International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series L
Supplement 27
(10/2016)

SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Success stories on e-waste management

ITU-T L-series Recommendations – Supplement 27

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

OPTICAL FIBRE CABLES	
Cable structure and characteristics	L.100–L.124
Cable evaluation	L.125–L.149
Guidance and installation technique	L.150–L.199
OPTICAL INFRASTRUCTURES	
Infrastructure including node element (except cables)	L.200–L.249
General aspects and network design	L.250–L.299
MAINTENANCE AND OPERATION	
Optical fibre cable maintenance	L.300–L.329
Infrastructure maintenance	L.330–L.349
Operation support and infrastructure management	L.350–L.379
Disaster management	L.380–L.399
PASSIVE OPTICAL DEVICES	L.400–L.429
MARINIZED TERRESTRIAL CABLES	L.430–L.449

For further details, please refer to the list of ITU-T Recommendations.

Supplement 27 to ITU-T L-series Recommendations

Success stories on e-waste management

Summary

This Supplement sheds light on e-waste management success stories in different countries. The Supplement covers different policies, legislation, initiatives, and different stakeholders' involvement (government, private sector, non-governmental organizations (NGOs), and informal sector).

It has been developed in response to WTSA Resolution 79 (Dubai, 2012), which instructed ITU-T Study Group 5 to develop and document examples of success stories in countries and regions in handling and managing e-waste generated from telecommunications and ICT equipment. It is complementary to the Supplement guidelines for developing a sustainable e-waste management system, currently being discussed by Q13/5. However, the guidelines introduced in this Supplement apply to all categories of Waste Electrical and Electronic Equipment (WEE). The Supplement presents some countries' and regions' success stories of e-waste management that could be used as best practice guidance. They may be adopted by countries or regions working on developing adequate e-waste management systems to improve their processes and procedures. Finally, the Supplement strongly encourages ITU membership to adopt ITU-T standards and internationally recognized indicators.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L Suppl. 27	2016-10-14	5	11.1002/1000/13150

Keywords

Africa, Asia, Australia, Caribbean, collection, dismantling, electronic equipment, end-of-life, end-of-life management, Europe, extended producer responsibility, informal sector, Latin America, legislation, North America, polices, producer, recycling, refurbishment, repair, reuse, secondary raw materials, second-hand EEE, e-waste, e-waste management, used EEE, waste, waste sorting, WEEE..

---

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

		Page
1	Scope	1
2	References	1
3	Definitions	1
	3.1 Terms defined elsewhere	1
	3.2 Terms defined in this Supplement	1
4	Abbreviations and acronyms	1
5	Introduction	1
6	Overview of e-waste management practices in regions and countries	2
	6.1 E-waste management practices in the African region	6
	6.2 E-waste management practices in the Asia-Pacific Region	16
	6.3 E-waste management practices in the Latin America and Caribbean region	18
	6.4 E-waste management in the North American region	22
	6.5 E-waste management practices in Europe	23
7	Next steps	25

Supplement 27 to ITU-T L-series Recommendations

Success stories on e-waste management

1 Scope

The scope of this Supplement is to present some countries' and regions' success stories on adequate e-waste management which could be adopted by countries working on developing adequate e-waste management systems.

The purpose of the Supplement is to present the different procedures and processes adopted by countries to adequately manage their e-waste, not to select or endorse the best methods or practices.

2 References

[ITU-T L.1410] Recommendation ITU-T L.1410 (2014), *Methodology for environmental life cycle assessments of information and communication technology goods, networks and services.*

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

CRC	Computer Restoration and refurbishment Centre
CRT	Cathode Ray Tube
CU	Central Unit board
EACO	East Africa Communications Organizations
EPR	Extended Producers' Responsibility
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
PCB	Printed Circuit Board
SWEEP NET	Regional Solid Waste Exchange of Information and Expertise Network
WEE	Waste Electrical equipment
WEEE	Waste Electrical and Electronic equipment

5 Introduction

Environmental challenges, including waste problems are recognized as a significant worldwide issue. The growing use of ICT and the innovations in its sector have resulted in large amounts of e-waste within a short span of time. This global problem is addressed by governments, non-governmental organizations' and relevant private companies. In many countries and regions, methods and solutions

are defined to measure and handle e-waste (collection, pre-processing, dismantling, end-processing etc.).

This Supplement has been developed in response to WTSA Resolution 79 (Dubai, 2012), which instructed ITU-T Study Group 5 to develop and document examples of countries' success stories for handling and managing e-waste generated from telecommunications and ICT equipment.

This Supplement does not intend to be a guideline for reducing, handling or managing e-waste, However, the guidelines introduced in this Supplement apply to all categories of waste electrical and electronic equipment (WEEE). The Supplement presents some countries' and regions' success stories of e-waste management that could be used by countries or regions working on developing adequate e-waste management systems to develop or improve their processes and procedures. Finally, the Supplement strongly encourages ITU membership to adopt ITU-T standards and internationally recognized indicators.

6 Overview of e-waste management practices in regions and countries

#	Countries or Region name	Polices and legislation	Lead institution or ministry in charge of e-waste management	Collaboration with other parties	Statistics on e-waste / EEE, including period of observation	Ratification to the conventions and protocols	End-of-life management practices (collection, pre-processing, dismantling, end processing)
6.1.1.1	Combination of North African countries via the Regional Solid Waste Exchange of Information and Expertise Network (SWEEP NET)	A study on e-waste was conducted in 2014. This study catered to the development of a harmonised e-waste legal framework		All countries' administrations	Not conclusive. Some countries have carried out inventories while other have not.		A study on e-waste was conducted in 2014 which suggests the following action plan in the region: carry out e-waste assessments; set up pilot projects allowing the elaboration of e-waste management practices; develop legal framework; organise multi-stakeholder dialogues; develop e-waste business models; promote EPR; study the setting-up of a regional treatment platform.

#	Countries or Region name	Polices and legislation	Lead institution or ministry in charge of e-waste management	Collaboration with other parties	Statistics on e-waste / EEE, including period of observation	Ratification to the conventions and protocols	End-of-life management practices (collection, pre-processing, dismantling, end processing)
6.1.1.2	Morocco	None			No adequate data		Collect computer equipment from companies, repair it and distribute it to other associations, organisations and rural schools; Train young people to repair, refurbish and dismantle computer equipment.
6.1.1.3	Egypt	Green ICT policy. Plans underway to develop a legal framework, regulation on the import of old equipment			None		
6.1.1.4	Eqypt						
6.1.1.5	Tunisia	Study to implement ECO-tax, a legal framework is in the making			An inventory was conducted but a challenge to get information and data		E-waste is collected by local collection mechanism. Pilot separation and collection systems have been set up. E-waste recycling facility is operated for all e-waste in the country and the model has state of the-art recycling facility
6.1.2.1	Nigeria	Formal-informal sector collaboration on e-waste collection			1,100,000 tonnes/year (2011)		
6.1.2.2	Cameroon	e-waste management law and practice					Introduced and EPR

#	Countries or Region name	Polices and legislation	Lead institution or ministry in charge of e-waste management	Collaboration with other parties	Statistics on e-waste / EEE, including period of observation	Ratification to the conventions and protocols	End-of-life management practices (collection, pre-processing, dismantling, end processing)
6.1.2.3	Ghana	Combating uncontrolled dumping of e-waste			179,000 tonnes/ year (2011)		Combating uncontrolled dumping of e-waste
6.1.3.1	The East African Region under East Africa Communicat-ions Organisa-tions (EACO)	Model framework for e-waste management, draft e-waste management strategy	The EACO secretariat	All countries' administrations	Not conclusive	Yes	Regional sensitisation and awareness through workshops, periodic meeting under the EACO to discuss initia tives on e-waste.
6.1.3.2	Kenya	Formal/ informal collaboration on e-waste processing	Ministry of Environment, National Environmental Management Authority (NEMA)	ICT regulator	None	Yes	Pilot study on collection, recycling centres (the WEEE centre)
6.1.3.3	Tanzania	E-waste is under the hazardous waste management	Ministry of ICT	NEMA, ICT regulator			e-waste assessment
6.1.3.4	Uganda	e-waste policy, strategy and guidelines	Ministry of ICT	NEMA, ICT regulator			e-waste policy, strategy and guidelines.
6.1.3.5	Rwanda	Supporting legal framework for e-waste management (draft policy)		Rwanda Environmental Management Agency (REMA), Rwanda Utilities Regulatory Authority (RURA)			e-waste assessment is conducted and the establishment of a dismantling facility is underway
6.1.4.1	Southern Africa under the Southern Africa Telecommun ications Association (SATA),	Guidelines for e-waste disposal		All countries under SATA			Guidelines for e-waste disposal The Southern African E-waste Alliance (SAEWA) was put in place to manage the entire e-waste stream

#	Countries or Region name	Polices and legislation	Lead institution or ministry in charge of e-waste management	Collaboration with other parties	Statistics on e-waste / EEE, including period of observation	Ratification to the conventions and protocols	End-of-life management practices (collection, pre-processing, dismantling, end processing)
6.1.4.2	South Africa	Law and technical strategy for e-waste management (2010)					e-waste recycling in South Africa under the e-waste association of South Africa (eWASA)
6.2.1	India		Formal/ informal collaboration on e-waste processing				ERP introduced, Take back system in place for some institutions, plans underway to put in place collection networks
6.2.2	China						Policing illegal traffic, ban in place on importation of WEEE
6.2.3	Japan						Tracking and tracing system for e-waste
6.3.1	Mexico	Voluntary collective initiatives			None		Project on increasing the recovery rate from mobile phones, raising awareness
6.3.2	Costa Rica and Brazil	Regulation for the integrated management of electronic waste					Retailer and service centres take back regulation for the integrated management of electronic waste national collection infrastructure in place
6.3.3	Peru						Formal/informal collaboration on e-waste processing

#	Countries or Region name	Polices and legislation	Lead institution or ministry in charge of e-waste management	Collaboration with other parties	Statistics on e-waste / EEE, including period of observation	Ratification to the conventions and protocols	End-of-life management practices (collection, pre-processing, dismantling, end processing)
6.3.4	Latin America (RELAC)	Guidelines for e-waste management			Voluntary collective initiatives	Not adequate	Harmonisation of e-waste management, guidelines for e-waste management, raising awareness on e-waste and its management
6.5.1	Switzerland	Multi-level and multi-stakeholder cooperation and monitoring					Multi-level and multi-stakeholder cooperation and monitoring
6.5.2	Spain						Tracking e-waste

6.1 E-waste management practices in the African region

6.1.1 North Africa

6.1.1.1 SWEEP-NET: regional forum for capacity building and best practices

The regional network for integrated solid waste management (SWEEP-Net) was established in September 2009 as a regional platform to exchange best practices, expertise and experience, as well as technical assistance and policy advice on resource and solid waste management [b-SWEEP-Net, 2014].

The platform gathers representatives from Algeria, Egypt, Jordan, Lebanon, Mauritania, Morocco, Palestinian Territories, Tunisia and Yemen. Designated national coordinators are members of the steering committee. The network is open to public and private institutions, local authorities, the private sector, NGOs and civil society, as well as academia and individual professionals working in resource and solid waste management [b-SWEEP-Net, 2014].

SWEEP-Net serves the following purpose:

1 Stimulating and facilitating exchange and sharing of information, experiences and knowledge, using an intelligent mix of communication means.

2 Allowing its members to share information and knowledge and support each other"s work through its information and communication systems and tools.

3 Providing advocacy and policy support for sustainable and integrated solid waste management.

4 Facilitating and promoting the successful application of policies, planning tools, financing mechanisms and technologies that are environmentally sound, socially acceptable economically viable.

A study[1] on e-waste under the SWEEP-Net was conducted in 2014 and suggested the following:

1 http://www.sweep-net.org/sites/default/files/RA%20E-WASTE.pdf

– carry out e- waste assessments;
– set up pilot projects allowing the elaboration on e-waste management practices;
– develop legal frameworks;
– organise multi-stakeholder dialogues;
– develop e-waste business models;
– promote EPR;
– study the setting-up of regional treatment platforms.

6.1.1.2 Morocco: green jobs for the underprivileged

Although the formal sector is still in its early stages of development, several initiatives have been recently launched by associations and non-profit organizations, which voluntarily collect computer equipment from companies, repair it and distribute it to other associations, organizations, and rural schools.

This is the case of Al Jisr, a non-governmental organization based in Morocco with the main goal of providing training for young people who have just left school. In order to self-fund these activities and introduce the underprivileged to informatics equipment, in 2012 Al Jisr and Managem, an e-waste recycling plant, launched the project Green Chip.

The project trains young people to repair, refurbish and dismantle computer equipment. Repaired computers are donated to academic institutions and to a project named Assoclic, which aims to bridge the digital divide.

Managem is the leading metal mining company in Morocco. It has identified many similarities between the recycling industry and the mining activity, in particular in regard to the separation of metals. In 2010, Managem launched a project on urban mining. To organize the collection, regrouping and treatment of e-waste, the group entered into a partnership with Al Jisr.

In the context of a partnership agreement between Managem, al Jisr, the foundation Drosos, the Ministry of National Education and the Ministry of Employment and Professional Education made it possible to set up the Green Chip workshop for the training of out-of-school young people in e-waste dismantling.

Materials and components recovered through the dismantling process (plastic, iron, glass, copper and motherboards) are transferred to Managem for further processing. In particular, metals are refined in the hydro metallurgical complex of Guemassa.

Apart from metal refining options (iron, copper), no national sound solutions for downstream processing is available. However, for CRT monitors, national refining options are being developed. For other fractions, such as precious metals containing printed wiring boards, it is still more convenient to transfer the processing operations to specialized plants abroad. These plants can guarantee better environment compliance and maximize the recovery rate for valuable materials [b-Seitz, 2014].

Green Chip facility is run by the French NGOs Guilde du Raid and Solidarité Technologique. It is a public-private partnership, involving PRODESO, GIZ, Allianz, Doualais, pmuc, French Development Agency, Alios, Biotropical, inTek tft, and Institut Supérieur de Technologie d'Afrique Centrale. Technical partners are Ateliers Sans Frontières and Association pour la Préservation de l'Environnement et le Progrès Social (Sarkam Zamountsi).

Formal e-waste management in Morocco is set to increase. In fact, the country intends to set up a new hazardous waste treatment plant called the National Centre of Hazardous Waste Treatment (CNEDS). The project, which is being developed in partnership with the German development bank KfW and the Land of North Rhine-Westphalia (Germany), is currently producing a detailed feasibility study.

The CNEDS centre will provide the necessary solutions to dispose of e-waste components that cannot be reused.

6.1.1.3 Morocco and Tunisia: data collection initiatives

Morocco is the only Northern African country that has conducted an in-depth e-waste assessment, improving the data available.

In 2007, Morocco launched an extensive e-waste project under the leadership of Centre Marocain de Production Propre (CMPP), with the aim of conducting a comprehensive diagnosis of the country's e-waste status. The project was finalised in 2008. Based on a methodology developed by the Swiss research institution for material sciences and technology development Empa, the study offers an analysis of the local context and the stakeholders, a mass flow analysis and an evaluation of social, economic and environmental impacts resulting from current e-waste management practices [b-Boujemi, H. 2012].

According to the assessment, in Morocco "the stock of televisions, computers and mobile phones was estimated at 222,000 tonnes in 2007. Mass wise, televisions have the largest share, with 68 per cent of the total, followed by computers with 30 per cent, while mobile phones only account for 2 per cent of the stock. However mobile phones constitute 81 per cent of the stock in term of numbers. This difference is explained by the very low average weight of phones (0.1 kg) compared to televisions (30 kg) and computers (25 kg) [b-Laissaoui, Rochat, 2008].

The e-waste flow resulting from the use of electronic devices amounts to 30,300 tonnes per year. Mass wise, televisions and computers account for 95 per cent, with 15,200 tonnes and 13,500 tonnes per year respectively. Mobile phone waste generates 1,700 tonnes per year.

The study concludes that the e-waste flow is dominated by household equipment (73 per cent), followed by professional WEEE (26 per cent) and e-waste generated by the public sector (1 per cent) [b-Boujemi, H. 2012].

A preliminary e-waste assessment has been conducted in Tunisia 2008 by the national waste management agency (Anged). Anged estimates that in 2010 about 50,000 tonnes of e-waste was generated. It included mainly TV sets, air conditioners, refrigerators and washing machines [b-Seitz, 2014].

6.1.1.4 Egypt: Green ICT policy

In February 2010, the Ministry of Communication and Information Technology (MCIT) and the Ministry of Environment signed a cooperation protocol to adopt the Egyptian Green ICT strategy. One of the main pillars of the protocol was the sustainable management of e-waste.

Since then, MCIT has established a green ICT committee involving e-waste stakeholders, organized workshops to raise awareness throughout governorates, built capacity and produced policies and regulations.

Furthermore, MCIT worked in cooperation with the World Bank to build a road map to advise NGOs and the private sector on business creation in e-waste recycling. The road map will be implemented through a pilot project.

Finally, in November 2013, MCIT, in cooperation with the Ministry of Environment, signed a new cooperation protocol examining the size of e-waste in specific regions of the country and the way forward for the e-waste management industry [b-COM5-C6, 2014].

6.1.1.5 Egypt: end-of-life management of e-waste

NGOs and private companies have set up promising initiatives to manage e-waste properly. Examples have been provided below.

International Technology Group (ITG)

The International Technology Group (ITG) was established in 2010 as an association aimed at studying e-waste in Egypt and refurbishing obsolete computers and laptops.

In 2011, a facility for refurbishing and dismantling electronic devices (mainly PC components, CRTs, and printers) was established in a rental area in cooperation with the European PC refurbishing company Tier1 Asset. The throughput of the recycling facility is 10-12 tonnes of e-waste per month of e-waste, sourced from public and private organizations through bids.

In 2013, a new e-waste recycling and refining company was established with a throughput of 200 tonnes of e-waste per month.

For the time being, ITG extracts only base and non-metals. Precious metals are handed over to Umicore, a global materials technology group for refining and extracting rare metal.

Spearink company

Spearink is an Egyptian company founded in 2006 which refills and refurbishes inkjet and toner cartridges, thus contributing to extend their lifetime. The market share for spear ink has gradually increased, both at the national and international level – Spearink has several branches in Egypt as well as franchises across the Middle East.

The company recovers and refurbishes between 3,000 and 4,000 cartridges annually, which translates into approximately four tonnes per year.

RecycloBekia company

RecycloBekia is an Egyptian electronic waste collection company founded in April 2011. It collects and refurbishes desktop PCs, cell phones, laptops, telecommunication boards, cables, lead batteries, other PCBs, X-ray paper-catalytic converters.

It offers green recycling and data destruction services, with refurbishment as a middle process. RecycloBekia either purchases e-waste from informal dealers or provides collection services for free. Refurbished equipment is then sold to local retailers. The remaining fraction is bundled and sold to a recycling plant abroad.

RecycloBekia's recycles up to 30 tonnes of e-waste per month.

Spirit of Youth NGO

In 2009, Spirit of Youth, a local NGO operating in waste collection in cooperation with partners, established an e-waste learning centre for the people in the Zabaleen [garbage collectors] district in Cairo.

The purpose of the school is to offer the youth a chance to "earn and learn" through plastic and electronic waste recycling. E-waste is gathered through regular collection and donations, creating and financing new jobs for poor youth and their families in Zabaleen area. This is a particularly disadvantaged area, especially after a rock collapse occurred on the Mokattam hills. Finally, the centre intends to reduce the negative environmental impact of the thousands of e-waste items dumped all over the city.

The initiative was supported by Mobinil, a mobile operator in Egypt.

Resala NGO

Resala is an Egyptian NGO founded in 2000. Resala collects e-waste and used EEE alongside with other waste materials such as paper and clothes. E-waste and materials are provided mainly through donations and door-to-door pick-ups. These are sold to waste dealers and repair shops to fund the organization's charity activities.

The NGO operates only in the Greater Cairo area, Alexandria and some big cities in delta and upper Egypt, where most consumers and users reside [b-Degreif et. al, 2014].

In 2010, Resala collected 139,153 units of e-waste, including telephones, laptops, irons and fridges [b-Degreif et. al, 2014].

6.1.1.6 Egypt: regulation on the import of old equipment

Decree n. 703/2007 by the Ministry of Trade and Industry (MTI) of Egypt regulates the imports and exports of obsolete electrical and electronic equipment. The decree states that imported computers and peripheral devices cannot be older than five years from date of production.

The decree clarifies and extends the scope of Telecommunications Regulation Law n.10/2003, article 46, which stated that "It is prohibited to import used Telecommunication Terminal Equipment for the purpose of trading". Telecommunication equipment here refers to telecommunication equipment used to connect to a public or private telecommunication network.

6.1.1.7 Tunisia: eco-tax

The Tunisian authorities are currently studying the opportunity to introduce a 5 per cent eco-tax on electrical and electronic equipment [b-Labidi, 2010]. The tax would generate funds in support of the nascent e-waste management system.

Tunisia is currently setting up an e-waste management system based on the extended producer responsibility principle. However, following the political and institutional changes after the revolution and due to the current transition period, political considerations regarding e-waste may have changed.

6.1.2 West Africa

6.1.2.1 Nigeria: formal-informal sector collaboration in e-waste collection

Contrary to most African countries, and the only exception in West Africa, Nigeria has in place a legal framework to increase the monitoring capacity of public authorities [b-NESREA, 2013] and to regulate the collection, treatment and disposal of e-waste [b-UNEP, 2011a]. It also promotes a voluntary mechanism to ensure compliance with these regulations.

In order to strengthen enforcement mechanisms against illegal trade of e-waste, the Nigeria Guide for Importers of UEEE requests that every importer of used electrical and electronic equipment is registered with the National Environmental Standards and Regulations Enforcement Agency (NESREA). The Guide also specifies the documentation that importers of used EEE should carry [b-NESREA, 2013]. The traffic of unusable electronic goods is prohibited and it can be punished with life imprisonment [b-Sthiannopkao, Wong, 2013]. Controls are also carried out voluntary by retailers of used EEE. For instance, in Ojo Local Government, Lagos State, southwest Nigeria, enterprises that wish to operate in the Alaba Market need to join an association (the International Market Association Alaba). Membership is granted only upon submission and verification of the importation documents (e.g., "bill of lading" and papers issued by the customs). In addition, the association represents its members at the governmental level guaranteeing that their interests and concerns are addressed. The same applies to other markets, including the Westminster Market and the Ikeja Computer Market. Operating in Lagos there are also associations for the representation of specific categories of scrap workers, although they mainly represent shop owners and formal operators: the Scrap Metal Dealers Association of Nigeria, which has a membership of 5,000 dealers, the Nigerian Association of Refrigeration and Air Conditioning Practitioners and the National Electronics Technician Association of Nigeria [b-Öko-Institut, Basel Convention, 2011].

The market authorities control customs papers and check that recycling operations carried out within the perimeter of the market are sound. In support of these efforts, the Lagos Waste Management Authority (LAWMA) has distributed collection bins throughout the markets. In fact, repair and refurbishing activities have generated a significant amount of e-waste that, if not managed properly,

could endanger the health of inhabitants and workers and deplete the environment. LAWMA collects the bins and guarantees that these by-products are managed according to the law[2]. This service is complemented by the presence of informal collectors that dismantle and sort e-waste. Although recyclers engage in improper activities such as burning cables to separate copper, scrap metals are recovered and reintroduced in the market, thus preventing waste generation [b-Öko-Institut, Basel Convention, 2011].

This represents a case of successful collaboration between the formal and informal sector, as well as the public and private sector. Such positive examples are not only in the markets' perimeters. LAWMA distributed recycling banks for different categories of waste, including e-waste in public areas and employed "scavengers" to manage them. The higher salaries offered by the authority constitute adequate incentive to prevent informal workers from handling and managing waste improperly. However as LAWMA cannot employ all scavengers, some are allowed to operate – they are advised to use protective equipment [b-Tobore, 2012].

Mr. Ola Oresanya, managing director of LAWMA, admitted that the formal sector cannot refrain from collaborating with informal operators [b-IPS, 2008] given that they play a "great impact in the reduction of the net volume of waste disposed of" [b-Tobore, 2012].

Although these public private partnership cannot control all e-waste sold and treated in Lagos due to the size of the city and the need for scattered recycling sites and "scrap metal yards" where e-waste is dismantled and reconditioned, they contribute to monitor informal entrepreneurs and enforce compliance with environmental regulations [b- Öko-Institut, Basel Convention, 2011] [b-Tobore, 2012].

In parallel, Nigeria's legislator has defined a legal framework to implement the principle of extended producer responsibility to e-waste management. The National Environmental (Electrical Electronic Sector) Regulations SI N.23 of 2011 states that "All importers, exporters, manufacturers, assemblers, distributors, and retailers, of various brands of EEE products shall subscribe to an Extended Producers' responsibility (EPR) Program including the Buy Back". In particular, manufacturers, importers, distributers or retailers are responsible for the take-back of EoL EEE and for the set-up of collection sites from where manufacturers and producers of EEE ensure "environmentally sound management of e-waste". In order to promote environmentally sustainable recycling of e-waste, importers are charged with a fee, paid to the National Environmental Standards and Regulations Enforcement Agency (NESREA). Finally, the act also places responsibility on consumers who are obliged to return their EoL equipment to authorized "collection points or centres" [b-NESREA, 2013].

To combat illegal traffic, NESREA is collaborating, at the national level, with the Nigeria Customs Service and the National Toxic Waste Dump Watch committee, and at the international level with the International Network for Environmental Compliance and Enforcement (INECE), Seaport Environmental Security Network (SESN), the International Criminal Police Organization (INTERPOL) and country governments and their competent agencies [b-NESREA, 2013].

So far, NESREA managed to register "credible" importers of used EEE and sanction those who did not hold a certificate. As a result in 2012, 14 containers and 12 trucks of e-waste were repatriated and 17 unregistered importers were sanctioned [b-NESREA, 2013].

[2] Namely, the National Environmental Protection (Waste Management) Regulations S.I.15 of 1991 which regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources, and the National Environmental (Sanitation and Wastes Control) Regulation S.I.28 of 2009 which applies to issues of environmental sanitation and all categories of wastes, including e-wastes. The National Environmental (Electrical/Electronics Sector) Regulations S.I. No. 23 of 2011 aims at reducing pollution caused by all handling and management operations of EEE at end-of-life [b-UNEP, 2011a].

6.1.2.2 Cameroon: e-waste management law and practice

In 2012, Cameroon introduced the principle of extended producer responsibility to e-waste management with the Joint Order No. 005/2012 by the Ministry of Environment, Nature Protection and Sustainable Development (MINEPDED) and the Ministry of Commerce (MINCOMMERCE), establishing specific conditions for the management of WEEE.

The Joint Order n. 005/2012 compels producers, retailers and municipalities to "take measures" in order to prevent WEEE from being mixed with municipal waste. For each product category, producers must set up an individual or collective scheme, approved by the Environmental Ministry, or pay a fee to an organization licensed by the Ministry of Environment. This association would cover the additional costs of collection in agreement with the municipality. Producers and distributors must also register with the Ministry of Environment, specifying their product category.

The Order also mandates that retailers, when selling new equipment, must take back similar quantities and types of WEEE free-of-charge.

Finally, municipalities, producers and retailers are entrusted with the responsibility of informing consumers with the correct disposal channels for e-waste.

Similar to formal collection, formal recycling is still at an embryonic stage. Consequently, after dismantling, the majority of materials and components recovered are shipped to France for further treatment. This is especially the case for PCBs and CRTs. However plastics, iron and wires are recycled in Cameroon.

The "Centre for recycling and reuse of Waste Electrical and Electronic Equipment (WEEE)" is one of the two e-waste collection, repair and dismantling companies in Cameroon. Its main goal is to provide vocational training to young people out of school. E-waste management operations are carried out to self-finance training activities.

Collection is entrusted to young people trained by the centre and partner companies. WEEE is then repaired, refurbished or dismantled, according to the condition of the equipment. Repaired computers are sold within the 'centre's premises with a one-month guarantee. Young people are trained to do maintenance work, use second-hand computers and dismantle what cannot be repaired. The main materials recovered are plastics, iron and wires. Further recycling is then conducted in other plants.

The centre tracks waste electrical and electronic equipment by assigning to each of them a unique reference number.

The facility is run by the French NGOs Guilde du Raid and Solidarité Technologique. It is a public-private partnership, involving PRODESO, GIZ, Allianz, Doualais, pmuc, French Development Agency, Alios, Biotropical, inTek tft, and Institut Supérieur de Technologie d'Afrique Centrale. Technical partners: Ateliers Sans Frontières; and Association pour la Préservation de l'Environnement et le Progrès Social (Sarkam Zamountsi).

6.1.2.3 Ghana: combating uncontrolled dumping of e-waste

Most of the electrical and electronic equipment in Ghana is either second-hand or substandard. Given the low price, this type of equipment fulfils key economic and social needs of the populace. However, its reduced lifespan increases e-waste.

Furthermore, most of this equipment is imported and is being dumped in Ghana. The remaining fraction is mostly recycled improperly to recover electronic components with copper and gold elements.

In order to protect human health and the environment and control the illegal dumping of e-waste, the Government of Ghana drafted a bill, currently under discussion in the Parliament. The bill, which will replace the Environmental Protection Agency (EPA) Act n.490/1994, provides policy guidelines for e-waste management and sanctions for illegal imports based on the Basel Convention.

The NCA had already introduced Act n. 769/2008, which enacts the Equipment Certification Regime and ensures that imports meet certain minimum regulatory requirements. Though this process has been in place for a time now, the effects have been minimal. Considering the data collected from various ports of entry, and the complaints issued by consumers and operators, the NCA intensified the enforcement of the act through stakeholder engagement and consumer education.

Another initiative undertaken by the Government of Ghana, through the NCA, is the Digital Terrestrial Television migration. The programme aims to prevent the uncontrolled dumping of analogue TV sets, combat illegal imports and avoid counterfeiting. To this end, TV sets and set top boxes are certified by the NCA to ensure that they conform to minimum requirements.

Finally, the Government of Ghana introduced a ban on second-hand fridges. The ban aims to reduce e-waste generated from used fridges imported into the country.

6.1.3 East African Region

6.1.3.1 East Africa Communications Organization: regional cooperation

The East African Communications Organization (EACO) is a regional regulatory body that brings together national ICT regulators, operators, service providers (in the telecommunication, broadcasting and postal sub-sectors), ICT training institutions and other stakeholders in the communication sectors within Rwanda, Burundi, Uganda, Kenya and Tanzania.

In order to jointly face the challenges posed by e-waste, EACO established the e-waste taskforce (now called Working Group on Environment and E-waste). To date, the working group has identified the need for sustainable and adequate e-waste management in the region, and committed to developing harmonized strategies, policies and guidelines.

To this end, the working group produced a "Proposed model framework for e-waste management" that guides member states when designing their e-waste management policies [b-EACO, 2013].

The model specifies the role that governments should play, the necessary legal, regulatory and institutional framework, the human, financial and infrastructural resources needed, private sector involvement/collaboration and consumers' responsibilities [b-EACO, 2013].

Although the EACO secretariat urged member states to use the model as a guide for e-waste management policies [b-EACO, 2014], the intention is not to negate existing policies (e.g., in Uganda) nor those that are currently under development (e.g., in Rwanda) [b-EACO, 2013].

Finally, the EACO secretariat committed to conducting a study to help member states improve their datasets in regard to e-waste management. The secretariat is convinced that better and more reliable data is crucial to make informed decisions at the governmental level [b-EACO, 2014].

6.1.3.2 Kenya: formal-informal collaboration in e-waste processing

Despite the lack of a legal framework, in the past few years multi-national companies have set up voluntary take-back schemes for old electrical and electronic products.

Since 2010, Hewlett Packard has been running a project to sort and dismantle domestic appliances, computers and mobile phones in partnership with the plant East African Compliant Recycling (EACR), the University of Northampton and the German investment organization Deutsche Investitions – und Entwicklungsgesellschaft.

For the collection stage, HP employs micro-businesses or individual collectors. For instance, in Kebira, HP works with the Soweto youth group to ensure the sorting of e-waste. HP provides them with equipment and training in compliance with international health and safety standards. In addition, collectors are given 40 shipping containers. Individual collectors receive a salary only upon delivery of the quantity requested, which may take days. However, the amount is higher than profits in the informal sector.

Recycling is carried out in the first e-waste recycling plant in East Africa: the East African Compliant Recycling (EACR), where plastics, metals and other materials are recovered and then sold to manufacturers.

HP project IT system provides EACR with full traceability of the material flow and financial transactions. Moreover, the system allows for a transparent e-payment that passes maximum value down the chain. Hewlett Packard provides funding, IT equipment and IT design expertise, using mobile phones and cloud technology.

Moving from the idea that collaboration between registered state-of-the-art facilities and informal collectors and dismantlers is preferable to the exclusion of scrap dealers and unregistered collectors from the system, the NGO WorldLoop facilitated an agreement between Kenya and Belgium for the recycling of Central Process Units (CUs). These are manually disassembled in a facility in Nairobi and then shipped to Belgium for end-processing [b-Vanegas et al., 2014].

A study demonstrated that without this international cooperation agreement, Kenya would have not been able to recover plastics, ferrous and non-ferrous materials, copper, Neodymium magnet, aluminium and leaded glass, among others. The profit derived from recovery operations was 60 per cent higher than if the two countries had managed the CUs autonomously [b-Vanegas et al., 2014].

This is due to the fact that a higher recovery rate can be achieved in recycling facilities in Belgium – almost double that of the informal sector for the recycling of PCB and 14 per cent higher for CUs. The higher profit relative to informal recycling in developing countries is mainly due to the recovery of rare metals and plastics, and to lower labour costs [b-Vanegas et al., 2014].

Furthermore, the environmental and health impact of improper operations is avoided. Higher profits can also be achieved when applying international cooperation agreements to cathode ray tube (CRT) monitors although less than for CUs [b-Vanegas et al., 2014].

6.1.3.3 Tanzania, Uganda: data collection

The magnitude and flow of e-waste generation in Tanzania is still unknown as there has been only a few studies providing a rough estimate of computers present in the country and e-waste generated [b-Magashi, Schluep, 2011].

An e-waste assessment study was carried out by UNIDO, EMPA and Microsoft in 2011 on computers mass flow trends. The study detected an exponential growth in waste computers, and indicated that in 2015 they could reach between 250,000 and 800,000 units (3,000-9,500 tonnes [b-Magashi, Schluep, 2011]).

In Uganda, the E-Government Readiness Assessment (2012) Final Report by the National Information Technology Authority Uganda (NITA) estimated that among the government institutions surveyed, 6,622 computers are out of use [b-UNDP, 2013].

6.1.3.4 Uganda: e-waste policy, strategy and guidelines

In October 2012, the Government of Uganda approved an e-waste management policy. The policy mandates for the establishment of an e-waste management infrastructure; awareness-raising and education; a legal framework; human resource development; resource mobilization; and an e-waste fund.

The Government of Uganda already approved a strategy that will lead to the implementation of such policy. The strategy includes targets and progress indicators; the designation of implementing agencies; a secretariat; and the identification of timelines for deliverables. E-waste guidelines have also been developed and endorsed accordingly.

The Government was preparing plans to build a plant that would dismantle manually obsolete computers generated at the national level. This is spearheaded by UNIDO and the Ministry of ICT (MoICT).

In parallel, the Uganda National Bureau of Standards (UNBS) re-instated from June 2013 a series of guidelines known as the pre-export verification of conformity to standards programme (PVoC); which verify the conformity of all products at the point of entry within the country.

The Ministry of ICT of Uganda and UNIDO spearheaded a national steering committee aimed at establishing a manual dismantling plant for obsolete computers.

The project aims to develop and strengthen a formal collection infrastructure; protect human health and the environment through safer recycling practices; avoid the release of hazardous sensitive materials into the environment; collect and process e-waste using a private sector model which includes market incentives and creates jobs for Ugandans; test a practical solution that addresses national concerns on e-waste management.

6.1.3.5 Rwanda: e-waste management project

Rwanda recently launched an e-waste management project to support the sustainable e-waste recycling industry. The project aims to:

1 support the legal framework for e-waste management in Rwanda (e.g., the five-year strategy for e-waste management, the technical guidelines and regulations and the national standard for e-waste management);

2 conduct a detailed inventory on e-waste status in Rwanda;

3 raise awareness; and

4 establish a dismantling facility, as well as country-wide collection centres and link the established networks to national and international recyclers.

The project is funded by the National Fund for Environment and Climate Change (FONERWA), UNIDO and UNEP. It is coordinated by the Rwanda Resource Efficient and Cleaner Production Centre and the Ministry of Trade and Industry, in collaboration with the Ministry of Youth and ICT, Rwanda Utilities Regulatory Authority, Rwanda Development Board, Rwanda Environment Management Agency (REMA) and Rwanda Bureau of Standards (RBS).

6.1.4 Southern African region

6.1.4.1 SATA: a regional platform for cooperation

At its 30th Annual Conference in Maseru (Lesotho), the Southern Africa Telecommunications Association (SATA), which is a forum of telecommunication/ICT operators in the Southern Africa Development Community (SADC) region, raised concerns on the amount of equipment that will be laid idle once the migration process to Next Generation Networks (NGN) is complete.

SATA drafted guidelines for e-waste disposal, which allow for the identification of e-waste and its proper handling. In addition, the guidelines call for the establishment of a SADC e-waste recycling plant that would recycle e-waste in an environmentally sound manner.

Besides the guidelines, the Southern African region has put in place a number of strategies and initiatives to ensure the adequate management of e-waste.

For instance, the Southern African E-Waste Alliance (SAEWA), a non-profit organization, is coordinating the responsible management of the entire electronic waste stream in a one-stop shop format in South Africa and its neighbouring countries. It takes many different working partners to achieve a fully comprehensive e-waste management solution. Therefore, SAEWA gathers independent business partners who are able and willing to work together to handle e-waste in an integrated fashion and according to the best technologies available locally, ensuring safe data destruction at all times. SAEWA provides constructive solutions to the handling and (where required) disposal of electronic waste, and ensures that all processes are environmentally sound and safe for workers.

6.1.4.2 E-waste recycling in South Africa

In 2011, South Africa implemented a new law and a technical strategy for dealing with e-waste.

The e-Waste Association of South Africa (eWASA) was established in 2008 to manage the establishment of a sustainable environmentally sound e-waste management system in South Africa. The non-profit organization works with manufactures, vendors and distributors of electrical and electronic goods and e-waste handlers (including re-furbishers, dismantlers and recyclers) to manage e-waste effectively.

eWASA is supported by the Swiss State Secretariat for Economic Affairs (SECO) and the Federal Laboratories for Materials Testing and Research (EMPA).

6.2 E-waste management practices in the Asia-Pacific Region

6.2.1 India: formal-informal collaboration in e-waste processing

In India, the extended producer responsibility principle was applied to e-waste in 2010 [b-MOEF, 2011]. However, its implementation is far from being achieved. Only a few manufacturers have set up an e-waste management system or joined one. Among the electronics companies operating in India, only four have established take-back schemes for their own products, of which only one is for B2B equipment.

The association of manufacturers (MAIT) is trying to organize a joint initiative to set up collection networks, but so far there is no nationwide organized formal system. The formal sector manages only three per cent of the total e-waste generated. Similar to other developing countries, India can count on a small number of large recycling facilities that struggle to gain access to e-waste, while the informal sector is constituted by numerous individual recyclers or organized enterprises [b-Kumar, Shah, 2013]. In such conditions, it is unreasonable to expect that the informal sector will be formalized [b-Schluep, 2011]. At the same time, the formal treatment facilities need to process an adequate amount of e-waste in order to cover their fixed costs and the actual situation does not guarantee them the possibility to process this quantity adequately.

Therefore, in 2013, Attero, one of the largest waste management companies in India, launched a project – the Clean E-India Initiative – to integrate informal waste collectors in a formal management system. Attero has placed the organization of the informal sector at the core of its business strategy [b-Attero, 2014]. In this view, the Clean E-India Initiative aims to foster the collection of e-waste by establishing collection schemes in Delhi, Mumbai, Ahmedabad, and Hyderabad [b-Attero, 2013]; and take advantage of the company's collection network that is already in place in over 22 States [b-the Guardian, 2013a]. In addition it would provide training programmes for informal recyclers [b-IFC, 2013], contracted or paid for collection and pre-processing operations [b-Attero, 2013]. Investing in the training of informal recycling is fundamental to improve the environmental sustainability of e-waste management. To this aim, semi-skilled workers should be employed [b-Chung, Murakami-Suzuki, 2008].

In order to maximize the economic value recovered and avoid the impact of improper practices on health and the environment, WEEE is then transported to the only end-processing facility in the country (located in Roorke) [b-Attero, 2013].

By raising awareness and increasing the number of collection points, the initiative aims also at reducing the amount of EoL equipment stocked in households, which according to Kumar and Shah (2014) accounts for 40 per cent of the e-waste generated. In addition, the project intends to increase the amount of e-waste which is treated properly [b-Attero, 2013].

The project was co-funded by 15 major manufacturers operating in India and obtained USD 5 million from the International Finance Corporation (IFC, he World Bank group) [b-Attero, 2013]. It received also the endorsement from former Minister for Communications and Information Technology, Kapil Sibal [b-IFC, 2013].

6.2.2 China: policing illegal traffic – Operation Green Fence

China banned imports of e-waste in 2000. The "Catalogue for Managing the Import of Wastes" included a list, regularly updated, of prohibited goods. China signed the Basel Convention and in 2012 the government announced actions to improve coordination between the customs and inspection departments. In 2007 the Ministry of Environmental Protection signed a Cooperation Arrangement with the Environmental Protection Department of Hong Kong – the main entrance port for scrap to combat the illegal movement of waste. However, due to inadequate enforcement and monitoring activities imports of e-waste did not diminish [b-StEP, 2013a].

It was only in 2013 that the People's Republic of China enforced the ban on imports of WEEE through a major initiative: Operation Green Fence. The ten-month operation aimed to prevent imports of bales with a percentage of contaminants higher than 1.5 per cent [b-MBA Polymers, 2013].

The Chinese customs and China Certification and Inspection Group (CCIC) control documentation and suspicious behaviour. These include low prices for shipments, freight and insurance; firms that have already shipped hazardous waste in the past through fraud and other malpractices; or companies that use different entrance points for imports [b-Thomas, 2013].

Operation Green Fence prevented 7,600 tonnes of equipment from being imported [b-MBA Polymers, 2013] and suspended 250 import licenses. Thus, the initiative boosted law enforcement [b-Ecns, 2014] and contributed to reducing the level of contaminants in shipped bales [b-Shanavas, 2013].

In the long term, according to some commentator from the scrap recycling industry, this operation will "streamline the type of material coming into China and will limit the environmental impact" of e-waste shipments. For instance, shipments of certain types of plastic scraps, which can be better recycled in Europe, are likely to diminish. In addition, the initiative will force the recycling industry in exporting countries to adopt better sorting techniques that improve the overall quality of scraps [b-Shanavas, 2013].

The recycling industry in China and developing countries will also benefit from the operation. Recycling companies will be forced to recycle scrap materials domestically and properly. Finally, Operation Green Fence will increase and improve pre-shipment inspections in exporting countries [b-Shanavas, 2013].

The initiative has already proven fruitful. It has been reported that waste management companies in exporting countries have already started improving the quality of the bales being shipped [b-Thomas, 2013].

However, in order to bypass the ban, some traders have resorted to ship e-waste away from Chinese ports [b-StEP, 2013a], through Indonesia, Malaysia [b-Thomas, 2013] or Vietnam. In China, entry points for illegal shipments have spread from the Guangdong Province to other regions [b-StEP, 2013a] and some of the rejected shipments have been discharged in landfills without undergoing processing [b-MBA Polymers, 2013].

While the operation did limit shipments of hazardous substances, it also reduced imports of plastic scrap and other materials, which are in high demand among local recyclers. Consequently, the lower supply caused a peak in prices which affected mostly recyclers [b-MBA Polymers, 2013], some of whom had to leave the market [b-Thomas, 2013]. In the Guandong province, approximately 30 per cent to 40 per cent of recycling facilities have had to shut down [b-Shanavas, 2013].

Furthermore, it was argued that the operation affected disproportionately exporters in developing countries since creating bales with no more than 1.5 per cent contaminants is possible only through "modern recycling equipment" [b-Thomas, 2013].

Coordination among enforcement agencies was not optimal either. In fact, the allocation of responsibility between Chinese customs and China Certification and Inspection Group (CCIC) was

not clear. This uncertainty resulted in a duplication of controls and contrasting decisions [b-MBA Polymers, 2013].

6.2.3 Japan: the docket system

The 2009 Law for the Recycling of Specified Kinds of Home Appliances (LRHA) introduced a manifest system to trace air conditioners, refrigerators, freezers, TV sets and washing machines from their purchase to disposal, and ensure appropriate recycling.

When disposing of home appliances, consumers purchase a five-part manifest (or docket) from a retail store (if they decide to return the equipment there) or from a post office (if they ship the equipment back to the manufacturer or take it directly to a collection point) [b-Chung et al., 2009].

Consumers retain one copy of the manifest and apply another, which includes a bar code, to the appliance's package. When taking back the equipment, the retailer scans the bar code, uploading the information included to a database. The bar code is scanned again when the equipment is entrusted to a collection facility, the manufacturer, a logistic company or a recycling facility [b-Chung et al., 2009]. In this latter case, the scan must take place upon receipt of the equipment, before it undergoes depollution, dismantling and other operations [b-dti, 2005].

Each of the operators involved retain a paper copy of the manifest as proof [b-Chung et al., 2009]. The last copy is sent to the Home Appliance Recycling Law Ticket Centre, a public foundation owned by the Government of Japan, which is also responsible for the administration of the manifest system, together with the Post Office system [b-dti, 2005].

Both consumers and waste management operators have to register information regarding the handling of the equipment in a database [b-Aizawa et al., 2008]. Data is also uploaded to the Association for Electric Home Appliances (AEHA) website to enable consumers and authorities to trace the equipment. Tracking is made possible because each manifest is assigned a reference number. This is linked to the appliance, its characteristics, the issuance date, the consumers' name and contact information, as well as the name and address of the producer and retailer [b-dti, 2005].

The system allows consumers and authorities to make sure that WEEE is managed properly by authorized operators only [b-Chung et al., 2009].

In addition, the system facilitates compliance, identifying applicable collection points and recycling plants for each brand and category of WEEE. It also allows treatment facilities to identify the producer and receive compensation for recycling the appliance. In turn, manufacturers can request feedback from recyclers to improve the design of their products. Finally, the system improves the quantity and quality of data collected [b-Atasu, Wassenhove].

Finally, the manifest system guarantees that treatment facilities receive a pre-sorted flow of equipment and have access to information regarding products' composition and manufacturing method. Often the model ID and serial number of the appliance is also included in the bar code [b-dti, 2005].

The Japanese manifest system for e-waste works because consumers are compelled by law to return their EoL appliance, and because retailers are requested to take it back and entrust it to the manufacturer or importer responsible for its management. In addition, despite the costs, consumers are willing to pay for the manifest [b-dti, 2005].

6.3 E-waste management practices in the Latin America and Caribbean region

6.3.1 Mexico and Brazil: voluntary collective initiatives

Most Latin America countries do not have a legal framework or a country-wide system for the management of e-waste. Hence, some manufacturers and service operators have established voluntary take-back schemes. Most of these initiatives are limited in scope to the very brands or the types of products sold by the initiators and they privilege valuable equipment such as mobile phones. Mobile

phones are one of the most coveted WEEE by PCSs and processing facilities due to the presence of more than 20 rare metals, such as titanium, indium, gallium, barium, tantalum, arsenic, neodymium, zirconium [b-ITU-T, 2012c] and yet consumers still prefer to store them in households. In order to overcome this tendency, all stakeholders involved, from governments to manufacturers and facilities should raise awareness on the opportunity of recycling mobile phones while putting in place adequate incentives [b-Yin et al., 2013].

One of the challenges facing the management of e-waste in Brazil is the infrastructural divide within the country. In fact, 85 per cent of the municipalities equipped for recycling e-waste are located in the southeast of the country. Meanwhile, the number of mobile subscribers are increasing while the prices for devices diminish [b-GSMA, 2014], placing Brazil at fourth place for mobile phone usage (265.5 million) after China, India and the United States [b-Flag It, 2013].

Given all these challenges, the National Union of Mobil Operators (SindiTelebrasil), which represents all mobile operators in the country, presented a project together with two associations[3] in order to manage e-waste collectively and cooperate in the development of an infrastructure for e-waste management. The agreement was presented to the Ministry of Environment in June 2013. Some of the members of SindiTelebrasil had already established individual take-back schemes and the project was able to benefit from their experience [b-GSMA, 2014].

The proposal commits the three parties to distribute by 2018 dedicated bins for the collection of waste mobile phones, batteries and accessories in retail stores and customer service centres in all cities with more than eight million inhabitants, such as Belo Horizonte, Brasília, Cuiabá, Curitiba, Fortaleza, Manaus, Natal, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo. After 12 months the project will be extended to state capitals with more than five million inhabitants and, after five years, to 366 municipalities [b-GSMA, 2014].

In Mexico, mobile operators decided to pool together resources to raise awareness and recover the materials incorporated in the equipment out of use. To this end, in July 2013, the National Association of Telecommunication (ANATEL) of Mexico, which includes 43 members, both mobile operators and manufacturers, presented a Plan for the special handling and management of mobile phones (Programa Verde, i.e., Green Program) [b-GSMA, 2014].

This project serves not only the purpose of increasing the recovery rate from mobile phones, but also of collectively complying with the Standard NOM-161-SEMARNAT-2011[4], which classifies e-waste as requiring "special handling" measures. The project can be joined voluntarily, but its signatories have to comply with it obligatorily [b-GSMA, 2014].

The plan provides that retailers and manufacturers take-back e-waste when it is returned by consumers, and transport it to appropriate collection and treatment facilities. The project intends to distribute 350 recycling bins throughout the national territory. Customers, manufacturers, importers and retailers will be able to locate them on ANATEL website. In parallel, participants in the project have also been asked to organize awareness campaigns. Finally, recycling facilities have been requested to comply with additional reporting obligations. The association ANATEL collects reports from recycling facilities and is in charge of publishing data concerning the progress of the programme. ANATEL is also responsible for monitoring the effectiveness of the system in biannual dedicated sessions [b-GSMA, 2014].

---

3 The Association of Electrical and Electronic Industry of Brazil (ABINEE) and the Association of Retailers of Information Technology of Brazil (ABRADISTI) [b-GSMA, 2014].

4 "Mexican Official Standard NOM-161-SEMARNAT-2011, that establishes the criteria for the classification of special handling wastes and for determining which wastes are subject to a handling plan; the list of the same, the procedure for the inclusion or exclusion from said list; as well as the elements and procedures for the formulation of the handling plans" [b-SEGOB, 2013].

During the first semester of this campaign the number of mobile phones recycled increased to 347.715 units [b-GSMA, 2014].

One of the companies that joined the Green Program, Nextel México, launched two initiatives in support of the reuse and recycling of mobile phones: a programme for equipment renovation and Nextel Guardian Program. The former offers approximately USD 11 of credit to clients who return a mobile phone when subscribing to a new plan. The latter offers clients the possibility to return faulty devices free of charge in exchange for a second-hand device [b-GSMA, 2014].

Considering that consumers tend to replace their mobile phones every 18 months, the Guardian Program contributes to reducing e-waste by recovering approximately 50 tonnes of mobile phones, of which 30 tonnes are recyclable and 20 tonnes can be directly reused [b-GSMA, 2014].

6.3.2 Costa Rica and Brazil: retailers and service centres take-back

In 2010 the Ministry of Health of Costa Rica published Executive Decree n.35933-S, a regulation for the Integrated Management of Electronic Waste, which places on all manufacturers, importers, and retailers of EEE the responsibility for the proper management of e-waste [b-Costa Rica decree n. 35933-S, 2010].

In order to comply with this regulation, in 2012, 115 retail stores launched a programme called "Gollo Recicla", a permanent programme launched with the endorsement of the Ministry of Environment and Energy. The aim of the programme is to share the costs of establishing collection sites and organize collectively transportation towards appropriate recycling facilities. Retail stores have agreed to take back free-of-charge WEEE even if they did not originally sell them. WEEE is then processed by an authorized plant in Costa Rica, or exported to Canada or the Unites States [b-Coopservidores, 2013].

The programme contributed to the development of a national collection infrastructure with 120 permanent collection points [b-IC, 2014]. During the first year (May 2012 - May 2013) the programme collected more than 50 different categories of e-waste totalling 60,000 kg, and after two years 145,000 kg [b-Coopservidores, 2013].

Brazil can count on a network of service centres (Assistências Técnicas) distributed throughout the country to repair broken or faulty electric and electronic equipment, regardless of their brand. Service centres have agreements with nearly all electric and electronic companies operating in Brazil. In 2010, Philips signed a further agreement with more than 400 of those service centres to request them to take back products that could not be repaired. The agreement led to the implementation of the Sustainable Cycle Programme in 40 service centres. E-waste stored in service centres are transported to one of the few recycling plants in Brazil [b-The Guardian, 2013b].

The strength of the programme is that already existent infrastructure and logistic networks used by retailers is deployed to enhance the effectiveness of e-waste collection. In three years the Sustainable Cycle programme collected 360 tonnes of WEEE [b-The Guardian, 2013b].

Given the success of the programme, the Brazilian Association of Electrical and Electronics Industry (ABINEE) and the Government of Brazil have been discussing a sectorial agreement to replicate it on a larger scale [b-Flag It, 2013].

6.3.3 Peru: formal/informal collaboration in e-waste processing

In order to satisfy its internal demand and fulfil its contract with a German-based processing company, Peru Recicla purchases waste circuit boards not only from local registered businesses, but also from informal collectors and dismantling markets in Lima. Thus, the company avoids the end-processing phase being carried out informally [b-Williams et al., 2013].

Approximately 50 per cent of the scraps treated by Peru Recicla have been collected and dismantled by informal operators. Recovered materials are then sold and the remaining fraction is discharged in "well-managed" landfills [b-Williams et al., 2013].

In support of this business strategy, a 2014 study calculated that the transfer of e-waste to state-of-the-art facilities for processing, collecting and manual dismantling operations in developing countries is profitable for both developing and industrialized countries. Such agreements achieve higher recovery rates and avoid the negative environmental impact caused by improper treatment practices in developing countries [b-Vanegas et al., 2014].

6.3.4 Colombia: reuse for education

The programme Computadoras para Educar (Computers for education) was launched in 2000 by the Ministry of Information Technology and Communications of Colombia. The scope of the project is to extend the lifespan of EoL personal computers while bridging the digital divide in schools [b-OECD, 2014].

Used computers, donated by private companies, public authorities and households [b-RELPE, 2013], are sent to specialized centres for refurbishment [b-ITU-T, 2014] and then delivered to primary and secondary schools [b-RELPE, 2013].

When reaching their second end-of-life (which occurs on average after four years [b-ITU-T, 2014]), computers distributed through this programme are collected through the same logistic and infrastructure network used to distribute the equipment to school. Used personal computers are repaired, refurbished or dismantled by the National Centre for Electronic Waste (CENARE) which removes components and materials. These parts can either be used during reconditioning or sold in the national market [b-RELPE, 2013] through public auctions. In order to extend as much as possible the second life of donated computers, recipient schools are also provided with a maintenance service [b-ITU-T, 2014].

In addition to repairing and donating used computers, the programme uses e-waste mechanical components as teaching material in "robotic laboratories" where students can become familiar with technology and science [b-ITU-T, 2014].

The programme Computers for Education, which is now part of the country's national strategy on e-waste, received 61,012,397 Colombian pesos of public funds in 2012. However, the delivery of used computers is subject to co-funding by the municipalities or public institutions that request the service. This percentage can vary from 0 to 50 per cent, according to the financial capacity of the institution. The programme aims to achieve a target of 12 students per computer, to train teachers and parents, and to recycle computers [b-OECD, 2014b].

Since the beginning of the programme, Computers for Education has delivered 786,780 computers, starting with 1,904 used terminals in 2001. In 2013 it distributed 266,1547 [b-OECD, 2014b].

The initiative has undergone two "thorough" impact assessments in order to make sure that public money is allocated efficiently and that it can attract crowd or private funding [b-OECD, 2014b]. It was found that "the CPE programme reduces dropout rates, raises standardized test scores and increases the probability of entering higher education" [b-Rodríguez Rosales et al., 2011 in OECD, 2014b]. Furthermore, the programme generates employment opportunities for low-income people in Colombia [b-ITU-T, 2014].

Similar initiatives have been undertaken in Argentina with the "Connect equality" (Conectar Igualdad) project and in Hyderabad (India) through "Donate Your PC".

6.3.5 RELAC: regional fora for the harmonization of e-waste legislation

The Regional Platform for electronic waste in Latin America and the Caribbean (RELAC) is at the forefront of the regional process for the harmonization of e-waste management in the LAC region. The Platform RELAC has been working towards this goal since 2004 [b-GSMA, 2014]. In 2011 RELAC members agreed on a document regarding guidelines for e-waste management in Latin America. It was agreed that national e-waste legislations should place the responsibility on manufacturers. It was also agreed that RELAC guidelines should have been flexible in order to

accommodate the characteristics of each member state and businesses' commercial schemes. The guidelines provided that controls should be enforced over the transboundary movement of e-waste without hindering the movement of EoL devices for recycling, reconditioning, treatment and final discharge. Eco-design requirements should also be defined, restricting manufacturing and the import of hazardous and contaminating substances and components. It was also agreed that international standards would have not been translated into legislation, but referenced. The document endorsed gradual collection targets and supported the development and strengthening of infrastructure, the definition of technical standards for e-waste management. In addition, participants committed to preparing technical guidelines on best practices [b-RELAC, 2011].

6.3.6 Argentina: Programa E-Basura UNLP– E-Waste Program

The E-Waste Program (Programa E-Basura) is a University Extension Project of the School of Computer Science of the National University of La Plata (UNLP), Argentina, that has been extending equipment service life for social and educational purposes since 2009.[5]

The project has its own computer restoration and refurbishment centre (CRC) situated on land donated by the Government of the province of Buenos Aires.

The team is made up of a university group where teachers, students and researchers work together to solve an environmental, educational, social and cultural problem through its e-waste programme.

The programme that transforms a problem into a tool to service the community offers the following: education and awareness-raising, extension of computing equipments' service life, digital and social inclusion, free software, safe final disposal, trade schools and internships, training for university students and more.

The project won WSIS Prize Champion 2016 in Category 7, "ICT Applications: E-Environment".

The project seeks to strengthen the commitment of the public university to society, through the following goals:

– generating awareness and education in the environment of UNLP and the rest of the country on the risks involved in not managing WEEE correctly;
– fostering technological re-use and extending computing equipment service life through its restoration;
– enabling access to technology through the donation of computing equipment to the most disfavored sectors of society (institutions, social organizations, social diners, schools, libraries and other public-good and non-profit organizations) to reduce the digital divide and contribute to social equity;
– contributing to safe final disposal by avoiding the final stage which involves burning in landfills;
– generating active action and alliances with corporations that minimize the ecological impact of WEEE;
– fostering corporate social responsibility by seeking to form alliances that boost initiatives among companies, the state and universities for the benefit of society.

6.4 E-waste management in the North American region

No contributions yet

[5] http://e-basura.linti.unlp.edu.ar

6.5 E-waste management practices in Europe

6.5.1 Switzerland: multi-level and multi-stakeholder cooperation and monitoring

SENS and SWICO foundations were established voluntarily by manufacturers and importers before any specific legislation was enacted, in 1990 and 1994, respectively. This gave them the opportunity to provide their technical contribution and experience in e-waste management during the legal consultations, obtaining a flexible legislation in return [b-Buletti, 2009]. The collaboration between legislator and stakeholders avoided the risk of freezing or slowing down the development of an e-waste management system [b-SWICO, 2013].

Manufacturers privileged collective producer compliance schemes, instead of individually, in order to benefit from the economies of scale and to accumulate the initial capital. National and local administrative authorities supported these collective schemes (foundations) through public procurement, requesting transparency in return. It was clear to them that it would have been easier to monitor and collaborate with a limited number of collective schemes rather than with a plethora of individual systems. Furthermore, this public-private collaboration facilitated the transfer of responsibility from municipalities to manufacturers long before the legislation on e-waste was introduced. In addition, given the limited size of the Swiss market and the high logistic costs derived from the administration of a dense network of collection sites, a fragmented system would have been too expensive [b-Khetriwal et al. 2009].

Thus, manufacturers preferred to establish only three producer compliance schemes: SWICO Recycling, which manages ICT equipment, "consumer electronics, office, telecommunications, graphical industry, measurement and medical technology"; SENS which focuses on devices "from the small and large domestic appliance sector, construction, garden and hobby equipment as well as toys"; and SLRS which focuses on lamps and lighting equipment across the whole national territory [b-SWICO, SENS, SLRS, 2014].

The balance between PCSs in terms of size and membership prevented one of them from becoming a monopoly. Although the legislation does not compel manufacturers to join PCSs, the majority of them (90 per cent) have joined [b-SWICO, 2013]. The transparency in the administration and reporting of PCS's financial resources, as well as in its relations with other operators in the e-waste market contributes to diminish the risk of monopoly [b-Khetriwal et al. 2009].

In order to avoid increasing recycling costs, SWICO Recycling contracts recycling transportation and treatment services out of operators that guarantee the most competitive costs per kilogram of e-waste. Territorial monopolies are avoided by contracting operators located no more than 30 km away from the e-waste they are requested to manage [b-Khetriwal et al. 2009].

It is important to notice that audits are also used to monitor progress towards recycling targets. Facilities have to recycle at least 20 per cent of e-waste collected by them. Although audits are conducted by independent third parties and not by governmental agencies, they are overlooked by the Canton [b-Khetriwal et al., 2009]. In addition, auditors have to report directly to a technical committee which has been established collegially by SWICO, SENS and SLRS. The evaluation criteria and the forms used for audits have been defined collegially by both schemes. Any variation to these criteria must be approved by the technical committee [b-Goodship, Stevels 2012:80]. In addition, all auditors employed by the three PCSs have to meet common criteria. Swico entrusts the audits to the Swiss Federal Institute for Materials Science and Technology (Empa) which pools together experts from the Polytechnic Institutes in Zurich (ETH) and Lausanne (EPFL) and four independent research centres [b-Goodship, Stevels 2012:87].

The combination of external (Canton, academia, research centers) and internal (peer control through technical committee) check and balance prevents PCS operators from accepting suboptimal recycling practices from treatment facilities in order to keep compliance costs low. Biannual audits are a requirement for accreditation before the PCS. Accreditation is not automatic as contracts are stipulated on a competitive basis. Hence, facilities have the incentive to comply with environmental

and health regulations and best practices and adopt technologies that reach a higher recovery rate at a lower cost [b-Khetriwal et al., 2009]. Goodship and Stevels (2012) audits carried out by PCS in Switzerland aim at highlighting potential improvements for facilities rather than carrying out a mere investigation [b-Goodship, Stevels 2012:80].

In certain parts of the country, including the Cantons of Aargau (population: 618,298), Thurgau (251,973 inhabitants) and Zurich (1,392,396 inhabitants), the environmental cantonal authorities have outsourced evaluation and assessment activities on e-waste management to SWICO Recycling and SENS, thus trying out a public-private partnership in the area of monitoring [b-Goodship, Stevels 2012:88]. These partnerships allow local administrations to save money and avoid duplication of monitoring activities, while retaining control over them. In fact, agreements set the requirements that producer compliance schemes should meet when carrying out audits on behalf of the Canton. The final decision on whether to assign a permit to recycling facilities is taken by the public authorities [b-SWICO, SENS, SLRS, 2013].

The effectiveness of the Swiss system depends also on the distribution of monitoring activities throughout various strategic points in the EEE/WEE flow, starting from the customs office. In a country where the vast majority of electric and electronic equipment is imported, this approach provides an accurate picture of the amount of equipment and it contributes to identify free-riders [b-Khetriwal et al., 2009]. Controls will be crucial for the effective implementation of the recast of the Ordonnance sur la restitution, la reprise et l'élimination des appareils électriques et électroniques (OREA), which will charge a disposal fee to any manufacturer of EEE operating in Switzerland without having established a proper individual e-waste management scheme or joined one of the three collective schemes. The recast establishes a new body dedicated to administer this additional financial flow and gives the authority the right to request the Swiss Customs Administration for information concerning producers suspected of not complying with the act [b-Confédération suisse, 2013]. Another critical control point on manufacturers is the retail store itself. Retailers often request that suppliers are registered with one of the three e-waste collective schemes [b-SWICO, 2013]. Peer pressure is another important factor in achieving a high compliance rate among manufacturers. Furthermore, with the new OREA, producer compliance scheme operators will be requested to identify and report to the Federal Department of the Environment, Transport, Energy and Communications (DETEC) any producer or importer who have not paid the advanced recycling fee [b-Khetriwal et al., 2009]. It is important to underline that the very choice of introducing a new discharge fee on non-compliant producers has been discussed and agreed upon by the PCSs, consumers and other stakeholders during official consultations [b-DATEC, UFAM, 2013].

Intuitively the organization of an adequate collection network is a precondition for high recycling rates. In Switzerland, the high return rate for e-waste in Switzerland is due to the strong environmental awareness among the population, to the effectiveness of the basic selective collection system[6] and to the zero-on-one take-back system organized at retail stores [b-Khetriwal et al., 2009]. As a result, in 2012, Switzerland collected 16 kg of e-waste per inhabitant [b-WEEE Forum, 2012].

The Swiss case teaches that to kick start an e-waste management system, it is not necessary to include all the economic operators (producers, treatment facilities, and recycling operators) from the very beginning. It is crucial, however, that the public administration, at the national and local level, support producer take-back schemes, requesting transparency in return, and seek collaboration in legislating over e-waste management. For the medium to long term, the sustainability of such a system, its inclusiveness and equity is crucial [b-Khetriwal, et al. 2009]. In addition, the Swiss case shows that multi-stakeholder cooperation is a crucial element for the success of e-waste management systems [b-Sawhney et al., 2008].

---

6 Swiss Agency for the Environment, Forests and Landscape (SAEFL). Environmental awareness in the Swiss population. 2014.

6.5.2 Spain: tracking e-waste

The WEEE trace program was launched in Spain in July 2011 by Ecolec, a producer compliance scheme, and MCCTelecom, a service and project developer in the ICT environment.

The programme uses RFID tags to track all categories of WEEE (and batteries) or batches of WEEE throughout the end-of-life chain: from the collection facility to the recycling plant, until the very last phase before shredding.

When scanning the RFID tag, operators (e.g., collectors, transporters, recyclers) can resolve information regarding the equipment and update it by synchronizing Ecolec central datacentre with their local databases [b-Rollón, 2014].

The tracking system ensures that tagged WEEE/batches are handled and managed only by operators holding an appropriate license. As soon as improper practices are identified, Ecolec intervenes, explaining to the operator how WEEE should be handled. Thanks to this system, WEEE Trace has so far collected 250,000 units of e-waste and tracked 35,000 tonnes. Workers now spend only five minutes on each batch (40 minutes less than before). In addition, operators do not have to send paper reports to Ecolec anymore because Ecolec database synchronizes automatically with local databases when RFID tags are scanned, thus facilitating compliance with reporting obligations. Finally, WEEE Trace project is compatible and replicable to other countries and other waste flows. In fact, the codification system is based on the International Standard GS1 [b-FuturENVIRO, 2014].

The implementation phase of the WEEE trace programme was finalized in July 2014. The programme is now being extended to other operators and partners [b- España electrónico, 2014].

7 Next steps

It is suggested to constantly review and keep this Supplement up-to-date. Considering the content of this Supplement, it has emerged that there is a need to develop the following:

– Supplement on best practice on e-waste management; and

– Recommendation for sustainable e-waste management.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	**Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant**
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2017