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CONSTRUCTION, INSTALLATION AND PROTECTION
OF CABLES AND OTHER ELEMENTS OF OUTSIDE
PLANT

E-waste and circular economy

**Guidance for institutions of higher learning to
contribute in the effective life cycle
management of e-equipment and e-waste**

Recommendation ITU-T L.1033

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

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Recommendation ITU-T L.1033

Guidance for institutions of higher learning to contribute in the effective life cycle management of e-equipment and e-waste

Summary

Managing e-waste has been a major problem in many countries. Emerging economies still face a multitude of challenges that hinder the effective management of e-equipment and e-waste. Many of them do not have suitable facilities to handle e-equipment and e-waste and have inadequate implementation frameworks and structures due to the lack of quantifiable data and statistics on e-equipment and e-waste, inadequate policies, regulations, standards and enforcement strategies, low stakeholder engagement/collaboration and limited expertise. Institutions of higher learning have a crucial role in leading society through its influence and the development of individuals. As societal issues become more complex and the boundaries between academia, industry, and the government become unclear, institutions of higher learning must remain the cornerstone of development. Universities among other higher learning institutions are better placed to ensure that the circularity of electrical and electronic equipment (EEE) is achieved to minimize the effects of waste electrical and electronic equipment (WEEE).

The role of universities as examples of institutions of higher learning, is to offer training, carry out research and share knowledge, ideas, research output and innovations developed and applied for its benefit and the surrounding communities. Universities have the capacity to develop a curriculum on life cycle-economy processes, including e-waste management, for formal training and material for informal and non-formal training. Universities can also join efforts to research and provide reliable information that can be used in policy formulation, development of standards and strategies on imports and exports to the region. Recommendation ITU-T L.1033 therefore aims to guide institutions of higher learning to collaboratively contribute on key aspects of managing e-resources and e-waste. It explores how these institutions can engage in EEE circularity by checking their effective involvement in every EEE and WEEE process.

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FOREWORD

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Introduction

Education is an essential tool in reshaping human values and has the enormous potential to address the sustainability challenges facing humanity. Education is also acknowledged as a means for achieving or inter-coordinating the SDGs [b-Koiupi 2019]. Since the core business industry of institutions of higher learning involve the development, dissemination of knowledge and learning, knowledge management is thus deemed as significant in the life cycle management of EEE as e-resources and e-waste.

The life cycle of equipment is a relatively new concept brought about by innovation and technology. Since it is a relatively new concept, much research, training and engagement within communities are required. Government ministries and agencies have endeavoured to come up with strategies, guiding principles and other legal instruments however they still lack the basis for the implementation of these documents owing to unreliable documented information to support the decisions made. For example, data on imports and exports remains insufficient, and countries might not know or may even not report how much electrical and electronic equipment is acquired and how much raw materials and e-wastes are generated annually [b-UNCTAD 2019]. Many countries are also struggling with how extended producer responsibilities (EPR) and take-back systems must be handled, due to this there is a huge need for designing procedures for the collection of e-waste and the development of technology for recycling, repair, etc.

Creating awareness and sensitizing the public towards effective and sustainable management of EEE at the end of life comes with the challenges of "how effective the communication is". Higher institutions of learning present advantages of adequate awareness through well-thought procedures, research and surveys and cost effectiveness.

As people buy and consume EEE, scholars must be at the forefront in advising governments, contributing to the development of policies, guiding principles and developing standards and training programmes. They should also advice other stakeholders on how to properly handle e-waste. Importantly, as part of its legal mandate, institutions of higher learning (IHL) are in the position to conduct research on quantities, carry out statistical measures, develop knowledge and methods to identify and manage e-resources and e-waste in their countries and regions.

Recommendation ITU-T L.1033

Guidance for institutions of higher learning to contribute in the effective life cycle management of e-equipment and e-waste

1 Scope

This Recommendation establishes guidance for institutions of higher learning to collaboratively contribute on key aspects of managing e-resources and e-waste. It explores how institutions of higher learning can engage in EEE circularity by checking its effective involvement in every EEE and WEEE process.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T L.361] Recommendation ITU-T L.361/L.64 (2012), *ID tag requirements for infrastructure and network elements management*.
- [ITU-T L.1010] Recommendation ITU-T L.1010 (2014), *Green battery solutions for mobile phones and other hand-held information and communication technology devices*.
- [ITU-T L.1015] Recommendation ITU-T L.1015 (2019), *Criteria for evaluation of the environmental impact of mobile phones*.
- [ITU-T L.1020] Recommendation ITU-T L.1020 (2018), *Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks*.
- [ITU-T L.1021] Recommendation ITU-T L.1021 (2018), *Extended producer responsibility – Guidelines for sustainable e-waste management*.
- [ITU-T L.1022] Recommendation ITU-T L.1022 (2019), *Circular economy: Definitions and concepts for material efficiency for information and communication technology*.
- [ITU-T L.1023] Recommendation ITU-T L.1023 (2020), *Assessment method for circular scoring*.
- [ITU-T L.1024] Recommendation ITU-T L.1024 (2021), *The potential impact of selling services instead of equipment on waste creation and the environment – Effects on global information and communication technology*.
- [ITU-T L.1030] Recommendation ITU-T L.1030 (2018), *E-waste management framework for countries*.
- [ITU-T L.1032] Recommendation ITU-T L.1032 (2019), *Guidelines and certification schemes for e-waste recyclers*.
- [ITU-T L.1100] Recommendation ITU-T L.1100 (2012), *Procedure for recycling rare metals in information and communication technology goods*.



- [ITU-T L.1400] Recommendation ITU-T L.1400 (2011), *Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies.*
- [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.*
- [ITU-T L.1420] Recommendation ITU-T L.1420 (2012), *Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations.*
- [ITU-T L.1430] Recommendation ITU-T L.1430 (2013), *Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects.*
- [ITU-T L.1440] Recommendation ITU-T L.1440 (2015), *Methodology for environmental impact assessment of information and communication technologies at city level.*
- [ITU-T L.1450] Recommendation ITU-T L.1450 (2018), *Methodologies for the assessment of the environmental impact of the information and communication technology sector.*
- [ITU-T L.1460] Recommendation ITU-T L.1460 (2018), *Connect 2020 greenhouse gases emissions – Guidelines.*
- [ITU-T L.1470] Recommendation ITU-T L.1470 (2020), *Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement.*
- [ITU-T L.1500] Recommendation ITU-T L.1500 (2014), *Framework for information and communication technologies and adaptation to the effects of climate change.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 circular economy [ITU-T L.1022]: Covers the full life cycle of both goods and business models. In general it is about closing the loop between different life cycles through design and corporate actions/practices that enable recycling and reuse in order to use raw materials, goods and waste more efficiently and to increase energy performance.

3.1.2 circularity [b-MCART 2020]: Designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

3.1.3 e-waste [b-ITU-T L.1031]: Electrical or electronic equipment that is waste, including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste. The term e-waste and waste electrical and electronic equipment (WEEE) are used interchangeably.

3.1.4 ID tag [b-ITU-T Y.2213]: A physical object which stores one or more identifiers and optionally application data such as name, title, price, address, etc.

3.1.5 linear economy [ITU-T L.1022]: Cradle-to-grave; the 'take-make-waste' model; that is, extracting, manufacturing, using and wasting.

3.1.6 sustainable development [b-UN 1987]: Development that meets the needs of the present without compromising the ability of future generations to meet their needs.

3.1.7 tag-based identification [b-ITU-T Y.2213]: The process of specifically identifying a physical or logical object from other physical or logical objects by using identifiers stored on an ID tag.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 electronic resource: Electrical or electronic equipment (EEE), part, or component that can produce benefits from usage for a purpose or by a person.

NOTE – Defined in contrast to unwanted or unusable EEE that is e-waste.

3.2.2 institutions of higher learning: Institutions that offer an optional final stage of formal learning after secondary education.

NOTE 1 – These are often delivered at universities, academies, colleges, seminaries, conservatories, and institutes of technology, and through certain college-level institutions, including vocational schools, trade schools, and other career colleges that award academic degrees or professional certifications.

NOTE 2 – Adapted from [b-Heduc 2019].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CRT	Cathode Ray Tube
EEE	Electrical and Electronic Equipment
EIT	European Institute of Innovation and Technology
EPR	Extended Producer Responsibility
ESD	Education for Sustainable Development
ESM	Environmentally Sound Management
GHG	Greenhouse Gases
ICT	Information Communication Technology
IHL	Institutions of Higher Learning
KIC	Knowledge and Innovation Community
LCA	Life Cycle Assessment
LCD	Liquid Crystal Display
LERU	League of European Research Universities
MOOC	Massive Open Online Courses
NFC	Near Field Communication
PCB	Print Circuit Board
PPE	Personal Protective Equipment
QR	Quick Response
RAM	Random Access Memory
RFID	Radio Frequency Identifier Device
SRI	Sustainable Recycling Industries
SDG	Sustainable Development Goals

VAT	Value Added Tax
WEEE	Waste EEE or Waste Electrical and Electronic equipment
WRF	World Resources Forum
e-waste	electrical and electronic waste
e-resource	electrical and electronic resource
e-equipment	electrical and electronic equipment

5 Conventions

None.

6 The challenges of electronic and electrical equipment and electrical and electronic waste

Electrical and electronic equipment (EEE) is composed of diverse materials, and these natural resources are purchased, used and disposed of when no longer suitable for a purpose. They can be repaired, refurbished or remanufactured, reused for another purpose by another user and their parts can be reused too, but in the end, it becomes e-waste or WEEE, and potentially a source of secondary raw materials for new devices. In contrast to the 'take-make-waste' model of the linear economy, the circular economy aims to keep EEE as useful e-resources for as long as possible, in their highest utility and minimize waste [b-ITU-T L-Sup.28]. Among all the EEE, information communication technology (ICT) devices exhibit a clear potential for a circular lifespan. ICT devices tend to have a wider or even general purpose with the ability to repurpose through capabilities for device reconfiguration, hardware modularity, or software reprogramming. This wider suitability results in the ability to repair, reuse and upgrade products to facilitate reuse, [ITU-T L.1022] that may or may not be that easy or feasible in specialized, specific-purpose, non-reconfigurable EEE. This can help to achieve the ambitious environmental footprint impact reduction required for climate change mitigation [ITU-T L.1470]. For this reason alone, despite being applicable to all EEEs there is a focus on ICT devices, or digital devices, due to their potential to bring added value to the environment and the towards circular economy [ITU-T L.1022].

EEE is composed of various components, i.e., hazardous and non-hazardous materials. Components such as lead (Pb) and mercury (Hg) contaminate the soil and water when disposed of in the landfills with other wastes. These hazardous components (inorganic lead compounds and methylmercury compounds) are also listed, respectively, as probable (group 2A) and possible (group 2B) human carcinogens [b-WHO 2021]. They also damage the lungs and liver when eaten, ingested or inhaled. Improper management of WEEE poses an environmental and human health threat. These contaminated sources affect the growth of plants and aquatic life and have the potential to cause adverse health effects to humans. Primitive recycling and incineration of components for material recovery also produces toxic fumes which may contain certain persistent organic pollutants which pollute the atmosphere and contribute to greenhouse gases (GHG) emissions, as well as sludge from melting processes that contaminate soil and water.

6.1 E-equipment management challenges

Solutions are required not only at the instant of disposal of the e-waste but are required to be developed bearing in mind a broader **life-cycle thinking**, back at the source of materials, design, manufacturing, procurement, and usage. Since, e-waste is x-times the result of a linear "take, make, use, dispose" model, the circular economy models can be improved by keeping all the devices (e-equipment) as useful e-resources (devices, parts) thereby reducing or ideally eliminating e-waste. In any case, after a shorter or longer lifespan, e-equipment needs to be recycled to extract secondary materials or it is dumped in a landfill. Circularity is the keyway to move forward [b-GISWatch 2020].

The context is about sustainable development [b-UN 1987], and the achievement of the sustainable development goals (SDGs) depends on addressing the societal and environmental challenges: "A universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030." [b-UNDP].

The diagram in Figure 1 is a visual framework for sustainable development – shaped like a doughnut or a lifebelt – combining the concept of planetary boundaries with the complementary concept of social boundaries [b-Raworth 2012]. The central circle of the model depicts the proportion of people that lack access to life's essentials (healthcare, education, equity and so on) while the crust represents the ecological ceilings (planetary boundaries) that life depends on and must not be overshoot.

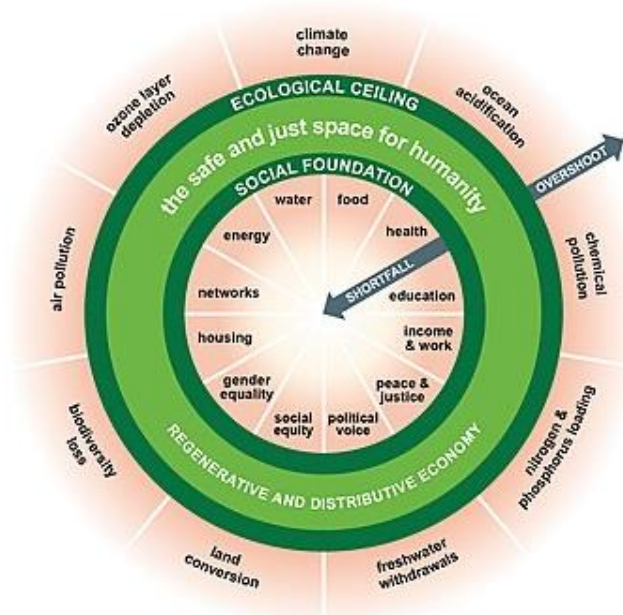


Figure 1 – Doughnut economics (Source: [b-Raworth 2012])

Therefore, there is a need to address environmental, economic and societal needs for a sustainable future, but we also have to ensure open ways to participate by considering the locations. There is a feasibility region within the planetary and social boundaries, that is also seen as economically viable.

6.2 E-waste management challenges

Globally, only 17.4 % of e-waste is documented to be formally collected and recycled [b-FOR 2020]. Monitoring the quantities and flows of e-waste is essential for evaluating developments of sound policies and legal instruments and can only be achieved with better e-waste data. Having better e-waste data is also essential to measure progress towards the global target set in 2018 at the International Telecommunication Union plenipotentiary conference of increasing the global e-waste recycling rate to 30 % by 2023. At a national level, harmonized and coherent e-waste data contributes to estimating the magnitude of challenges relating to e-waste, setting appropriate collections and recycling targets, establishing priorities for policy makers, influencing regulations, setting policy targets, and lastly allocating adequate financial resources [b-FOR 2020].

Developing countries and emerging economies have numerous e-waste management challenges to deal with. The challenges include lack of national legislation to manage and guide the management of e-waste, insufficient infrastructure and technology for treating e-waste, poor disposal methods and overreliance on the informal sector in the management of e-waste, lack of statistical data to inform on policies, improper handling of e-waste and lastly insufficient capacity building and awareness.

Many developing countries also have no suitable facilities to handle e-waste. The few available facilities are not able to process all e-waste components hence, they ship the hazardous components to Europe and Asia for further treatment [b-Basel 1989]. Extended producer responsibility (EPR) and take-back schemes, modern infrastructures and technologies for recycling are either non-existent or partially implemented. Handling of e-waste is characterized by manual stripping to remove electronic boards for resale, open-burning of wires to recover few materials, and the deposition of other bulk components, including cathode ray tubes (CRTs), in open dumpsites. These practices by the informal sector often involve the use of minors who lack the personal protective equipment (PPE) required for this kind of work. Developing countries have the least number of direct manufacturers of EEE, yet they carry a significant burden to the global e-waste problem.

7 The role of institutions of higher learning

The fundamental functions of institutions of higher learning are teaching and research, in addition to having the responsibility towards a wider society and supporting the communities in which they are embedded [b-UNESCO 2020]. In their teaching activities, universities provide the professional training as well as the education necessary for the development of a person. Furthermore, they carry out research to increase the body of theoretical knowledge as well as its application to practical problems.

7.1 Why institutions of higher learning?

Institutions of higher learning (IHL) combine the unique capabilities, activities, and the number of EEE devices they use and procedures to handle them, all this together when combined can have a traction effect within a country. In addition, given the difficulty or unfeasibility to transpose knowledge, procedures, practices and results from other world regions and economies, IHL are adaptive organizations capable of learning, choosing and adapting good practices elsewhere to the local conditions. These include developing methods and capabilities by ensuring that global objectives translate into adapted and feasible local ways, being able to propose local incentives, realize local benefits to ensure effective collective action towards maximizing the benefits of e-equipment and lastly minimizing the impact of e-waste and environmental impacts in general [b-Ostrom 2009].

Furthermore, in a competitive global economy, emerging economies suffer from external pressures that requires internal regulatory measures to protect their people, nature and economic activities, while they engage in a transformation to become "knowledge economies". *"Universities and other higher learning institutions have a role to play in this transformation, both as generators of new knowledge as well as actors that can interact with the local industry and contribute to its innovativeness."* [b-Giuliani 2012] Transformations can accelerate, as researchers can tap into international science results in diverse areas. They are or have the potential to be prepared to experiment, adapt and adopt, and transfer knowledge and its application to local students, industries, professionals and governments.

IHL can be complex institutions that require internal policies that can be a playground to test and develop its own experience as a consumer of EEE and generator of WEEE. The resulting practices and policies can be scaled up to other organizations and larger regions naturally, either by direct engagement with governments or indirectly through knowledge and experience of graduated students that join other public or private organizations and contribute to replicate these models, or those that create new innovative enterprises.

For these reasons, IHL can take a leading role in different countries and specifically in emerging economies in training, developing policies, carrying out research to quantify the number of devices produced or imported, in use and e-waste generated in their region. These include designing and developing new prototype products that are eco-friendly, developing new techniques and appropriate technologies for handling refurbishment or e-waste processing, and engaging with communities to

sensitize them on the proper and efficient usage and disposal of EEE. Institutions of higher learning presumably have the ability to access funds and grants for research, have the capacity to carry out studies and are objective in the analysis of the different processes of the circular economy.

Given their academic role, IHL can act as neutral stakeholders as they are neither policy makers, nor manufacturers. The inherent capabilities of IHL translate towards several areas of action with unique contributions that are detailed in the next section, with a summary of Recommendations in clause 8.

8 Actions by the institutions of higher learning

The actions by IHL presented below are divided as organizational decisions (environmental and social responsibility policies, incentives and goals), as each main IHL function (training, research, transfer, public awareness), as well as the required engagement of IHL in the circular processes of their own digital devices (e-equipment, EEE).

The ITU connect 2030 agenda [b-ITUC 2018], which aims to achieve the five bold goals of growth, inclusiveness, sustainability, innovation, and partnerships, provides a framework for the aims and activities for action in IHL related to ICT technology and its role, and how IHL can engage and contribute to achieving these aims within their regions of influence and countries. All EEE and WEEE related actions should be framed within the international agreements signed by the countries to which IHL belong, as well as within the framework of the applicable national legislation.

8.1 Environmental and social responsibility policies, incentives and goals

The goals of the IHL organizations relate to all the UN SDGs and specifically to: Goal 4: Quality education; Goal 5: Gender equality; Goal 8: Decent work and economic growth; Goal 9: Industry, innovation and infrastructure; Goal 11: Sustainable cities and communities; Goal 12: Responsible production and consumption; and Goal 17: Partnerships for the goals.

For instance, the University of Leeds [b-Leeds] shows a commitment to embed the three pillars of sustainability [b-UN 2005] (economic, social and cultural, environmental) in every aspect by drawing from the expertise of students, staff and partners to collaborate in finding sustainable solutions to global challenges. In addition to reports on environmental impact and sustainability, the university follow a living lab approach to find and test real life solutions to global challenges, which aligns with their research, curriculum and operation, and are socially committed to having a positive impact on their local, national and global societies, by implementing the results of their experience everywhere.

Compliance with [ITU-T L.1470] in terms of GHG emission trajectories for the ICT sector requires technological advances, well-prepared people and adequate policies to accelerate the achievement of the United Nations sustainable development goals (SDGs) by 2030.

8.1.1 Zero carbon emissions and zero waste targets

Carbon neutrality implies the reduction of emissions and compensates through established mechanisms that cannot be reduced and/or absorbed. Since different universities adhere to global initiatives and/or standards, they adopt specific mechanisms for implementation. There is a need to translate global commitment to environmental impact, implementation of the Paris agreement, and the specific goals of [ITU-T L.1470] for the ICT sector into mechanisms / processes for implementation. For this purpose, universities have to create actionable policies that help to accelerate research capabilities into action, not just by adopting, but adapting and contributing in unique and innovative ways. Some examples are as follows:

The University of Leeds in the United Kingdom of Great Britain and Northern Ireland (UK) aims to reach zero carbon and zero waste by 2050 as mentioned in their annual sustainability report [b-Leeds 2020].

The University of Cambridge in the UK [b-CAM 2015] has a zero carbon target aligned with the 1.5°C goal and to *"reduce energy related carbon emissions to absolute zero by 2048"*. The