ETSI TR 103 679 V1.1.1 (2019-05)

Environmental Engineering (EE);
Explore the challenges of developing product group-specific Product Environmental Footprint Category Rules (PEFCRs) for smartphones

Reference

DTR/EE-MICT2

Keywords

LCA, smartphone

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

In 2013, the European Commission (EC) released a proposal for the use of common methods to measure and communicate the life cycle environmental performance of products and organizations [i.1]. EC started a journey to test the Product and Organization Environmental Footprint methods in action. Together with more than 260 volunteering organizations EC tested how to develop product- and sector-specific rules, how to communicate and verify Environmental Footprint (EF) information. In January 2018 EC announced that the journey is coming to an end [i.2].

It can therefore be concluded that Life Cycle Assessment (LCA) seems to be slowly converging into a useful policy tool. To this end the electronics and ICT industry and others have in recent years started to prepare for possible LCA legislation from the European Commission according to the so called Product Environmental Footprint (PEF) method. The aim of PEF is to enhance the quality of LCAs by harmonization, leading to comparable product environmental footprints within specified product groups in a single market.

Figure 1 shows a set of non-comparable and non-standardized GWP100 results for smartphones for selected life cycle stages.

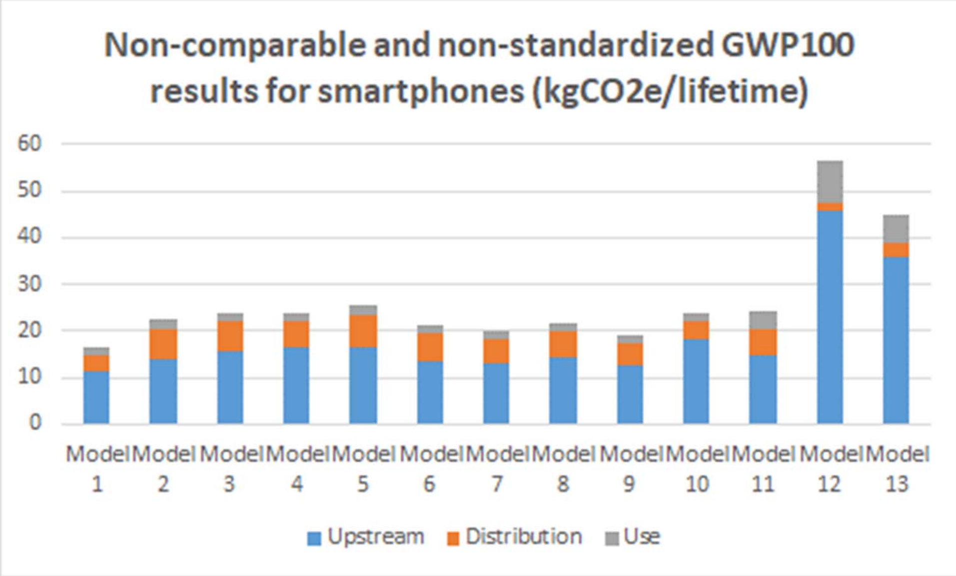

Figure 1: Non-comparable and non-standardized GWP100 results for smartphones

The PEF method might help verify the reliability of the results such as those shown in Figure 1.

Nevertheless, PEF has been questioned for not leading to comparative results but only reproducible results [i.3] and [i.25]. Using PEF, specific features of individual products can seemingly not be reflected (e.g. how to compare "standard" and "durable" devices when the same lifetime is assumed). Still, the PEF Category Rules (PEFCR) Guidance [i.7] states that comparability is possible if the results are based on the same PEFCR.

NOTE: This might be true for PEFCR but it is not true for the EPD System Product Category Rules (PCR) [i.19] which are too flexible regarding data quality and functional unit selection.

Examples of unique features of PEF - compared to e.g. the European Telecommunications Standards Institute (ETSI) standard for LCA [i.4] and [i.5] - are the strict requirements on data quality, definition of exact FU, default end-of-life (EoL) scenario, mid-point impact categories, and that cut-off should be avoided. Moreover - in order to be compliant with PEF - the industry leaders for each product group sold in the EU - such as smartphones - will have to reach consensus on the product category rules (PCR) for these product groups.

Recently IT storage equipment - belonging to classification 26.2 in Statistical Classification of Products by Activity in the European Economic Community [i.6] - was investigated in an official PEF pilot.

In 2017 a guidance document was published including the experience of the PEF pilots [i.7]. Oja et al. argued that it is important to find a balance between comparability, reliability, and costs when performing PEF LCAs [i.8].

The common wisdom is that simplified LCA approaches do not have enough precision compared to Full LCA (FLCA) when applied to the rather complex life cycle of smartphones. Still, there exist several simplified LCA methods for smartphones [i.10]. Andrae identified that there are at least 14 different - simplified and full - methods for LCA of consumer electronics such as smartphones [i.11]. One of the FLCA methods is the PEF method, expected to be the state-of-the-art for FLCA [i.7]. In the present document only FLCA of smartphones will be discussed. PEF has very strict data quality requirements as product comparisons need good quality data. Ojala et al. [i.8] argued that PEFCR developers should devote time to finding the most appropriate methodological choices. There exists no analyses of the degree to which current smartphone Full LCAs fulfil the requirements of the strict PEF Guidance [i.10]. To shed light on that issue is one of the main objectives of the present document.

Moreover, the present document will discuss the discrepancy between FUs currently formulated for smartphones compared with those required by PEF. While comparability is the ultimate aim of the PEF FLCA method, it will require very high data quality lowering the uncertainty. Even with "perfect" data quality, there will be variability of LCA scores for the same type of smartphones.

Andrae and Vaija [i.5] argued that PEF has several strengths and weaknesses. Strengths include guidance and requirements on FU definition. Moreover, PEF demands relatively precise analyses of the supply chains which could lead to eco-innovation. Furthermore, the fact that cut-off is not "allowed" gives an estimation of the truncation error. Another benefit is that the circular footprint formulae should improve the end-of-life modelling for all.

However, again, the PEF method has several weaknesses. First the ambitious data collection targets cannot - by most actors - be applied consistently along the supply chain. Furthermore, the usefulness beyond traditional ISO [i.12] and [i.13] and ETSI FLCA standards [i.14] is in doubt as these data and comparability issues are not solved.

PEF also might threaten the flexibility needed by LCA practitioners in their pursuit to influence the product design holistically. Such worries are echoed by recent research [i.25].

The present document is expected to provide valuable input for all users of LCA within the smartphone sphere and to some degree also for the consumer electronics sphere. Five smartphone manufacturers approaches for FLCA have been analysed based on openly available information.

1 Scope

The present document investigates current approaches, concepts and metrics of LCA as proposed by PEF and their applicability for the smartphones. The present document:

1) searches to identify if Product Category Rules (PCR) and Life Cycle Assessment (LCA) models for the smartphone product category have been developed;

2) explores existing PCRs and LCAs for gaps compared to the PEFCR Guidance requirements;

3) explorse the challenges associated with: setting the scope, defining the unit of analysis, reference flow, representative products, product classification, system boundaries, data quality requirements, data collection, benchmark and classes of environmental performance, interpretation, reporting, disclosure, communication, and verification;

4) explores the challenges with PEF Screening (impact assessment, interpretation and conclusion, report).

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] European Union: "Single Market for Green Products Initiative", 2014.

NOTE: Available at http://ec.europa.eu/environment/eussd/smgp/index.htm.

[i.2] European Union: "Final Conference of the Environmental Footprint Pilot Phase", 2018.

NOTE: Available at http://ec.europa.eu/environment/eussd/smgp/EFconference_2018.htm.

[i.3] Lehmann, A.; Bach, V.; Finkbeiner, M.: "EU product environmental footprint-mid-term review of the pilot phase", Sustainability 2016, pages 1 to 13, article 92.

NOTE: Available at http://www.mdpi.com/2071-1050/8/1/92.

[i.4] Andrae, A.S.G.; Vaija, M.S.: "To Which Degree Does Sector Specific Standardization Make Life Cycle Assessments Comparable? - The Case Of Global Warming Potential Of Smartphones", Challenges 2014, 5, 409-429.

NOTE: Available at http://www.mdpi.com/2078-1547/5/2/409/htm.

[i.5] Andrae, A.S.G.; Vaija, M.S.: "Life cycle assessments of an optical network terminal and a tablet: experiences of the product environmental footprint methodology", In Advances in Environmental Research, 1st Ed.; Daniels J.A., Ed.; Publisher: Nova Science Publishers, Hauppauge, NY, USA, 2017; Volume 55, pp. 31-46.

NOTE: Available at https://www.researchgate.net/publication/317934185_The_life_cycle_assessments_of_an_optical_network_terminal_and_a_tablet_Experiences_of_the_product_environmental_footprint_methodology.

[i.6] European Commission: "METADATA - Statistical Classification of Products by Activity in the European Economic Community, 2008 version".

NOTE: Available at http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CPA_2008&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC.

[i.7] European Commission: "Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase version 5.2", February 2016.

NOTE: Available at http://ec.europa.eu/environment/eussd/smgp/pdf/Guidance_products.pdf.

[i.8] Ojala, E.; Uusitalo, V.; Virkki-Hatakka, T.; Niskanen, A.; Soukka, R.: "Assessing product environmental performance with PEF methodology: reliability, comparability, and cost concerns", International Journal of Life Cycle Assessment 2016, 21, 1092-1105.

NOTE: Available at https://www.researchgate.net/publication/298908043_Assessing_product_environmental_performance_with_PEF_methodology_reliability_comparability_and_cost_concerns.

[i.9] Andrae, A.S.G.: "Life Cycle Assessment of a Virtual Reality Device", Challenges 2017, 8, 15.

NOTE: Available at http://www.mdpi.com/2078-1547/8/2/15.

[i.10] Andrae, A.S.G.; Vaija, M.S.: "Precision of a Streamlined Life Cycle Assessment Approach Used in Eco-Rating of Mobile Phones", Challenges 2017, 8, 21.

NOTE: Available at https://www.mdpi.com/2078-1547/8/2/21.

[i.11] Andrae, A.S.G.: "Life Cycle Assessment (LCA) of consumer electronics: A review of methodological approaches", IEEE Consumer Electronics Magazine 2016, 5, 51-60.

NOTE: Available at http://ieeexplore.ieee.org/document/7353286/.

[i.12] ISO 14040 (2006): "Environmental management -- Life cycle assessment -- Principles and framework".

NOTE: Available at https://www.iso.org/standard/37456.html.

[i.13] ISO 14044 (2006): "Environmental management -- Life cycle assessment -- Requirements and guidelines".

NOTE: Available at https://www.iso.org/standard/38498.html.

[i.14] ETSI ES 203 199 (V1.3.1): "Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services".

NOTE: Available at https://www.etsi.org/deliver/etsi_es/203100_203199/203199/01.03.01_60/es_203199v010301p.pdf.

[i.15] Smith, L.; Ibn-Mohammed, T.; Koh, S.L.; Reaney, I.M.: "Life cycle assessment and environmental profile evaluations of high volumetric efficiency capacitors", Applied Energy 2018, 220, 496-513.

NOTE: Available at https://www.sciencedirect.com/science/article/pii/S0306261918304057.

[i.16] Andrae, A.S.G., Xia, M., Zhang, J., Tang, X. "Practical eco-design and eco-innovation of consumer electronics-The case of mobile phones", Challenges 2016, 7(1), 3.

NOTE: Available at http://www.mdpi.com/2078-1547/7/1/3/htm.

[i.17] Allacker, K.; Mathieux, F.; Pennington, D.; Pant, R.: "The search for an appropriate end-of-life formula for the purpose of the European Commission Environmental Footprint initiative", International Journal of Life Cycle Assessment 2017, 22(9), 1441-1458.

NOTE: Available at https://link.springer.com/content/pdf/10.1007%2Fs11367-016-1244-0.pdf.

[i.18] Compal Communications: "Product-Category Rules (PCR) for Preparing an Environmental Product Declaration (EPD) for Smartphone PCR 2011:1.0".

NOTE: Available at https://www.idbcfp.org.tw/GetDownloadSubFile.ashx?id=85.

[i.19] The International EPD System: "Product Category Rules".

NOTE: Available at https://www.environdec.com/PCR.

[i.20] Heo, Y.C.; Bae, D.S.; Oh, C.Y.; Suh, Y.J.; Lee, K.M.: "Assessment of the Potential Environmental Impact of Smart Phone using LCA Methodology", Journal of Korean Society Environmental Engineers 2017, 39(9), 527-533.

NOTE: Available at http://www.jksee.or.kr/journal/view.php?number=4059.

[i.21] Yeom, J.M.; Jung, H.J.; Choi, S.Y. et al.: "Environmental Effects of the Technology Transition from Liquid-Crystal Display (LCD) to Organic Light-Emitting Diode (OLED) Display from an E-Waste Management Perspective", International Journal of Environmental Research 2018, 12, 479-488.

NOTE: Available at https://rd.springer.com/article/10.1007/s41742-018-0106-y.

[i.22] Belkhir, L., Elmeligi, A.: "Assessing ICT global emissions footprint: "Trends to 2040 & recommendations", Journal of Cleaner Production 2018, 177, 448-463.

NOTE: Available at http://www.electronicsilentspring.com/wp-content/uploads/2015/02/ICT-Global-Emissions-Footprint-Online-version.pdf.

[i.23] 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".

NOTE: Available at https://webstore.iec.ch/publication/7292.

[i.24] Corcoran, P., Andrae, A.S.G., Vaija, S.M., Garcia, C., Dechenaux, E.: "Effect of Modeling Approach on climate change focused life cycle assessments for a Contemporary Smartphone Device", 2014.

NOTE: Available at https://aran.library.nuigalway.ie/handle/10379/4522.

[i.25] Bach, V.; Lehmann, A.; Görmer, M.; Finkbeiner, M.: "Product Environmental Footprint (PEF) Pilot Phase-Comparability over Flexibility?", Sustainability 2018, 10, 2898.

NOTE: Available at https://www.mdpi.com/2071-1050/10/8/2898.

[i.26] Andrae, A.S.G.: "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 2018, 14, 531-540.

NOTE: Available at http://www.wseas.org/multimedia/journals/environment/2018/b125115-097.pdf.

[i.27] Zhu, Y.; Andrae, A.S.G. 2014.: "System and method of life-cycle assessment for equipment of information and communication technology", WO/2014/012590.

NOTE: Available at https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2014012590.

[i.28] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

NOTE: Available at https://eur-lex.europa.eu/legal-content/en/TXT/?qid=1532936325230&uri=CELEX:02006R1907-20180509.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

assessment method: procedure for determining the value of a metric or indicator and validating it

NOTE: The method could include measurement and calculation.

component: part of a product that cannot be taken apart without destruction or impairment of its intended use

indicator: quantifiable representation of a parameter

NOTE: Example includes acidification potential.

material: substance or mixture of substances within a product or product part [i.28]

metric: measurable representation of a parameter or indicator

NOTE: Examples include mass of product, disassembly time, and re-used parts.

parameter: entity representing an aspect

NOTE: Examples include acidification which is an entity representing environmental aspects

product: good or service

product part: sub-unit of a product

substance: chemical element and its compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the declarable substance or changing its composition [i.28]

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ASIC	Application Specific Integrated Circuit
CFC11E	CFC11 Equivalents
CFF	Circular Footprint Formulae
CO2E	CO2 Equivalents
EF	Environmental Footprint
EPCR	Existing PCR
EPD	Environmental Product Declaration
FLCA	Full LCA
FU	Functional Unit
GPS	Global Positioning System