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

Circular economy: Definitions and concepts for material efficiency for information and communication technology

Recommendation ITU-T L.1022

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.1022

Circular economy: Definitions and concepts for material efficiency for information and communication technology

Summary

Recommendation ITU-T L.1022 contains a guide to the circular economy (CE) aspects, parameters, metrics and indicators for information and communication technology (ICT) based on current approaches, concepts and metrics of the CE as defined in existing standards, while considering their applicability for ICT.

In this Recommendation ICT is defined based on the definition given by the Organisation for Economic Co-operation and Development (OECD) (See [b-ISIC] in the Bibliography).

This Recommendation discusses the special considerations and challenges in a broader and more in-depth context for all ICT defining parameters, metrics and indicators with the intention to guide the vertical standardization of material efficiency for ICT.

The guidelines aim to examine the kinds of standards that are available and to assess their relevance for ICT product groups citing examples of interrelated relevance throughout the text of the Recommendation.

History

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

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Introduction

In order to facilitate a shift to a more sustainable economy, a circular economy (CE) has been proposed as one of the main ways forward. Improving the resource efficiency (RE) of products is important in order to promote a transition towards a more circular economy in the EU and beyond. This can be supported, for example, through a series of measures aiming to manufacture goods that are more durable, easier to repair, reuse or recycle. Improving certain material efficiency metrics of products might be important to reduce their environmental impact. Particularly, an improvement of the durability of goods can have the potential of bringing added value to the environment and to the economy by limiting the early replacement of goods and thus saving resources. However, the design of products needs to be assisted by appropriate assessment methods.

ITU-T has made preliminary descriptions of RE for ICT goods [b-ITU-T L-Sup.5] and [b-ITU-T L-Sup.28], which have been considered in the development of this Recommendation which focuses on the applicability of CE metrics for ICT.

Recommendation ITU-T L.1022

Circular economy: Definitions and concepts for material efficiency for information and communication technology

1 Scope

This Recommendation provides a guide to the aspects of circular economy (CE), parameters, metrics, indicators for ICT based on current approaches, concepts and metrics of the CE as defined in existing standards, while considering their applicability for ICT. It is necessary to distinguish between CE concepts for product design and maintenance and general concepts aiming at the corporate practices of ICT companies.

The scope of the Recommendation, in addition to the above context, includes the following aspects:

- reparability
- durability
- reusability
- recyclability
- recoverability
- refurbish ability
- remanufacture ability
- upgradeability.

The following parameters, indicators and metrics are related:

- recycled and renewable content
- use of critical raw materials
- ability to reuse parts/components/materials
- quality of recycling.

This Recommendation is a framework standard that covers aspects that will be elaborated in future Recommendations.

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.1021] Recommendation ITU-T L.1021 (2018), *Extended producer responsibility – Guidelines for sustainable e-waste management*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 bio-based plastic [b-BioBag2]: Plastic that is made by plant material.

3.1.2 biodegradable plastic [b-BioBag1]: A plastic capable of undergoing biological, anaerobic or aerobic degradation leading to the production of CO₂, H₂O, methane, biomass, and mineral salts, depending on the environmental conditions of the process.

3.1.3 component [b-ETSI TR 103 679]: Part of a product that cannot be taken apart without destruction or impairment of its intended use.

3.1.4 compostable plastic [b-EN 13432]: Biodegradable/compostable plastic that completely decomposes in a composting setting in a specific time frame, leaving no harmful residues behind.

3.1.5 corrective maintenance [b-prEN 45554]: See Repair.

NOTE – An example is a fan filter exchange.

3.1.6 critical raw material (CRM) [b-EN 45558]: Materials which, according to a defined classification methodology, are economically important, and have a high-risk associated with their supply.

NOTE – For the purpose of this Recommendation, CRMs are the ones listed in Annex 1 of [b-COM CRM]. Future updates to this list will apply and replace former versions of this list.

3.1.7 disassembly [b-IEC 62452], [b-prEN 45554]: Process whereby a product is taken apart in such a way that it could subsequently be reassembled and made operational.

3.1.8 durability [b-prEN 45552]: Ability <of a part or a product> to function as required, under defined conditions of use, maintenance and repair, until a final limiting state is reached.

NOTE 1 – The degree to which maintenance and repair are within scope of durability will vary by product or product group.

NOTE 2 – The final limiting state has to be defined by the user of [b-prEN 45552].

3.1.9 important change [b-prEN 45553]: Modification which influences the safety, original performance, purpose or type of the product.

NOTE 1 – Refer to the EU Blue Guide [b-Blue] for conditions under which a product has to be considered as a new product when placing on the market after such changes.

NOTE 2 – The person who carries out the changes becomes then the manufacturer with the corresponding obligations.

3.1.10 limiting event [b-prEN 45552]: Event which results in a primary or secondary function no longer being delivered.

NOTE – Examples of limiting events are failure, wear-out failure or deviation of any analogue signal.

3.1.11 limiting state [b-prEN 45552]: Condition after one or more limiting event.

3.1.12 maintenance [b-pr45552]: Action carried out to retain a product in a condition where it is able to function as required.

NOTE – Examples of such actions include inspection, adjustments, cleaning, lubrication, testing, and replacement of worn-out parts. Such actions could be performed by users in accordance with instructions provided with the equipment (e.g., replacement or recharging of batteries); or the actions could be performed by service personnel in order to ensure that parts with a known time to failure are replaced in order to keep the product functioning.

3.1.13 material [b-EN 62474]: Substance or mixture of substances within a product or product part.

3.1.14 oxo-degradable plastic [b-BioBoxo]: Plastic that breaks into fragments in the presence of oxygen.

3.1.15 part [b-prEN 45552]: Hardware or software constituent of a product.

3.1.16 product [b-ETSI TR 103 679]: Goods or services.

3.1.17 recoverability [b-prEN 45555]: Ability of a waste product to be recovered.

3.1.18 recoverability rate [b-prEN 45555]: Ratio of the sum of recoverable products, product parts, materials mass to total waste product mass reprocessed.

3.1.19 recovery [b-EU WFD]: Any operation the principal result of which is waste serving a useful purpose by replacing other materials which 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.

3.1.20 recyclability [b-prEN 45555], [b-IEC62635]: Ability of a product to be recycled at end-of-life.

3.1.21 recycled material content [b-prEN 45557]: Proportion, by mass, of secondary material in a product.

3.1.22 recycling [b-EU WFD]: Any recovery operation by which waste materials are reprocessed into products, materials or substances 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 backfilling operations.

3.1.23 refurbish [b-prEN 45553]: Returning by industrial process a used product to a satisfactory working condition without making any important changes to the product.

3.1.24 reliability [b-prEN 45552]: Probability that a product functions as required under given conditions, including maintenance, for a given duration without failure.

NOTE 1 – The intended function(s) and given conditions are described in the user instructions provided with the product.

NOTE 2 – Duration can be expressed in units appropriate to the part or product concerned, e.g., calendar time, operating cycles, distance run, etc., and the units should always be clearly stated.

3.1.25 remanufacturing [b-prEN 45553]: Industrial process which creates a product from used products or used parts where at least one important change is made to the product.

3.1.26 repair [b-prEN 45554]: Process of returning a faulty product to a condition where it can fulfil its intended use.

3.1.27 reuse [b-EU WFD]: Operation by which products or parts that are not waste are used for the same purpose for which they were conceived by another user.

NOTE – The transfer of ownership is an essential part of the concept of reuse.

3.1.28 substance [b-REACH]: Means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

3.1.29 substances of concern [b-EUCOM32]: Hazardous to humans or the environment, present in products sold before they were restricted, have a long lifetime, are costly to detect or remove, create obstacles in particular for recycling.

3.1.30 upgrade [b-prEN 45554]: Process to enhance the functionality, performance, capacity or aesthetics of a product.

NOTE – Upgrade may involve changes to the software, firmware and/or hardware. IEC 62075:2012, definition 3.23, Note added in [b-prEN 45554].

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 benefit rate: Potential savings that can be achieved over status quo.

NOTE – Some examples include the following:

- "Potential environmental savings that can be achieved from recycling certain parts of the product over the environmental burdens of production of primary materials, manufacturing, use and disposal of the product" [b-ArdenteR].
- "Potential cost savings that can be achieved from reusing certain parts over the costs due to the production of primary materials, manufacturing, use and disposal of the product" [b-ArdenteR].

3.2.2 preventive maintenance: Preventive action carried out to retain a product in a condition where it is able to function as required. Adapted from [b-prEN 45552].

NOTE – e.g., cleaning.

3.2.3 recyclability rate: The ratio of the sum of recyclable products, product parts, materials mass to total waste product mass reprocessed.

3.2.4 renewable material: Natural material which can replace materials depleted by usage and consumption either through natural reproduction other reoccurring processes in a finite amount of time in a human time scale.

3.2.5 reparability: The ability of a product to be repaired.

3.2.6 reused component: A hardware constituent of a product that cannot be taken apart without destruction or impairment of its intended use, which is used again with or without alteration.

3.2.7 single-use plastic product: A product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its lifespan, multiple trips or rotations by being returned to the producer for refill or reused for the same purpose for which it was conceived.

NOTE – Single-use plastic products include a diverse range of commonly used fast-moving consumer products that are discarded after having been used once for the purpose for which they were provided, are rarely recycled, and are prone to littering.

3.2.8 single-use plastics: Any disposable plastic items, i.e., packaging or a consumer product that are thrown away after one brief use, not intended for longevity, reuse or recycle.

3.2.9 upgradeability: The ability of a product to be upgraded.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
CE	Circular Economy
CRM	Critical Raw Material
EPR	Extended Producer Responsibility
FMEA	Failure Mode and Effect Analysis
ICT	Information and Communication Technology
IHS	Integrated Heat Spreader
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCI	Life Cycle Inventory
ME	Material Efficiency
MTBF	Mean Time Between Failures
PSS	Product Service System

RE	Resource Efficiency
SUP	Single Use Plastics

5 Conventions

None.

6 Introduction to circular economy concepts

Circular economy (CE) covers the full life cycle of both goods and business models.

Most business models are linear cradle-to-grave; that is, extracting, manufacturing, using and wasting. This usually turns 90% of the resources extracted from nature into waste [b-Thomas].

In general CE 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 in a more efficient way and to increase energy performance. Thus CE is associated with strategies to minimize the input of primary materials and keep goods out of landfill and incineration. This is important as research has shown that the toxicity of waste mobile phones increased with technology innovation for phones produced from 2002 to 2013 [b-Chen]. CE deals with both environmental and economic aspects. In an ideal CE, all waste generated would be reused as raw material in production processes. Discarded goods represent a valuable source of materials.

NOTE – In order to be environmentally beneficial, CE strategies would need to be catered for the full life cycle of a given product category [b-Trusty].

Resource efficiency (RE) is sometimes used interchangeably with the CE concept. However, RE focuses more on the efficient use of resources and on minimizing the environmental impact of a good during its life cycle [b-Hamakawa]. An example of a generalized RE definition is dealing with the benefits obtained from the use of natural resources. Furthermore, materials efficiency (ME) is used in parallel with RE, or as a more precise concept dealing with raw materials only, excluding energy. In this Recommendation, RE is seen as a subcategory of CE and ME as a part of RE.

CE and RE aspects and parameters/metrics/indicators suitable for ICT are also discussed.

There are many examples of attempts to model different CE aspects of ICT [b-Hamakawa], [b-Talens], [b-Harivard], [b-Schischke], [b-Dimitrova], [b-Nissen], [b-Ardente], and [b-Andrae]. However, these efforts start from a bottom-up perspective and are potentially helpful in the production specific standardization of certain ICT applications. In case such standardization happens, it is intended to follow the guidelines of this Recommendation.

Previously, ITU-T [b-ITU-T L-Sup.28] attempted to provide an understanding of the scope and limitations of particular existing resource efficiency indicators in order to assist policy makers and the scientific community in the application and further development of indicators. This Recommendation builds on that information taking into account recent progress in other standards.

Through the design stage, it is possible to influence all the most important aspects, minimizing material usage and environmental impacts. Goods can be designed for increased lifespans, as well as to be repaired, upgraded, reused, refurbished, remanufactured and/or eventually recycled instead of being thrown away. However, in practice trade-offs have to be made with parameters such as safety aspects, reliability, phase out of specific substances (e.g., those dangerous to human health and the environment or which are detrimental in recycling processes) and cost. One important point of view is to avoid the use of hazardous materials and optimize the use of rare earth materials when possible.

This can lead to situations where recycling and reuse can be hampered by the presence of certain chemicals which were tolerated in the past, but are prohibited in current legislations.

In addition to reducing the materials, the focus is on energy usage during the whole life cycle of goods, which means improved efficiency in the production and use stages.

Table 1 shows a summary of CE aspects, the level of disassembly and the expected quality of the ICT good after CE related actions.

Table 1 – CE aspects for ICT goods, level of disassembly and expected quality

CE aspect	Level of disassembly of ICT goods	Expected quality of ICT goods	Examples
Maintenance (preventive)	None	Working order	Replace fan filter
Maintenance (corrective)	ICT goods down to faulty part	Working order	Replace damaged mobile phone display
Upgrade	None if software	Working order	Software upgrades
Repair	ICT goods down to faulty part	Working order	Replace damaged mobile phone display
Reuse (direct)	None	"As-is"	Operators can directly reuse base stations in another location
Refurbish	Good or module	Specified level	Set-top-box gateway are refurbished by combining parts from different set-top-box gateway goods. Another example is used laptops: inspection for functionality, replacement of parts where necessary.
Remanufacture	Part	'Like-new part'	Set-top-box gateways are remanufactured in several ways by upgrading the Wi-Fi module to a <i>better performance</i> standard.
Recycle	Recyclable streams	–	Gold recycling
Recover	Non-recyclable parts/materials	–	Energy recovery from plastics

7 Circular-economy-related legislation and standards

A number of specific policy measures and regulations have already been established that are intended to support the transformation to the CE.

Within the CE area, there is ongoing work on e-waste in ITU-T which includes studies of circular economy metrics for ICT.

For example, the publication of [ITU-T L.1021] on EPR.

IEC has developed standards covering the reliability of goods [b-IEC 62380]. Moreover IEC released a standard for environmental conscious design of EEE [b-IEC 62430] where it is recommended, among many other things, to consider reducing material complexity in order to make material recycling easier.