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Environmental Engineering (EE);
Example of a Life Cycle Assessment (LCA)
of a mobile phone

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Executive summary

The objective of the present document is to show how a Life Cycle Assessment (LCA) of an ICT good, a mobile phone, is performed by an ICT manufacturer, based on ETSI ES 203 199 [i.1].

For compliance with ETSI ES 203 199 [i.1] all body text and annexes need to be considered when performing an LCA, i.e. this example is fully compliant with ETSI ES 203 199 [i.1] as described in clause 4.2 except for a few deviations listed in the 'Reporting' clause 4.12.

Introduction

The present document has been developed to demonstrate the application of ETSI ES 203 199 [i.1] for the environmental assessment of the life cycle impact of a mobile phone.

ETSI ES 203 199 [i.1] defines a set of requirements to reflect the quality that practitioners should strive for. To foster results of LCAs becoming more transparent and, for the quality of data and LCA tools to improve over time, the present document is applying the requirements outlined in ETSI ES 203 199 [i.1] in the following pages. ETSI ES 203 199 [i.1] requires that deviation(s) from the requirements are clearly motivated and reported. For further details regarding compliance refer to clause 5.2 in ETSI ES 203 199 [i.1].

The present document is intended for LCA practitioners wanting to assess mobile phones environmental impacts and it will help them to perform and report their LCAs of mobile phones in a uniform and transparent manner.

The following uses of mobile phone LCA applications are the most frequently used ones, but others may be identified and used as well:

- Evaluation of product system environmental impact, such as climate change.
- Assessment of primary energy consumption.
- Identification of life cycle stages and activities with high significance.
- Comparisons of specific mobile phones under the conditions described in clause 5.3 in ETSI ES 203 199 [i.1].
- Comparative analysis between an ICT product system featuring mobile phones and reference product system.

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5. It will be published respectively by ITU and ETSI as ITU-T L.Supp60 [i.7] and ETSI TR 104 080 (the present document), which are technically-equivalent.

1 Scope

The present document aims to present an example of an objective and transparent Life Cycle Assessment (LCA) of a mobile phone.

The present document will provide an example of an LCA of a mobile phone fully compliant with ETSI ES 203 199 [i.1]. The present document will be technically aligned with ITU-T L.Suppl.60.

The present document can be read by anyone aiming for a better understanding of LCA of mobile phones. However, the present document is especially intended for LCA practitioners with a prior knowledge of ETSI ES 203 199 [i.1].

The purpose of the present document is to:

- provide an example of an LCA of a mobile phone, aligned with the requirements of ETSI ES 203 199 [i.1] to ensure a sufficient quality of LCA studies of mobile phones;
- harmonize the LCAs of mobile phones;
- increase the credibility of LCAs of mobile phones;
- increase the transparency and facilitate the interpretation of LCA studies of mobile phones;
- facilitate the communication of LCA studies of mobile phones.

Recognizing ETSI ES 203 199 [i.1] as reference, the present document will apply it for the LCA of a mobile phone. The present document is valid for all types of mobile phones.

While ETSI ES 203 199 [i.1] defines a set of requirements which reflect the quality that practitioners should strive for, the present document does not contain any requirements.

Comparisons of results from environmental assessments of mobile phones which have been performed by different organizations and with different tools, are beyond the scope of ETSI ES 203 199 [i.1], as such comparisons would require that the assumptions and context of each study are exactly equivalent.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI ES 203 199 (V1.4.1): "Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services".

[i.2] Recommendation ITU-T L.1015 (01/2019): "Criteria for evaluation of the environmental impact of mobile phones".

[i.3] ETSI TR 103 679 (V1.1.1): "Environmental Engineering (EE); Explore the challenges of developing product group-specific Product Environmental Footprint Category Rules (PEFCRs) for smartphones".

[i.4] Galen, J. V. (2023): "The environmental impact of reusing iPhones: a case study looking into the environmental benefits of reusing iPhones through Twig" (Master's thesis) (Accessed 28 May 2024).

[i.5] ISO 14040:2006: "Environmental management -- Life cycle assessment -- Principles and framework".

[i.6] ISO 14044:2006: "Environmental management -- Life cycle assessment -- Requirements and guidelines".

[i.7] ITU-T L.Supp60: "Example of a Life Cycle Assessment (LCA) of a mobile phone".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI ES 203 199 [i.1] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI ES 203 199 [i.1] apply.

4 Example of an LCA of a mobile phone fully compliant with ETSI ES 203 199

4.1 Introduction

The purpose of the present document is to show how an LCA of a mobile phone is performed by an ICT manufacturer based on ETSI ES 203 199 [i.1].

NOTE: The data presented in this example are not real data but rather examples.

For compliance with [i.1] all body text and annexes need to be considered when performing an LCA, i.e. this example as such is fully compliant with [i.1] as described in clause 5.2 in ETSI ES 203 199 [i.1] except for a few deviations listed in the Reporting clause below.

4.2 Goal definition

The goal of this example LCA study is to clarify and understand the environmental impact of a mobile phone, during all stages of the lifecycle, with respect to the mid-point impact categories Climate Change (CC) and Resource Use, Mineral, Resources (RDMR).

NOTE 1: The Environmental Footprint (EF) Life Cycle impact Assessment method consists of 14 further impact categories (such as Ozone Depletion and Respiratory Inorganics) beyond CC and RDMR which are not considered for the present example. It is encouraged to analyse the results for each impact category to further explore the environmental impacts.

The purpose of the LCA study is for internal use in order to develop the product and processes to be more environmentally sound. Based on previous experience [i.3], data availability and a screening, it is judged that beyond the mandatory CC, RDMR is enough to exemplify the application of [i.1].

NOTE 2: Many more impact categories exist and a two are selected for this example just to highlight that it is important to assess different categories to avoid burden shifting. The purposes of performing an LCA may vary e.g. from internal use cases to understanding the potential impact and identifying of opportunities to improve environmental performance of a good to external use cases to gain information about typical environmental performance of a good to assist in policy choices.

4.3 Scope definition

The studied product system is one mobile phone for Business-to-Consumer (B2C) with typical functionality such as voice, SMS and internet browsing. Except the operating system software program, it physically consists of general building blocks such as: display, battery, mechanics, electromechanics and electronic components. These building blocks can in turn be categorized according to Parts defined in Table E.1 in ETSI ES 203 199 [i.1]. Table E.1 also includes Software as a Part. In this case of an entry-level mobile phone the main software component is the general operating system which according to clause 6.1.3 in ETSI ES 203 199 [i.1] can be considered optional due to allocation difficulties. Moreover, applications that users may install themselves are excluded as the preferences and choices of users vary remarkably.

In the studied product system, the sales package is out of the scope such as sales package materials, user guide and accessories such as the charger, cable and headset.

NOTE 1: The limited scope for the present example is allowed in [i.1] however the sales package materials are commonly included in mobile phone LCAs. Including or excluding e.g. packaging materials and chargers could have significant effect for several impact categories.

NOTE 2: Depending on the goal and scope of the study sales package may or may not be included and the package content may vary.

The **operating lifetime** is estimated to be 4 years by the first owner based on the studied type of mobile phone and on consumer surveys. No extended operating lifetime or other lifetimes are considered.

NOTE 3: 4 years operating lifetime is considered longer than the average. However, it is nevertheless chosen as some consumers fit the profile [i.4]. Shorter and longer lifetime are tested in the sensitivity analysis.

The **functions** of a mobile phone are many such as calling, web browsing, creating mobile hotspot, watching videos on the internet, enable video meeting, setting alarm, setting of timer, keeping time, navigation.

The **applicable functional unit** is "*3G/4G/5G access for 1 hour daily calling and enable use of a 1080×2340 pixels video player for 2 hours web browsing and 4 hours video watching daily for 4 years*".

This use case is just one specific scenario. The use pattern and therefore energy consumption of the device may vary a great deal, for example depending on which features are used and for how much time and on whether the charger is left plugged into the power socket. Other scenario-based sensitivity analyses may be conducted. The assessment scope is also focused on direct operations and therefore infrastructure capacity buildings (like factories, roads, vehicles and telecommunications) are excluded. Also, capital goods, like production machinery are excluded. Human resources, corporate overhead and travels are also excluded.

ICT Manufacturers facility data are included (energy, materials, waste, etc.).

NOTE 4: Manufactures have the possibility to use primary data and other practitioners can use external sources e.g. manufacturer external reports and LCI databases.

The assessed mobile phone is a globally sold and used product. As the geographical and temporal coordinates vary dynamically for the Raw Material Acquisition and Production of most mobile phones the presented results for Raw Material Acquisition and Production will therefore represent a global snapshot for the mobile phone.

4.4 System boundaries

Table 2 in ETSI ES 203 199 [i.1] specifies the mandatory, recommended and optional life cycle stages/unit processes for ICT goods. Listed below are the life cycle stages included in this LCA example for a mobile phone:

- A1 Raw material extraction.
- A2 Raw material processing.
- B1.1 Parts production.
- B1.2 Assembly.
- C1 ICT goods use.
- D2.1 Storage/Disassembly/Dismantling/ Shredding.
- D2.2 Recycling.
- D3 Other EoLT.

The recommended B1.3 is left out due to allocation problems and B3 (ICT specific site construction), is not applicable to the studied product system of one mobile phone.

Moreover, C2, C3 and C4 are not applicable to the studied product system.

In EoLT D2.1, D2.2. and D3 processes are included. D1 is not applicable to the studied product system.

Support activities are intentionally excluded for any unit processes.

Underlined Processes in Figure 1 are included in the studied product system.

Processes below in italic style are not included as they are optional or not part of the studied product system scope.

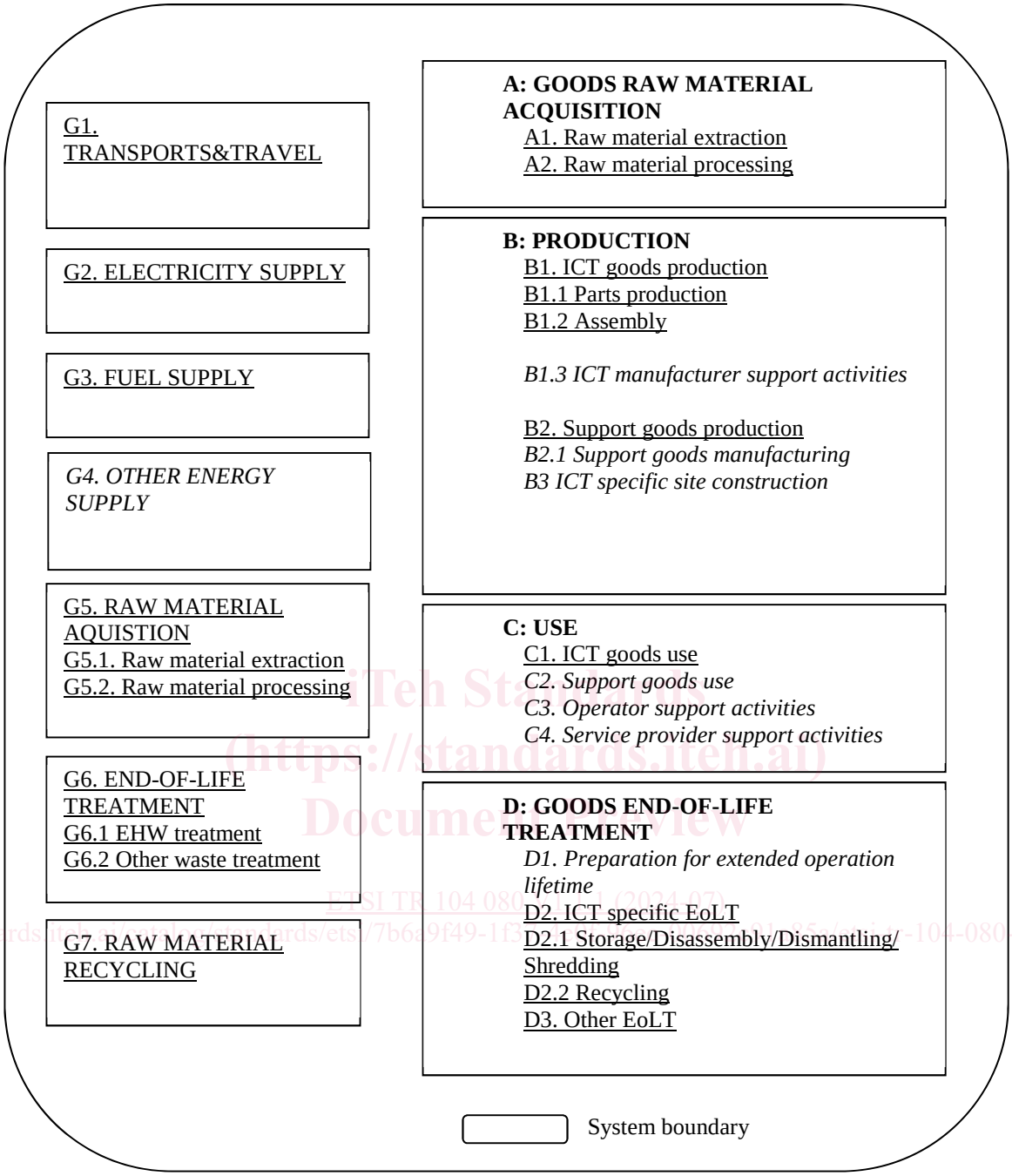

Figure 1: The system boundary of the product system for LCA of the mobile phone

4.5 Data collection

4.5.1 Goods Raw material acquisition (A)

Selected external databases are used for Raw Material Extraction (A1) and Raw Material Processing (A2) data.

ICT manufacturer Bill Of Materials (BOM) and primary material data are used to identify the Parts and Raw material contents of the mobile phone.

NOTE: There are also other ways of collecting material content and BOM data, e.g. teardown reports, manufacturers, external data sources. Data quality evaluation is always important and the chosen approach needs to be motivated.

4.5.2 Production (B)

Primary data (transportation mode, distance and masses) are collected for transports of Raw Materials (G5) and Parts (B1.1.1-10) to Final Product and from own production (Assembly, B1.2) operations. Primary data for consumption of Electricity, Fuel and Raw Materials in B1.2 are also collected. Part Production (B1.1.1-10) and Raw Materials Acquisition LCI data (G5) are collected from external databases and case by case, from suppliers based on BOMs and material content.

4.5.3 Use (C)

Energy consumption during mobile phone use stage in the described specific scenario is estimated based on the third alternative in clause 6.3.1.2.1 of ETSI ES 203 199 [i.1] (with certain user profile / product category) including typical use of all functionalities of multifunctional ICT goods. Phone charging energy efficiency is based on the ICT manufacturer's own charger relevant for the study. It is assumed that the charger is not unplugged and therefore no-load consumption has been considered (worst case scenario). Battery capacity is based on relevant battery for the study. World average energy mixes are used as the product is intended for global market.

4.5.4 Goods End of Life Treatment (D)

For EoLT data are based on average data from literature (e.g. regarding amount of electricity used per piece or mass of mobile phone for Storage/Disassembly/Dismantling/Shredding (D2.1) and Recycling (D2.2.1, D2.2.2, D2.2.4 and D2.2.5).

4.5.5 Generic processes (G1-G7)

For transports (G1) distances, transportation modes and own facilities consumption of electricity (G2), Fuels (G3), Raw Materials (G5) and Raw Material Recycling (G7) primary data are used. Relevant local and global energy mixes are collected from LCI databases.

4.5.6 Other information

For Raw Material Acquisition the LCI databases used are not transparently reporting data on transports (G1), thus impact from these transports between Raw Material Extraction (A1) and Raw Material Processing (A2) cannot be reported separately.

Furthermore, the amount and type of Transport of Raw Materials to Part Production are not transparent.

4.6 Data calculation

4.6.1 B1.1.1 Battery

Below follows some examples of data calculations.

The mass of the battery used in the mobile phone is measured. An LCI module for Lithium ion batteries expressing the impacts per mass is applied according to Figure B.1 in ETSI ES 203 199 [i.1].

NOTE: Depending on the LCI data available also other possibilities exist that are based on battery capacity and energy content.

4.6.2 B1.1.2 Cables

There are no cables in the studied product system.