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SERIES L: ENVIRONMENT AND ICTS, CLIMATE
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CONSTRUCTION, INSTALLATION AND PROTECTION
OF CABLES AND OTHER ELEMENTS OF OUTSIDE
PLANT

Guidelines for developing a sustainable e-waste management system

ITU-T L-series Recommendations – Supplement 4

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Supplement 4 to ITU-T L-series Recommendations

Guidelines for developing a sustainable e-waste management system

Summary

Supplement 4 to the L series of Recommendations provides a set of guidelines that countries can refer to when designing or adjusting their e-waste management systems. It provides guidance on policy/legal framework, collection mechanisms, financial mechanisms and engagement with all relevant stakeholders.

It has been developed in response to WTSA Resolution 79 (Dubai, 2012), which instructs ITU-T Study Group 5 to develop guidelines for developing an adequate e-waste management system for telecommunications and ICT equipment as well as to respond to Plenipotentiary Resolutions 182 and 200 (Busan, 2014).

Edition 2 introduces minor editorial updates to the Supplement.

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FOREWORD

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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.

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Supplement 4 to ITU-T L-series Recommendations

Guidelines for developing a sustainable e-waste management system

1 Scope

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

2 Definitions

2.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

2.1.1 audit [b-ISO/IEC 17000]: Systematic, independent, documented process for obtaining records, statements of fact or other relevant information and assessing them objectively to determine the extent to which specified requirements are fulfilled.

2.1.2 component [b-SBC, 2011]: Element with electrical or electronic functionality connected together with other components, usually by soldering to a printed wiring board, to create an electronic circuit with a particular function (for example, an amplifier, radio receiver or oscillator).

2.1.3 discarded [b-StEP, 2014]: It is the critical point at which the potential nature of the item changes from a useful product to that of waste". It does not include equipment which "can be directly re-used by someone else for the same purpose for which the product was originally designed [b-StEP, 2014].

2.1.4 electrical and electronic equipment (EEE) [b-EU, 2012/19/EU]: Equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current.

2.1.5 disposal [b-StEP, 2014]: Material that cannot be recycled into raw material for use in manufacture of new EEE or other products would need to be disposed of using other methods, such as energy recovery or landfill.

2.1.6 distributor [b-EU, 2012/19/EU]: Any natural or legal person in the supply chain, who makes an EEE available on the market. A distributor may also be a producer.

2.1.7 formal sector [b-PMID]: Represents the e-waste that is regulated by environmental protection laws specifically designed for e-waste.

2.1.8 gate fees [b-Chalmin]: The "exchange value" associated to waste electrical and electronic equipment. It identifies the monetary flow from collection or treatment facilities operators to producer compliance schemes when the e-waste value is higher than management costs, e.g., recovery, recycling, re-use. The inverse money transfer takes place when e-waste management activities generate a net cost for the facility. Some of the factors that concur to determine the gate fee are the potential energy generated, the presence of recoverable materials and the ratio between secondary and primary raw materials price.

2.1.9 generation (of WEEE) [b-UNU, 2014]: The weight of discarded products (waste) due to national consumption from a national territory in a given reporting year prior any activity (collection, reuse, treatment or export).

2.1.10 illegal traffic [b-Basel]: Any trans-boundary movement of hazardous wastes or other wastes that has not been notified nor received consent, or whose consent has been obtained "through falsification, misrepresentation or fraud"; whose content "does not conform in a material way with the documents" or "that results in deliberate disposal" ([b-Basel], article 9).

2.1.11 lifetime (or residence time) of electrical and electronic equipment [b-PMID]: The time the equipment spends at household, businesses and the public sector is called the lifetime or residence time. This includes the exchange of second hand equipment among and between households, and businesses.

2.1.12 orphan waste [b-Hester]: Products deposited for recycling that are the responsibility of a company that is either no longer present in the market or has not paid for its recycling.

2.1.13 put-on-the-market [b-EU, 2012/19/EU]: First making available of a product on the market within the territory of a [...] State on a professional basis.

2.1.14 producer [b-EU, 2012/19/EU]: any natural or legal person, established in a state, who manufactures or markets or resells EEE under his own name or trademark; places on the market of that state, on a professional basis, EEE from a third country or from another state; or sells EEE by means of distance communication directly to private households or to users other than private households in a state, and is established in another state or in a third country.

2.1.15 recovery [b-EU, 2012/19/EU]: Any operation the principal result of which is waste serving a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.

2.1.16 recycling [b-EU, 2012/19/EU]: Any recovery operation by which waste materials are reprocessed into products or materials whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for back-filling operations.

2.1.17 re-use [b-StEP, 2012a]: Re-use of electrical and electronic equipment or its components is to continue to use of it (for the same purpose for which it was conceived beyond the point at which its specifications fail to meet the requirements of the current owner and the owner has ceased use of the product.

2.1.18 treatment [b-EU, 2012/19/EU]: Recovery or disposal operations, including preparation prior to recovery or disposal.

2.1.19 used electrical and electronic equipment [b-StEP 2014]: Any electrical and electronic equipment that is discarded by the owner as waste with the intention of re-use "for the same purpose for which it was conceived [...] beyond the point at which its specifications fail to meet the requirements of the current owner and the owner has ceased use of the product. Products could be donated or traded before or in this phase".

2.1.20 waste electrical and electronic equipment: "Electrical or electronic equipment which is "Any substance or object which the holder discards or intends or is required to discard" [b-EU, 2008/98/EC], "including all components, sub-assemblies and consumables which are part of the product at the time of discarding" [b-EU, 2012/19/EU].

2.2 Terms defined in this Supplement

This Supplement defines the following terms:

2.2.1 exporter of WEEE: Any person under the jurisdiction of the state of export who arranges for waste electrical and electronic equipment to be exported. (Adapted from the Basel Convention [b-Basel].)

2.2.2 importer of WEEE: Any person under the jurisdiction of the state of import who arranges for waste electrical and electronic equipment to be imported. (Adapted from the Basel Convention [b-Basel].)

3 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

AC	Alternating Current
Al	Aluminium
Ag	Silver
Au	Gold
CFC	Chlorofluorocarbons
CRT	Cathode Ray Tube
Cu	Copper
DC	Direct Current
DVD	Digital Versatile Disc
EEE	Electrical and Electronic Equipment
EHS	Environment, Health and Safety
EPR	Extended Producer Responsibility
EOL	End Of Life
EU	European Union
Fe	Iron
ID	Identifiers
IT	Information Technology
MOEF	Ministry of Environment and Forests
PCB	Printed Circuit Board, Polychlorinated Biphenyl
PCS	Producer Compliance Scheme
Pd	Palladium
POM	Put-On-the-Market
ppm	parts per million
QR-Code	Quick Response-Code
RFID	Radio Frequency Identification
StEP	Solve the E-waste Problem
TV	Television
UNEP	United Nations Environment Programme
UNU	United Nations University
UPA	Universal Power Adapter
US-EPA	United States-Environmental Protection Agency
WEEE	Waste Electrical and Electronic Equipment

4 Scope for regulation and standardization

This Supplement draws the attention of policy makers to one of the main environmental problems and economic opportunity of our time: the generation of waste electrical and electronic equipment (WEEE).

Manifold are the reasons why countries should establish or reinforce their e-waste management national systems. According to the European Union WEEE directive, the appropriate management of WEEE is paramount due to the presence of hazardous substances, such as "mercury, cadmium, lead, hexavalent chromium, polychlorinated biphenyls (PCBs) and ozone-depleting substances" [b-EU, 2012/19/EU]. Consequently, if not treated properly, WEEE could have significant environmental, economic, and social negative effects.

It has been observed, for instance, that improper management of e-waste can have severe effects on the human health, causing allergies, respiratory diseases and cancer [b-Puckett]. Furthermore, leaching, open air burning and heating, as well as the uncontrolled discharge of scrap, acids, cyanides and other by-products from processing operations pollute the soil, groundwater and food [b-Terazono]. On the contrary, the effective recycling of e-waste has a direct positive impact on the environment, economy and society.

Prevention is paramount as 20-50 million tonnes of e-waste is generated globally each year [b-UNEP, 2013a]. E-waste is one of the fastest growing waste streams in the world. In developed countries, it amounts to 1% of total solid waste on average.

The increasing "market penetration" in developing countries, "replacement market" in developed countries, and "high obsolescence rate" make e-waste one of the fastest growing waste streams. [b-UNEP, 2007].

E-waste is also an economic opportunity. Equipment can contain rare metals, including gold, silver, palladium, lithium, ruthenium, antimony, indium and tin [b-UNEP, 2013a], as well as base metals (e.g., copper, lead and zinc). E-waste is a rich source of precious metals compared to primary ores [b-ATMI]. The case is often made that per every ton of ore at a gold mine only 5g of gold can be extracted, whereas 1 t of mobile phones can contain up to 400 g of gold [b-SMG]. One ton of used mobile phones (around 6,000 handsets) contains approximately 3.5 kg of silver, 340 g of gold, 140 g of palladium and 130 kg of copper. The combined present value is just over \$25,000. Moreover, one ton of waste personal computers contains more gold than 17 tons of gold ore [b-ATMI].

The extraction of precious and base metals from e-waste is a major economic driver due to their associated value, as summarized in Table 1 below [b-ATMI].

Table 1 – Weight vs. value distribution

Weight vs. value distribution %	Fe (wt%)	Al (wt%)	Cu (wt%)	Plastics (wt%)	Ag (ppm)	Au (ppm)	Pd (ppm)
TV-board	28%	10%	10%	28%	280	20	10
PCBs	7%	5%	20%	23%	1000	250	110
Mobile phone	5%	1%	13%	56%	1380	350	210
Portable audio	23%	1%	21%	47%	150	10	4
DVD-player	62%	2%	5%	24%	115	15	4
Calculator	4%	5%	3%	61%	260	50	5
Value-share	Fe	Al	Cu	Sum PMs	Ag	Au	Pd
TV-board	4%	11%	42%	43%	8%	27%	8%
PCBs	0%	1%	14%	85%	5%	65%	15%

Table 1 – Weight vs. value distribution

Weight vs. value distribution %	Fe (wt%)	Al (wt%)	Cu (wt%)	Plastics (wt%)	Ag (ppm)	Au (ppm)	Pd (ppm)
Mobile phone	0%	0%	7%	93%	5%	67%	21%
Portable audio	3%	1%	77%	19%	4%	13%	2%
DVD-player	13%	4%	36%	47%	5%	37%	5%
Calculator	0%	5%	11%	84%	7%	73%	4%

As primary materials are increasingly more difficult and expensive to extract, recycling becomes an attractive option. Recycling would in fact contribute to preserving natural resources and move towards more sustainable production practices.

Furthermore, the use of secondary raw materials allows energy savings [b-Cui] and greenhouse gas emission avoidance [b-Khaliq]. For example, recycling 1 kg of aluminium saves 95% of the energy required for primary production as shown in Table 2 below [b-Cui].

Table 2 – "Recycled materials energy savings over virgin materials"

#	Materials	Energy savings (%)
1	Aluminium	95
2	Copper	85
3	Iron and steel	74
4	Lead	65
5	Zinc	60
6	Paper	64
7	Plastics	>80

Furthermore, reuse, refurbishing and recycling offer direct business development opportunities for communities, contributing to job creation. On a per-ton basis, sorting and processing recyclables alone generate 10 times more jobs than dumping or incineration. For example, computer reuse and recycling creates 296 more jobs for every 10,000 t of material disposed each year [b-ILSR].

Finally, improving the effectiveness and pervasiveness of national e-waste management systems contributes to counteract and prevent illegal shipments of e-waste. These flows affect disproportionately developing countries, due to the presence of low-cost, low-skilled labour force and loose environmental, health and safety (EHS) requirements and controls. According to [b-Gartner], global shipments of electronic devices (personal computers, tablets, ultra-mobiles and mobile phones) are expected to reach 2.5 billion units in 2014, a 6.9% increase since 2013. This equipment will eventually become waste. Therefore countries must have an appropriate management system in place. Yet, according to a report by the United States Environmental Protection Agency (2008), only 19% of e-waste is recycled whereas 81% is disposed in landfills [b- EPA, 2008].

5 Definition of waste electrical and electronic equipment

There is no internationally agreed definition of waste electrical and electronic equipment (WEEE). Most countries' legislations refer to electrical and electronic equipment (EEE) as "any device that for functional reasons is dependent on electric currents or electro-magnetic fields in order to work properly. It becomes e-waste when the holder discards, intends or requires to discard" [b-Morselli]. Appendix I contains a list of definitions that may be taken as a reference for policy-makers. The term

e-waste is generally used interchangeably for both electrical and electronic equipment due to the increasing integration of electronic components into electrical appliances.

E-waste does not include used EEE as the latter is still considered a commodity. "Reuse of electrical and electronic equipment or its components is to continue the use of it (for the same purpose for which it was conceived) beyond the point at which its specifications fail to meet the requirements of the current owner and the owner has ceased use of the product" [b-StEP, 2014].

The European Union defines electrical and electronic equipment as "equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 V for alternating current and 1500 V for direct current" [b-EU, 2012/19/EU].

It defines waste electrical and electronic equipment as EEE that is waste, i.e., "any substance or object which the holder discards or intends or is required to discard" [b-EU, 2008/98/EC], "including all components, sub-assemblies and consumables which are part of the product at the time of discarding" [b-EU, 2012/19/EU].

Appendix III of the aforementioned directive provides an indicative list of categories and types of waste electrical and electronic equipment. However, should policy makers in countries need to prioritize certain types or categories, taking into account their environmental impact and socio-economic relevance, Appendix II and III of this supplement, can be used as a reference to determine the environmental impact. National statistics and inventories should be used to determine the socio-economic relevance of each category or type of WEEE.

A preliminary nucleus could be constituted for example by refrigerators, clothes dryers, washing machines, computers, CRT and LCD screens, printers, mobile phones and lamps.

In a subsequent stage, the following e-waste categories could be considered:

- temperature exchange equipment
- large household appliances
- fluorescent lamps
- photovoltaic panels
- small equipment, especially IT and telecommunication equipment.

6 E-waste management system design

As a preliminary step for the preparation of draft e-waste management legislation, countries must:

- 1) Identify sources of e-waste generation and compile an inventory of e-waste in the country.
- 2) Consult producers, traders, service operators, industry associations, voluntary producer compliance schemes, municipalities, collection and treatment facilities operators, informal operators (i.e., collectors, dismantlers, recyclers, and scrap dealers), consumer associations and civil society organizations.
- 3) Ensure the availability of public funds to:
 - a) Promote cooperation among competent ministries and enforcement agencies (e.g., customs, police).
 - b) Organize nationwide, publicly funded awareness raising campaigns to inform consumers of available collection points for their waste equipment and of the risks that improper handling and management of e-waste may cause to human health and the environment.
 - c) Assess e-waste technologies, practices and skills already available in the country compiling an inventory of:
 - available collection and recycling facilities (name, address and specialization)