PRODUCT ENVIRONMENTAL FOOTPRINT CATEGORY RULES

Uninterruptible Power Supply (UPS)



Version: 5.3

With critical review statement and report and final EC comments

Date of publication: February 2020 (original publication date is on 15 February 2019)"

Time of validity: 31st December 2021

Participating Organizations:

Link to Wikipage: https://webgate.ec.europa.eu/fpfis/wikis/pages/viewpage.action?pageId=61835546

Contact person: **Eric BONNEVILLE** Schneider Electric
Tel: +33 (0)4 76 39 44 17
Email: eric.bonneville@schneider-electric.com
Address: 38TEC – 37 quai Paul Louis Merlin – 38000 Grenoble – France

Table of Contents

List of figures

List of tables

Acronyms

EFTA: European Free Trade Association

EPD: Environmental Product Declaration

ErP: Energy related Product

EU: European Union

IEC: International Electrotechnical Commission

IGPT: Insulated Gate Bipolar Transistor

ISO: International Organization for Standardization

LCA: Life Cycle Assessment

PEF: Product Environmental Footprint

PEFCR: Product Environmental Footprint Category Rules

PEP: Product Environmental Profile

PWB: Printed Wiring Board

UPS: Uninterruptible Power Supply

VFD: Voltage and Frequency Dependent

VFI: Voltage and Frequency Independent

VI: Voltage Independent

W: Watt

Wh: Watt-hour

Definitions

Activity data: This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF Guide it is also called “non-elementary flows”. The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data and then combined to derive the environmental footprint associated with that process. Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. In the context of PEF, the amounts of ingredients from the bill of material (BOM) shall always be considered as activity data.

(PEFCR Guidance 6.3, 2017)

Additional Environmental Information: Relevant potential environmental impacts beyond the life-cycle-based EF impact assessment models and viewed as complementary to the default list of EF impact categories such as additional EF impact categories or additional qualitative descriptions where impacts cannot be linked to the product supply chain in a quantitative manner.

Note: Additional environmental information may include (non-exhaustive list): (a) Bill-of-materials data; (b) Disassemblability, recyclability, recoverability, reusability information, resource efficiency; (c) Information on the use of hazardous substances; (d) Information on the disposal of hazardous/non-hazardous waste; (e) Information on energy consumption; (f) Information on local/site-specific impacts, e.g. local impacts on acidification, eutrophication and biodiversity.

(derived from PEF Guide, 2013/179/EU)

Aggregated dataset: Defined as a life cycle inventory of multiple unit processes (e.g. material or energy production) or life cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level. Aggregated datasets are also called "LCI results", “cumulative inventory” or “system processes” datasets. The aggregated dataset can have been aggregated horizontally and/or vertically. Depending on the specific situation and modelling choices a "unit process" dataset can also be aggregated.

(PEFCR Guidance 6.3, 2017)

Allocation: Approach to solving multi-functionality problems. It refers to partitioning the input or output flows of a process, a product system or a facility between the system under study and one or more other systems.

(ISO 14040:2006).

Application specific: Refers to the generic aspect of the specific application in which a material is used. For example, the average recycling rate of PET in bottles.

(PEFCR Guidance 6.3, 2017)

Average Data: Refers to a production-weighted average of specific data.

(PEF Guide, 2013/179/EU)

Background Process: Refers to those processes of the product supply chain for which no direct access to information is possible. For example, most of the upstream supply-chain processes and generally all processes further downstream will be considered to be background processes.

(PEF Guide 2013/179/EU)

Benchmark: A standard or point of reference against which any comparison can be made. In the context of PEF, the term ‘benchmark’ refers to the average environmental performance of the representative product sold in the EU market. A benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.

(PEFCR Guidance 6.3, 2017)

Business-to-Business (B2B): Describes transactions between businesses, such as between a manufacturer and a wholesaler, or between a wholesaler and a retailer.

(PEFCR Guidance 6.3, 2017)

Business-to-Consumers (B2C): Describes transactions between business and consumers, such as between retailers and consumers. According to ISO 14025:2006, a consumer is defined as “an individual member of the general public purchasing or using goods, property or services for private purposes”.

(PEFCR Guidance 6.3, 2017)

Bill of materials: Bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product.

(PEFCR Guidance 6.3, 2017)

Characterisation: Calculation of the magnitude of the contribution of each classified input/output to their respective EF impact categories, and aggregation of contributions within each category. This requires a linear multiplication of the inventory data with characterisation factors for each substance and EF impact category of concern. For example, with respect to the EF impact category “climate change”, CO2 is chosen as the reference substance and tonne CO2 -equivalents as the reference unit.

(PEF Guide 2013/179/EU)

Characterisation factor: Factor derived from a characterisation model which is applied to convert an assigned Resource Use and Emissions Profile result to the common unit of the EF category indicator.

(derived from ISO 14040:2006)

Classification: Assigning the material/energy inputs and outputs tabulated in the Resource and Emissions Profile to EF impact categories according to each substance's potential to contribute to each of the EF impact categories considered.

(PEF Guide, 2013/179/EU)

Close loop & open loop: A close-loop allocation procedure applies to close-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.

(derived from ISO 14044:2006)

Commissioner of the EF study: Organisation (or group of organisations) that finances the EF study in accordance with the PEF Guide, PEFCR Guidance and the relevant PEFCR, if available.

(PEFCR Guidance 6.3, 2017)

Company-specific data – It refers to directly measured or collected data from one or multiple facilities (site-specific data) that are representative for the activities of the company. It is synonymous to "primary data". To determine the level of representativeness a sampling procedure can be applied.

(PEFCR Guidance 6.3, 2017)

Cradle to cradle: A specific kind of cradle-to-grave, where the end-of-life disposal step for the product is a recycling process.

(PEF Guide, 2013/179/EU)

Cradle to gate: A partial Organisation supply chain, from the extraction of raw materials (cradle) up to the manufacturer's "gate". The distribution, storage, use stage and end-of-life stage of the supply chain are omitted.

(PEF Guide, 2013/179/EU)

Cradle to grave: An Organisation supply chain that includes raw material extraction, processing, distribution, storage, use, and disposal or recycling stages. All relevant inputs and outputs are considered for all of the stages of the life cycle.

(PEF Guide, 2013/179/EU)

Data Quality Rating (DQR): Semi-quantitative assessment of the quality criteria of a dataset based on Technological representativeness, Geographical representativeness, Time-related representativeness, and Precision. The data quality shall be considered as the quality of the dataset as documented.

(PEFCR Guidance 6.3, 2017)

Disaggregation: The process that breaks down an aggregated dataset into smaller unit process datasets (horizontal or vertical). The disaggregation can help making data more specific. The process of disaggregation should never compromise or threat to compromise the quality and consistency of the original aggregated dataset.

(PEFCR Guidance 6.3, 2017)

Environmental Footprint (EF) Impact Assessment: Phase of the PEF analysis aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (based on ISO 14044:2006). The EF

impact assessment methods provide impact characterisation factors for elementary flows in order to aggregate the impact to obtain a limited number of midpoint and/or damage indicators.

(PEF Guide, 2013/179/EU)

Environmental Footprint (EF) Impact Assessment Method: Protocol for quantitative translation of Resource Use and Emissions Profile data into contributions to an environmental impact of concern.

(PEF Guide, 2013/179/EU)

Environmental Footprint (EF) Impact Category: Class of resource use or environmental impact to which the Resource Use and Emissions Profile data are related.

(PEF Guide, 2013/179/EU)

Environmental Footprint (EF) Impact Category Indicator: Quantifiable representation of an EF impact category (based on ISO 14000:2006).

(PEF Guide, 2013/179/EU)

Environmental Footprint (EF) study: Term used to identify the totality of actions needed to calculate the EF results. It includes the modelling, the data collection, and the analysis of the results.

(PEFCR Guidance 6.3, 2017)

Environmental impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

(EMAS regulation)

Flow diagram: Schematic representation of the flows occurring during one or more process stages within the life cycle of the product being assessed.

(PEF Guide, 2013/179/EU)

Foreground Process: Refers to those processes of the product life cycle for which direct access to information is available. For example, the producer's site and other processes operated by the producer or contractors (e.g. goods transport, head-office services, etc.) belong to the foreground system.

(PEF Guide, 2013/179/EU)

Functional Unit: Quantified performance of a product system, to be used as a reference unit. Meaningful comparisons shall only be made when products can fulfil the same function. Therefore, the FU of a PEFCR describes qualitatively and quantitatively the function(s) and duration of the product, according to the four aspects: (a) The function(s)/service(s) provided: "what" (b) The extent of the function or service: "how much" (c) The expected level of quality: "how well" (d) The duration/life time of the product: "how long".

(derived from PEFCR Guidance 6.3, 2017)

Input flows: Product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products.

(PEFCR Guidance 6.3, 2017)

Life Cycle Assessment (LCA): Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

(ISO 14040:2006)

Life-Cycle Impact Assessment (LCIA): Phase of life cycle assessment that aims at understanding and evaluating the magnitude and significance of the potential environmental impacts for a system throughout the life cycle (ISO 14040:2006). The LCIA methods used provide impact characterisation factors for elementary flows in order to aggregate the impact to obtain a limited number of midpoint and/or damage indicators.

(PEF Guide, 2013/179/EU)

Life Cycle Inventory (LCI): The combined set of exchanges of elementary, waste and product flows in an LCI dataset.

(PEFCR Guidance 6.3, 2017)

Life Cycle Inventory (LCI) dataset: A document or file with life cycle information of a specified product or other reference (e.g., site, process), covering descriptive metadata and quantitative life cycle inventory. A LCI dataset could be a unit process dataset, partially aggregated or an aggregated dataset.

(PEFCR Guidance 6.3, 2017)

Multi-functional process: If a process or facility provides more than one function, i.e. it delivers several goods and/or services ("co-products"), it is “multifunctional”. In these situations, all inputs and emissions linked to the process shall be partitioned between the product of interest and the other co-products in a principled manner.

(PEFCR Guidance 6.3, 2017)

Output flows: Product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases.

(ISO 14040:2006)

Product Category Rules (PCR): Drafting rules that provide a method of environmental data recovery and analysis, and the declaration format used to generate the data in the form of a Product Environmental Profile (PEP).

PEFCR Supporting study: The PEF study done on the basis of a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.

(PEFCR Guidance 6.3, 2017)

PEF Profile: The quantified results of a PEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to be reported.

(PEFCR Guidance 6.3, 2017)

Practitioner of the EF study – Individual, organisation or group of organisations that performs the EF study in accordance with the PEF Guide, PEFCR Guidance and the relevant PEFCR if available. The practitioner of the EF study can belong to the same organisation as the commissioner of the EF study.

(PEFCR Guidance 6.3, 2017)

Primary data: This term refers to data from specific processes within the supply-chain of the company applying the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply-chain-specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the company applying the PEFCR. In this PEFCR, primary data is synonym of "company-specific data" or "supply-chain specific data".

(derived from PEFCR Guidance 6.3, 2017)

Product Environmental Footprint Category Rules (PEFCRs): Product category-specific, life-cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased

relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF guide.

(PEFCR Guidance 6.3, 2017)

Reference flow: Measure of the outputs from processes in a given product system required to fulfil the function expressed by the unit of analysis (based on ISO 14040:2006). The reference flow is the amount of product needed in order to provide the defined function. All other input and output flows in the analysis quantitatively relate to it. The reference flow can be expressed in direct relation to the unit of analysis or in a more product-oriented way.

(PEF Guide, 2013/179/EU)

Reference product: product or product system, supplied by the manufacturer, modelled in the LCA and allowing the defined functional unit to be matched.

(Product Category Rules for Electrical, Electronic and HVAC-R Products, 2015)

Representative product (model): The “representative product” may or may not be a real product that one can buy on the EU market. Especially when the market is made up of different technologies, the “representative product” can be a virtual (non-existing) product built, for example, from the average EU sales-weighted characteristics of all technologies around.

(derived from PEFCR Guidance 6.3, 2017)

Secondary data: Refers to data not from specific process within the supply-chain of the company applying the PEFCR. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third-party life-cycle-inventory database or other sources. Secondary data includes industry-average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and can also be based on financial data, and contain proxy data, and other generic data. Primary data that go through a horizontal aggregation step are considered as secondary data.

(PEFCR Guidance 6.3, 2017)

Site-specific data – Refers to directly measured or collected data from one facility (production site). It is synonymous to “primary data”.

(PEFCR Guidance 6.3, 2017)

Supply-chain – It refers to all of the upstream and downstream activities associated with the operations of the company applying the PEFCR, including the use of sold products by consumers and the end-of-life treatment of sold products after consumer use.

(PEFCR Guidance 6.3, 2017)

Supply-chain specific: It refers to a specific aspect of the specific supply-chain of a company. For example the recycled content value of an aluminium can produced by a specific company.

(PEFCR Guidance 6.3, 2017)

Unit process dataset: Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 14040:2006). In LCA practice, both physically not further separable processes (such as unit operations in production plants, then called “unit process single operation”) and also whole production sites are covered under "unit process", then called “unit process, black box”.

(PEFCR Guidance 6.3, 2017)

Voltage and Frequency Dependent (VFD) UPS: A UPS that produces an ac output where the output voltage and frequency are dependent on the input voltage and frequency.

(ENERGY STAR® Program Requirements for UPSs, 2017)

Voltage Independent (VI) UPS: Capable of protecting the load as required for VFD, above, and in addition from:

a) Under-voltage applied continuously to the input; and

b) Over-voltage applied continuously to the input

(ENERGY STAR® Program Requirements for UPSs, 2017)

Voltage and Frequency Independent (VFI) UPS: A UPS where the device remains in normal mode producing an ac output voltage and frequency that is independent of input voltage and frequency variations and protects the load against adverse effects from such variations without depleting the stored energy source.

(ENERGY STAR® Program Requirements for UPSs, 2017)

1. Introduction

The Product Environmental Footprint (PEF) Guide provides detailed and comprehensive technical guidance on how to conduct a PEF study. PEF studies may be used for a variety of purposes, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this PEFCR, the applicant shall refer to the documents this PEFCR is in conformance with (see chapter 2.7).

The compliance with the present PEFCR is optional for PEF in-house applications, whilst it is mandatory whenever the results of a PEF study or any of its content is intended to be communicated.

Terminology: shall, should and may

This PEFCR uses precise terminology to indicate the requirements, the recommendations and options that may be chosen when a PEF study is conducted.

- The term “shall” is used to indicate what is required in order for a PEF study to be in conformance with this PEFCR.
- The term “should” is used to indicate a recommendation rather than a requirement. Any deviation from a “should” requirement has to be justified when developing the PEF study and made transparent.
- The term “may” is used to indicate an option that is permissible. Whenever options are available, the PEF study shall include adequate argumentation to justify the chosen option.

2. General information about the PEFCR

2.1. Technical Secretariat

This PEFCR was developed by a consortium of UPS manufacturers, an EPD programme operator specialized on electronic products and LCA experts within the EU PEF/OEF Pilot phase. The following table presents the members of the Technical Secretariat of the project:

Logo	Name	Activity	Website	Contact	Date of entry in the TS
CEMEP European Committee of Manufacturers of Electrical Machines and Power Electronics	CEMEP UPS	European trade association of UPS manufacturers	https://www.cemep.eu/	cjagu@gimelec.fr	July 2013
EATON Powering Business Worldwide	EATON	UPS manufacturer	http://www.eaton.com	NicolasSamman@Eaton.com	July 2013
Gimélec	GIMELEC	French trade association of UPS manufacturers	http://www.gimelec.fr	cjagu@gimelec.fr	July 2013
legrand®	Legrand	UPS manufacturer	http://www.legrand.com	jean-michel.rossignol@legrand.fr	July 2013

Logo	Name	Activity	Website	Contact	Date of entry in the TS
	PEP ecopassport ®	EPD programme operator	http://www.pep-ecopassport.org	bertrand.hugoo@schneider-electric.com	July 2013
	Riello UPS	UPS manufacturer	http://www.riello-ups.com	R.Facci@riello-ups.com	June 2018
	Schneider Electric	UPS manufacturer	http://www.schneider-electric.com	eric.bonneville@schneider-electric.com	July 2013
	SOCOMEC	UPS manufacturer	http://www.socomec.com	nicolas.zehnder@socomec.com	July 2013
	VERTIV	UPS manufacturer	https://www.vertivco.com/en-us/	Matteo.Tricarico@vertivco.com	July 2013 as Emerson June 2018 as Vertiv
	B4Green consulting	LCA consultancy	www.b4green-consulting.com	Maud.Jacquot@b4green-consulting.com	April 2015 as TAB representative
	SGS	LCA consultancy	http://www.sgs.com	xavier.vital@sgs.com	July 2013

Table 1. Members of the Technical Secretariat

2.2. Consultations and stakeholders

According to the PEFCR Guidance 6.3 (2017) Figure 3, this PEFCR has been developed following several steps and consultations:

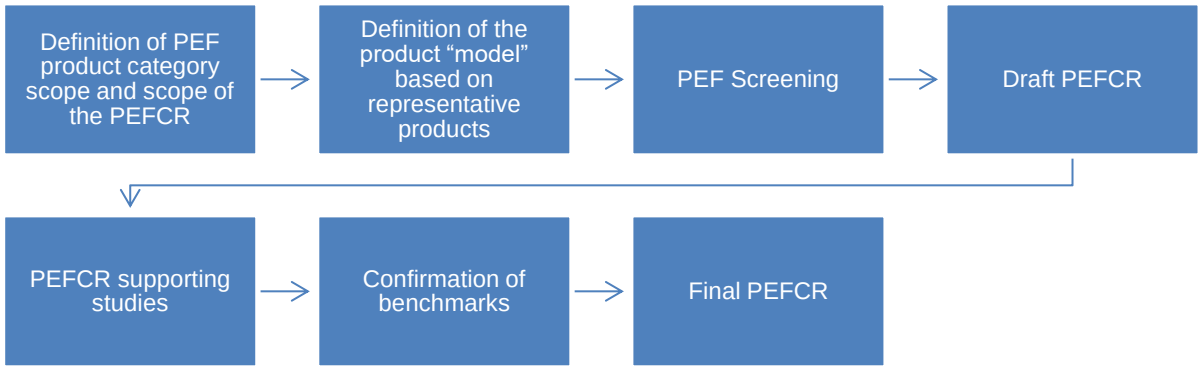


Figure 1: PEFCR development process

Dedicated website pages to the EU PEF/OEF Pilot Phase[1] and UPS Pilot[2] were created and maintained during the whole duration of the Environmental Footprint (EF) pilot phase.

[1] https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/EU+Environmental+Footprint+Pilot+Phase
[2] https://webgate.ec.europa.eu/fpfis/wikis/pages/viewpage.action?pageId=61835546

This Forum is the location where all documents related to the PEF rules and UPS pilot rules are stored, where each consultation step was carried out, where the periodic communication on the pilots' advancements took place.

The 1st physical consultation for this pilot took place on the 14th of February 2014 in Brussels where the definition of PEF product category, the scope of PEFCR and the definition of the representative product were presented and commented. The TS received and treated 43 comments from 4 different stakeholders (namely Bureau Veritas CODDE, Saft, EF Technical Helpdesk and Eurobat).
The consultation on the 1st draft of the PEFCR took place from 10th of July to 10th of August 2015. The TS received and treated 18 comments from 3 different stakeholders (namely Union de Normalisation de la Mécanique (UNM), International Lead Association (ILA) and Thinkstep AG).
The consultation on the final draft of the PEFCR took place from 29th September 2016 to 27th October 2016. The TS received and treated 75 comments from 3 different stakeholders (namely Bureau Veritas CODDE, PEF Metal Sheet Pilot and European Commission EF Team).

Stakeholders could provide comments all along the PEFCR development process through the Pilot stakeholders' wiki page and by e-mail.
In addition, during the consultation phases, the TS invited a wide range of stakeholders including SMEs, environmental organizations and consumer associations. In total, close to 80 representatives are registered as stakeholders.

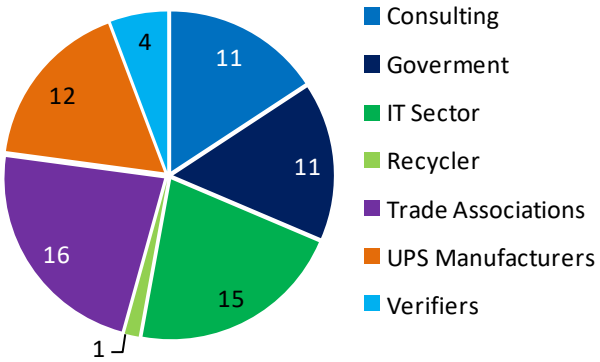


Figure 2: Stakeholder distribution

The document hereby constitutes the final PEFCR, which is the deliverable required by the European Commission after the completion of the full PEFCR development process, including the critical review by an independent panel (see chapter 2.3)

2.3. Review panel and review requirements of the PEFCR

2.3.1. PEFCR review panel

Name	Contact information	Affiliation
Kim Christiansen (chair)	kim@kimconsult.dk	kimconsult.dk
Etienne Lees-Perasso	Etienne.lees-perasso@fr.bureauveritas.com	LCIE Bureau Veritas
Caroline Catalan	caroline.catalan@i-care-consult.com	I Care & Consult

Table 2. PEFCR critical review panel

2.3.2. Review requirements for the PEFCR document

The reviewers have verified that the following requirements have been fulfilled:

- The PEFCR has been developed in accordance with the requirements provided in the PEFCR Guidance 6.3 (2017), and where appropriate in accordance with the requirements provided in the most recent approved version of the PEF Guide, and supports creation of credible and consistent PEF profiles,
- The functional unit, allocation and calculation rules are adequate for the product category under consideration,
- Company-specific and secondary datasets used to develop this PEFCR are relevant, representative, and reliable,
- The selected LCIA indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in the PEFCR Guidance version 6.3 and the most recent approved version of the PEF Guide,
- The benchmarks are correctly defined, and
- Both LCA-based data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product.

The detailed review report is provided in Annex 3: Critical review report of the PEFCR.

2.4. Review statement

This PEFCR has been developed in compliance with Version 6.3 of the PEFCR Guidance, and with the PEF Guide adopted by the Commission on July 17th 2012. The representative product(s) correctly describe the average UPS products sold in Europe. The methods used for carrying out the PEF study are valid from a technical and scientific point of view. The data used was adequate, reasonable and corresponds to the quality data requirements. Interpretation of the results takes the limitations identified into account. The PEFCR is clear, precise and coherent, although some text is repetitive of the PEFCR guidance (as required by the EC).

PEF studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions.

The content of lead and antimony in the batteries used in UPS, and secondary the PWB components, are the most relevant contributors to the overall environmental profile out of the energy consumption in the use stage. Therefore, both energy efficiency of the UPS and production and recycling of batteries and PWBs are the most relevant aspects to control and influence from the producers of UPS.

The verification panel raised 19 pp of technical and editorial comments, which have all been addressed and solved by the TS. The review also identified some more generic challenges in developing PEFs and PEFCRs, which we hope can help improve the guidelines in the transition period of the EF project.

2.5. Geographic validity

This PEFCR is valid for products in scope sold/consumed in the European Union + EFTA.

Each PEF study shall identify its geographical validity listing all the countries where the product object of the PEF study is sold with the relative market share. In case the information on the market for the specific product object of the study is not available, Europe + EFTA shall be considered as the default market, with an equal market share for each country.

2.6. Language

The PEFCR is written in English. The original in English supersedes translated versions in case of conflicts.

2.7. Conformance to other documents

This PEFCR has been prepared in conformance with the following documents (in prevailing order):

- **PEFCR Guidance document**, Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 14 2017.
- **Product Environmental Footprint (PEF) Guide**; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, May 4 2013
- **ISO 14040:2006** Environmental management - Life cycle assessment - Principles and framework
- **ISO 14044:2006** Environmental management - Life cycle assessment - Requirements and guidelines
- **Product Category Rules (PCR) for Electrical, Electronic and HVAC-R Products**, PCR-ed3-EN-2015 04 02, PEP ecopassport®, April 2015

  The Technical Secretariat identified this existing PCR that was developed by PEP ecopassport® program and is currently being used by some members of the technical secretariat. PEP Ecopassport® program is an Environmental Product Declaration program operator with international scope. Its Product Category Rules core document is applicable to all equipment falling within the scope of the Program, UPS included.
- **Product Specific Rules (PSR) for Uninterruptible Power Supply (UPS)**, PSR-0010-ed1.1-EN-2015 10 16, PEP ecopassport®, October 2015

  The above-mentioned PCR is completed with specific rules for UPS (PSR). PSRs are specific additional rules to the general PCR rules, defined according to the diversity of equipment categories covered by the Program, among which the UPS product category belongs.

  Both PCR and UPS PSR documents can be downloaded using the following link:

  http://www.pep-ecopassport.org/create-a-pep/produce-a-lca/

  The analysis of those documents was carried out in order to check the similarities and differences in respect with the PEF methodologies and recommendations. The relevant methodological inputs from these existing PCR and PSR completed by the return on experiment of their application were considered during the study and the preparation of this PEFCR.

In addition, the Urban Mine Platform database determines the recycled content for some elements in composition of the batteries and International Electrotechnical Commission (IEC) standardisation guidelines are followed to provide the energy recovery and recyclability rates:

- **Urban Mine Platform**[3] Composition of batteries - elements per country
- **IEC/TR 62635** Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment

Finally, the scenario and assumptions set up to calculate the energy consumption of UPSs in the use stage were defined in conformance with the Energy Star® Program Requirements for Uninterruptible Power Supplies (UPSs):

- **ENERGY STAR® Program Requirements for UPSs**, Product Specification for Uninterruptible Power Supplies (UPSs), Eligibility Criteria Version 2.0, section 3.2 Energy Efficiency Requirements for Ac-output UPSs, 2017.

[3] http://www.urbanmineplatform.eu/composition/batteries/elements

3. PEFCR scope

3.1. Product classification

3.1.1. UPSs included in the PEFCR scope

The product category covered by this PEFCR is "Uninterruptible Power Supply" (UPS).

An **Uninterruptible Power Supply (UPS)** is a "combination of convertors, switches and energy storage devices (such as batteries) constituting a power system. (…) The primary function of the UPS is to ensure continuity of an a.c. power source. The UPS may also serve to improve the quality of the power source by keeping it within specified characteristics."[4] It acts as an interface between the power mains and the sensitive applications. A UPS supplies the load with continuous, high quality electrical power regardless the status of the mains.

Power distribution systems, both public and private, theoretically supply electrical equipment with a sinusoidal voltage of fixed amplitude and frequency (e.g. 400Vrms, 50Hz on low voltage systems). In real-life conditions however, utilities indicate the degree of fluctuation around the rated values. Because digital equipment (computers, telecom systems, instruments, etc.) use microprocessors that operate at frequencies of several mega or even gigahertz, i.e. they carry out millions or even billions of operations per second, a disturbance in the electrical supply lasting just a few milliseconds can affect thousands or millions of basic operations. This results for instance in malfunctions or loss of data with dangerous (e.g. airports, hospitals) or costly consequences (e.g. loss of production).

Intended use

The main use of a UPS is to ensure continuity of an a.c. power source (alternating current (Ac)-output UPSs). Depending on the architecture, the UPS may also serve to improve the quality of the power source by keeping it within specified characteristics. Even if the architecture of the UPSs may vary, the main function remains the same.

There are UPSs for private and professional use in different size ranges. Basically, all types of UPSs have the same components. However, they vary, for example, in size, topologies and life time.

UPS Topologies

Topologies are defined in relation with input dependency characteristic. Most common UPS topologies are stand-by UPSs (VFD), line interactive UPSs (VI) or online UPSs (VFI). Refer to 3.2.2 to see the detailed description.

PEFCR scope option

The scope is relatively narrow, there is a single main function, but alternative technologies/materials delivering the same function are available.

[4] Definition from IEC 62040-3:2011. 3.1.1

3.1.2. CPA codes

The Eurostat guidance indicates that the manufacture of UPS is covered by Prodcom class 27.90. A review of the codes for this class indicates there is no specific code associated with UPSs.

The most potentially appropriate CPA codes are covering electrical machines and apparatus, having individual functions.

The CPA codes for the products included in this PEFCR are:

- **27.90.11.50**: Machines with translation or dictionary functions, aerial amplifiers and other electrical machines and apparatus, having individual functions, not specified or included elsewhere in HS 852 (excluding sunbeds, sunlamps and similar sustaining equipment).

In addition, a review of other Prodcom codes suggests that UPSs may also potentially be covered by the following code:

- **27.11.50.40**: Power supply units for telecommunication apparatus, automatic data-processing machines and units thereof.

These definitions are very broad and include products other than UPSs. CPA codes do not help precisely identifying the products covered by this PEFCR.

There is a suitable and precise available classification in ecl@ss technical data standard[5] under no-break power supply group (27-06-06):

- 27-06-06-01 UPS on line (double conversion)
- 27-06-06-02 UPS off line (standby)
- 27-06-06-03 UPS line-interactive (main parallel)
- 27-06-06-90 no-break power supply (complete unspecified).

3.1.3. UPSs excluded from the PEFCR scope

The following UPSs are excluded from the scope of this PEFCR:

- Rotary UPSs as they don't rely on the same power conversion mechanism as static UPSs. These UPSs rely on a diesel engine (integrated or not) to supply power to the load during an input power failure.
- Direct Current (Dc)-output UPSs, also known as rectifiers, as they supply power with a continuous flow of electric charge that is unidirectional. A rectifier is a product that converts alternating current to direct current to supply a load and an energy storage mechanism. As such, this category of UPSs does not provide the same function as alternating current (Ac)-output UPSs in the scope of this PEFCR.
- UPSs with no backup time as it may be considered being a frequency converter (eg.)
- UPSs for special applications as they are designed for definite conditions, with unique specifications or requiring other technologies (e.g.):
    - UPSs exposed to extreme temperatures, excessive dust, moisture, vibration, flammable gasses, corrosive or explosive atmospheres
    - UPSs in vehicles, on board of ships or aircrafts, in tropical countries, in nuclear plants or at elevations higher than 1000m
    - UPSs in electrometrical applications with the UPS located within 1.5m of the patient contact

[5] ecl@ss is a product classification and description standard for information exchange between customers and their suppliers http://www.eclass.de/

- UPSs in systems classified as emergency power systems by an authority having jurisdiction.

3.2. Representative products

3.2.1. UPS size ranges based on apparent output power

There are different UPS size ranges. They are defined based on the apparent output specified in kW or W. In this PEFCR, the following 4 UPS size ranges from the ErP Lot 27[6] are used to set up 4 representative products:

- UPSs <1.5 kW
- UPSs ≥1.5 kW to 5.0 kW
- UPSs >5 kW to 10 kW
- UPSs >10 kW to 200 kW

There are also larger UPSs, i.e. bigger than 200 kW, but in most cases, they are made of several smaller ones. Detailed definitions of the 4 UPS representative products are provided in Annex 4: Description of the representative products.

The screening study is available upon request to the TS coordinator that has the responsibility of distributing it with an adequate disclaimer about its limitations.

3.2.2. UPS topologies or input dependency characteristics

Depending on the protection to apply and the characteristics (voltage or frequency or both) that are necessary to control, there are three different UPS topologies or input dependency characteristic:

- The **stand by topology** voltage and frequency depends from the main, it is also the maximum energy saving mode (VFD). The normal mode of operation consists on supplying the load from the company-specific power source.
- The **line interactive topology** allows the voltage independence (VI), during the normal mode of operation the load is supplied with conditioned AC input power at the input frequency.
- The **double conversion topology** provides the highest power conditioning (VFI), output voltage and frequency are independent from input conditions.

The representative UPSs cover the vast majority of sales (based on units), which are highest in the smaller UPS sizes.

Note: a representative product has not been selected for UPSs above 200 kW, as these are generally tailored and cannot be represented by a typical bill of materials.

Main topology	UPS size	EU-27 Sales (in Million units)	Market share (in %)
Standby (VFD)	**< 1.5 kW**	0,99	69,23
Line Interactive (VI)	**≥ 1.5 kW - 5 kW**	0,40	27,97
Double Conversion (VFI)	**≥ 5.1 kW - 10 kW**	0,03	2,10
Double Conversion (VFI)	**≥ 10.1 kW - 200 kW**	0,01	0,70
		1,43	**~ 100%**

Table 3. Sales repartition per UPS topology

[6] https://www.eup-network.de/fileadmin/user_upload/Lot-27-Consolidated-Final-Report.pdf

3.2.3. UPS components

UPSs generally contain the following components, whatever the size range:

- transformers (if incorporated inside the UPS)
- electrolytic capacitors (if incorporated inside the UPS)
- semi-conductors: IGBT / THYRISTOR, etc.
- circuit boards
- housing
- fans and / or cooling systems
- switches
- relays
- circuit breaker
- lead-acid battery, if included inside the UPS (In some specific cases, other types of batteries are used.)
- wires

The Bill Of Materials (BOM) of each UPS representative product were derived from the ErP Lot 27 preparatory study and updated according to the Data Mining project[7] concerning the composition of lead-acid batteries.

3.3. Functional unit and reference flow

3.3.1. Functional unit

Although there are different UPS size ranges only one unit of analysis was defined, as UPS commonly share the same function, application and technology.

Based on the definition of the representative products (see chapters 3.1 and 3.1.3) the functional unit was defined as follows:

To ensure the supply of power without interruption to equipment with load of 100 watts for a period of 1 year, including a backup time capacity of 5 minutes during power shortages.

Table 4 defines the key aspects used to define the functional unit.

The function(s) / service(s) provided: "**what**"	to ensure power supply to equipment
The magnitude of the function or service: "**how much**"	100 W supply to the equipment for 5 minutes *5 minutes is the most frequent UPS backup time for small and large UPSs.*
The amount of service provided over the life time: "**how long/ how often**"	1 year

[7] Source: http://www.urbanmineplatform.eu/composition/batteries/elements

The expected level of quality: "**how well**"	without interruption

Table 4. Key aspects used to define the functional unit

3.3.2. Reference flow

The reference flow (Rf) is the amount of product needed to fulfil the defined function and shall be measured in kg of UPS per 100W over 1 year of its service life (kg UPS/100W/y).

The product Life Cycle Inventory shall be firstly done for the product full lifecycle, including all flows and processes necessary to fulfil the product lifecycle.

To obtain the reference flow, the Life Cycle Inventory shall be divided by the "fraction of UPS" factor. This factor is dimensionless and is defined using the following formula:

$$fraction\ of\ UPS = \frac{1\ (year)}{PO\ (W) \times L\ (years)} \times 100\ (W)$$

Where:

- PO = output power of UPS in watts
- L = life time of UPS in years

Formula 1: "Fraction of UPS" factor for the calculation of the reference flow

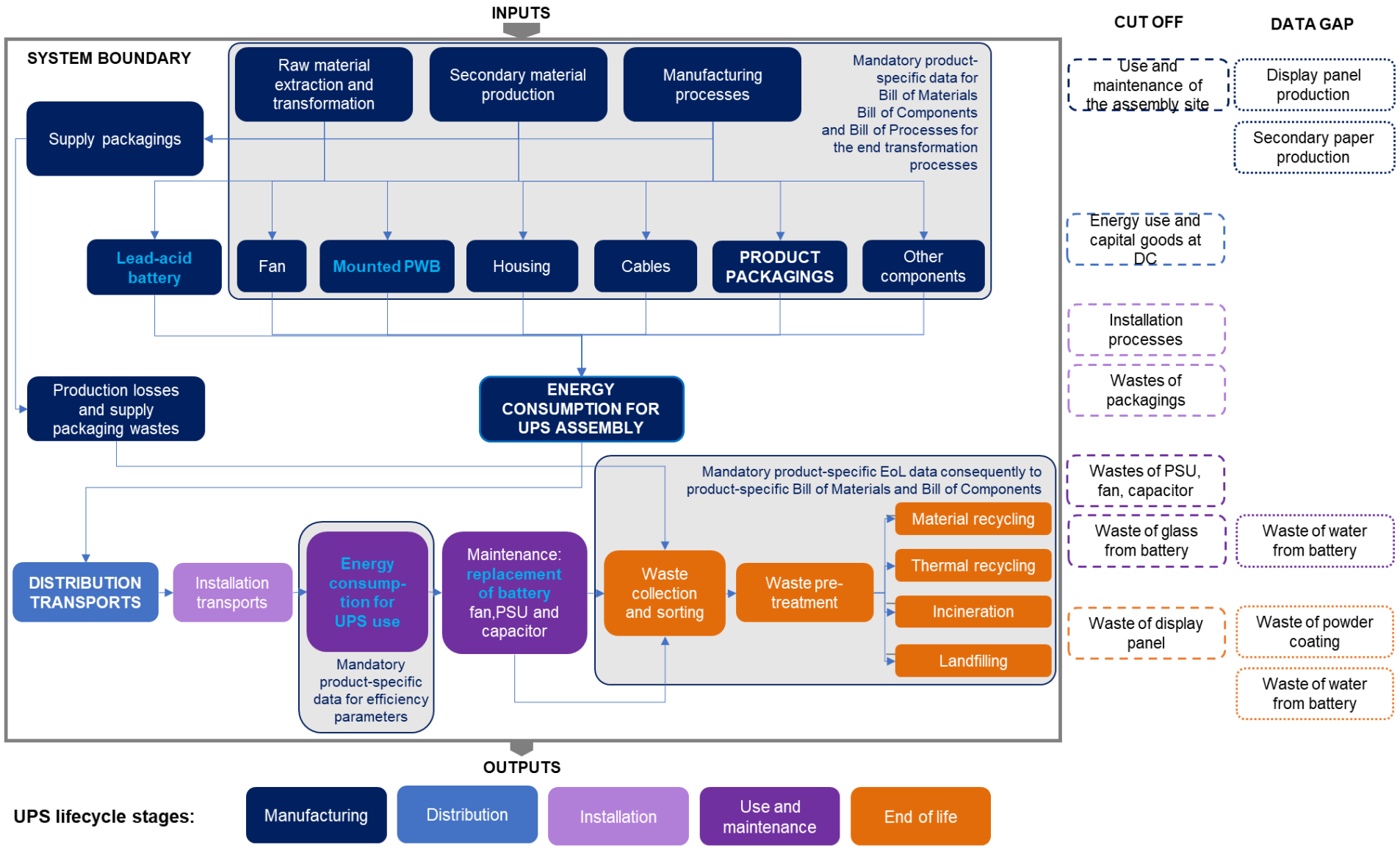
How to use in practice this dimensionless factor:

The results of the lifecycle impact assessment (LCIA) of the Product Life Cycle Inventory done according to section 5 and 6 of this PEFCR shall be multiplied by the "fraction of UPS" factor.

3.4. System boundary

3.4.1. Life-cycle stages

The system boundaries are defined based on the cradle-to-grave principle. It includes all the life cycle stages of the UPS from raw material acquisition through processing, production, distribution, installation, use and end of life of decommissioned UPS as shown in the below system diagram. The processes that are cut off are described section 0 and remaining data gaps are described section 5.3.



Notes: Processes in bold capital letters are processes expected to be run by the Applicant;
Processes in blue bold are the most relevant of UPS' lifecycle

Figure 3: UPS system diagram, cut off and remaining data gaps

The following life cycle stages and processes described in Table 5 shall be included in the system boundary (processes in capital letters shall be product-specific as defined section 5.1). The following chapters provide more details on the lifecycle stages' boundaries.

Life cycle stage	Short description of the processes included
• Manufacturing	• Raw material acquisition and pre-processing • Production of the main product: MANUFACTURING OF THE PARTS AND COMPONENTS and end of life treatment of the production losses • Electricity consumption for the UPS assembly • Production of the packaging of the product and supplies • Transport of the parts and components to the assembly site • Transport of the final product to the last distribution centre of the manufacturer
• Distribution	• Transport of the final product from the distribution centre to the end user
• Installation	• Transport of a technician installing the UPS

• Use and maintenance	• ENERGY CONSUMPTION DURING THE LIFE TIME OF THE PRODUCT
	• Maintenance:
	  • Replacement of parts – manufacturing and delivery to the site of use of PSU, capacitor, fan, battery
	  • Waste collection and treatment of replaced battery (lead and antimony)

• End of Life	• Transport of decommissioned UPS to waste treatment facilities • TREATMENT OF WASTE AT FACILITIES DEPENDING ON PRODUCT COMPOSITION (including product recovery and recycling)

Table 5. Life cycle stages

Disclaimer to the applicant:

The "manufacturing" stage is the aggregation of the "raw material acquisition and pre-processing" stage with the "production" stage. This aggregation is a deviation from the PEFCR Guidance v6.3 requirements. This deviation has been motivated by the following:

- **The "raw material acquisition and pre-processing" and "production" stages have variable boundaries depending on UPS manufacturers. The only process that can strictly be affected to production stage is "energy consumption for UPS assembly" and contributes to a very negligible extent to UPS lifecycle impact**
- **In addition, electric and electronic (E&E) related components such as batteries or mounted PWBs are supplied as "intermediate" products from third-tier suppliers with a "cradle to gate" boundary. To facilitate consistency between the different UPS manufacturers' practices, the consistency of materials and E&E related components LCI boundaries, the aggregated "manufacturing" stage approach has been favored.**
- **The PEFCR complies with other documents (refer to 2.7) including the PEP ecopassport® PCR that already chose this manufacturing stage aggregation option and is already applied by the UPS manufacturers involved in the development of this PEFCR. Aligning the PCR and PEFCR system boundaries aims at fostering the PEFCR potentials in the context of Environmental Product Declarations.**

3.4.1.1. Raw material acquisition, pre-processing and production stage

Upstream processes consist of the pre-processing of the raw material constituting the parts and components and the manufacturing and packaging of these parts and components.

The parts and components are then sent to the assembly location of the manufacturer.

UPS manufacturers design the equipment and proceed with its assembly.

The supply chain of electrical and electronic equipment such as UPS can involve several hundreds of suppliers and manufacturing locations (all tiers included). Some intermediate brokers of materials and components are usually involved. This multi stakeholders' chain reduces the likelihood of obtaining a complete mapping of the full supply chain. UPS manufacturers usually buy components that are not customised, but on the basis of their technical specifications, standard and regulatory conformance.

The following diagram gives an overview of the organisation of the UPS supply chain:

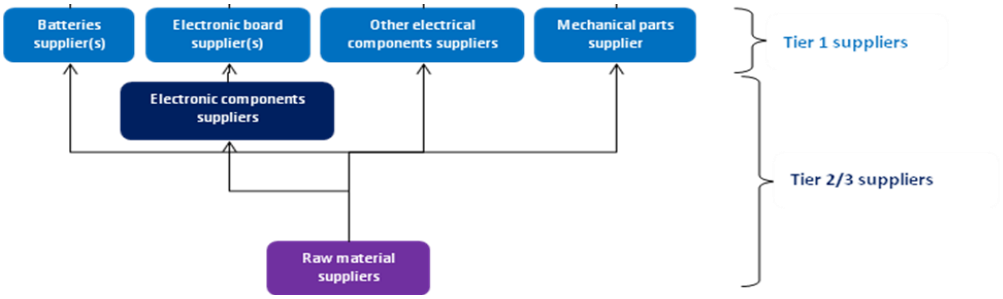


Figure 4: Overview of the supply chain of a UPS

Figure below gives an example of the supply chain of a semiconductor used in a logic circuit board of a UPS. This graphic shows that only one component has multiple processes and components, adding to the complexity of the UPS's supply chain.

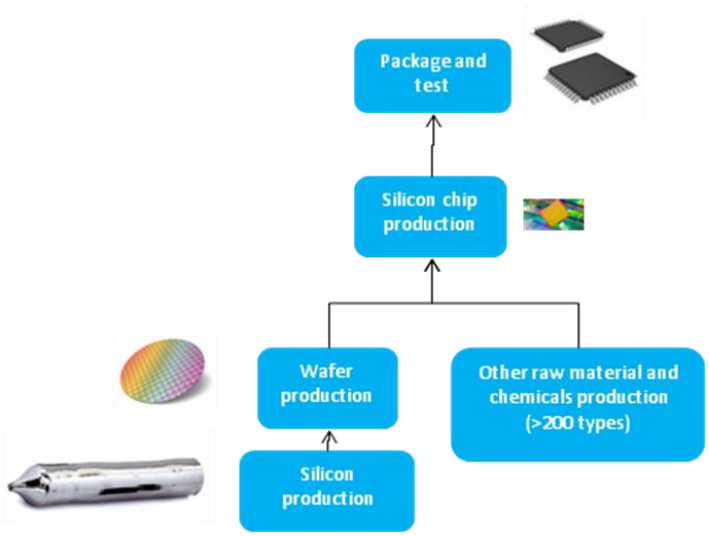


Figure 5: Overview of the supply chain of one component in composition of the UPS

The inputs and outputs related to the following aspects are included in the raw material acquisition, pre-processing and production stage:

- Production of the materials and components making up the reference product and assembly:
  - Production (extraction, pre-processing, transformation, etc.) and transportation of raw materials necessary to manufacture the parts and components, including the flows associated with the waste and discarded materials generated by the manufacturing processes.
  - Industrial transforming and manufacturing processes of the various parts (cable compounding, plastics injection or moulding…), components and sub-assemblies.
  - Transportation of materials, components and subassemblies from the supplier's production site to the assembly site(s).
  - Collection and treatment of the waste.
- Production (extraction, treatment, transformation, etc.) of packaging raw materials and transportation of the packaging from its manufacturing site to the product packaging site.

Packaging shall include the reference product packaging and the product manuals and labels, where applicable.

- Energy consumption for the product assembly process.
- Collection from the assembly site and treatment of production wastes at the waste treatment facilities.
- Transportation of the packaged product from the assembly site to the manufacturer's last logistics platform.

3.4.1.2. Distribution stage

The inputs and outputs associated with the following aspects are included in the distribution stage:

- Transportation of the product in its packaging from the manufacturer's last logistics platform to the distributor and from the distributor to the installation place.
- Where appropriate, production, procurement and transportation of reconditioning packaging materials:
  - Production (extraction, treatment, transformation, etc.) of raw materials and procurement of the reconditioning packaging,
  - Transportation of the reconditioning packaging from the point of reconditioning to the place of use.

3.4.1.3. Installation stage

The installation stage includes the transport of a technician on the installation site.

3.4.1.4. Use stage

The use stage of the reference product shall consider product operation under normal conditions of use as defined in this PEFCR section 6.4.
The inputs and outputs associated with the following aspects are included in the use stage:

- Energy consumption of the product during its use over its lifetime.
- Production, distribution, installation and end-of-life of elements required to operate, service and maintain the reference product over its lifetime.

3.4.1.5. End of life stage

The inputs and outputs associated with the following aspects are included in the end-of-life stage:

- Required transportation to collect the decommissioned product and transport from the installation site to the waste treatment facilities.
- Treatment processes, including depollution treatment of items (for example items covered by WEEE Directive 2012/19/EU) to be sent to special end-of-life product treatment centres, up to final treatment.

3.4.2. Cut offs

According to this PEFCR, the following processes shall be excluded based on the cut-off rule[8]:

- Manufacturing stage:
  - Capital goods
  - Energy consumptions for the use and maintenance of the assembly site
- Distribution stage:
  - Energy use and capital goods for the storage at the Distribution Centre (DC)
- Installation stage:
  - Installation processes
  - Collection and treatment of installation wastes (product packagings)
- Use and maintenance stage:
  - Waste treatment of decommissioned fans, capacitors and PSUs[9]
  - Waste treatment of glass from decommissioned lead-acid batteries
  - Production, transport and end of life of replacing component packaging

In addition, the exclusion of Waste treatment of display panel (LCD) from the system boundary ensures there is no artificial credits due to the recycling of the LCD while its production is not accounted for at the manufacturing stage (data gap listed section 5.3)

Each PEF study done in accordance with this PEFCR shall provide in the PEF study a diagram indicating the organizational boundary, to highlight those activities under the control of the organization and those falling into Situation 1, 2 or 3 of the data need matrix.

The PEF report shall document the exclusions.

3.5. EF impact assessment

Each PEF study carried out in compliance with this PEFCR shall calculate the PEF-profile including all PEF impact categories listed in the Table 6 below.

Impact category	Indicator	Unit	Recommended default LCIA method
Climate change	***Radiative forcing as Global Warming Potential (GWP100)***	***kg $CO_{2\ eq}$***	***Baseline model of 100 years of the IPCC (based on IPCC 2013)***
~~- Climate change – biogenic~~*			
~~- Climate change – land use and land transformation~~*			
Ozone depletion	*Ozone Depletion Potential*	*kg CFC-11 $_{eq}$*	*Steady-state ODPs 1999 as in WMO*

[8] In compliance with PEF Guidance 6.3 (2017): « In case processes are excluded from the model this shall be done based on a 1% cut-off for all impact categories based on environmental significance, additionally to the cut-off already included in the background datasets." Cut offs are defined based on the results of the screening study and confirmed by the supporting study results and the representative product results.

[9] The EoL of fan, PSU and capacitor are cut off from the Use stage but not from the EoL stage. Example is provided for more transparency to the applicant to justify this difference in treatment: fan EoL contributes in different proportions to the lifecycle stages. For example, it contributes to 0,12% of the Climate Change indicator at the EoL stage but to only 0,015% at the use stage. Cutting off the EoL of fan at the Use stage simplifies the modelling while the assessment quality remains constant.

Impact category	Indicator	Unit	Recommended default LCIA method
	(ODP)		*assessment*
*Human toxicity, cancer***	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model (Rosenbaum et al, 2008)*
*Human toxicity, non-cancer***	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model (Rosenbaum et al, 2008)*
Particulate matter	*Impact on human health*	*disease incidence*	*UNEP recommended model (Fantke et al 2016)*
Ionising radiation, human health	*Human exposure efficiency relative to U^{235}*	*kBq U^{235} eq*	*Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)*
Photochemical ozone formation, human health	*Tropospheric ozone concentration increase*	*kg NMVOC eq*	*LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe*
Acidification	*Accumulated Exceedance (AE)*	*mol H+ eq*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, terrestrial	*Accumulated Exceedance (AE)*	*mol N eq*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, freshwater	*Fraction of nutrients reaching freshwater end compartment (P)*	*kg P eq*	*EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe*
Eutrophication, marine	*Fraction of nutrients reaching marine end compartment (N)*	*kg N eq*	*EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe*
*Ecotoxicity, freshwater***	*Comparative Toxic Unit for ecosystems (CTU_e)*	*CTUe*	*USEtox model, (Rosenbaum et al, 2008)*
Land use	• *Soil quality index*[10] • *Biotic production* • *Erosion resistance* • *Mechanical filtration* • *Groundwater replenishment*	• *Dimensionless (pt)* • *kg biotic production*[11] • *kg soil* • *m^3 water* • *m3 groundwater*	• *Soil quality index based on LANCA (EC-JRC)*[12] • *LANCA (Beck et al. 2010)* • *LANCA (Beck et al. 2010)* • *LANCA (Beck et al. 2010)* • *LANCA (Beck et al. 2010)*
*Water use****	*User deprivation potential (deprivation-weighted water consumption)*	*m^3 world eq*	*Available WAter REmaining (AWARE) Boulay et al., 2016*
Resource use, minerals and metals	***Abiotic resource depletion (ADP ultimate reserves)***	***kg Sb eq***	***CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.***
Resource use, fossils	***Abiotic resource depletion – fossil fuels (ADP-fossil)***	***MJ***	***CML 2002 (Guinée et al., 2002) and van Oers et al. 2002***

* Refer to section 4.1 Most relevant impact categories of this PEFCR.

** Long-term emissions (occurring beyond 100 years) shall be excluded from the toxic impact categories. Toxicity emissions to this sub-compartment have a characterisation factor set to 0 in the EF LCIA (to ensure consistency). If included by the applicant in the LCI modelling, the sub-compartment 'unspecified (long-term)' shall be used.

*** The results for water use shall be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR include inconsistencies in the regionalization and elementary flow implementations. This problem has nothing to do with the impact assessment method or the implementability of EF methods. It is due to technical mistakes that occurred when developing some of the datasets. The PEFCR remains valid and usable. The affected EF datasets will be corrected by mid-2019. At that time, it will be possible to review this PEFCR accordingly, if seen necessary.

Table 6. List of the impact categories to be used to calculate the PEF profile

[10] This index is the result of the aggregation, performed by JRC, of the 4 indicators provided by LANCA model as indicators for land use

[11] This refers to occupation. In case of transformation the LANCA indicators are without the year (a)

[12] Forthcoming document on the update of the recommended Impact Assessment methods and factors for the EF

The full lists of normalization factors and weighting factors are available in Annex 1: List of EF normalisation factors and weighting factors. The full list of characterization factors (EC-JRC, 2017a) is available at this link: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml.

3.6. Limitations

PEFCR limitations:

- Due to lack of data on the recycled content of antimony and lead in the UPS lead-acid batteries, assumptions were made to reflect the average content in the battery market in 2016 and 2017 (source: Data Mining, 2018). In addition, other battery technologies are possibly replacing the lead-acid batteries. This could not be studied in this PEFCR. However, battery production and primary content of antimony in batteries contributing from 71% to 86% of the overall representative UPSs results (weighted and normalized, excluding use and maintenance stages) depending on the sub-category of UPS, it is highly recommended to the applicant to choose the most representative dataset for the production of the UPS batteries, in terms of technology and antimony and lead recycled content when applicable, as mentioned in sections 5.3, 6.1.2 and 6.4.3.2.
- The production of electronic components and batteries is complex and requires the use of secondary data despite their significant contribution to some of the life cycle impacts. This PEFCR is listing default datasets that shall be used, complemented with the datasets available in the EF nodes, but may be limited when the bill of components highly differs from the ones used for the UPS representative products. The applicant may need to refer to other databases, provided the requirements set in section 0 are followed.

  Therefore, we acknowledge that the results of the PEF study may vary according to the datasets used for electronic components and different battery technologies, when these differ from default components and technologies used in this PEFCR.
- UPSs are very complex products:
  - hundreds of materials enter in its composition, especially due to the electronic components of the product
  - the exact quantity of ores in electronic components is barely known: UPS manufacturers buy components to tier 2-3 suppliers and the pre-processing steps before the assembly are not ruled over by the UPS manufacturers
  - the end of life treatments of the product parts highly depends on the application and product design, this not being reflected in the CFF formula

  As a consequence, the “manual” application of the Circular Footprint Formula (CFF) to each of the UPS sub-systems, components and materials at their end of life is not recommended, in particular for the electronic aspects of the product:
  - it is hardly applicable as no default values for the R1, R2 and A parameters of the formula are available for raw materials embedded into components
  - it can lead to numerous deviations from the reality in the accounting
  - it always leads to artificial increase or decrease of the effect to the environment of the product end of life and generates additional uncertainties

  This limitation shall be compensated by strictly using EF and CFF compliant datasets for UPS Electronic Waste treatment and processes provided in the available EF nodes or selected in reference to section 0 on the selection of datasets.

Representative UPSs limitations:

- The manufacturing stage of the representative UPSs has been modelled using an average populated printed wiring board (populated PWB 2 layers). This assumption revealed that populated PWB is part of the most relevant processes of UPSs lifecycle (contribution of populated PWB production to the UPS lifecycle excluding the use stage reaches 30% of the climate change indicator for the "≥1.5 kW to 5 kW" sub-category). It is advisable to the applicant to model specific electronic components to improve the representativeness of the assessment.
- The transports at the manufacturing stage for the representative UPS <10 kW to 200 kW, from factory to DC, has been modelled using the assumption that the factory was based in Europe and not in Asia, using default assumptions from PEFCR Guidance 6.2. This was accepted as the change does not have consequences on the conclusions and slightly limits the comparability of PEF results with the benchmark.
- The maintenance stage in the representative products for the 3 UPS categories above 1.5 kW contains additional burdens due to the double counting of Polypropylene recycling (from lead-acid battery waste treatment). This is resulting in very negligible increase in the representative product impacts results and has no influence on the comparability with the PEFCR application results.
- The following datasets are EF-compliant proxies that have been used for the remodelling of the representative UPSs (refer to section 6 for the references to the datasets):
    - End of life process of Antimony from decommissioned batteries at the Use and End of Life stages of UPSs: it was assumed to be equally processed to lead at the end of life of lead-acid batteries, due to same processing routes and techniques.
    - EU-28:Steel cold rolled coil (UUID: cfe8972e-6b51-4a17-b499-d78477fa4294) is used as a proxy to model Stainless 18/8 coil
    - EU data instead of GLO data for all primary material productions

  These datasets are included in the list of default processes and are part of the limitations of this PEFCR.
- Some datasets are used as proxies (ILCD entry-level compliant) within the calculations of the representative UPSs (refer to section 6 for the references to the datasets and section 5.3 on data gaps).

In PEF studies, limitations to carrying out the analysis may arise and therefore assumptions need to be made. For example, the use of some datasets may not completely represent the reality of the product analysed and may be adapted for better representativeness.

Requirements formulated in this PEFCR shall be followed. Any limitation, deviation and assumption shall be transparently documented and justified in the PEF report.

4. Most relevant impact categories, life cycle stages, processes and elementary flows

The identification of the most relevant impact categories, life cycle stages, processes and elementary flows is based on the remodelling of the 4 representative UPSs.

4.1. Most relevant impact categories

The most relevant impact categories are the ones that cumulatively contribute to 80% or more of the total environmental impact (excluding toxicity related impact categories).

The most relevant impact categories for the sub-categories of UPSs in scope of this PEFCR are the following (highlighted in blue):

Impact category (excl. toxicity categories)	Contribution to the lifecycle impact			
	<1.5 kW	≥1.5 kW to 5 kW	>5 kW to 10 kW	>10 kW to 200 kW
Acidification terrestrial and freshwater	3,98%	3,81%	3,47%	3,17%
Climate Change	30,21%	28,36%	26,32%	24,35%
Eutrophication freshwater	0,03%	0,03%	0,03%	0,02%
Eutrophication marine	0,72%	0,69%	0,62%	0,57%
Eutrophication terrestrial	1,48%	1,40%	1,28%	1,17%
Ionising radiation - human health	5,45%	5,11%	4,77%	4,45%
Land Use	0,50%	0,45%	0,42%	0,39%
Ozone depletion	0,00%	0,00%	0,00%	0,00%
Photochemical ozone formation - human health	2,25%	2,14%	1,95%	1,77%
Resource use, energy carriers	24,65%	23,08%	21,45%	19,89%
Resource use, mineral and metals	24,32%	28,84%	34,13%	39,09%
Respiratory inorganics	5,24%	5,00%	4,60%	4,25%
Water scarcity	1,16%	1,09%	0,96%	0,86%
Total contribution from relevant impacts	84,63%	80,28%	81,91%	83,34%

Table 7. Most relevant impact categories per sub-categories of UPSs

Three of the most relevant impact categories are the same for the 4 product subcategories: Climate change, Resource use energy carriers and Resource use minerals and metals.

In addition, the analysis of the smallest category of UPS (<1.5 kW) reveals that the Ionising radiation indicator is also one of the most significant impact categories.

Climate change is identified as a most-relevant impact category. However, the sub-indicators 'Climate change - biogenic' and 'Climate change - land use and land transformation' shall not be reported separately as their contribution to the total climate change indicator, based on the representative UPSs' remodelling results (refer to 7.1), is less than 5% each.

4.2. Most relevant life cycle stages

The most relevant life cycle stages are the life cycle stages which together contribute to at least 80% of any of the most relevant impact categories identified. As the use stage accounts for more than 50% of the total impact, then the procedure is re-run by excluding the use stage.

The most relevant life cycle stages for the sub-categories of UPSs in scope of this PEFCR are the following:

Impact category	**Most relevant lifecycle stages for UPS <1.5 kW**			
	Including use stage		**Excluding use stage**	
Climate Change	Use and maintenance	95%	Manufacturing	85%
Resource use, energy carriers	Use and maintenance	95%	Manufacturing	83%
Resource use, mineral and metals	Manufacturing	55%		
	End of Life	45%		
Impact category	**Most relevant lifecycle stages for UPS ≥1.5 kW to 5 kW**			
	Including use stage		**Excluding use stage**	
Climate Change	Use and maintenance	98%	Manufacturing	81%
Resource use, energy carriers	Use and maintenance	99%	Manufacturing	79%
			End of Life	19%
Resource use, mineral and metals	End of Life	37%		
	Manufacturing	47%		
Impact category	**Most relevant lifecycle stages for UPS >5 kW to 10 kW**			
	Including use stage		**Excluding use stage**	
Climate Change	Use and maintenance	96%	Manufacturing	85%
Resource use, energy carriers	Use and maintenance	97%	Manufacturing	85%
Resource use, mineral and metals	End of Life	44%		
	Manufacturing	55%		
Impact category	**Most relevant lifecycle stages for UPS >10 kW to 200 kW**			
	Including use stage		**Excluding use stage**	
Climate Change	Use and maintenance	98%	Manufacturing	81%
Resource use, energy carriers	Use and maintenance	99%	Manufacturing	79%
			End of Life	19%
Resource use, mineral and metals	End of Life	37%		
	Use and maintenance	47%		

Table 8. Most relevant life cycle stages for the sub-categories of UPSs

The most relevant life cycle stages are the Use and maintenance, end of life and manufacturing stages, whatever the most relevant impact category and for the 4 representative UPSs.

4.3. Most relevant processes

The most relevant processes are those that collectively contribute to at least 80% of any of the most relevant impact categories identified.

The most relevant processes for the sub-categories of UPSs in scope of this PEFCR are the following:

Impact category	Most relevant processes for UPS <1.5 kW					
	Including use stage			Excluding use stage		
Ionising radiation - human health	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	99,20%	End of Life	EU-28+3: Aluminium ingot	8,62%
					EU-28+EFTA: Recycling of steel into steel scrap	2,82%
					EU-28+EFTA: Lead (primary)	4,23%
				Manufacturing	EU-28+3: Aluminium ingot mix	17,09%
					Lead acid battery UPS 1.5 kVA based on Ecodesign BOM <LC>	12,80%
					EU-28+EFTA: Injection moulding	10,18%
					World: Populated Printed wiring board (PWB) (2-layer)	7,22%
					EU-28+EFTA: Acrylonitrile Butadiene Styrene (ABS)	6,20%
					EU-28+EFTA: Carton board	5,15%
					EU-28+3: Electricity grid mix 1kV-60kV	4,77%
					EU-28+EFTA: Cast iron	3,18%
Climate Change	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	94,65%	End of Life	EU-28+EFTA: Steel cold rolled coil	4,92%
					GLO: Copper Concentrate (Mining, mix technologies)	3,68%
					EU-28+EFTA: Lead (primary)	2,89%
				Manufacturing	World: Populated Printed wiring board (PWB) (2-layer)	17,65%
					Lead acid battery UPS <1.5 kW	11,33%
					EU-28+EFTA: Acrylonitrile Butadiene Styrene (ABS)	8,91%
					EU-28+EFTA: Steel tinplated	6,29%
					World: Steel external plug	5,04%
					GLO: Transoceanic ship, containers	4,52%
					GLO: Copper Concentrate (Mining, mix technologies)	4,42%
					EU-28+EFTA: EPS Beads	4,23%
					EU-28+3: Aluminium ingot mix (high purity)	4,10%
					EU-28+EFTA: Carton board	3,37%
Resource use, energy carriers	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	95,21%	End of Life	GLO: Copper Concentrate (Mining, mix technologies)	2,99%
					EU-28+EFTA: Steel cold rolled coil	2,83%
					EU-28+EFTA: Lead (primary)	2,46%
				Manufacturing	EU-28+EFTA: Acrylonitrile Butadiene Styrene (ABS)	15,68%
					World: Populated Printed wiring board (PWB) (2-layer)	13,08%
					Lead acid battery UPS <1.5 kW	12,35%

				EU-28+EFTA: EPS Beads	9,16%
				World: Steel external plug	5,08%
				EU-28+3: Aluminium ingot mix (high purity)	4,07%
				EU-28+EFTA: Steel tinplated	3,67%
				GLO: Transoceanic ship, containers	3,55%
				EU-28+EFTA: Carton board	3,46%
				GLO: Copper Concentrate (Mining, mix technologies)	3,31%
Resource use, mineral and metals	Manufacturing	Lead acid battery UPS <1.5 kW	51,76%		
	End of Life	CN: Antimony	42,59%		

Table 9. Most relevant processes for UPS <1.5 kW

Impact category	Most relevant processes for UPS ≥1.5 kW to 5 kW					
	Including use stage			Excluding use stage		
Climate Change	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	94,54%	End of Life	EU-28+EFTA: Steel cold rolled coil	8,96%
					EU-28+EFTA: Lead (primary)	3,76%
					EU-28+3: Aluminium ingot	2,89%
					EU-28+EFTA: Recycling of steel into steel scrap	1,36%
					EU-28+EFTA: End of life of Capacitor, electrolyte	1,14%
					EU-28+EFTA: Copper billet/slab (smelting and refining to produce primary copper cathode)	0,88%
				Manufacturing	World: Populated Printed wiring board (PWB) (2-layer)	28,61%
					Lead acid battery UPS 1.5-5 kVA	12,26%
					EU-28+EFTA: Steel tinplated	9,61%
					EU-28+3: Aluminium ingot mix (high purity)	5,53%
					GLO: Transoceanic ship, containers	4,00%
					GLO: Copper Concentrate (Mining, mix technologies)	1,67%
Resource use, energy carriers	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	95,81%	End of Life	EU-28+EFTA: Steel cold rolled coil	5,95%
					EU-28+EFTA: Lead (primary)	3,83%
					EU-28+3: Aluminium ingot	3,40%
					GLO: Copper Concentrate (Mining, mix technologies)	1,91%
					EU-28+EFTA: Recycling of steel into steel scrap	1,51%
				Manufacturing	World: Populated Printed wiring board (PWB) (2-layer)	25,41%
					Lead acid battery UPS 1.5-5 kVA	16,75%
					EU-28+EFTA: Steel tinplated	8,01%
					EU-28+3: Aluminium ingot mix (high purity)	6,58%
					GLO: Transoceanic ship, containers	4,08%
					EU-28+EFTA: Acrylonitrile Butadiene Styrene (ABS)	2,03%
					EU-28+EFTA: Plastic bag, LDPE	2,01%

Resource use, mineral and metals	Manufacturing	Lead acid battery UPS 1.5-5 kVA	26,76%
	Use and maintenance	Lead acid battery UPS 1.5-5 kVA	26,76%
		CN: Antimony	21,99%
	End of Life	CN: Antimony	21,99%

Table 10. Most relevant processes for UPS ≥1.5 kW to 5 kW

Impact category	Most relevant processes for UPS >5 kW to 10 kW					
	Including use stage			Excluding use stage		
Climate Change	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	94,86%	End of Life	EU-28+EFTA: Steel cold rolled coil	8,47%
				Manufacturing	World: Populated Printed wiring board (PWB) (2-layer)	27,10%
					EU-28+3: Electricity grid mix 1kV-60kV	18,79%
					Lead acid battery UPS 5.1-10 kVA	14,19%
					EU-28+EFTA: Steel tinplated	10,34%
					EU-28+3: Aluminium ingot mix (high purity)	5,45%
Resource use, energy carriers	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	95,74%	End of Life	EU-28+EFTA: Steel cold rolled coil	5,12%
					EU-28+EFTA: Lead (primary)	3,24%
				Manufacturing	EU-28+3: Electricity grid mix 1kV-60kV	23,23%
					World: Populated Printed wiring board (PWB) (2-layer)	21,10%
					Lead acid battery UPS >5-10 kW	16,26%
					EU-28+EFTA: Steel tinplated	6,63%
					EU-28+3: Aluminium ingot mix (high purity)	5,68%
Resource use, mineral and metals	Manufacturing	Lead acid battery UPS 5.1-10 kVA	25,96%			
	Use and maintenance	Lead acid battery UPS 5.1-10 kVA	25,96%			
		CN: Antimony	20,80%			
	End of Life	CN: Antimony	20,80%			

Table 11. Most relevant processes for UPS >5 kW to 10 kW

Impact category	Most relevant processes for UPS >10 kW to 200 kW					
	Including use stage			Excluding use stage		
Climate Change	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	96,44%	End of Life	EU-28+EFTA: Lead (primary)	5,31%
					EU-28+EFTA: Steel cold rolled coil	5,15%
					EU-28+3: Aluminium ingot mix (high purity)	2,97%
				Manufacturing	Lead acid battery UPS 10.1 - 200 kVA	20,78%
					World: Populated Printed wiring board (PWB) (2-layer)	15,30%
					EU-28+EFTA: Steel tinplated	10,54%
					GLO: Copper Concentrate (Mining, mix technologies)	8,29%
					EU-28+3: Aluminium ingot mix	5,67%

					(high purity)	
					GLO: Transoceanic ship, containers	5,06%
					EU-28+EFTA: Copper billet/slab (smelting and refining to produce primary copper cathode)	3,80%
Resource use, energy carriers	Use and maintenance	EU-28+3: Electricity grid mix 1kV-60kV	96,16%	End of Life	EU-28+EFTA: Lead (primary)	5,11%
					EU-28+EFTA: Steel cold rolled coil	4,96%
					EU-28+3: Aluminium ingot	2,86%
					GLO: Copper Concentrate (Mining, mix technologies)	2,54%
				Manufacturing	Lead acid battery UPS >10 - 200 kW	21,04%
					World: Populated Printed wiring board (PWB) (2-layer)	15,49%
					EU-28+EFTA: Steel tinplated	10,16%
					GLO: Copper Concentrate (Mining, mix technologies)	7,99%
					EU-28+3: Aluminium ingot mix	5,46%
					GLO: Transoceanic ship, containers	4,88%
Resource use, mineral and metals	Manufacturing	Lead acid battery UPS 10.1 - 200 kVA	18,01%			
	Use and maintenance	Lead acid battery UPS 10.1 - 200 kVA	36,00%			
		CN: Antimony	29,62%			

Table 12. Most relevant processes for UPS >10 kW to 200 kW

As per the remodelling conclusions, the processes having the most contributing impact to the UPS lifecycle, whatever the range, are:

- the lead-acid battery production and primary antimony contained in the lead-acid batteries (needed both at the manufacturing and use stages),
- the manufacturing of the mounted printed wiring board
- and the energy consumption during the use of the product (process relevance to overall result, weighted and normalized, ranks between 95% and 99%).

5. Life cycle inventory

This section aims at providing the applicant with guidance and instructions on several aspects:

- Requirements concerning the collection of mandatory company-specific data (processes and direct elementary flows).
- The list of processes expected to be run by the applicant.
- Description of data gaps encountered and how to handle them.
- Description on the expectations for data collection criteria and quality (Data Need Matrix depending on both the level of control and knowledge of the information from the applicant).
- Description of the process to be applied to choose datasets that are not listed in the PEFCR.
- Description of the process to be applied to assess the average DQR of the study.
- Description of the process to allocate flows.
- Description of modelling requirements applicable to the PEFCR, concerning:
    - Electricity,
    - Climate change,
    - Circular footprint formula.

Disclaimer to the applicant:

All newly created processes shall be EF-compliant.

Sampling is not allowed.

5.1. List of mandatory company-specific data

Foreword:

Mandatory company-specific data has two consequences:

- Applicant may perform a PEF study by only searching for these data and using default data for everything outside this list, while
- Applicant who doesn't have company-specific data for ones listed cannot establish a PEFCR-compliant EF profile of the product in scope.

In addition:

- For each process for which company-specific data is mandatory the Applicant shall be using the secondary datasets listed in the "UPS PEFCR - Life Cycle Inventory.xlsx" Excel sheets referenced in of this section.
- For all other processes, the applicant shall apply the Data Needs Matrix as explained in section 5.5, ensuring that any process under the applicant control and relevant to the product lifecycle is primary.

All the criteria for the Data Quality Requirements – DQR (TiR, TeR, GR, and P) are detailed in section 5.4.

5.1.1. Data collection requirements for mandatory processes

The applicant shall collect product-specific information on the bill of materials and bill of components of the mounted printed wiring board. It shall also collect product-specific information on the raw material transformation processes (metal and plastics transforming and forming processes).

As a consequence to the above-mentioned statement, the materials and components in composition of the UPS that are treated at the end of life stage shall be product-specific as well.

The applicant shall collect product-specific information on the parameters for the calculation of the average energy consumption in the use stage, namely energy efficiencies and average output power. Product lifetime is the only parameter where the use of default value is required. Details of the energy consumption parameters are provided in section 6.4.2.

Process A: Manufacturing of the materials and electronic components in composition of the UPS

The details are described in an excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet named "5.1 Manufacturing-specific" for the list of all product-specific data to be collected. The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

An example of Process A is provided in the table below:

Requirements for data collection purposes			**Requirements for modelling purposes**								**Remarks**
Activity data to be collected	*Specific requirements*	*Unit of measure-ment*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	*TiR*	*TeR*	*GR*	*P*	*DQR*	
Acrylonitrile-butadiene-styrene part (ABS)		kg	EU-28+EFTA: Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE	http://lcdn.thinkstep.com/Node/	ec9ca75e-abdb-4d2e-9e18-ca1f5709a76d	2	3	3	2	2	Refer to note 1
		kg	EU-28+EFTA: Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	http://lcdn.thinkstep.com/Node/	6ac7e91c-ab83-4630-9900-a1707cfebed9	1	1	2	2	1	Refer to note 1

Note 1: There is no GLO data set for this process and the European Commission has made a decision to use the available EF compliant datasets

Table 13. Example of data collection requirements for mandatory process A

Process B: Average energy consumption for the use of the UPS

Major environmental aspect of the use stage of a UPS is due to the energy losses and consumption for the operation of the equipment. The average energy consumption shall be calculated as per the calculation method presented section 6.4.2 of this PEFCR.

The energy efficiencies and average output power parameters of this formula shall be company-specific as they are product-specific and are under the control of the UPS manufacturer.

The details are described in an excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet named "5.1 Use-specific". The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

Process B is described in the table below:

Requirements for data collection purposes			Requirements for modelling purposes								Remarks
Activity data to be collected	*Specific requirements*	*Unit of measure*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	*TiR*	*TeR*	*GR*	*P*	*DQR*	
AVERAGE ENERGY CONSUMPTION	Energy Efficiencies (Eff) are determined as specified in Annex J of IEC 62040-3:2011 Calculation of the average energy consumption during product lifetime shall be done in conformance with PEFCR §6.4.2	kWh	EU-28+3: Electricity grid mix 1kV-60kV AC, technology mix consumption mix, at consumer 1kV - 60kV	http://lcdn.thinkstep.com/Node/	af44062c-c968-4ed1-be3b-ef0c17934637	1	1	1	2	1,25	

Table 14. Data collection requirements for mandatory process B

Process C: End of life of the materials and electronic components in composition of the UPS

The details are described in an excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet named "5.1 EoL-specific" for the list of all product-specific data to be collected. The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

An example of Process C is provided in the table below:

Requirements for data collection purposes			Requirements for modelling purposes								Remarks
Activity data to be collected	*Specific requirements (scaling factor to calculate the quantity of material entering EoL process)*	*Unit of measurement*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	*TiR*	*TeR*	*GR*	*P*	*DQR*	
Steel EoL	(1-A) * R2	kg	EU-28+EFTA: Recycling of steel into steel scrap collection, transport, pretreatment, remelting production mix, at plant steel waste, efficiency 95%	http://lcdn.thinkstep.com/Node/	7bd54804-bcc4-4093-94e4-38e4facd4900	2	2	2	2	2	
	(1-B)*R3	kg	EU-28+EFTA: Waste incineration of ferro metals waste-to-energy plant with dry flue gas treatment, including transport and pre-treatment production mix, at consumer ferro metal waste	http://lcdn.thinkstep.com/Node/	2cbdc30b-e608-4fcf-a380-fdda30b1834e	2	1	1	1	2	
	(1-R2-R3)	kg	EU-28+EFTA: Landfill of inert (steel) landfill including leachate treatment and with transport without collection and pre-treatment production mix (region specific sites), at landfill site	http://lcdn.thinkstep.com/Node/	33d6d221-f91d-4a33-9b00-9fb1ea8cd3ca	2	2	2	2	2	
	-(1-A)*R2 *Qsout/Qp	kg	ROW: Steel cold rolled coil blast furnace route single route, at plant carbon steel	http://lcdn.thinkstep.com/Node/	f0c5f556-7f10-440b-a828-9b587f182773	2	2	3	3	2	

Table 15. Example of data collection requirements for mandatory process C

5.1.2. Direct elementary flow collection requirements

No direct elementary flow requires specific data collection by the Applicant.

5.2. List of processes expected to be run by the company

It is assumed that the following processes are expected to be run by the company applying the PEFCR (situation 1/option 2 of the DNM, refer to 5.5.1):

- Manufacturing of the primary, secondary and tertiary packaging of the product.
- Energy consumption for the UPS assembly.

  Data refers to the activities happening at the manufacturing sites owned by the manufacturer where parts for the UPS are produced plus the final assembly sites owned by the company.
- Transport of the product from the assembly site to the distribution centre.

These processes account for a small portion of the overall impact categories. As such, it falls into Situation 1/Option 2 of the DNM. As it is common within UPS manufacturers it may be the only processes in Situation 1.

Default datasets to be used for the considered processes are listed in the PEFCR section 6.1.2.

5.3. Data gaps

Mandatory company-specific data shall be collected in conformance with section 5.1. Data gap is not allowed for mandatory company-specific data.

Data gaps may be encountered when data used for the representative products are not applicable. These gaps shall be filled using the data hierarchy presented in paragraph 0.

For example, battery production datasets are not provided in this PEFCR for non lead-acid battery technologies:

- First option: the battery technology is covered by the “Battery” PEFCR. The dataset of the representative product for the technology shall be used.
- Second option: ILA and Eurobat are developing datasets that are not published at the time of the PEFCR publication date. The Applicant shall use the most representative dataset to the technology of the battery under the condition that the dataset is EF-compliant.
- Otherwise:
  - The applicant shall use another EF-compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitation" section of the PEF report.
  - The applicant shall use an ILCD-entry level-compliant dataset. In such case this information shall be included in the "data gap" section of the PEF report.

The following shall be applied unless more specific information is available. The use of more specific information shall be clearly justified in the PEF report.

- For some processes that are most relevant, ILCD entry-level compliant proxy dataset shall be used for PEF studies:
    - Lead-acid battery manufacturing
    - Antimony end of life

  These datasets are used as proxies within the calculations of the representative UPSs. However, the applicant of the PEFCR shall apply an EF compliant dataset if available (following the rules laid out section 5.6 on which dataset to use). If not available, the applicant shall in this case use the same proxy as used for the calculation of the representative UPSs.
- For some processes that are NOT most relevant, ILCD entry-level compliant proxy dataset shall be used for PEF studies. This is the case for:
    - Fan production (UUID: 2130D1E9-CE0A-4815-A796-18AFF8EE6AC7)
    - Secondary plastic production used in the place of plastic recycling: When no specific recycling process and no EF-compliant recycling process exists for a given plastic, the recycling of materials shall be approximated by the use of secondary plastic production (unspecified) process (UUID: 3b801715-5e3f-426f-8b24-a84dbd4f3165; node: http://lcdn.thinkstep.com/Node/) and a correction of the output with Qs/Qp ratio applied to the production of primary plastic.

      An example is provided section 5.11.2.

  However, the applicant of the PEFCR shall apply an EF compliant dataset if available (following the rules laid out in section 0 on which dataset to use). If not available, the applicant shall use the same proxy as used for the calculation of the representative UPSs.

In this PEFCR, the following data gaps remain for some processes where no EF-compliant or ILCD entry-level compliant proxy dataset were found:

- Manufacturing stage:
    - Material extraction and production of the LCD module
    - Production of secondary paper
- Use and Maintenance stage:
    - Waste treatment of water from decommissioned lead-acid battery
    - Transports for the collection of recycled plastics where no specific EF compliant recycling dataset exists
- End of life stage
    - Waste treatment of water from decommissioned lead-acid battery
    - End of Life of Powder coating
    - Transports for the collection of recycled plastics where no specific EF compliant recycling dataset exists

For these processes, there is no replacement possible.

5.4. Data quality requirements

The data quality of each dataset and the total EF study shall be calculated and reported. The calculation of the DQR shall be based on the following formula with 4 criteria:

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Tl_R}+\bar{P}}{4}$$

Formula 2: DQR formula

Where:

- Te_R is the Technological-Representativeness,
- G_R is the Geographical-Representativeness,
- Ti_R is the Time-Representativeness,
- P is the Precision/uncertainty.

The representativeness (technological, geographical and time-related) characterises to what degree the processes and products selected are depicting the system analysed, while the precision indicates the way the data is derived and related level of uncertainty.

The next chapters provide tables with the criteria to be used for the semi-quantitative assessment of each criterion. If a dataset is constructed with company-specific activity data, company-specific emission data and secondary sub-processes, the DQR of each shall be assessed separately.

5.4.1. Company-specific datasets

The score of criterion P cannot be higher than 3 while the score for Ti_R, Te_R, and G_R cannot be higher than 2 (the DQR score shall be ≤1.6). The DQR shall be calculated at the level-1 disaggregation, before any aggregation of sub-processes or elementary flows is performed. The DQR of company-specific datasets shall be calculated as following:

1) Select the most relevant sub-processes and direct elementary flows that account for at least 80% of the total environmental impact of the company-specific dataset, listing them from the most contributing to the least contributing one.

2) Calculate the DQR criteria Te_R, Ti_R, G_R and P for each most relevant process and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table 16.

2.a) Each most relevant elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, evaluate the 4 DQR criteria named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF}.

It shall be evaluated for example, the timing of the flow measured, for which technology the flow was measured and in which geographical area.

2.b) Each most relevant process is a combination of activity data and the secondary dataset used. For each most relevant process, the DQR is calculated by the applicant of the PEFCR as a combination of the 4 DQR criteria for activity data and the secondary dataset:

(i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}) and

(ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary dataset used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}SD}$ and $G_{R\text{-}SD}$).

As Ti_R is evaluated twice, the mathematical average of $Ti_{R\text{-}AD}$ and $Ti_{R\text{-}SD}$ represents the Ti_R of the most relevant process.

3) Calculate the environmental contribution of each most-relevant process and elementary flow to the total environmental impact of all most-relevant processes and elementary flows, in % (weighted using 13 EF impact categories, with the exclusion of the 3 toxicity-related ones).

For example, the newly developed dataset has only two most relevant processes, contributing in total to 80% of the total environmental impact of the dataset:

- *Process 1 carries 30% of the total dataset environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Process 1 carries 50% of the total dataset environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).*

4) Calculate the Te_R, Ti_R, G_R and P criteria of the newly developed dataset as the weighted average of each criterion of the most relevant processes and direct elementary flows. The weight is the relative contribution (in %) of each most relevant process and direct elementary flow calculated in step 3.

5) The applicant of the PEFCR shall calculate the total DQR of the newly developed dataset using the Formula 3, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \bar{P}$ are the weighted average calculated as specified in point 4).

$$DQR = \frac{\overline{Te_R} + \overline{G_R} + \overline{Ti_R} + \bar{P}}{4}$$

Formula 3: DQR formula

NOTE: in case the newly developed dataset has most relevant processes filled in by non-EF compliant datasets (and thus without DQR), then these datasets cannot be included in step 4 and 5 of the DQR calculation.

(1) The weight of step 3 shall be recalculated for the EF-compliant datasets only. Calculate the environmental contribution of each most-relevant EF compliant process and elementary flow to the total environmental impact of all most-relevant EF compliant processes and elementary flows, in %. Continue with step 4 and 5.

(2) The weight of the non-EF compliant dataset (calculated in step 3) shall be used to increase the DQR criteria and total DQR accordingly. For example:

- *Process 1 carries 30% of the total dataset environmental impact and is ILCD entry level compliant. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Process 1 carries 50% of the total dataset environmental impact and is EF compliant. The contribution of this process to all most-relevant EF compliant processes is 100%. The latter is the weight to be used in step 4.*
- *After step 5, the parameters $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \bar{P}$ and the total DQR shall be multiplied with 1.375.*

	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	1 $Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
1	*Measured/calculated and externally verified*	*The data refers to the most recent annual administration period with respect to the EF report publication date*	*The EF report publication date happens within the time validity of the dataset*	*The elementary flows and the secondary dataset reflect exactly the technology of the newly developed dataset*	*The data(set) reflects the exact geography where the process modelled in the newly created dataset takes place*

	P_{EF} and P_{AD}	Ti_{R-EF} and Ti_{R-AD}	Ti_{R-SD}	1 Te_{R-EF} and Te_{R-SD}	G_{R-EF} and G_{R-SD}
2	*Measured/calculated and internally verified, plausibility checked by reviewer*	*The data refers to maximum 2 annual administration periods with respect to the EF report publication date*	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The elementary flows and the secondary dataset is a proxy of the technology of the newly developed dataset*	*The data(set) partly reflects the geography where the process modelled in the newly created dataset takes place*
3	*Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer*	*The data refers to maximum three annual administration periods with respect to the EF report publication date*	*Not applicable*	*Not applicable*	*Not applicable*
4-5	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

Table 16. How to assess the value of the DQR criteria for datasets with company-specific information

5.5. Data needs matrix (DNM)

All the processes required to model the product and outside the list of mandatory company-specific (listed in section 5.1) shall be evaluated using the Data Needs Matrix (see Table 17). The DNM shall be used by the PEFCR applicant to evaluate which data is needed and shall be used within the modelling of its PEF, depending on the level of influence the applicant (company) has on the specific process. The following three cases are found in the DNM and are explained below:

1. **Situation 1**: the process is run by the company applying the PEFCR.
2. **Situation 2**: the process is not run by the company applying the PEFCR but the company has access to (company-)specific information.
3. **Situation 3**: the process is not run by the company applying the PEFCR and this company does not have access to (company-)specific information.

		Most relevant process	Other process
Situation 1: process run by the company applying the PEFCR	Option 1	Provide company-specific data (as requested in the PEFCR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criteria + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process not run by the company applying the PEFCR but with access to (company-)specific information	Option 1	Provide company-specific data (as requested in the PEFCR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criterion + total)	
	Option 2	Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets (DQR ≤3.0).* Re-evaluate the DQR criteria within the product specific context	
	Option 3		Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets (DQR ≤4.0). Use the default DQR values
Situation 3: process not run by the company applying the PEFCR and without access to (company)-specific information	Option 1	Use default secondary dataset, in aggregated form (DQR ≤3.0). Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤4.0) Use the default DQR values

*Disaggregated datasets shall be used.

Table 17. Data Needs Matrix (DNM)

5.5.1. Processes in situation 1

For each process in situation 1 there are two possible options:

- The process is in the list of most relevant processes as specified in the PEFCR or is not in the list of most relevant process, but still the company wants to provide company specific data (option 1);
- The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 2).

Situation 1/Option 1

For all processes run by the company and where the company applying the PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section 5.4.1

Situation 1/Option 2

For the non-most relevant processes only, if the applicant decides to model the process without collecting company-specific data, then the applicant shall use the secondary dataset listed in the PEFCR together with its default DQR values listed here.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the metadata of the original dataset.

5.5.2. Processes in situation 2

When a process is not run by the company applying the PEFCR, but there is access to company-specific data, then there are two possible options:

- The company applying the PEFCR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[13] (Option 1);
- The company has some supplier-specific information and want to make some minimum changes (Option 2).
- The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 3).

Situation 2/Option 1

For all processes not run by the company and where the company applying the PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section 5.4.1

Situation 2/Option 2

Company-specific activity data for transport are used and the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets are substituted starting from the default secondary dataset provided in the PEFCR.

Please note that, the PEFCR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

The applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R and Ti_R, using the Table 18. The criteria G_R shall be lowered by 30%[14] and the criteria P shall keep the original value.

Situation 2/Option 3

For the non-most relevant processes, the applicant may use the corresponding secondary dataset listed in the PEFCR together with its DQR values.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the original dataset.

[13] The review of the newly created dataset is optional

[14] In situation 2, option 2 it is proposed to lower the parameter G_R by 30% in order to incentivize the use of company specific information and reward the efforts of the company in increasing the geographic representativeness of a secondary dataset through the substitution of the electricity mixes and of the distance and means of transportation.

	TiR	TeR	G_R
1	*The EF report publication date happens within the time validity of the dataset*	*The technology used in the EF study is exactly the same as the one in scope of the dataset*	*The process modelled in the EF study takes place in the country the dataset is valid for*
2	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The technologies used in the EF study is included in the mix of technologies in scope of the dataset*	*The process modelled in the EF study takes place in the geographical region (e.g. Europe) the dataset is valid for*
3	*The EF report publication date happens not later than 4 years beyond the time validity of the dataset*	*The technologies used in the EF study are only partly included in the scope of the dataset*	*The process modelled in the EF study takes place in one of the geographical regions the dataset is valid for*
4	*The EF report publication date happens not later than 6 years beyond the time validity of the dataset*	*The technologies used in the EF study are similar to those included in the scope of the dataset*	*The process modelled in the EF study takes place in a country that is not included in the geographical region(s) the dataset is valid for, but sufficient similarities are estimated based on expert judgement.*
5	*The EF report publication date happens later than 6 years after the time validity of the dataset*	*The technologies used in the EF study are different from those included in the scope of the dataset*	*The process modelled in the EF study takes place in a different country than the one the dataset is valid for*

Table 18. How to assess the value of the DQR criteria when secondary datasets are used

5.5.3. Processes in situation 3

When a process is not run by the company applying the PEFCR and the company does not have access to company-specific data, there are two possible options:

- It is in the list of most relevant processes (situation 3, option 1)
- It is not in the list of most relevant processes (situation 3, option 2)

Situation 3/Option 1

In this case, the applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R, Ti_R and G_R, using the table(s) provided. The criteria P shall keep the original value.

Situation 3/Option 2

For the non-most relevant processes, the applicant shall use the corresponding secondary dataset listed in the PEFCR together with its DQR values.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the original dataset.

5.6. Which datasets to use?

The secondary datasets to be used by the applicant are those listed in this PEFCR. Whenever a dataset needed to calculate the PEF-profile is not among those listed in this PEFCR, then the applicant shall choose between the following options (in hierarchical order):

- Use an EF-compliant dataset available on one of the following nodes:
    - http://eplca.jrc.ec.europa.eu/EF-node/
    - http://lcdn.blonkconsultants.nl
    - http://ecoinvent.lca-data.com
    - http://lcdn-cepe.org
    - https://lcdn.quantis-software.com/PEF/
    - http://lcdn.thinkstep.com/Node
    - http://soda.rdc.yp5.be
- Use an EF-compliant dataset available in a free or commercial source;
- Use another EF-compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitation" section of the PEF report.
- Use an ILCD-entry level-compliant dataset. In such case this information shall be included in the "data gap" section of the PEF report.

5.7. How to calculate the average DQR of the study

In order to calculate the average DQR of the EF study, the applicant shall calculate separately the Te_R, Ti_R, G_R and P for the EF study as the weighted average of all most relevant processes, based on their relative environmental contribution to the total single score (excluding the 3 toxicity-related ones). The calculation rules explained in section 5.4 shall be used.

5.8. Allocation rules

Allocation is generally not recommended. Default allocations are set up in the datasets and shall not be modified.

When unavoidable, subdivision shall be used for processes that can be directly attributed to certain outputs (e.g. energy use and emissions related to manufacturing processes). When the processes cannot be subdivided due to the lack of separate data or because technically impossible, the upstream burden:

- Material production shall be allocated to process outputs using a mass allocation method.
- Electronic components shall be allocated to process outputs per unit produced.
- Printed wiring board shall be allocated to process outputs using a surface allocation method.

No default allocation values are provided in this PEFCR.

If applicable in PEF study, allocation rules shall be clearly identified and documented in the PEF report. Influence on the PEF study results shall be expressed.

5.9. Electricity modelling

The guidelines in this section shall only be used for the processes where company-specific information is collected (situation 1 / Option 1 & 2 / Option 1 of the DNM).

The following electricity mix shall be used in hierarchical order:

(i) Supplier-specific electricity product shall be used if:
  (a) available, and
  (b) the set of minimum criteria to ensure the contractual instruments are reliable is met.

(ii) The supplier-specific total electricity mix shall be used if:
  (a) available, and
  (b) the set of minimum criteria that to ensure the contractual instruments are reliable is met.

(iii) As a last option the 'country-specific residual grid mix, consumption mix' shall be used (available at http://lcdn.thinkstep.com/Node/). Country-specific means the country in which the life cycle stage occurs. This may be an EU country or non-EU country. The residual grid mix characterizes the unclaimed, untracked or publicly shared electricity. This prevents double counting with the use of supplier-specific electricity mixes in (i) and (ii).

Note: if for a country, there is a 100% tracking system in place, case (i) shall be applied.

Note: for the use stage, the consumption grid mix shall be used.

The environmental integrity of the use of supplier-specific electricity mix depends on ensuring that contractual instruments (for tracking) **reliably and uniquely convey claims to consumers**. Without this, the PEF lacks the accuracy and consistency necessary to drive product/corporate electricity procurement decisions and accurate consumer (buyer of electricity) claims. Therefore, a set of minimum criteria that relate to the integrity of the contractual instruments as reliable conveyers of environmental footprint information has been identified. They represent the minimum features necessary to use supplier-specific mix within PEF studies.

Set of minimal criteria to ensure contractual instruments from suppliers

A supplier-specific electricity product/mix may only be used when the applicant ensures that any contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then 'country-specific residual grid mix, consumption mix' shall be used in the modelling.

A contractual instrument used for electricity modelling shall:

1. Convey attributes:

- Convey the energy type mix associated with the unit of electricity produced.
- The energy type mix shall be calculated based on delivered electricity, incorporating certificates sourced and retired on behalf of its customers. Electricity from facilities for which the attributes have been sold off (via contracts or certificates) shall be characterized as having the environmental attributes of the country residual consumption mix where the facility is located.

2. Be a unique claim:

- Be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.

- Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g. by an audit of contracts, third party certification, or may be handled automatically through other disclosure registries, systems, or mechanisms).

3. Be as close as possible to the period to which the contractual instrument is applied.

Modelling 'country-specific residual grid mix, consumption mix'

Datasets for residual grid mix, per energy type, per country and per voltage have been purchased by the European Commission and are available in the dedicated node (http://lcdn.thinkstep.com/Node/). In case the necessary dataset is not available, an alternative dataset shall be chosen according to the procedure described in section 0.

If no dataset is available, the following approach may be used:

Determine the country consumption mix (e.g. X% of MWh produced with hydro energy, Y% of MWh produced with coal power plant) and combined them with LCI datasets per energy type and country/region (e.g. LCI dataset for the production of 1MWh hydro energy in Switzerland):

- Activity data related to non-EU country consumption mix per detailed energy type shall be determined based on:
  - Domestic production mix per production technologies
  - Import quantity and from which neighbouring countries
  - Transmission losses
  - Distribution losses
  - Type of fuel supply (share of resources used, by import and / or domestic supply)

  These data may be found in the publications of the International Energy Agency (IEA).
- Available LCI datasets per fuel technologies in the node. The LCI datasets available are generally specific to a country or a region in terms of:
  - Fuel supply (share of resources used, by import and / or domestic supply),
  - Energy carrier properties (e.g. element and energy contents)
  - Technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.

Allocation rules

The allocation rules defined section 5.8 and section 6.4.2.4 shall be followed.

If the consumed electricity comes from more than one electricity mix, each mix source shall be used in terms of its proportion in the total kWh consumed. For example, if a fraction of this total kWh consumed is coming from a specific supplier, a supplier-specific electricity mix shall be used for this part. See below for on-site electricity use.

A specific electricity type may be allocated to one specific product in the following conditions:

1. The production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site may be used.
2. The production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product specific information (measure, record, bill) may be used.

3. All the products produced in the specific plant are supplied with a public available PEF study. The company who wants to make the claim shall make all PEF studies available. The allocation rule applied shall be described in the PEF study, consistently applied in all PEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.

On-site electricity generation

If on-site electricity production is equal to the site own consumption, two situations apply:

- No contractual instruments have been sold to a third party: the own electricity mix (combined with LCI datasets) shall be modelled.
- Contractual instruments have been sold to a third party: the 'country-specific residual grid mix, consumption mix' (combined with LCI datasets) shall be used.

If electricity is produced in excess of the amount consumed on-site within the defined system boundary and is sold to, for example, the electricity grid, this system can be seen as a multifunctional situation. The system will provide two functions (e.g. product + electricity) and the following rules shall be followed:

- If possible, apply subdivision.
- Subdivision applies both to separate electricity productions or to a common electricity production where you can allocate based on electricity amounts the upstream and direct emissions to your own consumption and to the share you sell out of your company (e.g. if a company has a wind mill on its production site and export 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the PEF study.
- If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[15].
- Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.

5.10. Climate change modelling

The impact category 'climate change' shall be modelled considering three sub-categories:

1. Climate change – fossil: This sub-category includes emissions from peat and calcination/carbonation of limestone. The emission flows ending with '(fossil)' (e.g., 'carbon dioxide (fossil)'' and 'methane (fossil)') shall be used if available.
2. Climate change – biogenic: This sub-category covers carbon emissions to air (CO_2, CO and CH_4) originating from the oxidation and/or reduction of biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO_2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or aboveground plant residues such as litter and dead wood. Carbon exchanges from native forests[16] shall be modelled under sub-category 3 (incl.

[15] For some countries, this option is a best case rather than a worst case.

[16] Native forests – represents native or long-term, non-degraded forests. Definition adapted from table 8 in Annex V C(2010)3751 to Directive 2009/28/EC.

connected soil emissions, derived products, residues). The emission flows ending with '(biogenic)' shall be used.

A simplified modelling approach shall be used when modelling the foreground emissions: Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane.

As the product life cycle or part of the life cycle is never expected to have a carbon storage beyond 100 years, credits from biogenic carbon storage shall not be modelled.

3. Climate change – land use and land transformation: This sub-category accounts for carbon uptakes and emissions (CO_2, CO and CH_4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (incl. soil carbon emissions). For native forests, all related CO_2 emissions are included and modelled under this sub-category (including connected soil emissions, products derived from native forest[17] and residues), while their CO_2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.

   For land use change, all carbon emissions and removals shall be modelled following the modelling guidelines of PAS 2050:2011 (BSI 2011) and the supplementary document PAS2050-1:2012 (BSI 2012) for horticultural products. PAS 2050:2011 (BSI 2011): Large emissions of GHGs can result as a consequence of land use change. Removals as a direct result of land use change (and not as a result of long-term management practices) do not usually occur, although it is recognized that this could happen in specific circumstances. Examples of direct land use change are the conversion of land used for growing crops to industrial use or conversion from forestland to cropland. All forms of land use change that result in emissions or removals are to be included. Indirect land use change refers to such conversions of land use as a consequence of changes in land use elsewhere. While GHG emissions also arise from indirect land use change, the methods and data requirements for calculating these emissions are not fully developed. Therefore, the assessment of emissions arising from indirect land use change is not included.

   The GHG emissions and removals arising from direct land use change shall be assessed for any input to the life cycle of a product originating from that land and shall be included in the assessment of GHG emissions. The emissions arising from the product shall be assessed on the basis of the default land use change values provided in PAS 2050:2011 Annex C, unless better data is available. For countries and land use changes not included in this annex, the emissions arising from the product shall be assessed using the included GHG emissions and removals occurring as a result of direct land use change in accordance with the relevant sections of the IPCC (2006). The assessment of the impact of land use change shall include all direct land use change occurring not more than 20 years, or a single harvest period, prior to undertaking the assessment (whichever is the longer). The total GHG emissions and removals arising from direct land use change over the period shall be included in the quantification of GHG emissions of products arising from this land on the basis of equal allocation to each year of the period[18].

   a. Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out, no emissions from land use change should be included in the assessment.

[17] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2).

[18] In case of variability of production over the years , a mass allocation should be applied.

b. Where the timing of land use change cannot be demonstrated to be more than 20 years, or a single harvest period, prior to making the assessment (whichever is the longer), it shall be assumed that the land use change occurred on 1 January of either:

- the earliest year in which it can be demonstrated that the land use change had occurred; or
- on 1 January of the year in which the assessment of GHG emissions and removals is being carried out.

The following hierarchy shall apply when determining the GHG emissions and removals arising from land use change occurring not more than 20 years or a single harvest period, prior to making the assessment (whichever is the longer):

i. where the country of production is known and the previous land use is known, the GHG emissions and removals arising from land use change shall be those resulting from the change in land use from the previous land use to the current land use in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);

ii. where the country of production is known, but the former land use is not known, the GHG emissions arising from land use change shall be the estimate of average emissions from the land use change for that crop in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);

iii. where neither the country of production nor the former land use is known, the GHG emissions arising from land use change shall be the weighted average of the average land use change emissions of that commodity in the countries in which it is grown.

Knowledge of the prior land use can be demonstrated using a number of sources of information, such as satellite imagery and land survey data. Where records are not available, local knowledge of prior land use can be used. Countries in which a crop is grown can be determined from import statistics, and a cut-off threshold of not less than 90% of the weight of imports may be applied. Data sources, location and timing of land use change associated with inputs to products shall be reported.

Soil carbon storage shall not be modelled, calculated and reported as additional environmental information.

Disclaimer to the applicant:

The sum of the three sub-categories shall be reported.

The sub-category 'Climate change-biogenic' shall NOT be reported separately.

The sub-category 'Climate change-land use and land transformation' shall NOT be reported separately.

5.11. Modelling of wastes and recycled content

The waste of products used during the manufacturing, distribution, retail, the use stage or after use shall be included in the modelling of the life cycle of the product. This shall be modelled and reported at the life cycle stage where the waste occurs. This section gives guidelines on how to model the End-of-Life of products as well as the recycled content.

5.11.1. Circular footprint formula (CFF)

The Circular Footprint Formula is used to model the End-of-Life of products as well as the recycled content and is a combination of "material + energy + disposal", i.e.:

Material $$(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_p}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$$

Energy $$(1-B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$$

Disposal $$(1-R_2-R_3) \times E_D$$

With the following parameters:

A: allocation factor of burdens and credits between supplier and user of recycled materials.

B: allocation factor of energy recovery processes: it applies both to burdens and credits. It shqll be set to zero for all PEF studies.

Qs_{in}: quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.

Qs_{out}: quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.

Q_p: quality of the primary material, i.e. quality of the virgin material.

R_1: it is the proportion of material in the input to the production that has been recycled from a previous system.

R_2: it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.

R_3: it is the proportion of the material in the product that is used for energy recovery at EoL.

$E_{recycled}$ (E_{rec}): specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.

$E_{recyclingEoL}$ (E_{recEoL}): specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.

E_v: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.

E^*_v: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.

EER: specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …).

$E_{SE,heat}$ and $E_{SE,elec}$: specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.

ED: specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.

$X_{ER,heat}$ and $X_{ER,elec}$: the efficiency of the energy recovery process for both heat and electricity.

LHV: Lower Heating Value of the material in the product that is used for energy recovery.

5.11.2. Reference scenario for the modelling of wastes and recycled content

Whenever using an EF-compliant dataset available on one of the referenced nodes (refer to 0), transports are included in the datasets and shall not be modelled separately.

Datasets to be used for the modelling of wastes are set up in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx". The excel file is available at this link:

http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

Case 1: CFF is integrated into EoL datasets

When modelling the end of life of certain components, the CFF parameters are already integrated in the datasets. This is the case for all the datasets for electronic component end of life. As a few examples:

- Solder paste: End of life of Solder paste
- PSU: End of life of PSU
- External ports: End of life of Steel external plug

The dataset for the End of Life treatment of LCD display panel is provided in the EF nodes (UUID: 1acd4d0a-8943-49a7-b51f-8bb9570c98b5; node: http://lcdn.thinkstep.com/Node/). However, it shall not be used, excepted if the data gap for the LCD panel production could be filled and modelled at the manufacturing stage (refer to data gaps section 5.3) by the applicant.

Case 2: CFF shall be applied manually

Default values applicable to the modelling of UPS end of life are listed in the table below (source: PEFCR Guidance 6.3 (2017) Annex C):

Category	Material	A	R1	R2 EU** : Europe (post consumer)	R3	Qsin/Qp	Qsout/Qp
Metals	Steel	0,2	0	0,93*		1	1
	Aluminium	0,2	0	0,9*		1	1
	Copper	0,2	0	0,93*		1	1
	Copper alloys	0,2	0	0,93*		1	1
	Lead (lead-acid batteries)	0,2	0,80	0,99***			
	Antimony (lead-acid batteries)	0,2	0,79	0,99***			
	Ferrite	0,2	0	0		1	1
Plastics	ABS	0,5	0	0,7	0,2		
	PE-LD	0,5	0	0,7	0,2	0,75	0,75
	PE-HD	0,5	0	0,7	0,2	0,9	0,9
	PMMA	0,5	0	0,7	0,2		
	PP (lead-acid batteries)	0,2	0	0			
	PVC	0,5	0	0	0,9		
	PA6	0,5	0	0,7	0,2		

	Polycarbonate PC	0,5	0	0,7	0,2		
Glass	Glass (lead-acid batteries)	0,2	0	0			
Resins	Epoxy	0,5	0	0	0,9		
Fibers	E-glass fiber	0,5	0	0			
	Aramid	0,5	0	0			
Fillers	Talc filler	0,5	0	0			

* Each R2 value is valid for all metal types used in the UPS.

** Set up to 1 when the recycling process considers fibre losses.

*** R2 is an input rate to the recycling process. As a consequence, a yield shall be applied to assess the recycled output quantity.

Table 19. A, R1, R2, R3, Qsin/Qp and Qsout/Qp values to be implemented by default

For elements not mentioned in Table 19, values shall be set up in compliance with the PEFCR Guidance 6.3 (2017) instructions set up section 7.18.1 on CFF.

5.11.3. Specific instructions for the modelling of lead-acid battery end of life

When modelling the end of life of batteries, the CFF and EoL datasets shall be applied considering the mass of lead, antimony and glass contained in the default lead-acid battery datasets per UPS sub-category, as provided in Table 20.

A list of default values and datasets, according to the representative UPSs are provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheets “6.4 Use-maintenance” and “6.5 EoL”. The excel file is available at this link:

http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

Material	<1.5 kW	≥1.5– 5 kW	≥5.1– 10 kW	≥10.1-200 kW
Lead/lead oxides – total	1997,4	10619,7	27563,4	487402,2
Glass	66,6	354,0	918,8	16246,7
Antimony - total (3% of lead content)	59,5	316,5	821,5	14525,8

Table 20. Instructions of the modelling of lead-acid batteries EoL per UPS sub-categories

Modelling of waste of antimony from lead-acid battery

The “lead-recycling” dataset is used as a Proxy, assuming that the recycling of Antimony and Lead from lead-acid batteries are following the same process.

To properly model Antimony recycling, the applicant shall determine a “credit of Primary antimony”, using the amount sorted from the recycling process ($M_{Sb\_Recycled}$). The yield of the recycling process is defined in the dataset.

The proportion of Antimony that is not entering the recycling process is assumed to be entirely landfilled.

As a consequence, when modelling the end of life of antimony from lead-acid batteries, the following modelling principles shall be applied:

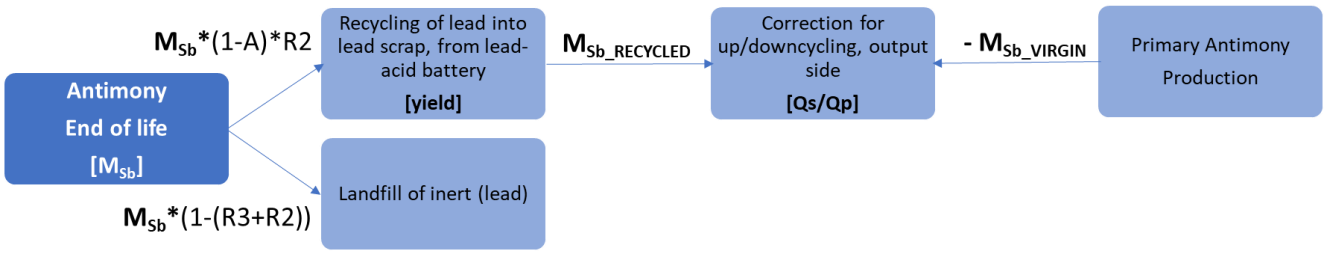


Figure 6: Proxy for modelling the end of life of Antimony

With scaling factors to be used to determine which quantity shall be set up in the respective datasets:

(1-A)*R2 = 0,8*0,99 = 0,792

1-(R3+R2) = 1-0,99 = 0,01

Qs/Qp = 1

Using:

Lead recycling dataset (UUID: 3309a9b5-760d-42a0-bf5c-6d946e11276a; node http://lcdn.thinkstep.com/Node/).

Primary antimony production dataset (UUID: e856ebf4-daad-41c0-a531-13c7a516d350; node http://lcdn.thinkstep.com/Node/).

Lead landfilling dataset (UUID: 7107e3f4-4ebd-4f8d-9e36-ec5d0df9cc3b; node http://lcdn.thinkstep.com/Node/).

Modelling of waste of lead from lead-acid battery

To properly model Lead recycling, the applicant shall determine a "credit of Primary lead", using the amount sorted from the recycling process ($M_{Pb\_Recycled}$). The yield of the recycling process is defined in the dataset.

The proportion of Lead that is not entering recycling process is assumed to be entirely landfilled.

As a consequence, when modelling the end of life of lead from lead-acid batteries, the following principles shall be applied:

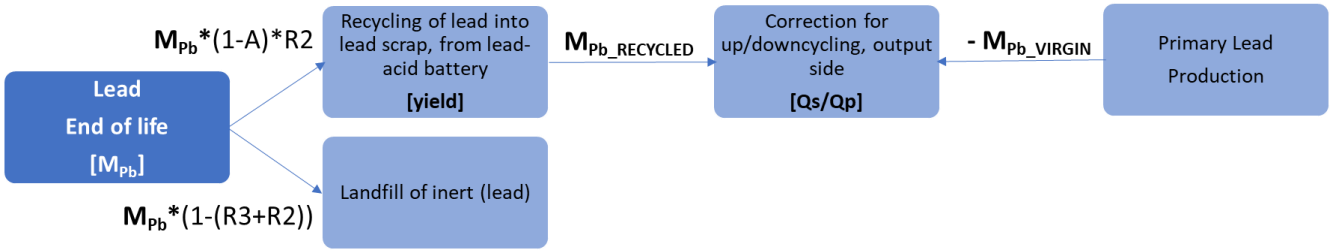


Figure 7: Proxy for modelling the end of life of Lead

With scaling factors to be used to determine which quantity shall be set up in the respective datasets:

(1-A)*R2 = 0,8*0,99 = 0,792

1-(R3+R2) = 1-0,99 = 0,01

Qs/Qp = 1

Using:

Lead recycling dataset (UUID: 3309a9b5-760d-42a0-bf5c-6d946e11276a; node http://lcdn.thinkstep.com/Node/).

Primary lead production dataset (UUID: 6edc85f3-d53b-4a2e-8e7b-7d834fce666a; node http://lcdn.thinkstep.com/Node/).

Lead landfilling dataset (UUID: 7107e3f4-4ebd-4f8d-9e36-ec5d0df9cc3b; node http://lcdn.thinkstep.com/Node/).

Modelling of waste of glass from lead-acid battery

Waste of glass from lead-acid battery shall be modelled using the Glass landfilling dataset (UUID: 01196227-0627-440c-9f2f-94b8f1e7d1ad; node http://lcdn.thinkstep.com/Node/).

Modelling of the other wastes from lead-acid battery

An allocation of the polypropylene and sulfuric acid recycling is already applied in the Lead recycling dataset (UUID: 3309a9b5-760d-42a0-bf5c-6d946e11276a; node http://lcdn.thinkstep.com/Node/). As a consequence, no further modelling is needed.

Recycling of water contained in lead-acid battery is part of this PEFCR remaining data gaps (refer to 5.3)

5.11.4. Specific instructions for the modelling of the end of life of certain plastics

When modelling the end of life of some materials for which there is no recycling process, then a proxy shall be used.

When no specific recycling process exists for a given plastic, the recycling of materials shall be approximated by the use of secondary plastic production (unspecified) process and a correction of the output with Qs/Qp ratio applied to the production of primary plastic.

Example of proxy for modelling the end of life of HDPE:

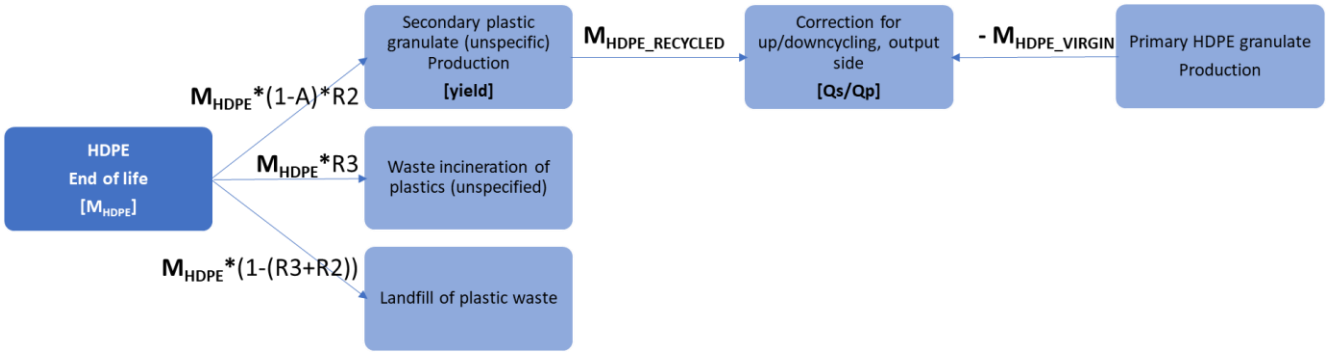


Figure 8: Proxy for modelling the end of life of certain plastics, example of HDPE

Using:

When existing, recycling process of a specific plastic dataset, or if no EF-compliant dataset exists, ILCD entry-level proxy for secondary plastic production (unspecified) process (UUID: 3b801715-5e3f-426f-8b24-a84dbd4f3165; node: http://lcdn.thinkstep.com/Node/)

When existing, primary material production of a specific plastic dataset, or if no dataset exists, Acrylonitrile Butadiene Styrene (ABS) production dataset (UUID: 6ac7e91c-ab83-4630-9900-a1707cfebed9; node http://lcdn.thinkstep.com/Node/).

When existing, waste incineration of specified plastics dataset, or if no dataset exists Waste incineration of plastics (unspecified) dataset (UUID: 8137b889-a1d8-4109-8aa7-e2aaee38fa5f; node http://lcdn.thinkstep.com/Node/).

Landfill of plastic waste dataset (UUID: f2bea0f5-e4b7-4a2c-9f34-4eb32495cbc6; node http://lcdn.thinkstep.com/Node/).

5.11.5. Specific instructions for the modelling of the end of life of fan

When modelling the end of life of fans, the CFF and EoL datasets shall be applied considering the following bill of materials:

Material	Mass (kg)
Polycarbonate granulate (PC)	0,1672
Copper	0,6232
Steel sheet part (St)	3,1008
Cast iron	0,4408
Plastic part (unspecified)	1,6036
Polybutylene terephthalate granulate (PBTP)	1,6568

Table 21. Bill of Material (kg) of UPS fan model

A list of default values and datasets, according to the representative UPSs are provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet “6.5 EoL”. The excel file is available at this link:

http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

6. Life cycle stages

This section provides guidance and instructions for the modelling of a UPS lifecycle and shall be completed with the instructions provided in section 5 on Life Cycle Inventory.

Disclaimer to the applicant:

All the default values that are provided in this section are provided per unit of UPS. To correspond to the functional unit, the results of the assessment shall be scaled by the "fraction of UPS" factor to fulfil the defined function (refer to 3.3.2).

6.1. Raw material acquisition, pre-processing and production stage (Manufacturing stage)

6.1.1. Raw material acquisition, pre-processing and production stage (Manufacturing stage) requirements and assumptions

Raw material acquisition and pre-processing happens in the third tier of the UPS supply chain. Raw material acquisition is embedded into the datasets used to model the components in composition of the UPS.

As defined in the PEFR section 5.1.1 on data requirements for mandatory company-specific processes, the applicant shall collect specific information on the composition of the product, the processes involved in the manufacturing stage and the ingredients in composition of the different parts.

The Table 22 below gives an example of the fields that are related to the product manufacturing aspects:

Descrip-tion	Level First level must be 0	Material in composit ion	Quantity	Unit	Unit mass g	Total mass after losses g	Process losses %	Mass of base g	% of first additive	Mass of first additive g	% of second additive	Mass of second additive g

Parts / Compon ents transport class	Distance km	Quantity	Unit	Surface Treatmen t	Surface	Treated Surface mm²

Table 22. Example of BOM / BOP

Default assumptions in regards with the raw material acquisition, pre-processing and production stage shall comply with the table content below:

Parameter	Assumption	Source
Blowing technique of the EPS contained in the packaging	It is assumed that the EPS is blown with HFC-134a.	Assumption from manufacturers based on site data
Origin of raw and basic materials	Raw and basic materials are assumed to be internationally supplied. Then international default scenario for transport shall be applied for the provision of raw and basic materials.	Assumption from manufacturers based on site data
Production region of components	Production of components is assumed to be international, mainly Asia. International default scenario for transport shall be applied for the provision of sub-assemblies and components on the product assembly site, if not based in Asia. If based in Asia, continental transport scenario shall be applied.	Assumption from manufacturers based on site data
Powder coating	• 50% of the powder coating is used for aluminium parts • 50% of the powder coating is used for steel parts	Assumption from manufacturers based on site data
Loss of material during processing	If the applicant is willing to modify the default loss rates that are set up in the manufacturing process datasets, the applicant shall assume generic losses of 10% for plastics, and 20% for all other materials. The change shall be applied to the disaggregated datasets.	Assumption from manufacturers based on site data

Table 23. Assumptions regarding the production of raw and basic materials

Disclaimer to the applicant:

In some cases, UPSs and batteries are likely to be bought separately by customers. To ensure homogeneity in the modelling, the flows due to the battery manufacturing shall be considered at the manufacturing stage of the UPS lifecycle.

The amount of virgin antimony (primary raw material) contained in lead-acid batteries is one of the most relevant process of UPS' lifecycle but hardly collectable by UPS manufacturers as they refer to third-tier suppliers. The supply of antimony for the batteries is typically a mix of primary and secondary. The exact content is confidential with the suppliers of antimony, so it cannot be mandatory company-specific data. In most cases, situation 3/option1 of the DNM applies. If the applicant can access product-specific data, then situation 2/option 1 of the DNM applies (refer to section 6.1.2).

Packaging manufacturing and supply shall be considered in the manufacturing stage of the UPS. Specific data on Packaging composition (material and weight) may be collected.

Transports shall be accounted as defined by the PEFCR Guidance 6.3 (2017) section 7.14:

- Supplying transports for suppliers located within Europe
  - 230 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), with default utilisation ratio of 64% (load limited in mass) including the empty return trip; and
  - 280 km by train (average freight train; UUID 02e87631-6d70-48ce-affd-1975dc36f5be); and

  - 360 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae)
- Supplying transports for suppliers located outside Europe
  - 1000 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), for the sum of distances from harbour/airport to factory outside and inside Europe, with default utilisation ratio of 64% (load limited in mass) including the empty return trip; and
  - 18000 km by ship (transoceanic container; UUID 6ca61112-1d5b-473c-abfa-4accc66a8a63) or 10'000 km by plane (cargo; UUID 1cc5d465-a12a-43da-aa86-a9c6383c78ac).
  - If producer country (origin) is known: the adequate distance for ship and airplane shall be determined using http://www.searates.com/services/routes-explorer or https://co2.myclimate.org/en/flight_calculators/newhttps://co2.myclimate.org/en/flight_calculators/new
- Transports from factory to DC:
  - For assembly sites located within Europe
    - 3 500 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57) (Eurostat 2014), with default utilisation ratio of 64% (load limited in mass) including the empty return trip
  - For assembly sites located outside Europe
    - 1 000 km truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), with default utilisation ratio of 64% (load limited in mass) including the empty return trip; and
    - 18 000 km by ship (transoceanic container; UUID 6ca61112-1d5b-473c-abfa-4accc66a8a63). Note that for specific cases, plane or train may be used instead of ship.

All the assumptions shall be documented, and deviations from the default scenario provided in this PEFCR shall be justified in the PEF report.

6.1.2. Modelling of the raw material acquisition, pre-processing and production stage – Manufacturing stage

If the applicant is willing to modify the default loss rates that are set up in the manufacturing process datasets, the wastes generated at the manufacturing stage shall be modelled using the guidance provided in chapter 6.5.2 on the End of life modelling of this PEFCR together with the default parameters listed in the table section 5.11.

Modelling of recycled content shall comply with section 6.1.3.

A list of default packaging and transports taking place at the production stage, as well as default datasets for the modelling of battery manufacturing and default values for the consumption of electricity for the assembly of the product, according to the representative UPSs, are provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet "6.1 Manufacturing".

The list of product-specific data to be collected is described in sheet named "5.1 Manufacturing-specific". The datasets listed for manufacturing processes already include default loss rates and their end of life treatments. The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

The applicant shall report the DQR values (for each criterion + total) for all the datasets used.

Disclaimer to the applicant:

If the applicant can access product-specific data concerning the effective amount of lead and antimony primary and secondary content in lead-acid battery, then situation 2/option 1 of the DNM applies (refer to 5.5) and the partially disaggregated dataset for the manufacturing of lead-acid batteries shall be adapted by the applicant.

If the battery technology differs from lead-acid, then instructions provided section 5.3 on data gaps apply.

The current lead-acid battery datasets (UUIDs: ffbeae6c-2a62-42a2-a85f-6a34b89b67de; 3c9111e2-e08e-4af3-b1af-fd6a570b03e1; b24ab599-4891-4fbd-ae02-059c8a8f4e76; 4e5ce305-8ed2-4c6a-b128-7c8271454ec5) are based on the following bill of materials per UPS sub-category:

Material	Mass ratios	<1.5 kW	≥1.5– 5 kW	≥5.1– 10 kW	≥10.1-200 kW
Lead/lead oxides – total	60,0%	1997,4	10619,7	27563,4	487402,2
Primary lead (20% of lead content)		*407,4*	*2166,0*	*5621,8*	*99410,6*
Secondary lead (80% of lead content)		*1590,0*	*8453,7*	*21941,6*	*387991,6*
Polypropylene	10,0%	332,9	1770,0	4593,9	81233,7
Sulphuric acid	10,0%	332,9	1770,0	4593,9	81233,7
Water	16,2%	539,7	2869,4	7447,6	131694,8
Glass	2,0%	66,6	354,0	918,8	16246,7
Antimony - total (3% of lead content)	1,8%	59,5	316,5	821,5	14525,8
Primary antimony (21% of antimony content)		*12,4*	*65,9*	*171,0*	*3024,6*
Secondary antimony (79% of antimony content)		*47,1*	*250,6*	*650,4*	*11501,3*
Total weight	**100%**	**3329,0**	**17699,5**	**45939,0**	**812337,0**

Table 24. Lead-acid batteries Bill of Materials (g) per UPS sub-categories

6.1.3. Modelling the recycled content

The following formula is used to model the recycled content:

$$(1 - R_1)E_V + R_1 \times \left(AE_{recycled} + (1 - A)E_V \times \frac{Q_{Sin}}{Q_p} \right)$$

The R_1 values applied shall be supply-chain or default as provided in the Table 19 (section 5.11.2), in relation with the DNM. Material-specific values based on supply market statistics are not accepted as a proxy. The applied R_1 values shall be subject to PEF study verification.

When using supply-chain specific R_1 values other than 0, traceability throughout the supply chain is necessary. The following general guidelines shall be followed when using supply-chain specific R_1 values:

- The supplier information (through e.g., statement of conformity or delivery note) shall be maintained during all stages of production and delivery at the converter;
- Once the material is delivered to the converter for production of the end products, the converter shall handle information through their regular administrative procedures;

- The converter for production of the end products claiming recycled content shall demonstrate through his management system the [%] of recycled input material into the respective end product(s).
- The latter demonstration shall be transferred upon request to the user of the end product. In case a PEF profile is calculated and reported, this shall be stated as additional technical information of the PEF profile.
- Company-owned traceability systems can be applied as long as they cover the general guidelines outlined above.

Default parameters for A, Q_{sin}/Q_p and $E_{recycled}$ are provided in the Table 19 section 5.11.2 on the modelling of waste and recycled content.

6.2. Distribution stage

Transports from DC to final client shall be accounted as defined by the PEFCR Guidance 6.3 (2017) section 7.14:

- 100% Local: 250 km round trip by van (lorry <7.5t, EURO 3, utilisation ratio of 20%; UUID aea613ae-573b-443a-aba2-6a69900ca2ff).

Storage at the distribution centre is cut off, as defined in section 0.

A list of default transports taking place at the distribution stage, according to the representative UPSs are provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet "6.2 Distribution". The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm .

All the assumptions shall be documented, and deviations from the default scenario provided in this PEFCR shall be justified in the PEF report.

6.3. Installation stage

Transport of a technician on site shall be accounted as defined by the PEFCR Guidance 6.3 (2017) section 7.14:

- 100% Local: 250 km round trip by van (lorry <7.5t, EURO 3, utilisation ratio of 20%; UUID aea613ae-573b-443a-aba2-6a69900ca2ff).

Installation processes as well as end of life of product packaging are cut off, as defined in section 0.

A list of default transports taking place at the installation stage, according to the representative UPSs are provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet "6.3 Installation". The excel file is available at this link:

http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

All the assumptions shall be documented, and deviations from the default scenario provided in this PEFCR shall be justified in the PEF report.

6.4. Use stage

The applicant shall analyse and declare separately the use stage following the instructions in this section.

All the use stage processes are product dependent and shall be included in the system boundary. A main function approach shall be applied when modelling the use stage. Some aspects involved in the use stage shall be modelled using product-specific data, as defined section 5.1.1.

6.4.1. Lifetime

The lifetime of UPSs shall be defined according to the power output as established in Table 25 below (Source: UPS PSR0010 from PEP ecopassport® (2015)):

UPS output power	Lifetime (in years)
<1.5 kW	5
≥1.5 kW to 5 kW	8
>5 kW to 10 kW	10
>10 kW to 200 kW	15

Table 25. Typical lifetimes of different UPSs

Disclaimer to the applicant:

The applicant may consider that the reference lifetime is not appropriate to the UPS under study. In that case, the applicant shall justify and document the reasons that explain the deviation from the PEFCR default rules in the PEF report. Justifications shall refer to an applicable standard on the assessment of the product durability.

6.4.2. Energy consumption

6.4.2.1. Operating profiles

The electricity consumption of a UPS is related to its load. To calculate the total electricity consumption of a UPS, it is required to know:

- The energy efficiency of the product at different loads. Values are specific for each product.
- The typical usage profile of a UPS as shown in the Table 26.

The practitioner shall use the scenario described in the table below (Source: ENERGY STAR® Program Requirements for UPSs, Version 2.0):

UPS output power	Input Dependency Characteristic	Proportion of time spent at specified proportion of load, $[t]_{n\%}$			
		Load 25%	Load 50%	Load 75%	Load 100%
<1.5 kW	VFD	0,20	0,20	0,30	0,30
	VI or VFI	0,00	0,30	0,40	0,30
≥1.5 kW to 5 kW	VFD, VI or VFI	0,00	0,30	0,40	0,30
>5 kW to 10 kW	VFD, VI or VFI	0,00	0,30	0,40	0,30
>10 kW to 200 kW	VFD, VI or VFI	0,25	0,50	0,25	0,00

Table 26. Operating profiles for the different ranges of UPSs

Note on how to read the table: A UPS <1.5 kW is working 20% (0,2 in the table) of its time at 25% load, 20% of its time at 50% load, 30% of its time at 75% load and 30% of its time at 100% load.

6.4.2.2. Calculation of energy efficiencies

As presented in chapter 3.2.2, UPSs can be of different topologies. Some UPSs just have one operating mode (single mode) and some more sophisticated UPSs may have several operating modes and are able to switch between them during usage. The operating mode influences the electricity consumption of the UPS considerably.

As a consequence, the calculation of the total energy consumption of the product shall be done with respect to the following options:

1. Energy efficiency calculation in case of a single mode UPS.

To calculate the average loading efficiency of a single mode UPS, the applicant shall:

- Collect the specific energy efficiency values of the product under study at each of these different loads
- and apply the following Average efficiency formula (Source ENERGY STAR® Program Requirements for UPSs, Version 2.0):

$$\text{Average-Efficiency}_{\text{single mode}} = [t]_{25\%} \times \text{Eff}_{25\%} + [t]_{50\%} \times \text{Eff}_{50\%} + [t]_{75\%} \times \text{Eff}_{75\%} + [t]_{100\%} \times \text{Eff}_{100\%}$$

Formula 4: Calculation of energy efficiency for a single mode UPS

Where

- Average-Efficiency $_{\text{single mode}}$ is the average loading-adjusted efficiency,
- $[t]_{n\%}$ is the proportion of time spent at the particular n% of the load, as specified in the loading assumptions in Table 26, and
- $\text{Eff}_{n\%}$ is the efficiency at the particular n% of the load, as measured according to the Annex J of IEC 62040-3:2011 standard.

Example:

- $[t]_{25\%}$ is the amount of time the UPS is running at 25% load as per Table 26
- $\text{Eff}_{25\%}$ is the energy efficiency of the UPS at 25% load. This value is product-specific.

Summary: in case of a single mode UPS, the energy efficiency of the product under study shall be calculated based on the following table, depending on the UPS output power and the efficiency of each UPS load (Source: ENERGY STAR® Program Requirements for UPSs, Version 2.0):

UPS output power	Input Dependency Characteristics	Average-Efficiency $_{\text{single mode}}$
<1.5 kW	VFD	$0{,}2\text{xEff}_{25\%}+0{,}2\text{xEff}_{50\%}+0{,}3\text{xEff}_{75\%}+0{,}3\text{xEff}_{100\%}$
	VI or VFI	$0{,}3\text{xEff}_{50\%}+0{,}4\text{xEff}_{75\%}+0{,}3\text{xEff}_{100\%}$
≥1.5 kW to 5 kW	VFD, VI or VFI	$0{,}3\text{xEff}_{50\%}+0{,}4\text{xEff}_{75\%}+0{,}3\text{xEff}_{100\%}$
>5 kW to 10 kW	VFD, VI or VFI	$0{,}3\text{xEff}_{50\%}+0{,}4\text{xEff}_{75\%}+0{,}3\text{xEff}_{100\%}$
>10 kW to 200 kW	VFD, VI or VFI	$0{,}25\text{xEff}_{25\%}+0{,}5\text{xEff}_{50\%}+0{,}25\text{xEff}_{75\%}$

Table 27. Calculation of energy efficiency for a single mode UPS

2. Energy efficiency calculation in case of a multimode UPS.

The energy efficiency of a multimode UPS is the combination of the average efficiency of each mode, considered as single modes.

To calculate the average loading efficiency of a multimode UPS, the applicant shall:

- Collect the specific energy efficiency values of the product under study at each load and in each of the 2 modes
  - Mode 1 is for the rated output power and lowest input dependency mode provided by the UPS
  - Mode 2 is for the rated output power and highest input dependency mode provided by the UPS
- Apply the Formula 4 (Average-Efficiency single mode) to each mode to obtain both Eff_{LOW} and Eff_{HIGH}
- Combine the 2 efficiencies by applying the Average efficiency in multimode formula (Source: ENERGY STAR® Program Requirements for UPSs, Version 2.0):

$$\text{Average-Efficiency}_{\text{multimode}} = 0{,}75 \times Eff_{LOW} + 0{,}25 \times Eff_{HIGH}$$

$$= 0{,}75 \times ([t]_{25\%} \times Eff_{LOW\ 25\%} + [t]_{50\%} \times Eff_{LOW\ 50\%} + [t]_{75\%} \times Eff_{LOW\ \mathbf{75\%}} + [t]_{100\%} \times Eff_{LOW\ 100\%})$$

$$+ 0{,}25 \times ([t]_{25\%} \times Eff_{HIGH\ 25\%} + [t]_{50\%} \times Eff_{HIGH\ 50\%} + [t]_{75\%} \times Eff_{HIGH\ \mathbf{75\%}} + [t]_{100\%} \times Eff_{HIGH\ 100\%})$$

Formula 5: Calculation of energy efficiency for a multimode UPS

Where:

- $\text{Average-Efficiency}_{\text{multimode}}$ is the average loading-adjusted efficiency,
- Eff_{LOW} is the average loading-adjusted efficiency in the lowest input dependency mode (i.e., VFI or VI) as calculated per Formula 4, and
- Eff_{HIGH} is the average loading-adjusted efficiency in the highest input dependency mode (i.e., VFD) as calculated per Formula 4

Summary: in case of a multimode UPS, the energy efficiency of the product under study shall be calculated based on the following table, depending on the UPS output power and the efficiency of each UPS load at the lowest and highest input dependency modes (Source: ENERGY STAR® Program Requirements for UPSs, Version 2.0):

UPS output power	Input Dependency Characteristics	Average-Efficiency $_{\text{multimode}}$
<1.5 kW	VFD	$0{,}75 \times (0{,}2 \times Eff_{LOW\ 25\%} + 0{,}2 \times Eff_{LOW\ 50\%} + 0{,}3 \times Eff_{LOW\ 75\%} + 0{,}3 \times Eff_{LOW\ 100\%}) + 0{,}25 \times (0{,}2 \times Eff_{HIGH\ 25\%} + 0{,}2 \times Eff_{HIGH\ 50\%} + 0{,}3 \times Eff_{HIGH\ 75\%} + 0{,}3 \times Eff_{HIGH\ 100\%})$
	VI or VFI	$0{,}75 \times (0{,}3 \times Eff_{LOW\ 50\%} + 0{,}4 \times Eff_{LOW\ 75\%} + 0{,}3 \times Eff_{LOW\ 100\%}) + 0{,}25 \times (0{,}3 \times Eff_{HIGH\ 50\%} + 0{,}4 \times Eff_{HIGH\ 75\%} + 0{,}3 \times Eff_{HIGH\ 100\%})$
≥1.5 kW to 5 kW	VI or VFI	$0{,}75 \times (0{,}3 \times Eff_{LOW\ 50\%} + 0{,}4 \times Eff_{LOW\ 75\%} + 0{,}3 \times Eff_{LOW\ 100\%}) + 0{,}25 \times (0{,}3 \times Eff_{HIGH\ 50\%} + 0{,}4 \times Eff_{HIGH\ 75\%} + 0{,}3 \times Eff_{HIGH\ 100\%})$
>5 kW to 10 kW	VFD, VI or VFI	$0{,}75 \times (0{,}3 \times Eff_{LOW\ 50\%} + 0{,}4 \times Eff_{LOW\ 75\%} + 0{,}3 \times Eff_{LOW\ 100\%}) + 0{,}25 \times (0{,}3 \times Eff_{HIGH\ 50\%} + 0{,}4 \times Eff_{HIGH\ 75\%} + 0{,}3 \times Eff_{HIGH\ 100\%})$
>10 kW to 200 kW	VFD, VI or VFI	$0{,}75 \times (0{,}25 \times Eff_{LOW\ 50\%} + 0{,}5 \times Eff_{LOW\ 75\%} + 0{,}25 \times Eff_{LOW\ 100\%}) + 0{,}25 \times (0{,}25 \times Eff_{HIGH\ 50\%} + 0{,}5 \times Eff_{HIGH\ 75\%} + 0{,}25 \times Eff_{HIGH\ 100\%})$

Table 28. Calculation of energy efficiency for a multimode UPS

6.4.2.3. Calculation of the average energy consumption during product lifetime

To calculate the UPS average energy consumption in use stage during its reference lifetime, the required input parameters are:

- Average energy efficiency of the UPS as defined in chapter 6.4.2.2
- Product lifetime as defined in Table 25
- Average output power according to load rate

The average energy consumption of the product under study shall be calculated based on the following formula, whatever if the UPS is single or multimode (Source: UPS PSR0010 from PEP ecopassport® (2015)):

Average energy consumption = (1 - Average Efficiency) x Average output power x Product lifetime

Formula 6: Calculation of energy consumption of UPS products

6.4.2.4. Modelling of the average energy consumption

The 'country-specific residual grid mix, consumption mix' shall be used. The electricity mix shall reflect the ratios of sales between EU countries/regions. To determine the ratio, a physical unit shall be used (e.g. number of pieces or kg of product).

Where such data are not available, the average EU consumption grid mix (EU-28+EFTA) shall be used.

Name of the process*	Unit of measurement (output)	Default amount per unit of UPS	Default dataset to be used	Dataset source	UUID	Default DQR				Most relevant process [Y/N]
						P	Ti_R	G_R	Te_R	
AVERAGE ENERGY CONSUMP-TION	kWh	No default: product-specific	Electricity grid mix 1kV-60kV AC, technology mix consumption mix, at consumer 1kV - 60kV	http://lcdn.thinkstep.com/Node/	af44062c-c968-4ed1-be3b-ef0c17934637	1	1	1	2	Y

Table 29. List of default dataset to be used for electricity consumption at the Use stage

6.4.3. Maintenance

6.4.3.1. Maintenance requirements and assumptions

The use stage includes all activities and products that are needed for a proper use of the UPS during its lifetime:

- Manufacturing, distribution and waste of materials needed for maintenance, repair or refurbishment (e.g. spare parts needed to repair/maintain the product and waste management due to losses).

Some UPSs may require to be maintained to reach the expected lifetime. A minimum list of typical UPS components to be maintained is:

- Electrolytic capacitors
- Fans

- Batteries if incorporated in the UPS
- Power supply

For the maintenance of the UPSs, the following assumptions shall be made. The Table 30 describes the number of times the UPS components shall be replaced during the life of the product (Source: P.E.P. Association (2014)):

UPS output power	Number of times UPS components are replaced during the product lifetime			
	Capacitor	Fan	Power supply	Battery
<1.5 kW	No maintenance			
≥1.5 kW to 5 kW	1	1	1	1
>5 kW to 10 kW	1	2	1	1
>10 kW to 200 kW	2	3	2	2

Table 30. Default UPS maintenance frequency during product lifetime

The inputs and outputs associated with the following aspects shall be collected and modelled:

- Production of the replacing components for maintenance and transport to supply them on the use site.
- End-of-life of the decommissioned batteries

Production, transport and end of life of replacing component packaging, as well as end of life of decommissioned PSUs, fans and electrolytic capacitors and glass from battery waste are cut off, as defined in section 0.

Disclaimer to the applicant:

The amount of virgin antimony (primary raw material) contained in lead-acid batteries is one of the most relevant processes of UPS' lifecycle but hardly collectable by UPS manufacturers as they refer to third-tier suppliers. The supply of antimony for the batteries is typically a mix of primary and secondary. The exact content is confidential with the suppliers of antimony, so it cannot be mandatory company-specific data. In most cases, situation 3/option1 of the DNM applies. If the applicant can access product-specific data, then situation 2/option 1 of the DNM applies (refer to section 6.4.3.2).

All the assumptions shall be documented, and deviations from the default scenario provided in this PEFCR shall be justified in the PEF report.

6.4.3.2. Modelling of the maintenance

Datasets to be used for the modelling of the maintenance are set up in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet "6.4 Use-maintenance". The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

The applicant shall report the DQR values (for each criterion + total) for all the datasets used.

The wastes generated at the maintenance shall be modelled using the guidance provided in chapter 6.5.2 on the End of life modelling together with the instructions provided section 5.11.

Disclaimer to the applicant:

As mentioned section 6.1.2, if the applicant can access product-specific data concerning the effective amount of lead and antimony primary and secondary content in lead-acid battery, then situation 2/option 1 of the DNM applies (refer to 5.5) and the partially disaggregated dataset for the manufacturing of lead-acid batteries shall be adapted by the applicant.

If the battery technology differs from lead-acid, then instructions provided section 5.3 on data gaps apply.

6.5. End of life

6.5.1. End of life stage requirements and assumptions

The End-of-Life stage is a life cycle stage that includes the waste of the product in scope, left at its end of use.

According the IEC/TR 62635, End of Life (EoL) treatment needs to comply with applicable regulations, observe relevant industry practices and allow efficient recycling and recovery, while at the same time addressing safety and environmental concerns.

EoL treatment generally presents four phases:

- **pre-treatment**: pre-treatment usually includes operations to mitigate hazards and dismantling parts for selective treatment. Parts are dismantled when there is a possibility for reuse, or they require selective treatment (e.g. regulations applicable to the recycling facility or contractual agreement), where this would allow a better end-of-life treatment efficiency;
- **material separation**: several techniques may be used, such as mechanical separation (e.g. shredding), chemical separation or thermal separation (smelting), with appropriate sorting processes;
- **energy recovery**: after these operations, the remaining and unsorted material may then be considered for energy recovery;
- **disposal**: residues are then disposed in appropriate landfills.

The following indicative list that is applicable to UPSs gives items commonly covered by legislation[19]:

- parts containing polychlorinated biphenyls (PCB);
- batteries;
- printed circuit boards if larger than 10 cm^2;
- plastic containing regulated flame retardants;
- parts containing asbestos;
- cathode ray tubes (CRTs);
- chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC) or hydrofluorocarbons (HFC), fluid hydrocarbons (HC);
- liquid crystal displays (together with their casing where appropriate) of a surface greater than 100 cm^2 and all those back-lighted with gas discharge lamps;
- external electric cables;
- components containing mercury;
- components containing refractory ceramic fibres;
- components containing radioactive substances;

[19] IEC/TR 62635:2012 Annex A on the basis of the WEEE directive (2012/19/EU) Annex VII

- electrolyte capacitors containing substances of concern (height > 25 mm, diameter > 25 mm or proportionately similar volume).

In addition, there are two main elements which influence recycling rates and recovery rates of electric and electronic equipment in EoL treatment[20]:

- the design characteristics of the product such as the structure, material composition, size, weight, ability of part dismantling, etc.
- the characteristics and performances of the EoL treatment process.

To establish a default scenario, applicable to any UPS at its end of life, assumptions regarding the end of life stage of the product shall comply with the table content below:

Assumption		Source
UPS component	**Treatment**	
Entire UPS	is 100% sent to WEEE compliant treatment facilities and dismantled to separate electronic components that enter specific end of life treatment processes from the rest of the product	B2B regulatory requirement in EU27
Metal parts	are melted	Interview with German recycling company
PWBs including ICs, diodes, ports, etc.	are melted and sent to specific end of life treatment processes	
Fan	are dismantled manually and separated in metal parts, plastic parts	
Power supply unit	are shredded mechanically and separated in metal parts, plastic parts and PWBs.	
Plastic parts	are shredded, sorted, and sold	
Battery	specific end of life treatment processes	
LCD module	specific end of life treatment processes – data gap	

Table 31. Assumptions regarding the EoL stage

In addition to the selective treatments of the product, transports shall be accounted:

- to collect the decommissioned UPS from its use site to the first end of life treatment facility for its dismantling and pre-treatment.
- to transport the items of the product that need specific end of life treatment from the first facility where the product is dismantled to the specific end of life treatment facilities.

6.5.2. Modelling of the end of life stage

A list of the processes taking place at the end of life stage is provided in the complementary Excel file named "UPS PEFCR - Life Cycle Inventory.xlsx", sheet "5.1 EoL-specific". The excel file is available at this link: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm.

The applicant shall report the DQR values (for each criterion + total) for all the datasets used.

The end of life shall be modelled using the guidance provided in this chapter together with the instructions provided section 5.11.

Before selecting the appropriate R_2 value, an evaluation for recyclability of the material shall be done and the PEF study shall include a statement on the recyclability of the materials/products. The

[20] IEC/TR 62635:2012 section 7 Calculation method for recyclability and recoverability rate – sub-section 7.1 General

statement on the recyclability shall be provided together with an evaluation for recyclability that includes evidence for the following three criteria (as described by ISO 14021:1999, section 7.7.4 'Evaluation methodology'):

1. The collection, sorting and delivery systems to transfer the materials from the source to the recycling facility are conveniently available to a reasonable proportion of the purchasers, potential purchasers and users of the product;
2. The recycling facilities are available to accommodate the collected materials;
3. Evidence is available that the product for which recyclability is claimed is being collected and recycled.

Point 1 and 3 can be proven by recycling statistics (country specific) derived from industry associations or national bodies. Approximation to evidence at point 3 can be provided by applying for example the design for recyclability evaluation outlined in EN 13430 Material recycling (Annexes A and B) or other sector-specific recyclability guidelines if available[21].

Following the evaluation for recyclability, the appropriate R_2 values (supply-chain specific or default) shall be used. If one criteria is not fulfilled or the sector-specific recyclability guidelines indicate a limited recyclability an R_2 value of 0% shall be applied.

Company-specific R_2 values (measured at the output of the recycling plant) shall be used when available. If no company-specific values are available and the criteria for evaluation of recyclability are fulfilled (see below), application-specific R_2 values shall be used as listed in the table section 5.11,

- If an R_2 value is not available for a specific country, then the European average shall be used.
- If an R_2 value is not available for a specific application, the R_2 values of the material shall be used (e.g. materials average).
- In case no R_2 values are available, R_2 shall be set equal to 0 or new statistics may be generated in order to assign an R_2 value in the specific situation.

The applied R_2 values shall be subject to the PEF study verification.

[21] E.g. the EPBP design guidelines (http://www.epbp.org/design-guidelines), or Recyclability by design (http://www.recoup.org/)

7. PEF results

7.1. Benchmark values

Reminder derived from PEFCR Guidance 6.3 (2017): A benchmark is a standard or point of reference against which any comparison can be made. In the context of this PEFCR, the term 'benchmark' refers to the environmental performance of each of the 4 UPS average (or representative) products, sold in the EU market. A benchmark is not the environmental performance of best in class or best performing products. Values of a benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.

This section reports the results of the benchmark for each one of the 4 representative UPSs. The results are provided characterised, normalised, and weighted (as absolute values), each in a different table. Most relevant impact categories for the sub-categories of UPSs in scope of this PEFCR are highlighted in blue.

Characterisation methods, as well as normalisation and weighting factors have been applied in conformance with section 3.5 and Annex 1: List of EF normalisation factors and weighting factors.

7.1.1. Benchmark values for representative UPS <1.5 kW

Impact category	Unit	Life cycle excl. use stage	Use stage
Climate change	kg $CO_{2\ eq}$	1,19E+00	2,97E+01
Ozone depletion	kg CFC-11 $_{eq}$	2,19E-10	1,12E-08
Particulate matter	disease incidence	1,18E-07	9,06E-07
Ionising radiation, human health	kBq U^{235} $_{eq}$	7,17E-02	1,25E+01
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	4,71E-03	4,76E-02
Acidification	mol H+ $_{eq}$	8,13E-03	8,91E-02
Eutrophication, terrestrial	mol N $_{eq}$	1,74E-02	1,78E-01
Eutrophication, freshwater	kg P $_{eq}$	1,18E-05	6,17E-05
Eutrophication, marine	kg N $_{eq}$	1,75E-03	1,75E-02
Land use	Dimensionless (pt)	2,73E+01	2,04E+02
Water use	m^3 world $_{eq}$	2,18E-01	4,12E+00
Resource use, minerals and metals	kg Sb $_{eq}$	5,00E-04	9,64E-06
Resource use, fossils	MJ	1,84E+01	5,09E+02

Table 32. Characterised benchmark values for UPS <1.5 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	1,53E-04	3,82E-03
Ozone depletion	9,37E-09	4,77E-07
Particulate matter	1,85E-04	1,42E-03
Ionising radiation, human health	1,70E-05	2,95E-03
Photochemical ozone formation, human health	1,16E-04	1,17E-03
Acidification	1,47E-04	1,61E-03
Eutrophication, terrestrial	9,83E-05	1,01E-03
Eutrophication, freshwater	4,63E-06	2,43E-05
Eutrophication, marine	6,17E-05	6,18E-04
Land use	2,05E-05	1,63E-04
Water use	1,89E-05	3,58E-04
Resource use, minerals and metals	8,63E-03	1,66E-04
Resource use, fossils	2,81E-04	7,81E-03

Table 33. Normalised benchmark values for UPS <1.5 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	3,57E-05	8,48E-04
Ozone depletion	2,92E-07	3,22E-08
Particulate matter	1,75E-05	1,36E-04
Ionising radiation, human health	1,10E-06	1,58E-04
Photochemical ozone formation, human health	5,88E-06	5,99E-05
Acidification	9,67E-06	1,07E-04
Eutrophication, terrestrial	3,85E-06	3,93E-05
Eutrophication, freshwater	1,38E-07	7,16E-07
Eutrophication, marine	2,63E-06	1,93E-05
Land use	1,00E-06	1,37E-05
Water use	1,68E-06	3,24E-05
Resource use, minerals and metals	6,97E-04	1,35E-05
Resource use, fossils	2,41E-05	6,96E-04

Table 34. Weighted benchmark values for UPS <1.5 kW

7.1.2. Benchmark values for representative UPS ≥1.5 kW to 5 kW

Impact category	Unit	Life cycle excl. use stage	Use stage
Climate change	kg $CO_{2\ eq}$	4,62E-01	2,93E+01
Ozone depletion	kg CFC-11 $_{eq}$	8,92E-11	1,08E-08
Particulate matter	disease incidence	5,32E-08	9,48E-07
Ionising radiation, human health	kBq U^{235} $_{eq}$	2,74E-02	1,20E+01
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	2,05E-03	4,90E-02
Acidification	mol H^+ $_{eq}$	3,71E-03	9,17E-02
Eutrophication, terrestrial	mol N $_{eq}$	7,72E-03	1,83E-01
Eutrophication, freshwater	kg P $_{eq}$	6,61E-06	6,72E-05
Eutrophication, marine	kg N $_{eq}$	7,48E-04	1,79E-02
Land use	Dimensionless (pt)	5,01E+00	2,10E+02
Water use	m^3 world $_{eq}$	1,29E-01	4,04E+00
Resource use, minerals and metals	kg Sb $_{eq}$	2,86E-04	3,33E-04
Resource use, fossils	MJ	5,89E+00	5,01E+02

Table 35. Characterised benchmark values for UPS ≥1.5 kW to 5 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	5,95E-05	3,77E-03
Ozone depletion	3,81E-09	4,60E-07
Particulate matter	8,34E-05	1,49E-03
Ionising radiation, human health	6,49E-06	2,85E-03
Photochemical ozone formation, human health	5,04E-05	1,21E-03
Acidification	6,69E-05	1,65E-03
Eutrophication, terrestrial	4,36E-05	1,03E-03
Eutrophication, freshwater	2,59E-06	2,63E-05
Eutrophication, marine	2,64E-05	6,32E-04
Land use	3,77E-06	1,58E-04
Water use	1,12E-05	3,52E-04
Resource use, minerals and metals	4,95E-03	5,75E-03
Resource use, fossils	9,02E-05	7,67E-03

Table 36. Normalised benchmark values for UPS ≥1.5 kW to 5 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	1,32E-05	8,37E-04
Ozone depletion	2,57E-10	3,10E-08
Particulate matter	7,96E-06	1,42E-04
Ionising radiation, human health	3,48E-07	1,53E-04
Photochemical ozone formation, human health	2,57E-06	6,15E-05

Impact category	Life cycle excl. use stage	Use stage
Acidification	4,44E-06	1,10E-04
Eutrophication, terrestrial	1,71E-06	4,04E-05
Eutrophication, freshwater	7,65E-08	7,77E-07
Eutrophication, marine	8,24E-07	1,97E-05
Land use	3,17E-07	1,33E-05
Water use	1,02E-06	3,18E-05
Resource use, minerals and metals	4,00E-04	4,65E-04
Resource use, fossils	8,04E-06	6,84E-04

Table 37. Weighted benchmark values for UPS ≥1.5 kW to 5 kW

7.1.3. Benchmark values for representative UPS from >5 kW to 10 kW

Impact category	Unit	Life cycle excl. use stage	Use stage
Climate change	kg $CO_{2\ eq}$	5,83E-01	2,15E+01
Ozone depletion	kg CFC-11 $_{eq}$	1,12E-10	7,97E-09
Particulate matter	disease incidence	5,20E-08	6,85E-07
Ionising radiation, human health	kBq U^{235} $_{eq}$	8,62E-02	8,91E+00
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	2,08E-03	3,51E-02
Acidification	mol H^+ $_{eq}$	3,73E-03	6,60E-02
Eutrophication, terrestrial	mol N $_{eq}$	7,82E-03	1,31E-01
Eutrophication, freshwater	kg P $_{eq}$	6,37E-06	4,74E-05
Eutrophication, marine	kg N $_{eq}$	7,61E-04	1,29E-02
Land use	Dimensionless (pt)	6,07E+00	1,55E+02
Water use	m^3 world $_{eq}$	1,76E-02	2,92E+00
Resource use, minerals and metals	kg Sb $_{eq}$	2,99E-04	2,89E-04
Resource use, fossils	MJ	8,17E+00	3,69E+02

Table 38. Characterised benchmark values for UPS >5 kW to 10 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	7,51E-05	2,77E-03
Ozone depletion	4,79E-09	3,41E-07
Particulate matter	8,16E-05	1,08E-03
Ionising radiation, human health	2,04E-05	2,11E-03
Photochemical ozone formation, human health	5,13E-05	8,66E-04
Acidification	6,73E-05	1,19E-03
Eutrophication, terrestrial	4,42E-05	7,41E-04
Eutrophication, freshwater	2,50E-06	1,86E-05
Eutrophication, marine	2,69E-05	4,54E-04
Land use	4,56E-06	1,17E-04
Water use	1,53E-06	2,54E-04
Resource use, minerals and metals	5,16E-03	4,99E-03
Resource use, fossils	1,25E-04	5,65E-03

Table 39. Normalised benchmark values for UPS >5 kW to 10 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	1,67E-05	6,15E-04
Ozone depletion	3,23E-10	2,30E-08
Particulate matter	7,79E-06	1,03E-04
Ionising radiation, human health	1,10E-06	1,13E-04
Photochemical ozone formation, human health	2,62E-06	4,42E-05
Acidification	4,47E-06	7,89E-05
Eutrophication, terrestrial	1,73E-06	2,90E-05
Eutrophication, freshwater	7,37E-08	5,48E-07
Eutrophication, marine	8,39E-07	1,42E-05
Land use	3,84E-07	9,84E-06

Impact category	Life cycle excl. use stage	Use stage
Water use	1,38E-07	2,29E-05
Resource use, minerals and metals	4,17E-04	4,03E-04
Resource use, fossils	1,12E-05	5,04E-04

Table 40. Weighted benchmark values for UPS >5 kW to 10 kW

7.1.4. Benchmark values for representative UPS >10 kW to 200 kW

Impact category	Unit	Life cycle excl. use stage	Use stage
Climate change	kg $CO_{2\ eq}$	2,52E-01	1,94E+01
Ozone depletion	kg CFC-11 $_{eq}$	1,72E-11	7,23E-09
Particulate matter	disease incidence	3,63E-08	6,20E-07
Ionising radiation, human health	kBq U^{235} $_{eq}$	1,34E-02	8,08E+00
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	1,16E-03	3,15E-02
Acidification	mol H^+ $_{eq}$	2,10E-03	5,92E-02
Eutrophication, terrestrial	mol N $_{eq}$	4,45E-03	1,18E-01
Eutrophication, freshwater	kg P $_{eq}$	2,51E-06	4,24E-05
Eutrophication, marine	kg N $_{eq}$	4,16E-04	1,15E-02
Land use	Dimensionless (pt)	1,13E+00	1,41E+02
Water use	m^3 world $_{eq}$	1,23E-02	2,53E+00
Resource use, minerals and metals	kg Sb $_{eq}$	2,38E-04	4,10E-04
Resource use, fossils	MJ	3,02E+00	3,34E+02

Table 41. Characterised benchmark values for UPS >10 kW to 200 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	3,24E-05	2,51E-03
Ozone depletion	7,34E-10	3,09E-07
Particulate matter	5,69E-05	9,73E-04
Ionising radiation, human health	3,17E-06	1,92E-03
Photochemical ozone formation, human health	2,87E-05	7,75E-04
Acidification	3,78E-05	1,07E-03
Eutrophication, terrestrial	2,51E-05	6,64E-04
Eutrophication, freshwater	9,84E-07	1,66E-05
Eutrophication, marine	1,47E-05	4,08E-04
Land use	8,51E-07	1,06E-04
Water use	1,07E-06	2,20E-04
Resource use, minerals and metals	4,11E-03	7,08E-03
Resource use, fossils	4,63E-05	5,11E-03

Table 42. Normalised benchmark values for UPS >10 kW to 200 kW

Impact category	Life cycle excl. use stage	Use stage
Climate change	7,20E-06	5,56E-04
Ozone depletion	4,96E-11	2,08E-08
Particulate matter	5,43E-06	9,29E-05
Ionising radiation, human health	1,70E-07	1,03E-04
Photochemical ozone formation, human health	1,46E-06	3,95E-05
Acidification	2,51E-06	7,09E-05
Eutrophication, terrestrial	9,83E-07	2,60E-05
Eutrophication, freshwater	2,90E-08	4,90E-07
Eutrophication, marine	4,59E-07	1,27E-05
Land use	7,17E-08	8,92E-06
Water use	9,64E-08	1,99E-05
Resource use, minerals and metals	3,32E-04	5,72E-04
Resource use, fossils	4,13E-06	4,56E-04

Table 43. Weighted benchmark values for UPS >10 kW to 200 kW

7.2. PEF profile

The applicant shall calculate the PEF profile of its product in compliance with all requirements included in this PEFCR. The following information shall be included in the PEF report:

- full life cycle inventory;
- characterised results in absolute values, for all impact categories (including toxicity; as a table);
- normalised and weighted result in absolute values, for all impact categories (including toxicity; as a table);
- the aggregated single score in absolute values.

Together with the PEF report, the applicant shall develop an aggregated EF-compliant dataset of its product in scope. This dataset shall be made available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node/). The disaggregated version may stay confidential.

7.3. Additional technical information

Additional technical information shall be reported by the applicant:

- The total mass of the product, packaging and additional elements supplied with the product by the manufacturer shall be indicated.
- Their distribution in percentage of the total mass of the product, packaging and elements supplied with the product shall be indicated as follows:
    - Plastics,
    - Metals,
    - Others.
- Materials may be also further listed by material groups or by base materials as defined in IEC 62474 in its latest edition:
    - Example of material groups: copper and alloys, thermoplastics.
    - Example of base materials: copper, zinc, lead, polycarbonate, talc, dye.
    - Plastics may be identified in conformity with the relevant current standards.
- Some components (e.g.: electronic circuit boards, cells and batteries…) may be listed with their mass in the material balance without a description of the constituent materials, except for hazardous substances such as those listed in the section 7.4.1.
- Beyond the 15 material groups or basic materials that are most represented in mass, other materials shall be listed under "Miscellaneous".
- Distribution data for materials shall be expressed as a % of the product mass with 1 digit after the decimal point and ranked in descending order of mass if it is presented in the form of a table.
- The value of substances and materials with a mass lower than 0.1 % shall be given as "<0.1%".

7.4. Additional environmental information

7.4.1. Manufacturing

The additional environmental information may include information on the absence or level of presence of antimony and lead as primary and secondary content in UPS batteries.

It shall not refer to the absence of substances or features that are not or have never been associated with the product category.

The hazardous substances specified in the various regulations (REACH, RoHS, etc.) or standards (IEC 62474, etc.) in force in the countries concerned and used in the composition of the reference flow may be mentioned as additional information.

For example, the following hazardous substances specified in the RoHS Directive may be declared when present in the homogeneous materials of the product:

- Lead,
- Mercury,
- Cadmium,
- Hexavalent chromium,
- Polybrominated biphenyl (PBB),
- Polybrominated diphenyl ether (PBDE).

If the quantity of a hazardous substance is indicated, it shall be expressed as specified by the regulations in force.

Systems to reduce the environmental impact of manufacturing activities such as any environmental management systems or a regulatory monitoring device may be mentioned, with a statement on where an interested party can find details of the system.

7.4.2. Use

The following aspects shall be provided to the purchaser or user:

- Instructions and limits for efficient use,
- Energy consumption reduction features,
- Maintenance and battery replacement instructions and disclaimer focussing on the importance of battery recycling.

Systems to reduce product pollution and its impact on the environment according to the characteristics of the product and consistent with the product use scenario may be mentioned.

7.4.3. End of life

As UPS are submitted to end-of-life treatment regulations, the presence and mass of any components or sub-assemblies that shall be sent to specific treatment centres shall be mentioned (e.g. Directive 2012/19/EU on Waste Electrical and Electronic Equipment).

A disclaimer shall be provided to the purchaser or user that is destined to the recycler mentioning the importance of Battery recycling for the environmentally-sound recycling of UPSs.

Actions to reduce the end-of-life impact of the product on the environment may be mentioned, such as participation in recycling or recovery programs, provided that details of these programs and contact information are readily available to the purchaser or user.

The quality of design of the product with respect to end of life may be mentioned. In this case, it may be measured with a recyclability rate indicator. The recyclability rate represents the recycling potential of the product in terms of its design: technology and input materials. The recycling method and potential values shall be compatible with the relevant standards. Standard IEC/TR 62635 shall be favoured. Other methods shall be documented and justified in the PEF report.

7.4.4. Biodiversity

Mining activities may have major impacts on the local area, including on the biodiversity. However, there are no data readily available for assessing biodiversity impacts of UPSs lifecycle.

8. Verification

The verification of an EF study/report carried out in compliance with this PEFCR shall be done according to all the general requirements included in Section 8 of the PEFCR Guidance 6.3 (2017) and the requirements listed below.

The verifier(s) shall verify that the EF study is conducted in compliance with this PEFCR.

These requirements will remain valid until an EF verification scheme is adopted at European level or alternative verification approaches applicable to EF studies/report are included in existing or new policies.

The verifier(s) shall validate the accuracy and reliability of the quantitative information used in the calculation of the study. As this can be highly resource intensive, the following requirements shall be followed:

- the verifier shall check if the correct version of all impact assessment methods was used. For each of the most relevant impact categories, at least 50% of the characterisation factors (for each of the most relevant EF impact categories) shall be verified, while all normalisation and weighting factors of all ICs shall be verified. In particular, the verifier shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with;
- all the newly created datasets shall be checked on their EF compliancy (for the meaning of EF compliant datasets refer to Annex H of the PEFCR Guidance 6.3 (2017)). All their underlying data (elementary flows, activity data and sub processes) shall be validated;
- the aggregated EF-compliant dataset of the product in scope (meaning, the EF study) is available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node).
- for at least 70% of the most relevant processes in situation 2 option 2 of the DNM, 70% of the underlying data shall be validated. The 70% data shall include all energy and transport sub processes for those in situation 2 option 2;
- for at least 60% of the most relevant processes in situation 3 of the DNM, 60% of the underlying data shall be validated;

- for at least 50% of the other processes in situation 1, 2 and 3 of the DNM, 50% of the underlying data shall be validated.

In particular, it shall be verified for the selected processes if the DQR of the process satisfies the minimum DQR as specified in the DNM.

The selection of the processes to be verified for each situation shall be done ordering them from the most contributing to the less contributing one and selecting those contributing up to the identified percentage starting from the most contributing ones. In case of non-integer numbers, the rounding shall be made always considering the next upper integer.

These data checks shall include, but should not be limited to, the activity data used, the selection of secondary sub-processes, the selection of the direct elementary flows and the CFF parameters. For example, if there are 5 processes and each one of them includes 5 activity data, 5 secondary datasets and 10 CFF parameters, then the verifier(s) has to check at least 4 out of 5 processes (70%) and, for each process, (s)he shall check at least 4 activity data (70% of the total amount of activity data), 4 secondary datasets (70% of the total amount of secondary datasets), and 7 CFF parameters (70% of the total amount of CFF parameters), i.e. the 70% of each of data that could be possible subject of check.

The verification of the EF report shall be carried out by randomly checking enough information to provide reasonable assurance that the EF report fulfils all the conditions listed in section 8 of the PEFCR Guidance.

9. References

ENERGY STAR® Program Requirements; Product Specification for Uninterruptible Power Supplies (UPSs); Eligibility Criteria, Version 2.0, 2017.

ErP Lot 27; Uninterruptible Power Supplies; Task 5: Definition of Base Cases, report for the European Commission, issue number 1, 2013.

IEC 62040-3:2011 Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements.

IEC/TR 62635 Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment.

ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework.

ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines.

PEFCR Guidance document, Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 14 2017.

Product Category Rules (PCR) for Electrical, Electronic and HVAC-R Products, PCR-ed3-EN-2015 04 02, PEP ecopassport®, 2015.

Product Environmental Footprint (PEF) Guide; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, May 4 2013.

Product Specific Rules (PSR) for Uninterruptible Power Supply (UPS), PSR-0010-ed1.1-EN-2015 10 16, PEP ecopassport®, 2015.

Supporting information to the characterisation factors of recommended EF Life Cycle Impact Assessment method; New models and differences with ILCD, Fazio, S. Castellani, V. Sala, S. Schau, EM. Secchi, M. Zampori, L., Diaconu E, 2018.

Website: http://www.urbanmineplatform.eu/composition/batteries/elements (Consultation on May 3rd and May 22nd 2018)

10. Annexes

10.1. Annex 1: List of EF normalisation factors and weighting factors

10.1.1. EF normalisation factors

Global normalisation factors are applied within the EF. The normalisation factors as the global impact per person are used in the EF calculations.

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Climate change	kg $CO_{2\ eq}$	5.35E+13	7.76E+03	I	II	I	
Ozone depletion	kg CFC-11 $_{eq}$	1.61E+08	2.34E-02	I	III	II	
Human toxicity, cancer	CTUh	2.66E+05	3.85E-05	II/III	III	III	
Human toxicity, non-cancer	CTUh	3.27E+06	4.75E-04	II/III	III	III	
Particulate matter	disease incidence	4.39E+06	6.37E-04	I	I/II	I/II	NF calculation takes into account the emission height both in the emission inventory and in the impact assessment.
Ionising radiation, human health	kBq U^{235} $_{eq}$	2.91E+13	4.22E+03	II	II	III	
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	2.80E+11	4.06E+01	II	III	I/II	
Acidification	mol $H+_{\ eq}$	3.83E+11	5.55E+01	II	II	I/II	
Eutrophication, terrestrial	mol $N_{\ eq}$	1.22E+12	1.77E+02	II	II	I/II	
Eutrophication, freshwater	kg $P_{\ eq}$	1.76E+10	2.55E+00	II	II	III	
Eutrophication, marine	kg $N_{\ eq}$	1.95E+11	2.83E+01	II	II	II/III	

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Land use	pt	9.20E+15	1.33E+06	III	II	II	The NF is built by means of regionalised CFs.
Ecotoxicity, freshwater	CTUe	8.15E+13	1.18E+04	II/III	III	III	
Water use	m^3 world eq	7.91E+13	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
Resource use, fossils	MJ	4.50E+14	6.53E+04	III	I	II	
Resource use, minerals and metals	kg Sb eq	3.99E+08	5.79E-02	III			

10.1.2. EF weighting factors

WITHOUT TOX CATEGORIES	Aggregated weighting set (50:50) A	Robustness factors (scale 1-0.1) B	Calculation C=A*B	Final weighting factors C scaled to 100
Climate change	15.75	0.87	13.65	**22.19**
Ozone depletion	6.92	0.6	4.15	**6.75**
Particulate matter	6.77	0.87	5.87	**9.54**
Ionizing radiation, human health	7.07	0.47	3.3	**5.37**
Photochemical ozone formation, human health	5.88	0.53	3.14	**5.1**
Acidification	6.13	0.67	4.08	**6.64**
Eutrophication, terrestrial	3.61	0.67	2.4	**3.91**
Eutrophication, freshwater	3.88	0.47	1.81	**2.95**
Eutrophication, marine	3.59	0.53	1.92	**3.12**
Land use	11.1	0.47	5.18	**8.42**
Water use	11.89	0.47	5.55	**9.03**
Resource use, minerals and metals	8.28	0.6	4.97	**8.08**
Resource use, fossils	9.14	0.6	5.48	**8.92**

10.2. Annex 2: Check-list for the PEF study

Each PEF study shall include this annex, completed with all the requested information.

ITEM	Included in the study (Y/N)	Section	Page
[This column lists all the items that shall be included in PEF studies]	[The PEF study shall indicate if the item is included or not in the study]	[The PEF study shall indicate in which section of the study the item is included]	[The PEF study shall indicate in which page of the study the item is included]
Summary			
General information about the product			
General information about the company			
Scope of the study			
(sub)category to which the product belongs			
Diagram with system boundary and indication of the situation according to DNM			
List and description of processes included in the system boundaries			
List and description of the exclusions (cut off) implemented			
List of co-products, by-products and waste plus allocation rule(s) applied (if applicable)			
List of activity data used			
List of secondary datasets used			
Identification of data used to fill data gaps (if applicable)			
Company-specific dataset(s)			
Data gaps			
Limitations and proxies			
Assumptions for each lifecycle stage			
Test reports and measurement methods of energy consumption parameters			
Deviations from the PEFCR requirements and scenarii *Especially (if applicable):* • *Maintenance* • *Lifetime*			
DQR calculation of each dataset used for the most relevant processes and the new ones created.			

ITEM	Included in the study (Y/N)	Section	Page
DQR (of each criterion and total) of the study			
Justification of additional information			

10.3. Annex 3: Critical review report of the PEFCR

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	Review			ELP is using a document with a different line numbering from my version. I have changed line numbers as far as I could find. I attach my version of the PEFCR as reference for the line numbers. CC has same line numbering as KC.	N/A	
KC	General		ge	Comments from the critical review (version 28/3/2017) were checked. Outstanding major issues for remodelling were impact assessment, End-of-Life modelling, and data quality. The present PEFCR is updated on these issues.	N/A	
KC	General		ge	BoM was supposed to be added in annex; can be found in table 45. OK	N/A	
KC	General		ge	The final critical review is named “pre” as some information from the remodeller is still missing. The verification statement for the PEFCR will be written, when the document is final.		**Solved**
ELP	Acronym	205 - 215	ed	List the acronyms in alphabetical order.	Change applied	**Solved**
ELP	Acronym	205 - 215	ed	Acronyms to add: EU COM, ErP	Acronym ErP added, EU COM changed line 493	**Solved**
CC	Acronym	205	ed	Missing VI acronym	Acronym added	**Solved**
CC	Acronym	205	ed	Be careful: PCB acronym is not defined and it is used for two different terms in the PEFCR	Acronym removed	**Solved**
KC	Acronyms	205	ed	Add PWB: Printed Wiring Board	Acronym added	**Solved**
CC	Definitions	216	ed	Missing definition of reference product (to not be confused with representative product)	Definition added	**Solved**
CC	Definitions	217-433	ed	Missing relevant definitions from PEF Guidance v6.3: Bill of materials; EF study; Input flows; Type II environmental declaration	Definitions added at the exception of Type II environmental declaration, not useful to the PEFCR understanding. Reference to PEFCR Guidance 6.3 is made.	**Solved**
CC	Definitions	217-433	ed	List definitions in alphabetical order	Change applied	**Solved**
CC	2.1, table 1	461	ed	Starting date of participation shall be reported (Section B.2.1 Technical secretariat of PEF Guidance)	Change applied	**Solved**
CC	2.2	467	ed	Reference is Figure 3 of PEF Guidance 6.3 and not Figure 1	Change applied	**Solved**
ELP	2.1	469	ed	Some websites and email addresses are have a hypertext link to the page, others don’t. It should be consistent.	Change applied	**Solved**
ELP	2.1	469	ed	The PEP ecopassport logo is not displayed properly.	Change applied	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	2.2	487	te	Insert link to information on the “close to 80 representatives” and their respective affiliations.	Number of comments and stakeholders for each consultation is now included in the text List of stakeholders sent to the critical review panel	**Solved**
KC	2.3	493	ed	Change “Panel” to “panel”	Change applied	**Solved**
CC	2.3.1, table 2	497	ed	Correct spelling of affiliation is “I Care & Consult” and correct email is: caroline.catalan@i-care-consult.com	Change applied	**Solved**
KC	2.3.1, table 2	497	ed	KC affiliation is “kimconsult.dk”, not EEB. (EEB is European Environmental Bureau). KC worked as consultant to EEB for the pilot under EC funding.	Change applied	**Solved**
KC	2.3	503	ed	Last version is “May 2018”, but according to personal information from An de Schryver there are no substantial changes to the December 2017 version.	This version is not available on the Wiki. Version 6.3 is in use in the PEFCR.	**Solved**
KC	2.3.2	514	ed	There are no benchmarks defined? Chapter 7.1 defines “benchmark” – should be plural?	Should be plural as there are 4 representative products. Change applied	**Solved**
ELP	2.5	544	te	The sentence “Europe + EFTA shall be considered as the default market, with an equal market share for each country” is not clear. An equal market share would lead to a large importance to small countries compared to larger ones. The market share could be weighted, e.g. by population or GDP. Check consistency with the use of EU-27 electricity mix data used in 6.4.2.4 that includes a weighted market share.	Sentence is mandatory in PEFCR 6.3 §B.2.5 Geographic validity. Sentence in §6.4.2.4 “The electricity mix shall be adapted to the country (countries) specific conditions of the use stage. In case no country-specific information about the use stage is available, the “EU-27: Electricity Mix”, shall apply.” removed (error in the text of the section).	**Solved**
CC	2.7	549	ed	Correct citation is: PEFCR Guidance document – Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 2017. This document prevails in the list over PEF Guide.	Change applied	**Solved**
ELP	2.7	551	ed	Text of the chapter not in line with PEFCR guidance v.6.3 chapter B.2.7 requirements (the documents must be listed in prevailing order).	Change applied	**Solved**
ELP	2.7	554	ed	Last version of the document is “Product Environmental Footprint (PEF) Guide; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, 4 May 2013“.	Change applied	**Solved**
KC	2.7	554	te	The definitions of PCR and PSR should be added to clarify the type of documents versus the PEFCR. (A PEFCR is product group specific; what is then a PSR?)	Additional precisions added in 2.7	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
CC	3.1	577	te	According to PEFCR Guidance, the most relevant option for scope shall be clearly indicated (limited/wide/narrow) as it influences screening and benchmark process (6.6.6 from PEFCR Guidance)	PEFCR Guidance B.3 specifies: "This section shall include a description of the scope of the PEFCR and shall clearly list the number of sub-categories (if any) included in the scope of the PEFCR". This is what §3.1 provides. Sentence added to complete requirement from PEFCR Guidance 6.6.6: "PEFCR scope option The scope is relatively narrow, there is a single main function, but alternative technologies/materials delivering the same function are available." Be informed that the EC wanted the TS to remove the sentence	**Solved**
KC	3.1	584	ed	Why is the text blue? The citation is both black and blue.	Was not intentional. Change applied.	**Solved**
KC	3.1	596	ed	Delete ":" in headings.	Change applied	**Solved**
KC	3.1	603	te	Add more text explaining the different types of UPS and especially if this has implications for the environmental profile. And refer to 3.2.2.	Change applied: "Most common UPS topologies are stand-by (or backup) UPSs, line interactive UPSs or online UPSs (refer to 3.2.2 to see description)." No further description added to avoid repetitions.	**Solved**
ELP	3.1.2	622	ed	The sentence "UPSs in electrometrical applications with the UPS located within ≥1.5m of the patient contact" is not clear. The '≥' sign is confusing.	Typo error. ≥ sign is not applicable. Change applied	**Solved**
KC	3.1.2	618	te	Text should be added justifying the exclusions. Few sentences for each of the list points.	Change applied.	**Solved**
KC	3.1.3	633	Te	Add: "CPA does not help identifying the products covered by this PEFCR." Or something similar.	Sentence added: "CPA does not help precisely identifying the products covered by this PEFCR. There is a suitable and precise available classification in ecl@ss technical data standard[22] under no-break power supply group (27-06-06): • 27-06-06-01 UPS on line (double conversion) • 27-06-06-02 UPS off line (standby) • 27-06-06-03 UPS line-interactive (main parallel) • 27-06-06-90 no-break power supply (complete unspecified)."	**Solved**
KC	3.21	641	te	Insert reference to "ErP lot 27".	Change applied with reference to the preparatory study online	**Solved**

[22] ecl@ss is a product classification and description standard for information exchange between customers and their suppliers http://www.eclass.de/

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
ELP	3.2	642	ed	Missing sentence in this chapter, as per PEFCR guidance chapter B.3.2: "The screening study is available upon request to the TS coordinator that has the responsibility of distributing it with an adequate disclaimer about its limitations.".	Change applied	**Solved**
CC	3.2.1	648	te	Does it mean that larger UPS (bigger than 200 kW) are excluded from the scope of this PEFCR?	Not really, but there is no possible RP as this category is an addition of several smaller UPSs. As such, the applicant can apply the PEFCR for bigger UPSs, but they cannot make comparison with RP	**Solved**
CC	3.2.2	654	ed	The word "at" in the sentence "at the stand by topology" is confusing	Typo error, change applied removing "At"	**Solved**
KC	3.2.3	670	ed	Add IGBT to abbreviations.	Change applied	**Solved**
KC	3.2.3	676	ed	Circuit breaker (?)	Yes, change applied	**Solved**
KC	3.3.1	691	te	Is the 5 minutes backup for each power shortage or per year? For each – clarify!	Backup time fixes the number and capacities of batteries. When we fix this time to 5min, it is a maximum duration for 1 power shortage. There can be several power shortages during the life of the UPS depending on countries and usages (and so during 1 year of reference for the FU). Fixing the shortage duration allows using a reference for battery capacity and a reference dataset. It also allows setting up the maintenance frequency to replace batteries along UPS lifetime. For more clarity, FU is modified to: "To ensure the supply of power without interruption to equipment with load of 100 watts for a period of 1 year, including a backup time capacity of 5 minutes during power shortages."	**Solved**
KC	3.3.1	693	ed	Delete "an" – the UPS is not supplying a single electrical piece of equipment.	Change applied	**Solved**
CC	3.3.2	699	te	Considering Formula 1, I suggest to delete the part "of the total energy required by the product" from the sentence (it is not clear to me) or modify it with a mention such as "of the UPS defined output power" (for example)	"of the total energy required by the product" deleted as this is effectively confusing	**Solved**
ELP	3.3.1	693	ed	A part of the functional unit is missing: "To ensure the supply of power without interruption to *an electrical* equipment […].", as per table 4 line 1.	The most consistent is to harmonise "equipment" without mentioning "electrical" as many types of equipment may be power supplied by a UPS	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
CC	3.3.2	704	te	I understand that the choice of 1 year in the functional unit enables comparison between UPS, but is there any reference document that set some general guidance to define life time of UPS? (or refer to table 24)	Lifetime is defined in section 6.4.1	Solved
CC	3.3.2	713	ed	Replace “section 1” by “section 6”	Change applied to section 6.4	Solved
CC	3.4.1	720	ed	Remove “to” before the word “use”	Change applied	Solved
KC	3.4.1.1	740	Te	It is formally correct that the UPS manufacturer does not control the suppliers. But the UPS manufacturer, hopefully, choose among suppliers according to the manufacturers specifications. And thereby “control” the choice of supplier and the impacts from the suppliers’ activities. Delete the sentence.	“But UPS manufacturers do not control neither the material composition nor the manufacturing processes of the purchased parts (capacitors, batteries, fans, IGBT, thyristor, switch, fuse, printed circuit board, contactor, …) in the UPS.” deleted Proposal to replace “control” by “rule over” in the sentence: “UPS manufacturers usually buy components that are not customised, but on the basis of their technical specifications, standard and regulatory conformance. Therefore, UPS manufacturers do not rule over neither the composition nor the manufacturing processes of the supplied components.”	Solved
KC	3.4.1.1	753	te	Can you give an example of an “industrial transforming process” used in the production of an UPS? (Which is not covered by manufacturing). EXAMPLES ACCEPTED. MAYBE IT IS THE WORDING (FRENCH-ENGLISH)	I suppose you ask for examples of production processes applicable to the components of the product and not to the product itself. Eg included: compounding of cables, moulding or injection of plastics,…	Solved
KC	3.4.1.1	757	ed	Change “the wastes” to “waste”	Change applied	Solved
KC	3.4.1.2	778	te	Rephrase the sentence. I do not understand “set up in the cut off” and “out of the system boundary”. Change to “The distribution stage is not included in the product system according to the set cut-off rules; see 3.4.2.” (There is no need to write “section” in front of the number).	Change applied	Solved
KC	3.4.1.3	794	te	See comment to line 778.	Change applied	Solved
CC	3.4.1.4	797	ed	Replace “section 0” by the adequate section number	Reference to section 0 corrected in all the document	Solved
KC	3.4.1.4	798	ed	Why another “Use stage” heading? Delete.	Was not a heading but a reference to chapter 6.4 title that was no more functioning. Deleted	Solved
CC	3.4.1.4	802	te	Term “reference life time” could be confusing as it does not explicitly refer to “1 year” as in FU or “the life time of UPS” defined in Formula 1	“Reference” deleted All the flows during product lifetime shall be collected and assessment shall be brought back to the functional unit (explanations provided in 3.3.2 and 6)	Solved

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	3.4.1.5	810	te	What is “depollution treatment”? Detoxification?	It means sorting special handling components & removing hazardous materials as per WEEE requirements	**Solved**
KC	3.4.2	814	ed	Change title to “Cut-offs”. The paragraph is not defining the rule(s), but the consequences of the rule(s).	Change applied	**Solved**
KC	3.4.2	819	ed	Change to “Justification for the cut-off is given in Annex 5.” (remember hyphen in the heading)	Change applied	**Solved**
ELP	3.4.2	829-859	te	The exclusion of the listed processes is not justified. Their impact must be evaluated to be sure to stay under the 1% limit for the cumulated processes in cut-off for each indicator.	Sentence modified to ensure alignment with RPs and introduced in footnote. Footnote: In compliance with PEF Guidance 6.3 (2017): « In case processes are excluded from the model this shall be done based on a 1% cut-off for all impact categories based on environmental significance, additionally to the cut-off already included in the background datasets.” Cut offs are defined based on the results of the screening study and confirmed by the supporting study results and the representative product results.	**Solved**
KC	3.4.2	843	te	Some NOT (why upper case?) most relevant are included and others not? Which are not? Why are you looking for datasets for processes that are not most relevant? Missing data is NOT a cut-off, it is missing data. Delete the text here and include it in 5.3. Remark accepted. But why capital NOT?	Cut off, Limitation and data gap sections modified to align with RPs and include reviewers and EC comments.	**Solved**
KC	3.4.2	852	te	I do not understand how this works. Are you defining your own cut-off rules or repeating the PEFCR guidance? Is the second list point NOT a criterion? Put text in footnote (or delete).	Sentence deleted	**Solved**
KC	3.4.2	863-866	ed	Why is the text in bold?	To provide more visuals to the reader. Text back to normal.	**Solved**
ELP	3.5	879	ed	The link is not functioning.	Change applied Information: disclaimer added for the Water scarcity indicator	**Solved**
KC	3.6	884	ed	Change wording: Due to lack of data on the recycled content of antimony and lead in the UPS lead-acid batteries…” (or similar)	Change applied	**Solved**
CC	3.6	887	ed	I would replace “market” by “battery market” in order to not use an average recycled content in metal industry for example, which (I guess) would not be representative in this case	Change applied	**Solved**
KC	3.6	887	ed	PEFCR	Change applied	**Solved**
KC	3.6	893	ed	electronic (There are many editorial changes to be made for the final ENGLISH version. I am sure, we have identified all).	Change applied	**Solved**
CC	3.6	897	ed	Update “section 0”	Change applied	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	3.6	908	te	You don't need to control a supplier or sub-supplier to ask for data!!! "Data availability can be limited due to high number of suppliers and/or lack of willingness in supplying data. Secondary data for e.g. average electronic components shall be used as default in case of lack of specific data."? STILL NOT CLEAR. YOU CAN ALWAYS ASK FOR DATA. AND CHOOSE AMONG SUPPLIERS WHERE SUB-SUPPLIERS HAVE DELIVERED DATA. THE PRESENT TEXT INDICATES THAT THE UPS PRODUCER HAS NO RESPONSIBILITY. THIS IS NOT THE CASE	Suggested change: "UPS manufacturers buy components to tier 2-3 suppliers and the pre-processing steps before the assembly are not ruled over by the UPS manufacturers" Bill of components is in the company-specific data requirements. New suggestion: "the exact quantity of ores in electronic components is barely known: UPS manufacturers buy components to tier 2-3 suppliers and the pre-processing steps before the assembly are not ruled over by the UPS manufacturers"	**Solved**
KC	3.6	911	te	The CFF-M is developed for construction products. Is UPS a construction product? The modular form does not change the situation of lack of data. But as Sb and Pb are the sources of 71-86 % in all impact categories, the recycled content of Sb and Pb – as well as the recycling of UPS – will have huge impact on the results. I suggest to limit the EoL calculations to focus on Sb and Pb, but I am not sure if EC will accept this.	UPSs are not construction products but are part of buildings. As such and to ensure harmonisation with construction standards and other PEFCRs for construction elements, the CFF-M option is chosen by the TS. Note: the final form of the CFF implemented in the PEFCR is the initial CFF, not the modular form.	**Solved**
KC	3.6	925	te	Is "most significant" equal to "most relevant" used in the guidance? What is the contribution of PWB, compared to Sb and Pb? CONSIDER TO ADD % CONTRIBUTION FROM PWB	Changed to "most relevant processes" in reference with PEFCR section 4.3 Contribution is less relevant than Pb and Sb but still is ADDED: "(contribution of populated PWB production to the UPS lifecycle excluding the use stage reaches 30% of the climate change indicator for the "≥1.5 kW to 5 kW" sub-category)."	**Solved**
CC	3.6	936-940	te	Indicate source of these EF-compliant proxies	Mention added: "(refer to section 6 for the references to the datasets)"	**Solved**
CC	3.6	939	ed	Update mentions of "section 0"	Change applied	**Solved**
ELP	3.6	930	ed	Refer to PEFCR guidance version 6.3 instead of 6.2.	The PEFCR Guidance used as a reference by the remodellers for the transport assumptions is version 6.2	**Solved**
KC	3.6	948	ed	What is "chapter 0"?	Change applied	**Solved**
KC	3.6	953-54	te	Requirements shall be followed – you do no strictly follow recommendations! Avoid use of wording like "strictly", as it implies that some requirements shall not be followed so strictly!	Change applied: "Requirements formulated in this PEFCR shall be followed."	**Solved**
KC	4.1	971	te	The sentence is hard to understand. Rewrite e.g.: "The most relevant impact categories are those contributing the most to at least 80% of the total environmental impact (excluding toxicity related impact categories)." (The wording in the guidance is also not so clear!)	Changed to "The most relevant impact categories are the ones that cumulatively contribute to 80% or more of the total environmental impact (excluding toxicity related impact categories)."	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	4.1	977	ed	…subcategories (i.e. the four main types)	Changed to “for the 4 product subcategories”	**Solved**
KC	4.1	982	ed	Link to the remodelling results?	Reference to section 7.1 added	**Solved**
KC	4.2	990	te	What is the uncertainty? 2 decimals indicate very high precision. Consider NO decimals, rounded numbers.	Change applied, no decimals (results were provided as such by the remodeller)	**Solved**
KC	4.3	1003	ed	Sort the processes in order – highest contribution on top.	Change applied	**Solved**
KC	5	1017	ed	Change “Obligations” to “Requirements”	Change applied	**Solved**
KC	5	1019	ed	Description on how to handle data gaps?	Change: “Description of data gaps encountered and how to handle them”	**Solved**
KC	5	1023	ed	Section 0?	Change applied	**Solved**
KC	5	1032	te	What are “newly created processes”?	Sentence from the PEFCR Guidance 6.3	**Solved**
KC	5.1	1050	te	The list point are repetitive. No need to point out that the UPS producer does not control the activities at the suppliers. The UPS producer knows already. The document just stated that they can use secondary data. Delete 1049-1060.	Change applied	**Solved**
KC	5.1	1054	ed	Another “section 0”!	Change applied	**Solved**
CC	5.1.1	1076	ed	Replace “is” by “are”	The composition IS (not are) Change not accepted	**Solved (the line indicated for the correction was not the right one, but An made the correction anyway)**
KC	5.1.1	1067	Ed	Use rounded figures e.g. 95-99% - the uncertainty is not reported here, but the variation on data is higher than 0,01%.	Change applied	**Solved**
KC	5.1.1	1067	te	Explain the relation between the 71-86% in clause 3.6 and the 95-99% here.	71-86% contribution is concerning batteries (excluding the use stage) while 95-99% is concerning the contribution of the use and maintenance stage to the overall lifecycle Clarification included in section 3.6: “However, battery production and primary content of antimony in batteries contributing from 71% to 86% of the overall representative UPSs results (weighted and normalized, excluding use and maintenance stage) depending on the sub-category of UPS”	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	5.1.1	1068	ed	How can battery content be in primary antinomy? In general, the text is not easy to understand in many clauses. I would recommend to write the document through by a journalist or alike (in proper English), but this is not possible due to the timing. Sad! I THINK THE 3-TIER SUPPLIER KNOWS THE AVERAGE CONTENT OF SECONDARY Sb. IF DATA ARE NOT AVAILABLE, TEXT ON SENSITIVITY TO A TYPICAL VARIATION (0-100%?) SHOULD BE ADDED. ALTERNATIVELY, ADD A SENTENCE: "THE SUPPLY OF Sb FOR THE BATTERIES ARE TYPICALLY A MIX OF PRIMARY AND SECONDARY Sb. THE EXACT CONTENT IS CONFIDENTIAL WITH THE SUPPLIERS OF Sb."	Part of antimony content in lead-acid batteries is primary, the rest is secondary (from recycling). An average of the battery market has been found to model a typical primary/secondary antimony mix that is set up in the lead-acid battery dataset. Suggested change: "The amount of virgin antimony (primary raw material) contained in lead-acid batteries is hardly collectable by UPS manufacturers as they refer to third-tier suppliers." ADDED: "The supply of sb for the batteries are typically a mix of primary and secondary sb. The exact content is confidential with the suppliers of Sb."	**Solved**
KC	5.1.1	1068	te	The batteries are not easy to collect by the UPS producer as the use is with many different customers. But such take-back systems exists for other (electrical and electronic) products. And anyway, the UPS producers shall inform the users on the importance of recycling the batteries anyway, as confirmed by the results of the remodelling. The PEFCR is not intended to be an excuse for the producers for not doing what can be done, sorry!	For more user-friendliness, all the datasets have been listed in an accompanying excel file. In addition: - a disclaimer is added in the sections that recommends to the applicant to develop company-specific dataset for battery modelling (disclaimer included in §6.1.2 and §6.4.3) - disclaimers are requested to the purchaser or user and the recycler on the importance to recycle batteries (§7.4.2)	**Solved**
KC	5.1.1	1076	ed	What is "…"?	It depends on the UPS manufacturer Suggested change: (capacitors, batteries, fans, IGBT, thyristor, switch, fuse, printed circuit board, contactor - list depending on the UPS manufacturer)	**Solved**
CC	Table 13	1081	te	Is the default dataset "steel external plug" available on Thinkstep node?	Yes	**Solved**
CC	Table 13	1081	te	Are there any welding steps performed by UPS manufacturers? (implying various welding technologies)	Not referenced in the ErP lot 27 preparatory study at the basis of the assessment	**Solved**
CC	Table 13	1081	te	There is no default dataset for lead acid battery to recommend? I DON'T UNDERSTAND THE ANSWER. CANNOT BE REQUIRED AS COMPANY SPECIFIC?	Yes there are, for lead-acid battery technology only. Lead-acid Battery datasets are referenced in section 6.1.2 and in complementary Excel "UPS PEFCR – Life Cycle Inventory" Disclaimer to the applicant modified §6.1.2 and §6.4.3.2 referring to situation 2/option 1 and situation 3/option 1 of the DNM for more clarity	**Solved**
CC	Table 13	1081	te	Why is the DQR of electricity equal to 1?	This data is informed by the EC	**Solved**
CC	Table 13	1081	te	Is there any tin-plated steel process available?	Yes. Available in complementary Excel "UPS PEFCR – Life Cycle Inventory", sheet "5.1 Manufacturing-specific"	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
CC	Table 13	1081	te	It seems that EPS material is missing	Yes. Available in complementary Excel "UPS PEFCR – Life Cycle Inventory", sheet "5.1 Manufacturing-specific"	**Solved**
KC	Table 13	1081	ed	Add short explanation of TiR = Time Representativeness, TeR, GR, and P. They are used to calculate DQR. Or refer to 5.4.	Reference to section 5.4 added in 5.1 foreword	**Solved**
ELP	Table 13	1081	te	Two significant processes are not included in the table: PSU and capacitors.	PSU and capacitors have been integrated to the populated PWB for the modelling of RPs to simplify the modelling. Complementary Excel "UPS PEFCR – Life Cycle Inventory", sheet "5.1 Manufacturing-specific" provides the applicant with the full list of datasets that shall be "product-specific" for the UPS BOM, BOC and processes	**Solved**
ELP	Table 13	1081	te	Cast iron: the process chosen is for secondary production only.	Refer to previous answer	**Solved**
ELP	Table 13	1081	te	Epoxy resin: is there no hardener/curative associated?	Refer to previous answer	**Solved**
ELP	Table 13	1081	te	Steel sheet part: the material production process is missing.	Refer to previous answer	**Solved**
ELP	Table 13 – Note 1	1081	ed	"the EC have make a decision" to be replaced by "the EC have made a decision".	Change applied: "the European Commission has made a decision"	**Solved**
CC	Table 14	1088	ed	Keep the entire default dataset name for electricity (as in Table 13)	Change applied	**Solved**
ELP	5.1.1	1090	ed	Provide relevant titles for processes A and B.	Change applied	**Solved**
KC	5.1.2	1092	te	Who is "the Applicant"? Is it the use of the PEFCR? Where do the user apply? For what? The term is used in several places. Maybe add to definitions?	This wording is the one referred to in PEFCR Guidance 6.3 to address the name of the organisation applying the PEFCR. It is used as such in the UPS PEFCR.	**Solved**
CC	5.1.3	1096	te	Why the sampling procedure does not refer to steps defined in PEFCR guidance?	Suggestion for simplification of the PEFCR (as sampling is unlikely to happen): "Sampling is not allowed" (§5)	**Solved**
KC	5.1.3	1096	te	One year is the minimum? See Guidance 6.3.	Sampling no more allowed, section deleted from PEFCR	**Solved**
KC	5.2	1106	te	Delete the clause. Its repetition of text in several other clauses on what you can and cannot control. It is your decision to determine if data quality of secondary data is OK for certain processes. The PEFCR guidance requires primary data for all "most relevant" processes. This is the check point.	"UPS manufacturers control the design of the product (refer to 5.1.1). As they do not own neither the manufacturing of those parts and components, nor the composition, these processes belong to Situation 2 of the DNM (refer to 5.5.2)." deleted	**Solved**
KC	5.3	1128	ed	~~B~~battery	Change applied	**Solved**
KC	5.3	1135	ed	Otherwise	Change applied	**Solved**
KC	5.3	1140	te	If data are found, it is not a "data gap" but a case of potentially lower data quality!	Refer to above answer to comment: Data gap section changed	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	5.4	1164	te	The text is mostly redundant to other text including text of Guidance 6.3. For the user of the PEFCR, it is important to know which secondary data sets are acceptable from a data quality point of view i.e. section 5.6. Maybe 5.4 and 5.5 can be in an annex? The data quality does not increase because of a lot of text on data quality and data need, only by getting data of higher quality. And the data quality assessment is anyway highly subjective. Sorry, this is a challenge with the guidance that USP TS cannot solve. But I needed the air… AND THE REVIEWER ACCEPTS THE RULING OF EC	EC did not approve the requested change	**Solved**
ELP	5.6	1355	ed	While in line with the PEFCR guidance v.6.3 requirement, the RDC / FEVE node is missing in the list: (http://soda.rdc.yp5.be).	Change applied	**Solved**
KC	5.9	1370	te	What is specific to UPS? Most of the text is generic (Guidance 6.3)? Revise to what is specific to UPS (if anything!).	EC did not approve the requested change	**Solved**
KC	5.10	1486	te	As 5.9! (If readers of the UPS PEF needs a textbook on how to read the PEF, they can use the Guidance document. It the UPS TS determines to develop a "Pixi book on how to understand an UPS PEF", you should do so. But don't mix it with the PEFCR. 1575-1578 is all you need.	EC did not approve the requested change	**Solved**
KC	5.11	1580	te	As 5.9 and 5.10. The text should be focusing on the consequences of recycling or not the lead-acid batteries (and other components and materials); that is the "most relevant" processes.	Refer to answer to comment §5.1.1, li 1068	**Solved**
CC	5.11.1	1589	ed	Precise that the form of the CFF presented is the "modular" form	Change applied Note: the final form of the CFF implemented in the PEFCR is the initial CFF, not the modular form.	**Solved**
ELP	5.11	1600	ed	"The waste of products used during the manufacturing, distribution, retail, the use stage or after use shall be included in the overall modelling of the life cycle of the organisation". While in line with the PEFCR guidance, it should be "the life cycle of the product".	Change applied	**Solved**
ELP	Figure 5	1674	ed	The diagram has to be updated with "antimony" instead of "lead".	No. Lead is taken as an ILCD EL compliant proxy and as a consequence antimony EoL is in limitations (refer to §3.6)	**Solved**
KC	6	1680	ed	If would make more use to have this section before and not after the LCI text. But you have to follow the layout. (Clause 6 is actually what could be expected in the "Goal and scope definition" of an LCA, and therefore logically comes first)	OK, remark understood but no change applied to conform with PEFCR template	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
ELP	Table 23	1722	ed	All processes from table 13 and 14 are missing. The table shall list all processes taking place in this life cycle stage As per PEF guidance v.6.3 chapter B.6.1, the processes expected to be run by the company shall be included in the table in capital letter.	To avoid repetition and ensure PEFCR clarity, section is modified and complementary Excel file reference added. Processes excepted to be run by the company in capital letters.	**Solved**
ELP	Table 23	1722	ed	Diesel for train transport: the default amount for the <1.5 kW is written as 0 but it should have a value.	Transports are described with default PEFCR Guidance 6.3 instructions + default values are provided in the complementary Excel	**Solved**
ELP	Table 23	1722	ed	Steel cold rolled (alloyed): the process chosen is for secondary production only.	Accepted for the modelling of RPs.	**Solved**
ELP	Table 23	1722	ed	Title to be changed with content in PEFCR guidance v.6.3 table B.10 title: “Raw material acquisition and processing (capitals indicate those processes expected to be run by the company)”.	No table, reference to complementary Excel	**Solved**
KC	6.1.3	1731	te	What is specific to UPS? The UPS PEFCR shall not repeat the PEFCR Guidance?	Yes it does apply to UPSs This is a selection of mandatory section from PEFCR Guidance and refers to the default values provided in table 19 of the UPS PEFCR	**Solved**
ELP	6.1.3	1734	ed	“as provided in the Table 18 below”: the table 18 is above.	Modified	**Solved**
KC	6.4.1	1781	te	The text in the box is the conclusion? Sometimes, such conclusions are in bold without a box. What is the difference? I WOULD SUGGEST TO USE BOXES WITH THE CORE REQUIREMENTS OR RECOMMENDATIONS WHEN YOU HAVE A LONG CHAPTER TEXT. IN THE SHORT CHAPTERS THIS IS NOT NEEDED. AND TO ADD A DISCLAIMER THAT THE READER CANNOT USE THE BOXES ALONE!	(This is an editorial remark. Not a technical remark) Bold was chosen to raise the attention of the reader on aspects of importance. Text in bold was generally harmonised to normal text. Text in blue box is of specific importance to the applicant. Clarified as a disclaimer. Suggestion interesting but not seen as possible to apply	**Solved**
CC	Formula 5	1833	te	Is this formula coming from the Energy Star requirements also? (cite relevant reference for calculation)	Yes, reference introduced. Amendments to §6.4 have been made for more clarity and alignment with Energy Star® Program Requirements for UPSs, Version 2.0	**Solved**
ELP	Table 27	1843	te	The equations 1 for the average efficiency must include the 0.75 and 0.25 coefficients for the multimode calculation.	Change applied Change applied for table 28 and Formula 5	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
ELP	Table 30	1895	te	Battery, fan, PSU and capacitor: the default amount per unit of UPS is misleading: while it should be understood as a number of time the components are replaced during the use of the product, it could be understood as the replacement of a single component, especially for the PSU and capacitor for which the processes have an associated mass (0,27kg and 9,5 g).	Change applied: "The Table 30 describes the number of times the UPS components shall be replaced during the life of the product"	**Solved**
ELP	6.5.1	1897	ed	The list of substance could also refer to European WEEE directive (2012/19/EU) Annex VII as it is the source for the list. In addition, there is the "mercury containing components" category missing.	Reference added and list updated	**Solved**
CC	6.5.1	1897	ge	There is no specific process to decommission UPS?	No	**Solved**
CC	6.5.2	1947	ed	Replace "Maintenance" by "end of life"	Change applied	**Solved**
KC	Table 32	1953	te	Explain yellow and red colouring!	No more applicable	**Solved**
CC	Table 32	1953	te	Is there other default dataset for ferrite end-of-life?	Not in EC DB	**Solved**
CC	Table 32	1953	ed	Wood residue appears in the PC granulate section of the table	Error of UUID provided by the remodeller and is replaced by EU-28+EFTA: Plastic granulate secondary (simplified, non-specific) that is a "partly terminated" dataset, used in the RPs	**Solved**
ELP	Table 32	1953	te	There are default values for some process quantities that should be product-specific values in the manufacturing phase as defined in 5.1.1 (e.g. PWB). If the values are known, there is no need for default values in end of life. Other processes are not listed in 5.1.1 nor 6.1 and have default values in end of life, such as capacitors and PSU.	All the processes for UPS manufacturing, at the exception of electricity for assembly, packagings and transports, have been set up as company-specific in an accompanying excel file Idem for UPS EoL	**Solved**
ELP	Table 32	1953	te	Recycling ABS, cardboard, EPS, PC and wood data missing (for plastic they can be approximated by the use of secondary plastic production (unspecified) process, as per 5.11.3).	For plastics: Error of UUID provided by the remodeller and is replaced by EU-28+EFTA: Plastic granulate secondary (simplified, non-specific) that is a "partly terminated" dataset, used in the RPs	**Solved**
ELP	Table 32	1953	te	1% of lead is not recycled (table 19). It could have an important impact if emitted to the environment (e.g. though leaching in landfill) so is has to be accounted for with the right process, or its exclusion in the cut-off has to be justified.	Processes and instructions added both the PEFCR and in the Excel	**Solved**
ELP	Table 32	1953	te	Antimony and sulphuric acid: processes to be added.	Processes and instructions added both the PEFCR and in the Excel Sulphuric acid and PP are mass allocated in the Lead recycling dataset and shall not be further modelled. Water EoL is in the data gap Glass EoL: is to be modelled for EoL only, as in the maintenance cut off (alignment with RPs)	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
KC	7.1	1989	te	Add disclaimer that “benchmark” means the average of products on the market, not the best performing.	Sentence introduced: “Reminder derived from PEFCR Guidance 6.3 (2017): A benchmark is a standard or point of reference against which any comparison can be made. In the context of this PEFCR, the term ‘benchmark’ refers to the environmental performance of each of the 4 UPS average (or representative) products, sold in the EU market. A benchmark is not the environmental performance of best in class or best performing products. Values of a benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.”	**Solved**
KC	7.1	1989	te	Uncertainty (variation) of data should be added. Or at least an indication +/- 10 %, +/- 50 %? BAD REMODELLING!	Uncertainty was not assessed by the remodeller and cannot be provided, even if considered as useful also by the TS	**Solved**
CC	7.1	1992	te	Specify the set of normalisation factors used (Normalisation factor per person)	Sentence added: “Characterisation methods, as well as normalisation and weighting factors have been applied in conformance with section 3.5 and Annex 1: List of EF normalisation factors and weighting factors.”	**Solved**
ELP	7.2	2024	ed	The link is not functioning.	Change applied	**Solved**
KC	7.3	2028	te	Add definition of “Constituent Material” – and why upper case letters? ACCEPTED	Simplification suggested: “Additional technical information shall be reported by the applicant:”	**Solved**
KC	7.3	2047	ed	“Value”? It is not economic value? Use “Weight%”? ACCEPTED	Simplification suggested: “Masses of substances and materials lower than 0.1 % shall be reported as "<0.1%"	**Solved**
KC	7.4	2053	te	Nothing specific for UPS. Refer to PEFCR guidance and start with 7.4.1. Although, again 7.4.1 is generic to EEE, not specific to UPS. ACCEPTED	This introduction aimed at harmonising the PEFCR with current UPS manufacturer practice and refers to PEP ecopassport® PCR ed.3 requirements. Introduction removed.	**Solved**
KC	7.4.4	2117	te	Mining has a huge impact on biodiversity includng mining of antimony and lead. Biodiversity around the antimony mine in China is not very good. Maybe “There are no data readily available for assessing biodiversity impacts of the production, use and disposal of UPS. Mining activities have in general major impacts on the local area, including on the biodiversity.” ACCEPTED	Suggestion: “Mining activities may have major impacts on the local area, including on the biodiversity. However, there are no data readily available for assessing biodiversity impacts of the UPSs lifecycle.” + deleted sentence on relevance	**Solved**
ELP	10.1.2	2235	ed	The photochemical ozone formation, human health final weighting factor, and the land use calculation values different from PEFCR guidance v6.3 annex A p. 158.	The values are taken from the table “WITHOUT TOX CATEGORIES (applied in the pilot phase)”	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
CC	Table 45	2246	ed	33 4970.5 should be 334 970.5 (etc.)	Change applied	**Solved**
ELP	10.4.3	2269	Te	Capacitors are not listed while accounting for an important mass of the UPSs.	Capacitors are not listed as part of the populated PWBs.	**Solved**
ELP	10.4.3	2269	ed	Total weight for the >10 to 200 kW: writing is unclear.	Change applied	**Solved**
ELP	All document	805-806, 905, 930, 957, 1034, 1065, 1067, 1070, 1131, 1136, 1166, 1437, 1458, 1643	ed	Some links to sections are broken / must be updated.	Change applied	**Solved**

1	2	(3)	4	5	6	7
MB[1]	**Clause No./ Subclause No./ Annex / Figure / Table**	**Line Number**	**Type of coment[2]**	**Comment (non-conformity) by reviewer**	**Proposed change by practitioner/TS**	**Status (green = solved) (yellow = waiting) (red = not solved)**
ELP	All document	985, 1001, 1015, 1018, 1020, 1022, 1078, 1093, 1100, 1660, 1670, 1695, 1742, 1838, 1852, 1862, 1972, 2014, 2015, 2016, 2019, 2020, 2021, 2024, 2025, 2026, 2029, 2030, 2031, 2320	ed	Check the use of commas instead of periods for the decimal separator.	Check done	**Solved**

10.4. Annex 4: Description of the representative products

Rules described in the PEFCR were developed based on the screening study and remodelling conducted on 4 UPS representative products. The four representative products are described below.

10.4.1. Definition of the representative UPSs

As a first step, the representative products were defined reflecting the different UPS sizes and topologies in alignment with ErP Lot 27 Task 5 (2013).

Following the definition of the representative UPSs, their characteristics are based on the ErP Lot 27 Task 5 (2013) report including a bill of materials (a list of materials and their weight fractions) for the 4 different sizes of UPS. The topology highly influences the electricity consumption of the UPSs.

The BOMs were revised based on the PEFCR Guidance 6.3 (2017) requirements, in particular due to the changes in the Environmental Footprint (EF) Impact Assessment Method for a better representativeness of the Abiotic resource depletion indicator. The remodelling of the representative UPSs has included these revisions.

The description below provides the description of the different aspects of the representative UPSs that were taken into account for the remodelling.

10.4.2. "Fraction of UPS" that fulfils the FU

Parameter	UPSs < 1.5 kW	UPSs ≥1.5– 5 kW	UPSs ≥5– 10 kW	UPSs ≥10-200 kW
Min power output (in W)	0	1 500	5 100	10 100
Max power output (in W)	1 400	5 000	10 000	200 000
Average power output (in W)	540	2 870	6 250	94 500
Life time (in years)	5	8	10	15
Fraction of UPS (/y/100W)	0,037037	0,004355	0,001600	0,000071

10.4.3. Representative UPSs – manufacturing stage parameters

The following table provides the bill of materials for the four referent UPSs considered in the remodelling. The data were obtained from the ErP Lot 27 Task 5 (2013) and expanded by data collected in the TS.

Material	Below 1.5 kW	1.5 to 5 kW	>5 to 10 kW	>10 to 200 kW
LDPE	/	/	/	80,0
HDPE	/	/	/	1 333,3
PVC	85,0	261,6	241,8	6 000,0
ABS	1 216,0	547,7	662,5	5 197,3
PA6	/	19,9	57,5	73,3
PC	/	74,3	5,5	41,0
PMMA	/	/	/	10,0
Epoxy	10,0	19,7	44,5	66,7
Talcum filler	/	0,7	/	/

E glass fibre	/	13,9	17,3	3,3
Aramid fibre	/	/	/	1 666,7
St sheet galv	/	5 089,8	/	157 083,3
St tube/profile	/	7,5	15 106,0	/
Cast iron	1 123,0	1 277,8	125,7	32 000,0
Ferrite	91,0	303,2	955,5	18 790,0
Stainless 18/8 coil	25,0	/	/	/
Al sheet/extrusion	117,0	657,1	1 712,0	21 526,7
Cu winding wire	480,0	482,5	/	21 768,3
Cu wire	232,0	428,3	1 022,6	24 650,0
Cu tube/sheet	/	4,5	/	19 733,3
CuZn38 cast	/	103,9	183,4	2 916,7
Powder coating	/	20,7	12,5	1 500,3
LCD per m2 scrn	/	11,3	/	0,3
Slots. Ext. Ports	250,0	/	275,0	650,0
PWBs	172,5	1 154,8	2 895,9	19 740,0
Solder	70,0	158,2	66,8	140,0
Total weight	**3 871,5**	**10 637,1**	**23 384,5**	**334 970,5**

Table 44. Bill of Materials of the representative UPSs, in grams

The table below provides a bill of materials for the lead-acid batteries of the four representative UPSs. The data were obtained from the ErP Lot 27 Task 5 (2013) and updated with 2017 and 2016 Urban Mine Platform data for lead and antimony primary and secondary contents:

Material	Below 1.5 kW	1.5 to 5 kW	>5 to 10 kW	>10 to 200 kW
Lead/lead oxides – total	1 997,4	10 619,7	27 563,4	487 402,2
Primary lead (20% of lead content)	*407,4*	*2 166,0*	*5 621,8*	*99 410,6*
Secondary lead (80% of lead content)	*1 590,0*	*8 453,7*	*21 941,6*	*387 991,6*
Polypropylene	332,9	1 770,0	4 593,9	81 233,7
Sulphuric acid	332,9	1 770,0	4 593,9	81 233,7
Water	539,7	2 869,4	7 447,6	131 694,8
Glass	66,6	354,0	918,8	16 246,7
Antimony - total (3% of lead content)	59,5	316,5	821,5	14 525,8
Primary antimony (21% of antimony content)	*12,4*	*65,9*	*171,0*	*3 024,6*
Secondary antimony (79% of antimony content)	*47,1*	*250,6*	*650,4*	*11 501,3*
Total weight	**3 329,0**	**17 699,5**	**45 939,0**	**812 337,0**

Table 45. Bill of Materials of batteries, in grams, for each representative UPSs

The following tables provide the bill of materials for the packaging of the four representative UPSs. The data were obtained from the ErP Lot 27 Task 5 (2013):

Material	Below 1.5 kW	1.5 to 5 kW	>5 to 10 kW	>10 to 200 kW
Cardboard	535,0	946,0	3 520,0	8 850,0
PP	0,0	34,0	160,0	167,0
HDPE	36,0	0,0	0,0	12,0
EPS	78,0	108,0	0,0	290,0
PVC	0,0	0,0	0,0	500,0
LDPE	0,0	558,0	2 350,0	0,0
Office paper	77,0	150,0	0,0	0,0
Total weight	**726,0**	**1 796,0**	**6 030,0**	**9 819,0**

Table 46. Bill of Materials of the unitary packaging, in grams, for each representative UPSs

Parameter	Below 1.5 kW	1.5 to 5 kW	>5 to 10 kW	>10 to 200 kW
Palette space (p) for 1 UPS	0,0156	0,0572	0,3775	1
Packaging reuse rates	Packaging is considered to be used only once			

Table 47. Bill of Materials of the secondary packaging, for each representative UPSs

The following table provides the raw material processing and product manufacturing processes. The data were obtained from assumptions from TS manufacturers based on site data:

Parameter	Assumptions						
Blowing technique	Blown with HFC-134a.						
Processing of plastics contained in the BOM of the UPSs		Injection moulding	Blow moulding	Extrusion, plastic film	Foaming	Calendering	Thermofor-ming
	LDPE	80%	15%	5%	0%	0%	0%
	HDPE	100%	0%	0%	0%	0%	0%
	PVC	0%	0%	0%	100%	0%	0%
	ABS	100%	0%	0%	0%	0%	0%
	PA6	100%	0%	0%	0%	0%	0%
	PC	80%	0%	0%	0%	20%	0%
	PMMA	100%	0%	0%	0%	0%	0%
	Epoxy	0%	0%	0%	0%	0%	100%
Powder coating	• 50% of the powder coating is used for aluminium parts • 50% of the powder coating is used for steel parts						
Loss of material during processing	Generic loss of 10% for plastics, and 20% for all other materials.						
Origin of raw and basic materials	International.						
Production region of components	International.						

Table 48. Processes applied to each representative UPSs manufacturing

Transports (default parameter as required in PEFCR Guidance 6.2 (2016)):

- Suppliers located outside Europe: 1000 km by truck and 18000 km by ship.
- From factory to DC: 1200 km by truck (factory in Europe).

10.4.4. Representative UPSs – distribution stage parameters

Transport from DC to final client - 100% Local: 250 km round trip by van (default data as required in PEFCR Guidance 6.3 (2017)).

10.4.5. Representative UPSs – installation stage parameters

Transport of a technician on site - 100% Local: 250 km round trip by van (default data as required in PEFCR Guidance 6.3 (2017)).

Installation processes, collection and treatment of packaging wastes are excluded from the system boundary.

10.4.6. Representative UPSs – use stage parameters

The average consumption per year of each representative UPSs were defined based on ErP Lot 27 Task 5 (2013) and scaled up to the lifetime of the UPSs:

Parameter	<1.5 kW	≥1.5 to 5 kW	>5 to 10 kW	>10 to 200 kW
Electricity consumption (in kWh/year)	377,7	1 929,4	3 120,75	42 839,69
Electricity consumption (in kWh/lifetime)	1888,5	15435,2	31207,5	642595,35

Table 49. Electricity consumptions per year for each representative UPSs

The lifetimes and maintenance of each representative UPSs were defined based on PSR0010 (2015) from PEP ecopassport® EPD program operator:

Representative UPS	Typical lifetime in years	Maintenance frequency (nb unit replaced during UPS lifetime)			
		Capacitor	Fan	Power supply	Lead-acid battery
<1.5 kW	5	No maintenance			
≥1.5 kW to 5.0 kW	8	1	1	1	1
>5 kW to 10 kW	10	1	2	1	1
>10 kW to 200 kW	15	2	3	2	2

Table 50. Lifetime and maintenance frequencies for each representative UPSs

For the modelling of batteries end of life, the circular footprint formula is applied (refer to 10.4.7 for parameters).

Transport of a technician 100% Local: 250 km round trip by van (default data as required in PEFCR Guidance 6.3 (2017)).

10.4.7. Representative UPSs – recycled content and end of life parameters

For the modelling of each representative UPS end of life, the circular footprint formula is applied.

The R1, R2 and R3 values of the representative UPSs BOM elements were obtained from IEC TR 62635 standard, Urban mine platform, ILA and EUROBAT and complemented with PEFCR Guidance 6.3 (2017) Annex C:

UPS BOM elements*	R1	R2	R3	Source
LDPE	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
HDPE	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
PVC	0	0	0,9	IEC TR 62635:2012 (RCR recycling rate) Table D.4
ABS	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
PA6	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
PC	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
PMMA	0	0,7	0,2	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Epoxy	0	0	0,9	IEC TR 62635:2012 (RCR recycling rate) Table D.4
St sheet galv	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
St tube/profile	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Cast iron	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Ferrite	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Stainless 18/8 coil	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Al sheet/extrusion	0	0,9	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
Cu winding wire	0	0,95	0	PEFCR Guidance 6.3 (2017) Annex C (Copper, electronic applications, cables)
Cu wire	0	0,95	0	PEFCR Guidance 6.3 (2017) Annex C (Copper, electronic applications, cables)
Cu tube/sheet	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
CuZn38 cast	0	0,93	0	IEC TR 62635:2012 (RCR recycling rate) Table D.4
lcd per m2 scrn	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.1
PWB, components and soldering	0	Integrated into EF datasets		
Lead / Lead Oxides	0,80	0,99	0	Urban Mine platform (R1), ILA/EUROBAT (R2)
Polypropylene	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.1
Sulphuric acid	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.1
Water	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.1
Glass	0	0	0	IEC TR 62635:2012 (RCR recycling rate) Table D.1
Antimony	0,79	0,99	0	Urban Mine platform (R1), ILA/EUROBAT (R2)

* For elements not mentioned in the table, values are set to 0.

Table 51. R1, R2 and R3 values implemented in the CFF

All values (A, Qsin/Qp and Qsout/Qp) are set up in conformance with Table 19.

Page left blank intentionally