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Criteria for evaluation of the environmental impact of mobile phones

Recommendation ITU-T L.1015

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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.1015

Criteria for evaluation of the environmental impact of mobile phones

Summary

Recommendation ITU-T L.1015 focuses on the criteria to be used for evaluation of the environmental impact of mobile phones. It considers all life cycle stages of mobile phones such as the design, production, use and end-of-life management. The Recommendation also defines a minimum level of environmental performance.

Within the constraints of technology and affordability, sustainability should be considered for: materials; energy use; durability, upgrade and repair operations; end of life management; packaging, corporate practice; manufacturing and operations.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Environmental impact, life cycle, mobile phones.

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FOREWORD

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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

It has recently been estimated that around 2.3 billion mobile phones are sold every year [b-Andrae, 2015]. Mobile phones are products with high speed of innovation and high usage intensity and the adopted technologies are often changing very quickly. To promote a more sustainable society, the information and communication technology (ICT) industry has recognized that there is a need to provide relevant mobile phone information that will enable consumers to make more informed purchasing decisions, especially with regard to environmental performance.

Manufacturers and network operators have been reporting for several years the sustainability credentials of mobile phones based on consumer needs, corporate sustainability initiatives or environmental footprint assessments, amongst others. However, inconsistencies among approaches cause confusion and make comparisons difficult, wasting time and resources for both operators and manufacturers when collecting and providing similar data.

ITU-T developed a Supplement in 2016 containing eco-specifications and rating criteria for mobile phone eco-rating programmes [b-ITU-T L.Suppl.32]. The Supplement delivers useful information to end users on the environmental performance of mobile phones within the framework of existing eco-rating programmes, and complements previous published papers such as [b-UL 110, 2012]. UL later published, in 2017, a second edition [b-UL 110, 2017], which presents some differences and additional requirements. To provide criteria for the evaluation of the environmental impact of a mobile phone and to minimize its burden on the environment, ITU-T intends to develop a new Recommendation based on [b-ITU-T L.Suppl.32], which takes into account all the previous work carried out by its responsible study group (ITU-T SG5).

This Recommendation aims to help to reduce detrimental effects on the environment by delivering useful information to end users on the environmental performance of mobile phones. The Recommendation, complements the work represented in [b-UL 110, 2017] and [b-ITU-T L Suppl. 32], but is based mostly on life cycle assessment principles and eco design features.

This Recommendation provides a reference for manufactures to enhance environmental performance at a global level.

Recommendation ITU-T L.1015

Criteria for evaluation of the environmental impact of mobile phones

1 Scope

This Recommendation proposes criteria to be used when evaluating the environmental impact of mobile phones.

The Recommendation provides a reference for manufacturers to enhance environmental performance at a global level. It does not include eco-rating, scoring, eco-labelling or a life cycle assessment (LCA) methodology. Appendix I describes three scenarios using simplified LCA methodologies to support clause 6.4.2, but does not provide a LCA methodology in itself.

The Recommendation establishes the criteria to be used for the evaluation of the environmental impact of mobile phones considering all life cycle stages such as the design, production, use and end of user management of mobile phones.

Within the constraints of technology and affordability, sustainability should be considered for: materials; energy use; durability, upgrade, refurbish ("aesthetical" maintenance) and repair operations ("corrective" maintenance); end of life management; packaging; corporate practice; manufacturing and operations.

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.1000] Recommendation ITU-T L.1000 (2011), *Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices*.

[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

This Recommendation uses the following terms defined elsewhere:

3.1.1 mobile phone [b-UL 110, 2017]: A wireless handheld device that is designed to send and receive transmissions through a cellular radiotelephone service including only the device itself and packaging or accessories. Slates/tablets are excluded from this definition.

3.1.2 accessories [b-UL 110, 2017]: Components used external to the mobile phone, such as cables and external power supplies, shipped in box with the mobile phone, not including the mobile phone. Printed materials and packaging are excluded.

3.1.3 packaging [b-UL 110, 2017]: A container enclosing the product along with any required protective materials designed to contain and protect from the point of manufacture to the point of sale. The packaging includes any individual assembled parts of the packaging such as, but not limited

to, any interior or exterior blocking, bracing, cushioning, weatherproofing, exterior strapping, coatings, closures, inks, labels, bags, and films. The packaging does not include additional protective packaging used when transporting to a customer or reseller nor does it include printed information such as warranties and user guides.

3.1.4 homogeneous material [b-ITU-T L.Suppl.32]: A material of uniform composition throughout or a material, consisting of a combination of materials, that cannot be disjointed or separated into different materials by mechanical actions such as unscrewing, cutting, crushing, grinding and abrasive processes.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 durability: The ability 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 can vary.

NOTE 2 – The final limiting state has to be defined by the user of this Recommendation.

NOTE 3 – This is an adapted version of a draft definition developed by CEN-CENELEC TC10 WG2.

3.2.2 reliability: The 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.

NOTE 3 – This is an adapted version of a draft definition developed by CEN-CENELEC TC10 WG2.

3.2.3 upgradeability (based on [b-ISO 14021]): The design of a product that allows that relevant parts can be separately upgraded or replaced without having to replace the entire product.

3.2.4 upgrade (based on [b-IEC 62075]): The process to enhance the functionality or capacity of a product.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BBP	Benzyl Butyl Phthalate
CDP	Carbon Disclosure Project
CERFLOR	Certificação Florestal
CS	Corporate Sustainability
DBP	DiButyl Phthalate
DEHP	bis (2-EthylHexyl) Phthalate
DIBP	Diisobutyl Phthalate
EAIEP	European Average Impact Electric Power
EoL	End of Life
EoLT	End of Life Treatment
FA	Final Assembly
FSC	Forest Stewardship Council

GB	Gigabyte
LCA	Life Cycle Assessment
LCD	Liquid Crystal Display
PCB	Printed Circuit Board
MCCP	Medium Chain Chlorinated Paraffin
MP	Mega Pixel
PCF	Product Carbon Footprint
PEF	Product Environmental Footprint
PEFC	Programme for the Endorsement of Forest Certification
PFOA	Perfluoro Octanic Acids
PFOS	Perfluoro Octane Sulfonates
PVC	Polyvinyl Chloride
RAM	Random Access Memory
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
SCCP	Short Chain Chlorinated Paraffin
SFI	Sustainable Forestry Initiative
SVHC	Substances of Very High Concern
WEEE	Waste Electrical and Electronic Equipment

5 Conventions

None.

6 Eco criteria

6.1 Materials

6.1.1 Material restrictions

Information on material restrictions should be publicly posted, listing mobile phones that meet the requirements of the current European Union (EU) Restriction of Hazardous Substances (RoHS) Directive provisions and its amendments (including applicable exclusions and exemptions). Technical documentation, as required in Article 7(b) of the European Union RoHS Directive, can be generated in accordance with [b-IEC 63000:2016] or through product testing. Testing should utilize [b-IEC 62321]. Other applicable chemical analysis methods may be employed, provided that adequate performance can be demonstrated for the analyses.

6.1.2 Compliance with the EU REACH Regulation

The manufacturer shall provide any evidence to show that the mobile phones are in accordance with Article 33 disclosure requirements for substances of very high concern (SVHC) under the European registration, evaluation, authorization and restriction of chemicals (REACH) regulation and the restrictions under Annex XVII.

6.1.3 Low halogen electronics

Non-metal and non-ceramic homogeneous materials in the mobile phone's printed circuit board and accessories (including earphones, cables and adapters when supplied together with the mobile phone) shall not contain more than 900 ppm chlorine, 900 ppm bromine and a maximum combined total of chlorine and bromine of 1,500 ppm by weight. The manufacturer shall provide evidence to show that the mobile phone's printed circuit board and accessories meet these requirements.

6.1.4 Restrictions of DEHP, DBP, BBP and DIBP

DEHP, DBP, BBP and DIBP shall not exceed 1,000 ppm by weight in homogeneous plastic materials used in the mobile phones. Technical documentation, as required in Article 7(b) of the EU RoHS Directive, can be generated in accordance with [b-IEC 63000:2016] or through product testing. Testing should utilize [b-IEC 62321-8:2017]. Other applicable chemical analysis methods may be employed, provided that adequate performance can be demonstrated for the analyses and matrices of interest.

6.1.5 Recycled and bio-based plastic content

Indications should be publicly posted, listing whether the mobile phone contains post-consumer recycled and/or bio-based plastic.

The content shall be indicated as a percentage of total plastic (by weight) in the product. Indication of post-consumer recycled and bio-based plastic content shall be given separately. The following parts may be excluded from the calculation: printed circuit boards, labels, cables, connectors, electronic components, electrostatic discharge components, electromagnetic interference components, films, coatings and adhesives.

6.1.6 Problematic compounds

The manufacturer shall specify whether the following compounds are absent (<0.1 wt% of homogeneous materials) in the mobile phone:

– All chlorinated polymers including polyvinyl chloride (PVC), PVC blends and chloroprene rubbers e.g., [CAS 9002-86-2 +].
– Short chain (SCCPs) and medium chain (MCCPs) chlorinated paraffins e.g., [CAS 85535-84-8] and [CAS 85535-85-9].
– Antimony trioxide where used in conjunction with flame retardants [CAS 1309-64-4].
– Other Antimony compounds e.g., [CAS 545386-98-9], [CAS 139598-41-7], [CAS 127153-81-5], [CAS 126426-74-2], [CAS 89899-81-0]and [CAS 77824-44-3].
– Nickel (where used in surface parts in contact with the skin) [CAS 7440-02-0].
– Other chlorinated and halogenated hydrocarbons e.g., [CAS 115-96-8].
– Brominated/Halogenated flame retardants e.g., [CAS 3296-90-0], [CAS 96-13-9], [CAS 3194-55-6] and [CAS 201-236-9].
– Phthalates e.g., [CAS 85-68-7], [CAS 117-81-7], [CAS 84-74-2], [CAS 84-69-5]and [CAS 84-66-2].
– Perfluoro octane sulfonates (PFOS) and Perfluoro octanic acids (PFOA) (maximum combined concentration value 10ppm) e.g., [CAS 335-67-1].
– Perchlorates (e.g., as used in batteries) e.g., [CAS 14797-73-0] Benzene and compounds (e.g., Hexachlorobenzene) e.g., [CAS 71-43-2], [CAS 118-74-1].

6.2 Energy use requirements

The external power supply shall meet the minimum requirements of [ITU-T L.1000].

6.3 Substance restrictions in the mobile phone's battery

Each battery cell contained in the mobile phone shall, at a cell level, contain no more than 20 ppm cadmium and 5 ppm mercury as required by the EU Battery Directive 2013/56/EU.

6.4 End-of-life management

6.4.1 Producers' responsibility at end of life of the mobile phone

Recycling of mobile phones reduces the environmental burden of extracting virgin materials and supports the aim of a circular economy. Manufacturers should promote the design and production of mobile phones in view of facilitating dismantling and recovery of the phone, its components and materials. Manufacturers shall not apply any design measures or manufacturing processes that prevent treatment, unless such features or processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements.

Mobile phone design shall at least facilitate disassembly for removal of components requiring special treatment prior to recycling. This should cover at least the materials and components listed in Annex VII of the EU WEEE Directive. Mobile phone manufacturers shall provide, upon request, instructions to recyclers on how to remove components that require separate treatments. The mobile phone manufacturers, who additionally would like to measure the recyclability rate of the mobile phone at hand, can do that according to [b-IEC TR 62635:2012]. Alternative methodologies can be found in [b-PR EN 45555].

6.4.2 Durability and reliability of the mobile phone

As shown in AppendixI, Figures I.1 to I.4, durability is of high importance when reducing the overall environmental impact of mobile phones.

Design for reliability means to design products with high resistance to wear and tear without breaking down and to operate – according to high expected performance – throughout a specified period without failure.

Therefore the manufacturer shall, as a minimum, provide information on the following reliability related performance indicators of the mobile phone:

– Minimum expected life cycle of the battery measured according to [b-IEC 61960-3].

– Degree of protection against water ingress provided by the enclosure of the mobile phone measured according to [b-IEC 60529].

Furthermore the manufacturer shall:

– Inform the user of the phone of measures to be taken to maximize battery performance and avoid damage to the battery.

– Enable the user of the phone to check the actual health of the battery in order to determine whether it needs replacement.

– Inform the user about negative impacts of software upgrades on the performance of the mobile phone, if any.

6.4.3 Upgradeability of the mobile phone

Upgrading in principle may involve the hardware, software or the service that accompanies the phone. However due to rapid technological development of interdependent technologies employed in a small form factor, the updating of individual hardware components of mobile phones is technically very challenging. Since the introduction of smartphones, functionality of mobile phones to a large degree is determined by software applications as well as cloud services. Consequently, the availability of updates for the software, as well as related manufacturer services, has become the most important factor to ensure upgradeability.

The upgradeability of a mobile phone shall therefore be assessed in terms of a minimum time period during which the manufacturer ensures software support for the operating system of the mobile phone as well as access of the mobile phone to cloud services offered by the manufacturer.

6.4.4 Repair of the mobile phone

Repairing a mobile phone extends its useful life. This is another way of reducing overall product environmental impact. Posting repair information online, or otherwise providing public information regarding repair services, including repair contact details, allows customers to utilize appropriate repair services.

Manufacturers shall provide repair services through a programme that may include the use of manufacturer-authorized professionals, and which must be provided to customers in the markets where the manufacturer retails the mobile phone, at least for the duration of the warranty.

Manufacturers shall provide repair and disassembly information to contract and/or certified repair service providers. This may include step-by-step disassembly instructions, exploded diagram of parts and compatibility charts, product specification, maintenance procedures, or troubleshooting information.

Some phone parts, especially the battery, front and end casings, display and main printed circuit board (PCB) will have different degrees of disassemblability, which shall be assessed by the manufacturer.

6.4.5 Take-back programme

Manufacturers shall provide a take-back programme for mobile phones either directly or through a contracted third-party. Information about this programme should be publicly posted.

Compliance with the legal requirements should be satisfied in jurisdictions where the existing legislation prevents manufacturers from providing their own take-back programme, but establishes other programmes.

Primary recyclers selected in such programmes should have a certification to an environmental management system [b-ISO 14001:2015], [b-EMAS, 2009] (or similar) and a recycler specific certification comparable to [b-EN 50625].

6.4.6 Recycled content

The manufacturer shall be able to specify the recycled content of gold, aluminium and steel in the mobile phone. In order to determine the recycled content, [b-EN 45557] can be applied accordingly.

6.5 Packaging and printed material

6.5.1 Restriction of heavy metal in packaging

The sum of the concentrations of lead, cadmium, mercury and hexavalent chromium in any packaging component shall not exceed 100 ppm by weight, with the exception of packaging components that qualify for the recycled content exemption.

Indications should also be publicly posted, listing whether elemental chlorine has been used as a bleaching agent to bleach fibres used in the product packaging. Inks are exempted. Recycled fibres that may have been previously bleached with chlorine are acceptable, if not bleached again after the recycling process.

6.5.2 Sustainably sourced fibre packaging and printed content

Indications shall be publicly posted if virgin materials – used in the point of sale packaging and accompanying printed content (instruction manual, warranty documents, etc.) – have been sourced from certified sources. Acknowledged certificates are those issued by Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC) or a national forest certification system endorsed by PEFC (e.g., SFI, CSA-SFM, CERFLOR).

6.5.3 Recycled content

Indications should be publicly posted, listing whether the point of sale packaging contains recycled content in fibre and plastic packaging. Recycled content shall be calculated as a percentage of the total mass for each material.

6.5.4 Single-use plastic packaging

The manufacturer shall indicate if a strategy to eliminate single-use plastic packaging is adopted.

6.5.5 Product packaging minimization

It is expected that manufacturers will minimize the total volume and weight of the package to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer [b-CEN EN 13428:2004].

6.5.6 Packaging material

Materials used in the packaging that are greater than 25 g should be separable into recyclable streams.

Recyclability of packaging materials can only be achieved domestically (the route that most of the mobile phone packaging will go down) if it can be easily separated into its constituent materials (see criterion 4.7.2.1.1 in [IEEE 1680.1-2018]).

6.5.7 Plastic packaging marking

Plastic packaging should be marked according to [b-ISO 11469] and [b-ISO 1043] or country specific marking.

It is a good practice that total plastic materials be marked accordingly for parts weighing more than 25 g. A recyclable item of packaging that is not marked as such may still not get recycled.

6.5.8 Printing inks

The manufacturer shall be able to specify whether the printing inks used on their printed materials originate in non-petroleum-based sources or not.

6.5.9 Manuals

The manufacturer shall be able to specify whether – when not enforced by applicable regulation (e.g., safety legal regulation) – the mobile phone is sold without a physical manual (either paper or on a CD). Unless required by regulation, the mobile phone should come without a printed user manual.

Manuals add weight and volume to packaging. Excluding texts required under regulatory safety or other legal constraints, it is expected that the reference package does not include any physical manual. This requirement does not apply to separately printed material regarding the warranty, regulatory or safety information, a quick-start guide or equivalent which only provides essential information necessary for the mobile phone to be used for the first time.

6.6 Corporate practices

6.6.1 Corporate sustainability reporting

The manufacturer shall publish a corporate sustainability (CS) report or equivalent information, on at least every other year. Standards and/or frameworks for reporting and/or third-party assurance may include, but are not limited to the Global Reporting Initiative Sustainability Reporting Standards [b-GRI Standards] that are in effect at the time, or their equivalent (e.g., Electronic Industry Citizenship Coalition (EICC), Sustainability Accounting Standards Board (SASB), [b-AA1000] and [b-AICPA AT 101], third party verification standards accepted by Carbon Disclosure Project (CDP) as listed on the CDP website, and Sustainability Assessment Framework (SASF)). The information shall be made publicly available on the manufacturer's website.

6.7 Manufacturing and operations

6.7.1 Manufacturing facilities environmental management systems

The manufacturing facilities used in the final assembly of the mobile phone (manufacturer owned and contract facilities) shall be third-party certified according to either [b-ISO 14001:2015], or the European Union Eco-Management and Audit Scheme [b-EMAS].

6.7.2 Reduction of fluorinated greenhouse gas emissions from LCD display manufacturing

More than 75% of the manufacturing liquid crystal display (LCD) for the use in mobile phones (either by annual cost, part number, or volume purchased or sold) should be done under conditions that reduce, recover or destroy fluorinated greenhouse gases of at least 90% of the total volume used in manufacturing and ancillary operations. This can be done through optimization processes, abatement technology, gas recycling or other methods. Chemicals covered are CF_4, $_{C2F6}$, $C\text{-}C_4F_8$, C_4F_8o, CHF_3, NF_3 and SF_6.

6.7.3 Chemicals not used as cleaning solvent during manufacturing

Hydro chlorofluorocarbons (HCFCs), 1,1,1-trichloroethane ($C_2H_3Cl_3$), trichloroethylene (C_2HCl_3) two (CH_3CHCl_2), Dichloroethane ($CHCl_3$), 1-bromopropane (C_3H_7Br), n-hexane (C_6H_{14}), Toluene (C_7H_8), dimethylbenzene (C_6H_4 (CH_3) $_2$) shall not be used as cleaning solvents during the manufacturing process of mobile phones and the circuit board. The manufacturer shall provide evidence to show the mobile phones meet this requirement.

6.7.4 Conflict minerals

The manufacturer shall indicate if within the supply chain conflict minerals have been used for the production of the mobile phone. If so, the manufacturer should disclose use and source of these minerals [SEC rules or OECD Guidance].

Further, information on developing and implementing a comprehensive conflict minerals management system is available in [b-ITU-T L.Suppl. 21].

6.7.5 Life cycle assessment (LCA)

The manufacturer shall assess the life cycle environmental impacts related to the specific service or product.

In case the manufacturer provides life cycle assessment (LCA)/product carbon footprint studies, those shall be fully compliant with an international standard (for example, [b-GHG Product Protocol], [b-ISO 14040], [b- ISO 14044], [b-PEF Guide], [b-ITU-T L.1410] and/or [b-ETSI ES 203 199]).

Manufacturers are encouraged to provide externally verified results of the LCA/ PEF/ PCF, and make them available to the public.

6.7.6 Functionalities

The manufacturer shall be able to indicate whether the mobile phone has functionalities to replace other devices, which the user would need additionally.

7 Transboundary movements of used and end-of-life mobile phones

If manufacturers collect mobile phones at their end-of-life and do not send them for treatment in the country of collection, they shall comply with the requirements of transboundary waste shipments such as the Basel Convention.

Appendix II provides further information intended for regulatory agencies and authorities, manufacturers, network operators repair, refurbishment and recycling facilities and any organizations involved as follows:

– on the export or import of mobile phones for re-use;
– on the transboundary movement of used mobile phones suitable for re-use, possibly after repair, failure analysis, refurbishment or upgrading in the importing country;
– on the transboundary movements of end-of-life mobile phones destined for material recovery and recycling or final disposal.

Appendix I

Simplified life cycle assessments

(The appendix does not form an integral part of the Recommendation.)

The following paragraphs outline three simplified life cycle assessments (LCAs) investigating the potential environmental impact related to reliability, refurbishment and the collection rate of end-of-life (EoL) strategies of new generic smartphones[1]. The LCAs are performed in a streamlined manner in partial compliance with the requirements outlined for LCAs of ICT Goods in [ITU-T L.1410]. More details of the practical simulations done within the LCA tool to perform the three LCAs can be found in [b-Andrae2].

The *first* scenario (S1) assumes that the user buys a phone (with a ig 4 Ah 3.82 V = 15.28 Wh battery) and uses it for four years after which it is kept at the buyer's home or collected for metal and energy recovery.

The *second* scenario (S2) assumes that the user buys a phone (with a 2 Ah 3.82 V = 7.64 Wh battery) and uses it for one year after which it is collected and refurbished (new battery) or kept at the buyer's home. All batteries in the collected phones can be replaced. The refurbished phone is used for three years and then sent for metal and energy recovery. Whenever the phone is not collected in the second scenario it is replaced by a new phone. Consequently, when the collection rate is 100% the difference between the first and second scenario is the extra battery needed in the second. However, when the collection rate is 5%, $3 \times 0.95 = 2.85$ extra life cycles are added. In those life cycles neither metal recycling nor a second refurbishment is included, only hoarding after one-year use.

The *third* scenario (S3) assumes that the user buys a phone (with a 4 Ah 3.82 V = 15.28 Wh battery) and uses it for one year after which it is hoarded, and the then user buys a new one each year within a three year period. The phone is not collected, reused or recycled.

The possible benefit of the first scenario is strongly dependent on collection rate. A complete collection rate enhances the refurbishing benefits.

Table I.1 shows some of the major assumptions done in the LCAs.

Table I.1 – Scenarios for the smartphone headset lifecycle

Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)
Production of phone with 15.28 Wh battery cradle-to-gate, 14 kg and 9.6 g Sb-eq.	Production of phone with 7.64 Wh battery cradle-to-gate, 13 kg and 8.2 g Sb-eq.	Production of phone with 15.28 Wh battery cradle-to-gate, 14 kg and 9.6 g Sb-eq.
15.28 Wh Battery impact 1.62 kg CO2e, 2.72 g Sb-eq.	7.64 Wh Battery impact 0.76 kg CO2e, 1.27 g Sb-eq.	15.28 Wh Battery impact 1.62 kg CO2e, 2.72 g Sb-eq.
Airplane distribution	Airplane distribution	Airplane distribution

1 In this appendix, the term smart phone is used synonymously with mobile phones because the article referred to uses the term smart phone.

Table I.1 – Scenarios for the smartphone headset lifecycle

Scenario 1 (S1)	Scenario 2 (S2)	Scenario 3 (S3)
European average impact electric power (EAIEP) {500 gCO2e/kWh and 0.03 g Sb-eq./kWh} for Use	EAIEP for Use and Reuse	EAIEP for Use
No reuse, 5% or 100% collection. Then recycling of Al, Au, Ag, Cu, Co. Incineration of packaging materials and plastics.	5% or 100% collection. 5% or 100% disassembly and battery change. 5% or 100% reuse 3 years. Then, according to S1, recycling of Al, Au, Ag, Cu, Co. Incineration of packaging materials and plastics.	Neither collection nor reuse

I.1 Functional unit

The functional unit (f.u.) chosen here is rather simplistic: *"3G/4G access for 1 hour daily calling and enable use of a 1440 × 2560 pixels video player for 2 hours web browsing and 4 hours video watching daily for 4 years."* The reference lifetime is four years. This simplicity fits the objective of screening attributional LCA of smartphones in order to indicate which EoL strategy could be better than others.

Table I.2 shows how the functional unit is determined.

Table I.2 – Functional unit determination for smartphone

Functional unit constituents	15.28 Wh battery smartphone	7.64 Wh battery smartphone
What?	Provide wireless access to one smartphone.	Provide wireless access to one smartphone.
When?	2018	2018
How much?	1 hours 3G calling, 2 hours web browsing and 4 hours video watching per day.	1 hours 3G calling, 2 hours web browsing and 4 hours video watching per day.
How long?	For 4 years.	For 4 years.
How well?	1440 × 2560 pixels resolution (499 pixels per inch as pixel density) at 3G/4G speed.	1440 × 2560 pixels resolution (499 pixels per inch as pixel density) at 3G/4G speed.

Table I.2 – Functional unit determination for smartphone

Functional unit constituents	15.28 Wh battery smartphone	7.64 Wh battery smartphone
Reference flow	1 Smartphone with its primary packaging and charger. One smartphone device (64 Gigabyte (GB) storage, 5.9 inch screen size, 20 Mega Pixel (MP) Video Recorder, 4 GB Random Access Memory (RAM), 4,000 mAh battery capacity Environmental impact/[Resolution (pixel density)×Storage (GB)×Display size (inches)×Video recorder (MP)×RAM (GB)×Battery capacity (mAh)×Lifetime (years)]	1 Smartphone with its primary packaging and charger. One smartphone device (64 GB storage, 5.9 inch screen size, 20 MPVideo Recorder, 4 GB Random RAM, 2,000 mAh battery capacity Environmental impact/[Resolution (pixel density)×Storage (GB)×Display size (inches)×Video recorder (MP)×RAM (GB)× Battery capacity (mAh)×Lifetime (years)]
Functional unit	3G/4G access for 1 hour daily calling and enable use of a 1440×2560 pixels video player for 2 hours web browsing and 4 hours video watching daily for 4 years.	3G/4G access for 1 hour daily calling and enable use of a 1440×2560 pixels video player for 2 hours web browsing and 4 hours video watching daily for 4 years.

The difference between the phones is the size and capacity of the batteries within. The 7.64 Wh battery is assumed to lead to a faster replacement of the battery and/or the entire phone, compared to the 15.28 Wh battery.

System boundaries

The studied product system only considers the smartphone share of the hardware needed to provide the functions expressed in Table 2. Networks and data centres – that might be necessary to fulfil the function of the smartphones – are excluded.

I.2 Pre-final assembly: Raw material acquisition and part production – Final assembly

The pre-final assembly considers mechanical parts (plastics, screws, etc.) and electronics seen from a cradle-to-gate viewpoint. For screening LCAs and the purpose of this research, secondary LCI data are enough. The masses and material contents of each part are identified from bill-of-materials lists. The total mass of the generic smartphone and its packaging materials are ≈340 grams and ≈260 grams,

respectively. The 7.64 Wh battery phone has a smaller total mass than the 15.28 Wh battery phone. Final assembly (FA) impacts are assumed equal for all phones. No support activities – such as product development – are included.

I.3 Distribution

For S1–S3 the distribution assumes 1000 km transportation by truck from FA to the airport, and then 9500 km by air, and then 1000 km by truck from the airport to final use.

I.4 Use

The electricity consumption of a smartphone is generally related to the power use of different viewing modes. This implies that the range for the power consumption could be wide.

The calculation of the lifetime electricity used is performed according to Equation I-1.

$$USE = ABCD \times \frac{1}{E} \times \frac{F}{G} \quad \text{(I-1)}$$

Where:

USE = Lifetime Wh electricity use of a smartphone

A = Battery capacity [Ah], 4 for S1, and 2 for S2

B = Voltage [V]

C = Lifetime of smartphone [years]

D = 365 [days per year]

E = energy efficiency of the power adapter [%]

F = 24 [hours per day]

G = time between having to fully charge the battery if doing 1 hour 3G calls, 2 hours webbrowsing and 4 hour video playing [hours]. *G* is measured by [d]a third-party organization.

Inserting values into Equation 1 {*A*=4 Ah, *B*=3.82 V, *C*=4 years, *E*=78%, *G*=39 hours for S1, and 31 hours for S2} →

{for S1}:

$$USE = 4 \times 3.82 \times 4 \times 365 \times \frac{1}{78\%} \times \frac{24}{39} \sim 17600Wh \quad \text{(I-2)}$$

{for S2}:

$$USE = 2 \times 3.82 \times 1 \times 365 \times \frac{1}{78\%} \times \frac{24}{31} \sim 2770Wh + \{\text{reuse}\}\ 2 \times 3.82 \times 3 \times 365 \times \frac{1}{78\%} \times \frac{24}{31} \sim 8300Wh \quad \text{(I-3)}$$

{for S3}:

$$USE = 4 \times 3.82 \times 1 \times 365 \times \frac{1}{78\%} \times \frac{24}{39} \sim 4400Wh \quad \text{(I-4)}$$

During 4 years S3 requires four times 4400 Wh, i.e., the total same amount as S1.

The proposed approach – for estimating lifetime electricity in the use stage – seems fair as all factors are measurable including *G*. The difficulty might lie in deciding the normal behaviour scenario. Notwithstanding, *G* will scale equal for all smartphones independent of *G* settings.

No maintenance is included.

I.5 End-of-life treatment (EoLT)

For the end-of-life treatment (EoLT), simplified disposal scenarios are set up featuring shares for waste and reuse scenarios.

S1: The disposal scenario refers to the assembly of a smartphone with a 15.28 Wh battery. The waste scenarios are metal and energy recovery (5% or 100%) or hoarding (95% or 0%). Metal and energy recovery assumes that the entire product is transported 1000 km by truck to metal recovery and/or incineration. Recycling of some valuable metals, e.g., Au, is modelled by the 50/50 allocation approach. EAIEP is assumed to be avoided as electric power could be recovered as a by-product of plastics waste incineration.

S2: The disposal scenario refers to the assembly of a smartphone with a 7.64 Wh battery. The process used is "Reuse of smartphone 3 years" (clause I.4), the waste scenario is hoarding, and the disassembly is smartphone disassembly.

S3: The disposal scenario refers to the assembly of a smartphone with a 15.28 Wh battery. The waste scenario is hoarding.

As shown in Figures. I.1 to I.4, the most effective way of reducing the overall environmental impact of a new smart phone – at least as far as GWP100 and ADP for current relatively low collection rates – is to strive for maximum hardware quality – and reliability – and therefore reach a high durability (S1). However, if the collection rate is 100%, refurbishing (S2) might be more beneficial than S1 for GWP100.

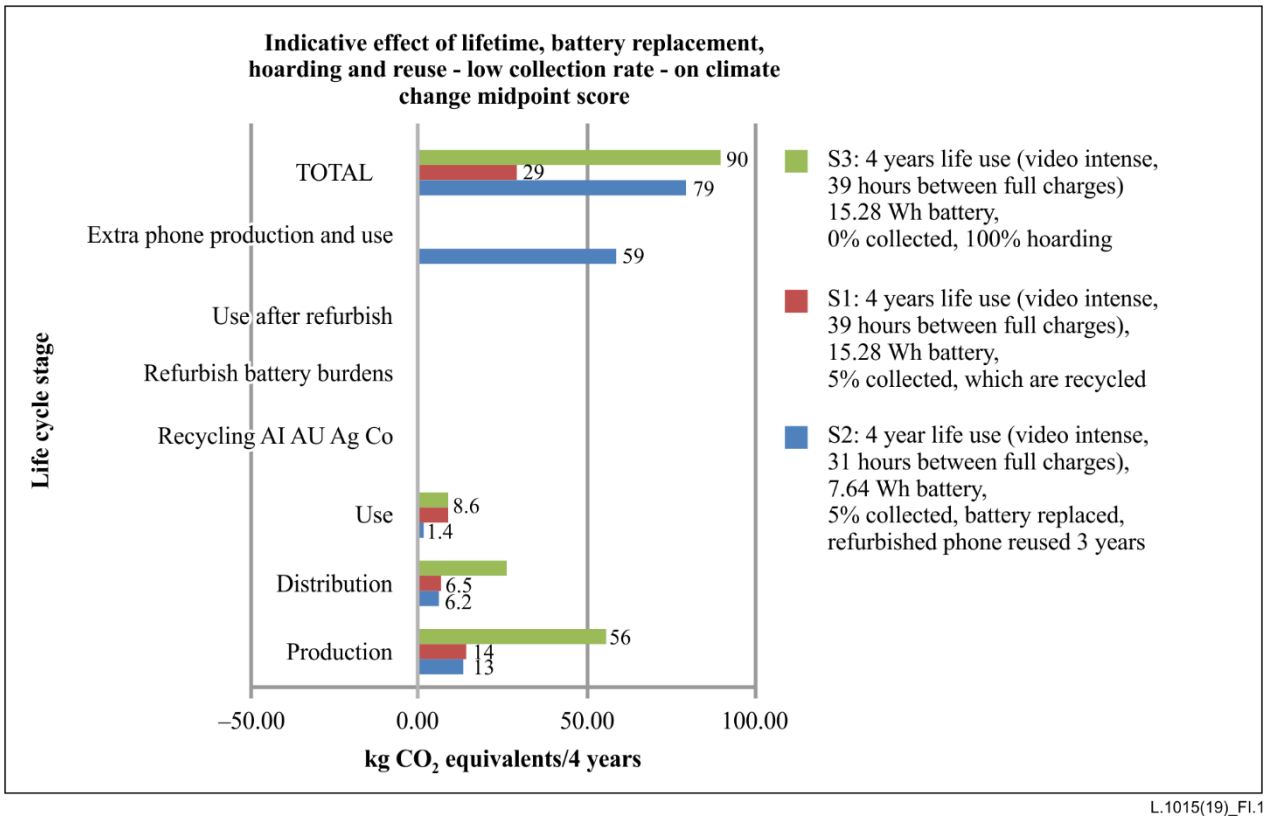
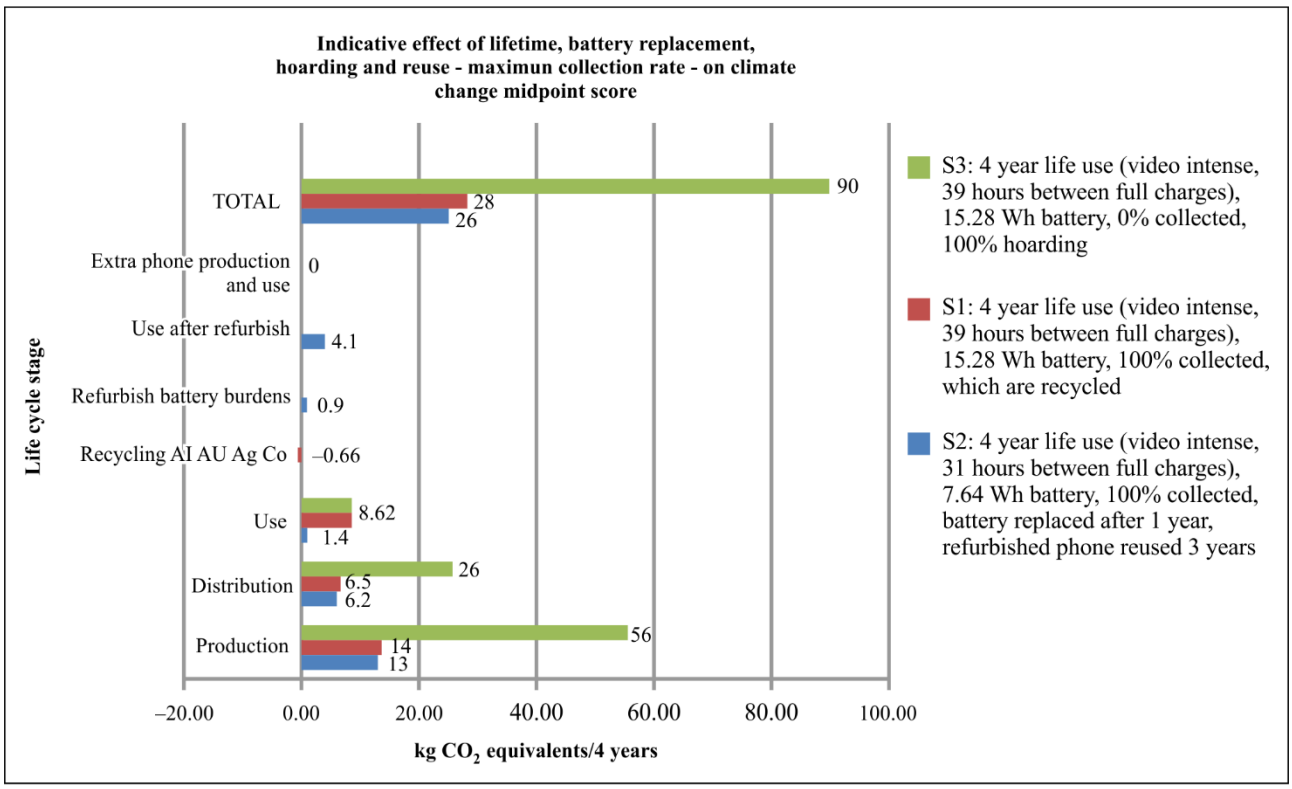
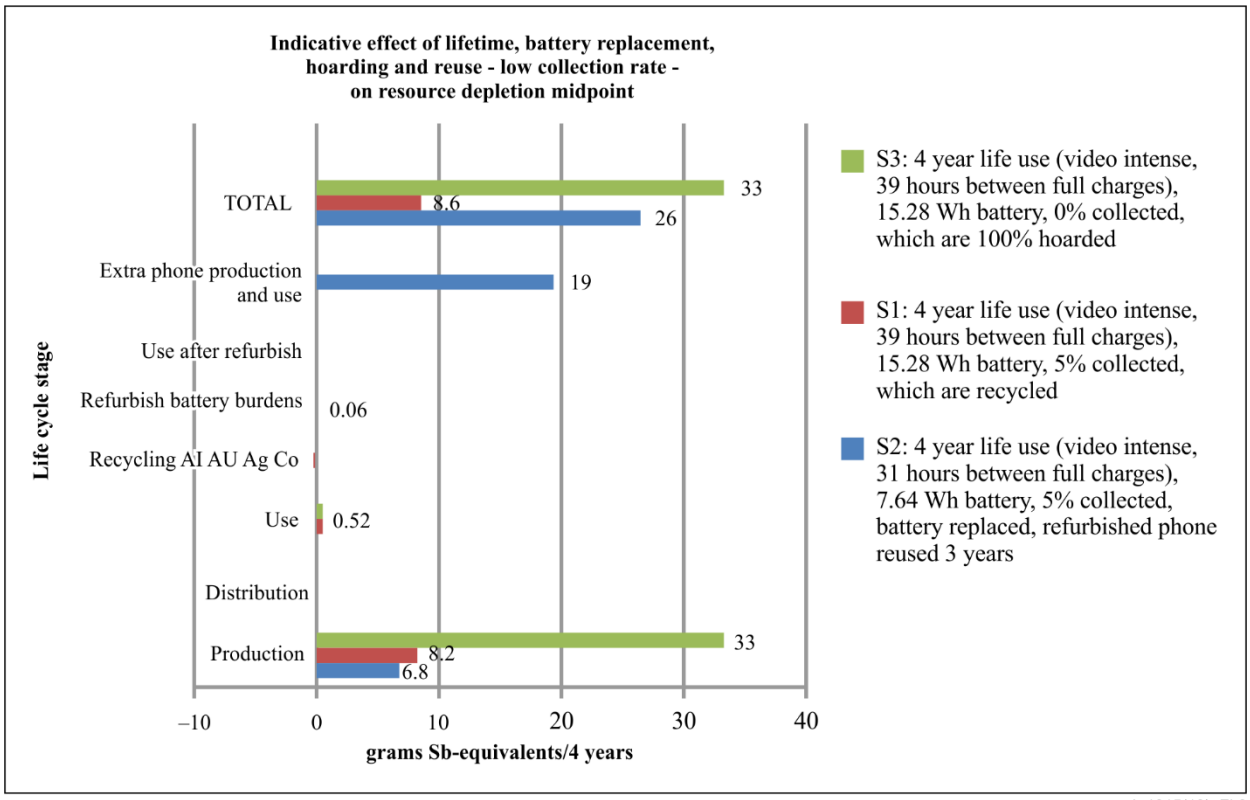


Figure I.1 – Indicative effect on GWP100 score of durability of mobile phones for a low collection rate



L.1015(19)_FI.2

Figure I.2 – Indicative effect on GWP100 score of durability of mobile phones for maximum collection rate



L.1015(19)_FI.3

Figure I.3 – Indicative effect on ADP score of durability of mobile phones for a low collection rate

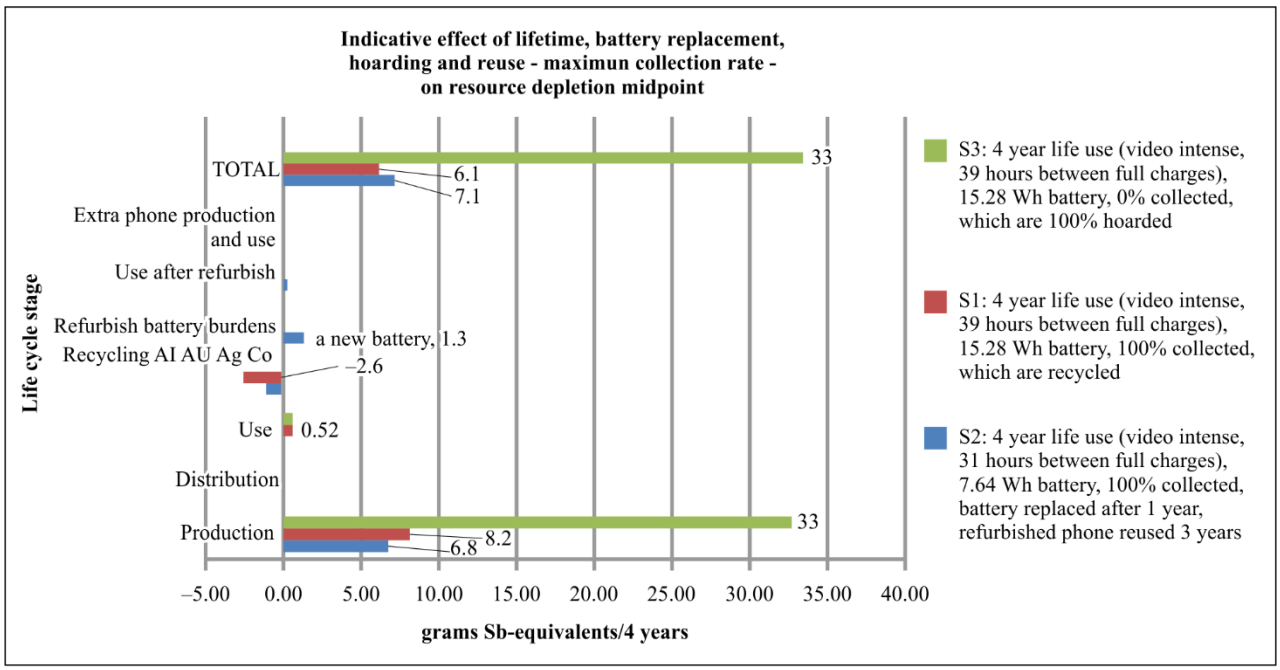


Figure I.4 – Indicative effect on ADP score of durability of mobile phones for maximum collection rate

Appendix II

Transboundary movement of used and waste mobile phones

(The appendix does not form an integral part of this Recommendation.)

The type of transboundary movement procedure to be applied depends on the condition of the collected mobile phones after evaluation and/or testing and labelling and on national legislation. The Basel Convention transboundary movement control procedure should be implemented for end-of-life mobile phones destined for material recovery and recycling (Annex IV B operations) or final disposal (Annex IV A operations), where the end-of-life mobile phones contain Annex I constituents, unless it can be demonstrated that these end-of-life mobile phones are not hazardous using Annex III characteristics. [b-MPPI Guidance Document].

To determine what is and what is not covered under the Basel Convention, the Convention defines the "wastes" to be covered in Article 2.1 of the Convention, and stipulates that wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. The Convention then defines disposal by reference to a set of technical annexes. The term disposal includes recovery, recycling operations as well as final disposal operations. In addition, every Party may determine, by its own national legislation, to define additional substances and objects as wastes and hazardous wastes.

If, following Article 2.1 of the Basel Convention or national legislation, at least one of the Parties involved in a transboundary movement has determined that used mobile phones destined for direct reuse or destined repair, refurbishment or failure analysis in the importing country are classified as hazardous wastes, then the Basel Convention control procedure would then apply where such waste mobile phones are hazardous wastes, in accordance:

– with Article 1.1 (a) and contain Annex I constituents, unless it cannot be demonstrated that these used mobile phones are not hazardous, using Annex III characteristics or,

– with Article 1.1 (b) and are considered hazardous wastes by the national legislation of one of the Parties involved in the transboundary movement.

However, if, following Article 2.1 of the Basel Convention and national legislation, none of the Parties involved in a transboundary movement have determined that used mobile phones destined for direct reuse or destined for failure analysis, repair or refurbishment in the importing country are classified as wastes, the Basel Convention control procedure will not apply. In such circumstances, the exporter should follow the procedure described in the Basel Convention Technical Guidelines on transboundary movements of e-wastes [b-Basel E-waste TGs] and ensure that mobile phones destined for direct reuse are accompanied by functionality tests and a reuse destination in the receiving country is assured, among others. For mobile phones that are destined for failure analysis, repair or refurbishment, the shipment should be accompanied by relevant documentation, including a contract for the failure analysis, repair or refurbishment operations in the importing country, among others.

Bibliography

[b-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*.

[b-ITU-T L.Suppl.21] Supplement 21 to ITU-T L-series Recommendations (2016), *Implementation guidance for small- and medium-sized enterprises on information and communication technology supply chain due diligence concerning conflict minerals*.

[b-ITU-T L.Suppl.32] Supplement 32 to ITU-T L-series Recommendations (2016), *Supplement for eco-specifications and rating criteria for mobile phones eco-rating programmes*. <http://www.itu.int/rec/T-REC-L.Sup32-201610-I>

[b-ETSI ES 203 199] ETSI ES 203 199 V1.3.1 (2015*), Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services*.

[b-IEC 60529] IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*.

[b-IEC 61960-3] IEC 61960-3:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications – Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them*.

[b-IEC 62075] IEC 62075:2012, *Audio/video, information and communication technology equipment – Environmentally conscious design*.

[b-IEC 62321] IEC 62321:Series - *Determination of certain substances in electrotechnical products*.

[b-IEC TR 62635] IEC TR 62635:2012, *Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment*.

[b-IEC 63000] IEC 63000:2016, *Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances*.

[b-IEEE 1680.1] IEEE 1680.1-2018, *IEEE Standard for Environmental and Social Responsibility Assessment of Computers and Displays*.

[b-ISO 1043-1] ISO 1043-1:2011, *Plastics – Symbols and abbreviated terms*.

[b-ISO 11469] ISO 11469:2016, *Plastics – generic identification and marking of plastics products*.

[b-ISO 14001] ISO 14001:2015, *Environmental management systems – Requirements with guidance for use*.

[b-ISO 14021] ISO 14021:2016, *Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling).*

[b-ISO 14040] ISO 14040:2006, *Environmental management – Life cycle assessment – Principles and framework.*

[b-ISO 14044] ISO 14044:2006, *Environmental management – Life cycle assessment – Requirements and guidelines*.

[b-AA 1000] AccountAbility AA1000 Series of Standards.

[b-AICPA AT 101] American Institute of Certified Public Accountants Section 10119SA09Oral.

[b-Andrae] Andrae, A.S.G., Edler, T., (2015), *On global electricity usage of communication technology*: Trends to 2030. Challenges. 6, 117-157. <http://www.mdpi.com/2078-1547/6/1/117>

[b-Andrae] Andrae, A.S.G. (2018), *Collection rate and reliability are the main sustainability determinants of current fast-paced, small, and short-lived ICT products*. *WSEAS Transactions on Environment and Development* 14, 531-540. <http://www.wseas.org/multimedia/journals/environment/2018/b125115-097.pdf>

[b-Basel E-waste TGs, 2015)] Technical Guidelines on transboundary movements of e-waste in particular on the distinction between waste and non-waste under the Basel Convention.

[b-CEN EN 13428] CEN – 13428 (2004), *Packaging – Requirements specific to manufacturing and composition – prevention by source reduction*.

[b-EMAS, 2009] EC Regulation 1221/2009 *on the voluntary participation by orgainsations in a Community eco-management and audit scheme (EMAS)*.

[b-EN 45557] EN 45557:2018, *General method for assessing the proportion of recycled material content energy-related products*.

[b-EN 50625] EN 50625 Collection, *Logistics and Treatment Requirements for WEEE*.

[b-GRI Standards] Global Reporting Initiative Sustainability Reporting Standards.

[b-GHG Protocol] Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, 2015.

[b-MPPI Guidance Document, 2012] Mobile Phone Partnership Initiative. Guidance Document on the Environmentally Sound Management of Used and End-of-Life Mobile Phones.

[b-PEF Guide] Product Environmental Footprint (PEF) Guide, European Commission.

[b-PR EN 45555] PR EN 45555:2018, *General methods for assessing the recyclability and recoverability of energy related products*.

[b-UL110, 2012] UL 110, Standard for Sustainability for Mobile Phones. 1st ed. March 24, 2012.

[b-UL110, 2017] UL 110, Standard for Sustainability for Mobile Phones. 2nd ed. March 24, 2017.

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