environmental impact of ICT in organizations • Assessment of the environmental impact of ICT in cities

Recommendation	Scope
	• Assessment of the environmental impact of ICT in countries or group of countries. This Recommendation also provides some examples of opportunities to reduce the environmental load due to ICT.
Recommendation ITU-T L.1410 (Methodology for environmental life cycle assessments of information and communication technology goods, networks and services	Deals with environmental life cycle assessments (LCAs) of information and communication technology (ICT) goods, networks and services. It is organized in two parts: • Part I: ICT life cycle assessment: framework and guidance • Part II: "Comparative analysis between ICT and reference product system (Baseline scenario); framework and guidance". Part I deals with the life cycle assessment (LCA) methodology applied to ICT goods, networks and services. Part II deals with comparative analysis based on LCA results of an ICT goods, networks and services product system, and a reference product system.

Source: (ITU, 2015)

## 8. Turning the challenge of e-waste management into an opportunity

The challenges that Latin America faces impeding the sustainable environmental management of e-waste were described in Section 6. This section will focus on turning these challenges into an opportunity for the region's future. As previously noted, among the identified regional challenges are: (i) the lack of specific legal frameworks around e-waste; (ii) the difficulty of implementing the EPR principle as a state policy; and (iii) the general lack of knowledge about the risks and opportunities that can be generated. Furthermore, additional challenges are associated with the environmental management of e-waste, such as: (iv) inherent environmental and social risks of disordered management processes and uncontrolled supply chains; (v) insufficient availability of technology for proper e-waste management; and (vi) lack of sustainable economic models where the actors are in accordance with their responsibilities.

All these challenges can be an opportunity in the region, as each country could benefit from the combined lessons learned of e-waste management worldwide. Such opportunities could include the future generation of green jobs; an important technology transfer to the region; the creation of relevant capacity for e-waste management; and, above all, an improvement in the quality of life of the region's populace.

A recent report by the UNEP states that there is an "urgent need to prepare developing countries for the emergence of a significant amount of electronic waste due to the enormous acceleration of the use of mobile phones, tablets or other devices, and other equipment". The report emphasizes that "the proper collection and recycling of solid electronic waste are essential for the recovery of economically valuable materials and to protect the health of the population, and the construction of a new green economy and that these actions are not carried out in many developing countries where they face the ghost of the mountains of hazardous waste, with serious consequences for the environment and public health". (Step Initiative, UNEP, 2009)

The project, developed under a collaboration between the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Centre for Strategic Studies and Management of Brazil (CGEE), aims to develop proposals for specific projects with the region's strategic development issues. The collaboration addresses the possibilities of moving towards the assembly and development of a reverse logistics chain of e-waste management in Latin America and the Caribbean. (ECLAC/CGEE, 2015) Figure 3 graphically presents the concept of a reverse chain proposed in this project:

Figure 3: Reverse chain of WEEE/e-waste
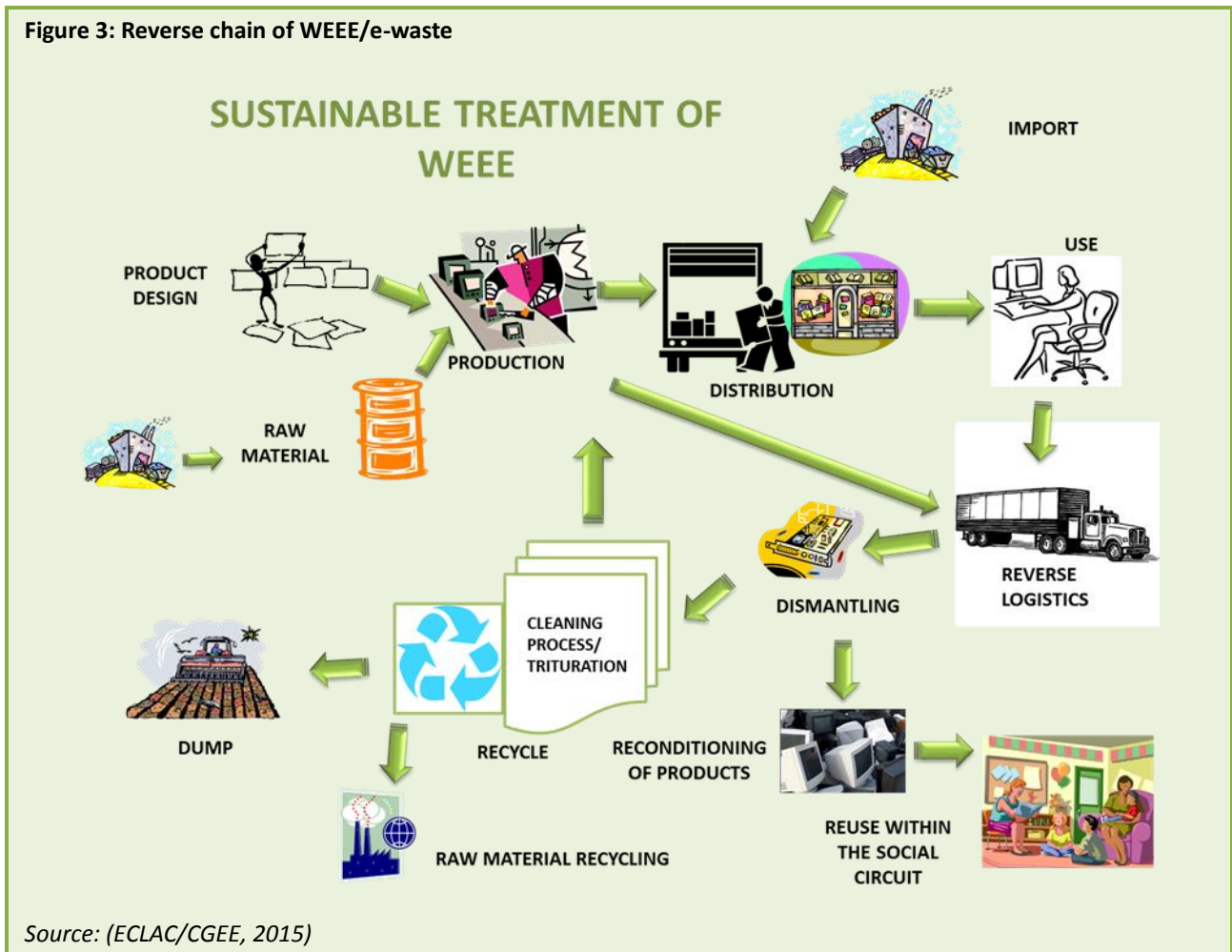
Source: (ECLAC/CGEE, 2015)

E-waste management is an urgent task. It affects the environment as well as public health for the countries of the region. At the same time, this management can become an economic opportunity that supports the development of new economic activities, the development of science and technology and the productive development of the countries.

EEE contains valuable and/or strategic materials and components that can be recovered industrially. The most common ones are gold (Au), silver (Ag) and copper (Cu), and the rarest and most strategic ones are indium (In) and ruthenium (Ru), among others. From modern EEE, it is possible to recover more than 19 chemical elements with high added value. (Step Initiative, UNEP, 2009)

New rules, such as the principle of EPR, guarantee additional funding for collection and recycling activities by creating more and better job opportunities and more income.

Though there are many initiatives in the region that address this issue, creating an environment conducive to technological consolidation of reverse logistic chain of EEE is still a pending task in Latin America. In this regard, the project's approach seeks to generate practical solutions in the region while generating a wide range of information to facilitate the public's participation in forthcoming public policies and to disseminate knowledge, so that each country will move towards the proper treatment of waste and profit from its economic value.

The project profile was approved by ministers and senior officials representing institutions that support the development of science, technology and innovation in Latin America and the Caribbean. They gathered at the First Meeting of the Conference of Science, Innovation and Technology of Information and Communication of the United Nations Economic Commission for Latin America and the Caribbean (Santiago de Chile, June 9 and 10, 2014) to consider setting up a network regarding this subject at the regional level.

The project aims to improve the areas of training, awareness, legislation, harmonization, technical standards and best practices regarding the treatment of e-waste. There are also seven sub-projects– one for each type of the selected equipment (cathode ray tubes (CRT), cell phones, computers, tablets and flat panel displays, batteries and telecommunication systems) and a technologically oriented development project to extract properly pre-treated e-waste and chemical elements, which would close the financial balance of the project.

In addition, the regional project includes a number of other goals, including:

a)   Providing trainings to countries to help establish e-waste collection systems in the region without damaging or threatening the environment or the health of collectors;

b)   Developing standards and best practices to make the presence of small and medium-sized enterprises (SMEs) in the reverse chain possible;

c)   Creating organized collection and dismantling systems in at least four countries of larger scale with a greater number of EEE users;

d)   Promoting the creation of institutions that will be responsible for scientific and technological development related to the reverse chain of WEEE; and

e)   Fostering the formulation of agreements between countries on cross-border movements of dismantled equipment that serve as an input to the industry.

Therefore, in order to solve the problems posed to human health and the environment by WEEE, the project foresees the possibility of developing a regional industry of WEEE. This would increase foreign exchange, create job opportunities, promote the creation of new companies and the formalization of some existing initiatives, and replace the use of raw materials, among others.

9. Towards building effective partnerships for sustainable management of EEE and e-waste

As described in the preceding sections, Latin America faces large challenges on reducing WEEE generation and soundly managing and disposing of it. The environmental, social, policy and operational issues described must be tackled through effective state governance and policies or relevant international instruments. This must also be addressed by involving national and international organizations that are currently developing, or that will develop, activities to support the sustainable management of EEE and WEEE. Coordinating with them to reach this goal is crucial in the region.

Various organizations actively support Latin American countries in establishing sustainable e-waste management systems, but each has its own mandate and supports specific countries on specific issues at different levels, according to their particular agreements. Hence, there is a clear need for furthering coordination and cooperation to assist countries on all tasks and intervention levels required. In addition, South-South cooperation among the countries should be enhanced and strengthened.

A good example of regional cooperation is the 2011 "Guidelines for the Management of WEEE in Latin America: Results of a Regional Public-Private Round Table",[1] a document prepared by a large and diverse group of stakeholders in the Latin America and the Caribbean region led by the RELAC Platform with support from the International Development Research Centre of Canada. This is an important milestone and one of the first steps towards regional harmonization of EEE and e-waste management in Latin America.

Certainly, at the regional level, the RELAC Platform set up in 2004 with the support from the Swiss government is a major player that has developed significant work on knowledge management. By producing information and communication materials and implementing key activities, RELAC has stimulated a fruitful dialogue among the relevant stakeholders on e-waste harmonization issues.

The Basel Convention Regional and Coordinating Centres (BCRCs) have also developed some initiatives at the regional level. The BCRC for South America in Argentina has generated information, organized international meetings and promoted e-waste awareness. BCRC for Central America and Mexico in El Salvador works together with the Commission of Environment and Development for Central America (CCAD) to set up a sub-regional project to develop a set of "Guidelines on WEEE for Central America Countries". There is no doubt that the activities of these centres have had influence in Latin America.

In 2010, the UN Economic Commission for Latin America and the Caribbean (ECLAC) had implemented an action plan for Latin America and the Caribbean according to the Millennium Development Goals and the World Summit on the Information Society, with a long-term vision towards 2015. The action plan states that ICTs are tools for economic development and social inclusion. ECLAC acts as the Technical Secretariat for such a regional action plan, monitors advances, publishes information bulletins and exchanges information among the stakeholders. The sustainable treatment of industrial waste is one of the goals of the plan, and ECLAC set up a working group that was active during 2012 and 2013. Currently, there are plans to reactivate this initiative beyond 2015.

The Swiss Federal Laboratories for Materials Science and Technology (EMPA) has been active on e-waste issues in Latin America since 2007. It has supported Peru and Colombia in setting up their e-waste management strategies and also supported strengthening the RELAC platform. EMPA has been instrumental in initiating cooperation that involves several stakeholders in raising general awareness on EEE and e-waste management in the region. In close cooperation with the World Resources Forum, EMPA currently implements the project "Sustainable Recycling Industries", which aims to improve local capacity for sustainable recycling with private and public organizations and the informal sectors of Colombia, Egypt, Ghana, India, Peru and South Africa.

---

[1] http://www.residuoselectronicos.net/documents/110620_final_version_guidelines_for_the_management_weee_in_la.pdf

UNIDO promotes sustainable e-waste management in developing countries and countries with economies in transition. It takes into account the EEE life cycle and the entire e-waste recycling chain, and it supports governments in developing or improving policies, upgrading or scaling dismantling and recycling operations (particularly those run by SMEs) to meet internationally recognized standards. It also promotes regional cooperation on e-waste management.

As previously mentioned, UNIDO is about to start a regional project covering seven countries in South America and six countries in Central America with the main objective of strengthening national initiatives and enhancing regional cooperation for the environmentally sound management of POPs in e-waste. The project includes national activities to strengthen local e-waste recycling capacities and regional activities to tackle key issues for harmonizing e-waste policies, strengthening knowledge management and information sharing, and enhancing South-South cooperation.

As stated in Section 7, ITU actively develops activities, particularly those focused on the development of international standards for WEEE management and the life cycle of ICT equipment. In Latin America, ITU develops capacity-building activities through seminars, awareness-raising activities and conferences. It conducts research and development programmes and educates wider audiences about the risks and opportunities for the effective e-waste management. ITU assists countries with the development of e-waste management policies, and it helps ICT companies become more sustainable and responsible about e-waste management. All these activities contribute to promoting regional cooperation and enhancing e-waste management harmonization.

International platforms exist to support decision-makers in defining sustainable solutions for WEEE management. The Step Initiative and the PACE Initiative are described in Table 6.

Table 6 – International WEEE management platforms

Platform Step: Solving the E-waste Problem	Led by the United Nations University.
	Hosts more than 65 members worldwide, including companies, international organizations, governments, NGOs and academic institutions
	Provides a forum for discussion among interested stakeholders to share information, find answers and propose alternatives to solve the global WEEE problem
	Implements a series of "E-Waste Academies" to train scientists and managers on e-waste management
	Further information:
	http://www.step-initiative.org
Platform PACE: Partnership for Action on Computing Equipment	Public-private partnership whose members are manufacturers of personal computers, recyclers, international organizations, associations, academia, environmentalists and environmental groups and governments
	Provides a forum for addressing the renovation, repair, material recovery, recycling and environmentally sound disposal of used and EoL computer equipment
	Assists decision-makers, through the preparation of PACE guidelines on various topics, including the transboundary movement of hazardous wastes
	Further information:
	http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/Overview/tabid/3243/Default.aspx

Sources: (Step Initiative, 2015) and (Basel Convention, 2011)

This short overview of activities implemented only by a handful of international organizations that are already working in the region shows a great deal of variety regarding goals, mandates and perspectives. This complexity is compounded when national governments, private entrepreneurs, the informal sector, NGOs, civil society organizations, research organizations and other key individuals are included in the scene. The issues of resource recovery, public health, environmental protection, workers' health and safety, eco-design, EPR, awareness raising, standardization, research and development, regulations, enforcement, knowledge management, certification and others are all relevant and conducive to reach sustainable EEE and e-waste management.

Therefore, considering that the e-waste agenda is scattered among different stakeholders, there is an urgent need to build a coordinated and synergetic approach. This would allow stakeholders to tackle ongoing activities more effectively and avoid duplication of efforts now and in the future. This approach, herein called **the effective partnerships for sustainable management of EEE and e-waste,** requires a permanent dialogue among the involved agencies and parties, as well as information and knowledge-sharing achieved through regular, virtual and face-to-face meetings, setting up committed working groups and focal points for communication, and conducting a serious follow-up of the agreed processes to better and more effectively serve each country and the region as a whole.

Recently, ITU, UNEP, UNESCO through its Regional Office for the Sciences in Latin America and the Caribbean, UNIDO, WIPO, UNU, ECLAC, the Basel Convention Secretariat and the Basel Convention Center in Argentina have decided to start such cooperation, but building an effective partnership still requires involving other relevant partners at the local, national, regional and global levels.

10. Conclusions and next steps

At the end of this study, it is clear that Latin American countries must quickly include e-waste management in their agendas and promote policies to support integrated management and disposal of e-waste. Some of the main issues for consideration are:

1. The coordination of different actors' agendas is essential; environmental agendas must be in accordance with the agendas of the ICT sector. This will streamline the incorporation and implementation of public policies regarding e-waste that will always guarantee sustainable growth of ICT as a development tool.

2. Certain countries in the region have specific regulatory frameworks around WEEE management, and others are working on the establishment of these. The creation of specific regulations that ensure the management and disposal of WEEE is necessary; however, it is also essential to have the means to fulfil them and to set up mechanisms that ensure compliance. In the specific case of the Latin American countries working on programmes and regulatory frameworks for e-waste, standards may become important guidelines.

3. E-waste management is associated with a complex governance of projects along the value chain, since it affects different ministerial responsibilities at both the national and local governmental levels. It is crucial to develop a model of governance with clear leadership, defined responsibilities and powers, as well as the designation of specific ministerial working teams that also include the participation of the private sector.

4. Environmental problems associated with e-waste management have a direct social impact, particularly on human health. Therefore, it is vital that e-waste management programmes have the necessary technological capacity for proper waste management, as well as the appropriate traceability systems to ensure health protection and environmental sustainability in all management processes: collection, transportation, treatment and disposal.

5. All e-waste management programmes must be accompanied by an economic evaluation of opportunity costs. The sustainability of programmes will depend on an economic assessment of the environmental risks associated with health and the lack of proper management of waste and technological alternatives. In terms of opportunities, the direct and indirect benefits of e-waste management should be assessed, such as the generation of "green jobs" or "innovation in management technologies".

Stakeholders have had diverse experiences around sustainable e-waste management in the region and at the international level. These experiences are useful in more effectively implementing sustainable e-waste management processes, as stakeholders can take into account the particularities of each country in terms of regulatory, technological, social and environmental aspects, etc.

Based on this study, the following key steps have been identified to achieve the sustainable management of e-waste in Latin America:

1. *Identify sources of e-waste generation and account for management volumes*. Countries should rely on international standards and uniform models of e-waste accounting flows. This will allow them to measure technological capacities and to measure the sustainable management of e-waste in the present and the future.

2. *Perform a detailed and comparable analysis about the situation of e-waste throughout the region*. This includes qualitative information, the identification of key actors and the applicable social framework, cultural boundaries, technological availability, etc.

3. *Base e-waste management in the region on a definition that covers the entire life cycle of EEE*. This includes everything from components that have been discarded by their owner to e-waste without the intention of reuse by its owner.

4. *Develop a preventive policy of WEEE management in order to avoid environmental and health risks*. It is advisable to propose collection systems with efficient technologies, informed by experiences in other countries. In this regard, the guidelines developed by various international organizations and platforms, such as ITU-T Study Group 5, the Step Initiative or PACE, can provide the necessary guidance.

5. *Foster closer cooperation between actors and stakeholders*. This cooperation should occur at the global, transcontinental, national and local levels with the goal of facilitating learning from the experiences of other countries and actors to take advantage of the lessons learned and to avoid making the same errors. Such cooperation requires the development of a greater number of initiatives that promote the advancement and implementation of policies and projects, as well as the establishment or strengthening of effective partnerships for sustainable management of EEE and e-waste.

6. *Develop international cooperation and partnerships for sustainable management of EEE and e-waste*. These are essential to ensure proper treatment of EEE at the end of its useful life. In the short term, the region has to invest heavily to develop the necessary infrastructure for the proper and efficient management of hazardous and scarce metal components in EEE and e-waste. Therefore, eco-efficient management alternatives should be evaluated between countries.

7. *Focus activities not only on recycling, but also on the repair and reuse of EEE*. Policies and strategies should promote the eco-design of EEE to extend the shelf life of the products, thus contributing to the reduction of e-waste generation.

8. *Make further efforts to raise consumers', businesses' and policymakers' awareness of e-waste*.

9. *Develop a high level of coordination between existing initiatives and those under development*. This avoids unnecessary duplication of activities and efforts and optimizes the use of existing scarce resources.

10. *Increase technological availability for the efficient management of e-waste*. It is important to promote innovation and technology transfer through the efficient identification of new alternatives or the adoption of existing technologies elsewhere. To achieve this, it is important to assess the economic implications of some alternatives and to identify the mechanisms that measure their implementation progress. Tools, such as the analysis of patent information contained in patents registry or technology databases, can facilitate the implementation and monitoring of technological processes in the medium and short term.

WEEE management in Latin America is visible and growing. Therefore, it is necessary to define the guidelines for a roadmap that helps combine the efforts of the different actors and stakeholders involved to ensure the region's environmental sustainability in e-waste management.

Sustainable management active participation from all stakeholders, particularly those related to the ICT sector, the environment, health and e-waste managers at the local level. This effort also requires the implementation of technological tools, appropriate regulatory frameworks, sustainable business models and the use of international technical standards.

11. Glossary

3R	Reduce, Reuse and Recycle
AC	Alternating Current
UPA	Universal Power Adapter
EEE	Electrical and Electronic Equipment
ATM	Automated Teller Machine
BCRC	Basel Convention Regional and Coordinating Centres
CEDC	Commission of Environment and Development for Central America
EC	European Commission
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
CGEE	Center for Strategic Studies and Management
IDRC	International Development Research Centre of Canada
COMEX	Committee of Foreign Trade
CONAM	National Environmental Council
CRT	Cathode Ray Tube
CSO	Civil Society Organization
DC	Direct Current
DGEEC	General Directorate of Statistics, Surveys and Censuses
EIA	Environmental Impact Assessment
EMPA	Swiss Federal Laboratories for Materials Science and Technology
EoL	End of Life
GEF	Global Environment Facility
GPS	Global Positioning System
GSM	Global System for Mobile communications
GSMA	Global System for Mobile Communications Association
ILO	International Labor Organization – Organización Internacional del Trabajo
IT	Information Technology
LAC	Latin America and the Caribbean
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MEE	Ministry of Environment of Ecuador
MERCOSUR	Southern Common Market
MINAM	Ministry of Environment of Peru
MIT	Massachusetts Institute of Technology
MPPT	Ministry of Popular Power for Trade
MPPEHV	Ministry of Popular Power for Eco-socialism, Habitat and Housing

MPPEUCT	Ministry of Popular Power for Higher Education, Science and Technology
MPPI	Ministry of People's Power Industry
MPPI	Mobile Phone Partnership Initiative
MPPRE	Ministry of Popular Power for Foreign Affairs
Mt	Metric tonne
NEPSI	National Electronics Product Stewardship Initiative
OECD	Organization for Economic Co-operation and Development
WIPO	World Intellectual Property Organization
WHO	World Health Organization
NGO	Non-Governmental Organizations
UNIDO	United Nations Industrial Development Organization
PACE	Partnership for Action on Computing Equipment
PCB	Polychlorinated Biphenils
IP	Intellectual Property
NEAP	National Environmental Action Plan
UNEP	United Nations Environment Programme
POP	Persistent Organic Pollutant
PPP	Polluter-Pays-Principle
PSR	Principle of Shared Responsibility
R2	Responsible Recycling standard
WEEE	Waste of Electrical and Electronic Equipment
EQR	Environmental Qualification Resolution
ER	Extended Responsibility
PRTR	Pollutant Release and Transfer Register
RELAC	Regional Platform for Electronic Waste in Latin America and the Caribbean
EPR	Extended Producer Responsibility
SEAM	Ministry of Environment
SECO	State Secretariat for Economic Affairs, Switzerland
SEIA	System of Environmental Impact Assessment
SIGMA	Integrated Platform for Management and Mediation Service Learning
SISNAM	National Environmental System of Paraguay
SME	Small and Medium-sized Enterprise
SRI	Sustainable Recycling Industries
Step	Solving the E-waste Problem Initiative
TAU	Non-Profit Civil Society Association
ICT	Information and Communication Technology
TV	Television

EU	European Union	
ITU	International Telecommunication Union	
ITU-T	ITU Telecommunication Standardization Sector	47
UMTS	Universal Mobile Telecommunications System	
UNEP	United Nations Environment Programme	
UNESCO	United Nations Educational, Scientific and Cultural Organization	
UNU	United Nations University	
VTT	VTT Technical Research Centre of Finland	
WRF	World Resources Forum – Foro Mundial de Recursos	
WSIS	World Summit on the Information Society	

Annex 1 Statistics and information of WEEE in Latin America – 2014
The Global E-waste Monitor 2014
Source: (Baldé et al, 2015)

The United Nations University developed a country-by-country analysis in its Global E-waste Monitor Report on WEEE – 2014 of the quantities, flows and resources associated with the management of WEEE. The data referring to Latin America and the Caribbean are described below.

Country	WEEE Per capita (kg/ inhabitant)	Annual WEEE (k tonnes)	Population (inhabitants)	WEEE legislation until 2013
Belize	6.5	2.3	355,000	no
Costa Rica	7.5	35.8	4,770,000	yes
Guatemala	3.5	55.0	15,870,000	no
Honduras	1.8	1.7	8,546,000	no
Mexico	8.2	957.9	117,181,000	no
Nicaragua	1.7	10.8	6,165,000	no
Panama	8.2	3.2	3,788,000	no
El Salvador	4.8	30.1	6,282,000	no
Argentina	7.0	291.7	41,961,000	no
Bolivia	4.0	44.7	11,246,000	yes
Brazil	7.0	1,411.9	201,413,000	no
Chile	9.9	176.2	17,711,000	no
Colombia	5.3	252.2	47,711,000	yes
Ecuador	4.6	72.9	15,699,000	yes
Guyana	6.1	4.7	780,000	no
Peru	4,7	147.6	31,424,000	yes
Paraguay	4.9	34.2	6,930,000	no
Surinam	8.5	4.8	560,000	no
Uruguay	9.5	32.4	3,404,000	no
Venezuela	7.6	232.7	30,457,000	no

Sustainable management of waste electrical and electronic equipment in Latin America

Annex 2 Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal under study in this report
Source: (Basel Convention, 2015)

The Basel Convention keeps track of its parties (countries), as well as the detailed status of entry into Force based on the date of their commitments. The summary of the status of the countries under study in this report is presented in the following table.

Participant	Signature, Date of Succession to Signature (d)	Ratification, Acceptance (A), Approval (AA), Accession (a)	Entry into force
Argentina	28/06/1989	27/06/1991	05/05/1992
Bolivia (Plurinational State of)	22/03/1989	15/11/1996	13/02/1997
Brazil		01/10/1992 (a)	30/12/1992
Chile	31/01/1990	11/08/1992	09/11/1992
Colombia	22/03/1989	31/12/1996	31/03/1997
Ecuador	22/03/1989	23/02/1993	24/05/1993
Paraguay		28/09/1995 (a)	27/12/1995
Peru		23/11/1993 (a)	21/02/1994
Uruguay	22/03/1989	20/12/1991	05/05/1992
Venezuela (Bolivarian Republic of)	22/03/1989	03/03/1998	01/06/1998

Annex 3   Regulatory context of WEEE applicable to telecommunication operators in Latin America – 2014
(Available in Spanish only) Source: (GSMA, 2014)

The Global System for Mobile Phone Communications Association in Latin America, GSMA Latam, conducted an analysis of the impact of the WEEE regulatory framework on the environmental sustainability of WEEE management in the telecommunication sector. The table below describes the current status of the legal framework of WEEE in the region applicable to mobile operators. (GSMA, 2014)

País	Normativa Aplicable	Situación General
Argentina	No existe normativa específica sobre RAEE. Lo que si las baterías de los dispositivos son considerados residuos peligrosos	Proyecto de Ley presentado en Octubre de 2013 y aún no ha sido aprobado. Los operadores de telecomunicaciones realizan planes voluntarios de reciclaje cubriendo costes de disposición final. Imposibilidad de exportar RAEE, teléfonos móviles y baterías para tratamiento final.
Brasil	La Política nacional de Residuos Sólidos (Ley No. 12.305/2010), reglamentada por el Decreto No. 7.404/2010, establece un marco de gestión de los RAEE, promueve el reciclaje y la reutilización.	Esta Política ha promovido el desarrollo de programas de reciclaje y reutilización de los RAEE en este país, dando lugar a normas estatales más específicas. Esta ley establece la responsabilidad compartida de los generadores de residuos: fabricantes, importadores, distribuidores, comerciantes, ciudadanos y titulares de la gestión municipal de residuos sólidos en la logística inversa de los residuos post-consumo y el envasado y post-consumo. Para el caso específico de los teléfonos móviles, tenemos que mencionar la Resolución del Estado de Sao Paulo, que establece el Programa de Responsabilidad Post-Consumo para el Sector de la Telefonía Móvil (SMA No. 11/2012). Por otro lado, también es necesario considerar las siguientes leyes que se aplican en el Estado de Sao Paulo: Ley Estatal 4091/84 (Se prohíbe lanzar, descarga o abandono de basura, escombros, basura u otro material en las rutas terrestres y pistas de dominio bajo la jurisdicción del Estado); Ley Estatal 12300/06 (Prevé la Política de Estado de Residuos Sólidos, que fue reglamentada por el Decreto Estatal 54645/09); Ley Estatal 13576/09 (Prevé para la gestión de los residuos y componentes electrónicos considerados desechos tecnológicos en el Estado de São Paulo); y Ley Municipal 8450/02 (Prevé la eliminación y desecho de las baterías usadas de los teléfonos móviles).
Bolivia	No existe todavía en el país un reglamento específico para el tratamiento y disposición final de este tipo de residuos RAEE.	Existen iniciativas de municipios en los diferentes departamentos que están haciendo esfuerzos con la Cooperación Internacional para tratar de sensibilizar y socializar con la atención de puntos verdes en algunos barrios de los principales departamentos del país promoviendo el acopio de estos residuos.
Chile	No existe normativa específica para RAEE. Se consideran residuos peligrosos de acuerdo al Reglamento Sanitario de Residuos Peligrosos.	Chile al ser miembro de la OECD, está obligado a gestionar sus RAEE, incluyendo la responsabilidad extendida del productor. En Agosto de 2013, el poder ejecutivo de Chile presentó un Proyecto de Ley Marco para la Gestión de RAEE y Responsabilidad Extendida del Productor; aún en revisión. No existen restricciones para la exportación de RAEE, incluidos los teléfonos móviles.

País	Normativa Aplicable	Situación General
Colombia	Existe la Ley 1672 del 19 de julio de 2013 por la cual se establecen los lineamientos para la adopción de una política pública de gestión integral de residuos de aparatos eléctricos y electrónicos RAEE.	Las empresas en calidad de importadores de computadores y/o periféricos, tienen la obligación de contar con un programa de recolección selectiva y gestión ambiental de residuos de computadores y/o periféricos en virtud de la Resolución 1512 del 5 de agosto de 2010 del Ministerio de Ambiente, Vivienda y Desarrollo Territorial. La empresa tienen la obligación de cumplir con las disposiciones regulatorias especiales para el sector de las telecomunicaciones que en materia ambiental estableció la Comisión de Regulación de Comunicaciones a través de la Resolución 3066 de 2011 "Por la cual se establece el régimen integral de protección de los derechos de los usuarios de los servicios de comunicaciones". Así mismo, en junio de 2014, las empresas de servicios públicos firmaron el acuerdo voluntario por la sostenibilidad, mediante el cual se comprometen, entre otros asuntos, a realizar una gestión integral de residuos sólidos.
Ecuador	Existen 3 Acuerdos Ministeriales de aplicación obligatoria.	AM No. 190, de la Política Nacional de post-consumo de equipos eléctricos y electrónicos en desuso; el No. 191, que aplica el principio de Responsabilidad Extendida del Productor (REP); y el No. 160, que establece normas para la prevención y control de sustancias químicas peligrosas y desechos especiales. Bajo el Acuerdo Ministerial No. 191, los operadores de telefonía móvil, están catalogados como importadores, y están obligados a registrarse frente a la Autoridad ambiental como generadores de residuos peligrosos o especiales. Además deben presentar un programa de gestión de equipos en desuso anual y reportar avances de gestión mensualmente. Existen restricciones para la importación de teléfonos móviles, ligados al desarrollo de planes de reciclaje.
Perú	Desde 2012, está en vigencia el Reglamento Nacional de Gestión y Manejo de los Residuos de AAE. Sujeto al Decreto Supremo 001-2012 por el Ministerio del Ambiente.	Bajo esta normativa, los operadores de telecomunicaciones están catalogados como Generadores de Residuos Peligrosos y al mismo tiempo como productores de RAEE, con la obligación de entregar informes de gestión para los residuos de sus operaciones.
Venezuela	No existe normativa específica sobre RAEE, sin embargo el Gobierno Venezolano se encuentra desarrollando el Plan Integral de Gestión de los (RAEE) en Venezuela	Este Plan incluye el establecimiento de la política ambiental para el tratamiento de RAEE en Venezuela que regule la participación efectiva de los fabricantes, así como la creación del Fondo Nacional de Reutilización y Reciclaje para el apoyo financiero en el desarrollo de programas públicos de gestión de residuos. Los teléfonos móviles son considerados materiales peligrosos y no hay procedimientos claros para poder exportar RAEE.
Uruguay	No existe normativa específica para RAEE en Uruguay.	Los operadores de telecomunicaciones, realizan programas voluntarios de reciclaje de RAEE. Existe una iniciativa de la Dirección Nacional de Medio Ambiente del Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente (DI.NA.MA). Un ejemplo interesante es el del operador Antel, que incentiva y promueve en el país la gestión de los RAEE para lo cual diseñó un programa que integra un sistema de recolección de desechos electrónicos con una campaña solidaria, involucrando otras instituciones, para ayudar a personas con capacidades especiales.

References

Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), *The global e-waste monitor 2014,* United Nations University, IAS – SCYCLE, Bonn, Germany. Obtained at: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

Basel Convention (2002), *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.* Obtained at: Mobile Phone Partnership Initiative (MPPI):http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/MPPI/Overview/tabid/3268/Default.aspx

Basel Convention (2010), *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.* Obtained at: Partnership for Action on Computing Equipment (PACE): http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/Overview/tabid/3243/Default.aspx

Basel Convention (2011), *Partnership for Action on Computing Equipment (PACE).* Obtained at: http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/Overview/tabid/3243/Default.aspx

Basel Convention (2015), *Parties of the Basel Convention.* Obtained at: http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/1290/Default.aspx

Directive EU WEEE 2002/96/CE (2002), *Directiva EU RAEE, 2002/96/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO de 27 de enero de 2003 sobre residuos de aparatos eléctricos y electrónicos.* Obtained at: http://eur-lex.europa.eu/resource.html?uri=cellar:ac89e64f-a4a5-4c13-8d96-1fd1d6bcaa49.0005.02/DOC_1&format=PDF

Directive EU WEEE, 2 (2012), *DIRECTIVA 2012/19/UE DEL PARLAMENTO EUROPEO Y DEL CONSEJO de 4 de julio de 2012 sobre residuos de aparatos eléctricos y electrónicos (RAEE)* Obtained at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:ES:PDF

Duan *et al*. (2013), *Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics, Analysis of Generation, Collection, and Export in the United States. MIT, 2013.* Obtained at: http://www.step-initiative.org/files/step/_documents/MIT-NCER%20US%20Used%20Electronics%20Flows%20Report%20-%20December%202013.pdf

ECLAC (2014): El nuevo paradigma productivo y tecnológico: la necesidad de políticas para la autonomía económica de las mujeres" obtained at: http://repositorio.cepal.org/handle/11362/37250

ECLAC/CGEE (2015), *Consolidación de la cadena reversa de aparatos electro-electrónicos en América Latina y el Caribe: una propuesta de proyecto regional.*

Environmental Health Perspectives (2015), E-Waste and Harm to Vulnerable Populations: A Growing Global Problem. Obtained at: http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/9/ehp.1509699.acco.pdf

GSMA (2014), *E-waste en América Latina: El aporte de los operadores móviles en la reducción de la basura electrónica.* Obtained at: http://www.gsma.com/latinamerica/wp-content/uploads/2014/05/eWaste-Latam-Esp-ResEje.pdf

GSMA (2014), *Posicion de la Industria sobre la Gestión de RAEE.*

GSMA-Latam (2015), *E-waste en Colombia. El aporte de los operadores móviles en la reducción de la basura electrónica – Estudio de caso.* Obtained at: http://www.gsma.com/latinamerica/ewaste-colombia-2015: http://www.gsma.com/latinamerica/wp-content/uploads/2015/02/ewaste-colombia.pdf

Magalini, F. (2015), *DEVELOPMENT OF FINANCING MODEL FOR SOUND E-WASTE MANAGEMENT IN ETHIOPIA.* London, UK.

Ministerio del Ambiente de Peru (2014), Obtained at: http://www.minam.gob.pe/calidadambiental/wp-content/uploads/sites/22/2013/10/REGLAMENTO-RAEE-X5.pdf

Ministerio del Ambiente de Perú (2014). Obtained at: http://www.minam.gob.pe/calidadambiental/manejo-de-raee/

Ministerio del Ambiente de Perú (2014), Obtained at: http://www.minam.gob.pe/wp-content/uploads/2014/03/110.pdf

Morselli, L., Passarini, F., Vassura, I., Waste Recovery. Strategies, techniques and applications in Europe: Strategies, techniques and applications in Europe.

OECD (2000), *Grupo de Trabajo sobre la prevención y el control de la contaminación.* Obtained at: *Extended Producer Responsibility: A Guidance Manual for Governments*. http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

OMPI (WIPO) (2013), *Patent Landscape Report on E-waste Recycling Technologies.* Obtained at: http://www.wipo.int/edocs/pubdocs/en/patents/948/wipo_pub_948_4.pdf http://www.wipo.int/patentscope/en/programs/patent_landscapes/reports/ewaste.html

OMS (2014), *Contaminación ambiental y afectación a la salud E-waste.*

ONUDI (2014), *Proyecto Ayudando a América Latina para la gestión de POPs provenientes de RAEE*. Obtained at: http://www.unido.org/news/press/ayudando-a-america.html

Plataforma RELAC (2011), *Plataforma Regional de Residuos Electrónicos en Latinoamérica y el Caribe.* Obtained at: http://www.residuoselectronicos.net/documents/110410-documento-lineamientos-para-la-gestion-de-raee-en-la-mesa-de-trabajo-publico-privada.pdf

Plataforma RELAC (2015), *Plataforma Regional de Residuos Electrónicos en Latinoamérica y el Caribe.* Obtained at: http://www.residuoselectronicos.net/?p=4306

PNUMA, Iniciativa Step (2009), *Recycling. From E-Waste To Resources.* Obtained at: http://www.unep.org/PDF/PressReleases/E-Waste_publication_screen_FINALVERSION-sml.pdf

RAEE-Perú (2015), Obtained at: http://www.raee-peru.pe.

RECICLAMETAL (2014), *Legilsación RAEE Ecuador*. Obtained at: http://www.reciclametal.com/index.php/raee/legislacion

Restrepo *et al*. (2010), *Manejo de los RAEE a través del Sector informal en Bogotá, Cali y Barranquilla.* Obtained at: Programa Seco/Empa sobre la Gestión de RAEE en América Latina. Page 12.: http://www.ewasteguide.info/files/100427_SectorInfomal_BOG-CAL-BQL.pdf

Secretaría de Energía Argentina (2015), *El Clima lo hacés vos*. Obtained at: https://www.elclimalohacesvos.gob.ar

Secretaria de Recursos Hídricos y Ambiente Urbano, M. d. (2014), *Secretaria de Recursos Hídricos e Ambiente Urbano*. (UIT, Entrevistador)

SIGRAEE (2014), *Economía Circular y Minería Urbana*. Obtained at: http://mineriaurbana.org/2014/06/07/los-residuos-electronicos-en-paraguay/Spanish Government (2014), Obtained at: http://www.lamoncloa.gob.es/espana/eh15/medioambiente/Documents/Durectiva%20residuos%20el%C3%A9ctricos%20y%20electr%C3%B3nicos.pdf

Step Initiative (2012), *Welcome To The Age Of Urban Mining*. Obtained at: http://www.forbes.com/sites/trevorbutterworth/2012/07/17/welcome-to-the-age-of-urban-mining/: y http://www.step-initiative.org/id-2012-07-17-welcome-to-the-age-of-urban-mining.html

Step Initiative (2014), *White Paper on Recommendations for Standards Development for Collection, Storage, Transport and Treatment of E-waste.* Obtained at: http://www.step-initiative.org/files/step/_documents/StEP_WP_Standard_20140602.pdf

Step Initiative (2014), *World Map*. Obtained at: http://www.step-initiative.org/step-e-waste-world-map.html

Step Initiative (2014), *One Global Definition of E-waste.* Obtained at: http://www.step-initiative.org/files/step/_documents/StEP_WP_One%20Global%20Definition%20of%20E-waste_20140603_amended.pdf

Step Initiative (2015), *Step Initiative – Solving the E-waste Problem*.

UIT (2012), *ITU Resolutions on WTSA, Dubai 2012*. Obtained at: https://www.itu.int/dms_pub/itu-t/opb/reg/T-REG-LIV.1-2012-TOC-HTM-S.htm

UIT (2013), *Toolkit for Environmental Sustainability for the ICT Sector. Chapter: End of life management of ICT Equipment.*

UIT (2014), Obtained at: ITU News: http://www.itu.int/ITU-T/newslog/New+Agenda+Seeks+To+Transform+Ewaste+Into+Opportunity.aspx

UIT (2015), *ITU Activities on E-waste*. Obtained at: http://www.itu.int/en/action/climate/Pages/ewaste.aspx

UIT (2015), *ITU Environment & Climate Change*. Obtained at: http://www.itu.int/en/ITU-T/climatechange/resources/Pages/

UNEP (2013) Metal Recycling: Opportunities, Limits, Infrastructure, A Report of the Working Group on the Global Metal Flows to the International Resource Panel. Reuter, M. A.; Hudson, C.; van Schaik, A.; Heiskanen, K.; Meskers, C.; Hagelüken, C.

UNESCO-RELAC (2010), *Los residuos electrónicos: Un desafío para la Sociedad del Conocimiento en América Latina y el Caribe.* Obtained at: http://www.unesco.org.uy/ci/fileadmin/comunicacion-informacion/LibroE-Basura-web.pdf

UNU (2014), *Global E-Waste Monitor 2014.* from: United Nations University: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

UNU (2015), *E-waste classification.* United Nations University.

UNU (2015), *E-waste statistics: Guidelines on classification, reporting and indicators*. Obtained at: http://i.unu.edu/media/ias.unu.edu-en/project/2238/E-waste-Guidelines_Partnership_2015.pdf

WIPO (2013), Patent Landscape Report on E-waste Recycling Technologies. From: http://www.wipo.int/patentscope/en/programs/patent_landscapes/reports/ewaste.html

May 2016