Product Environmental Footprint Category Rules Guidance

Version 6.3 – May 2018

Preface

This document (henceforward, the PEFCR Guidance) provides instructions on how to develop a Product Environmental Footprint Category Rules (PEFCR). The content of this PEFCR Guidance will be periodically revised by European Commission services. The PEFCRs developed during the Environmental Footprint pilot phase (2013-2018) shall be fully in line with this version of the guidance. Any derogation from this general rule is only possible with the agreement of the Commission.

Please cite this document as European Commission, *PEFCR Guidance document*, - Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 2017.

For any technical question related to the content of this guidance, please refer to the functional mailbox env-environmental-footprint@ec.europa.eu

Disclaimer

The European Commission accepts no responsibility whatsoever nature to third parties to whom this Guidance, or any part thereof, is made known. Any such party relies on the Guidance at their own risk.

Table of content

1 List of tables

2 List of figures

3 List of acronyms

AF	Allocation Factor
AR	Allocation Ratio
B2B	Business to Business
B2C	Business to Consumer
BoC	Bill of Components
BoM	Bill of Materials
BP	Bonne Practique
CF	Characterization Factor
CFF	Circular Footprint Formula
CFF-M	Circular Footprint Formula – Modular form
CMWG	Cattle Model Working Group
CPA	Classification of Products by Activity
DC	Distribution Centre
DMI	Dry Matter Intake
DNM	Data Needs Matrix
DQR	Data Quality Rating
EA	Economic Allocation
EC	European Commission
EF	Environmental Footprint
EI	Environmental Impact
EoL	End-of-Life
FU	Functional Unit
GE	Gross Energy intake
GR	Geographical Representativeness
GHG	Greenhouse Gas
GWP	Global Warming Potential
HD	Helpdesk
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	Joint Research Centre
LCDN	Life Cycle Data Network
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LT	Lifetime
NDA	Non Disclosure Agreement
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile compounds
P	Precision
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
RF	Reference Flow
RP	Representative Product
SB	System Boundary
SC	Steering Committee
SMRS	Sustainability Measurement & Reporting System
SS	Supporting study

TAB	Technical Advisory Board
TeR	Technological Representativeness
TiR	Time Representativeness
TS	Technical Secretariat
UNEP	United Nations Environment Programme
UUID	Universally Unique Identifier

4 Terms and definitions

For all terms used in this Guidance and not defined below, please refer to the most updated version of the Product Environmental Footprint (PEF) Guide, ISO 14025:2006, ISO 14040-44:2006, and the ENVIFOOD Protocol.

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[1] and then combined to derive the environmental footprint associated with that process (See Figure 1). 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.

Aggregated dataset - This term is 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. See Figure 1[2].

Application specific – It 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.

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.

Bill of materials – A 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.

[1] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2011).
[2] Source: UNEP/SETAC “Global Guidance Principles for LCA Databases"

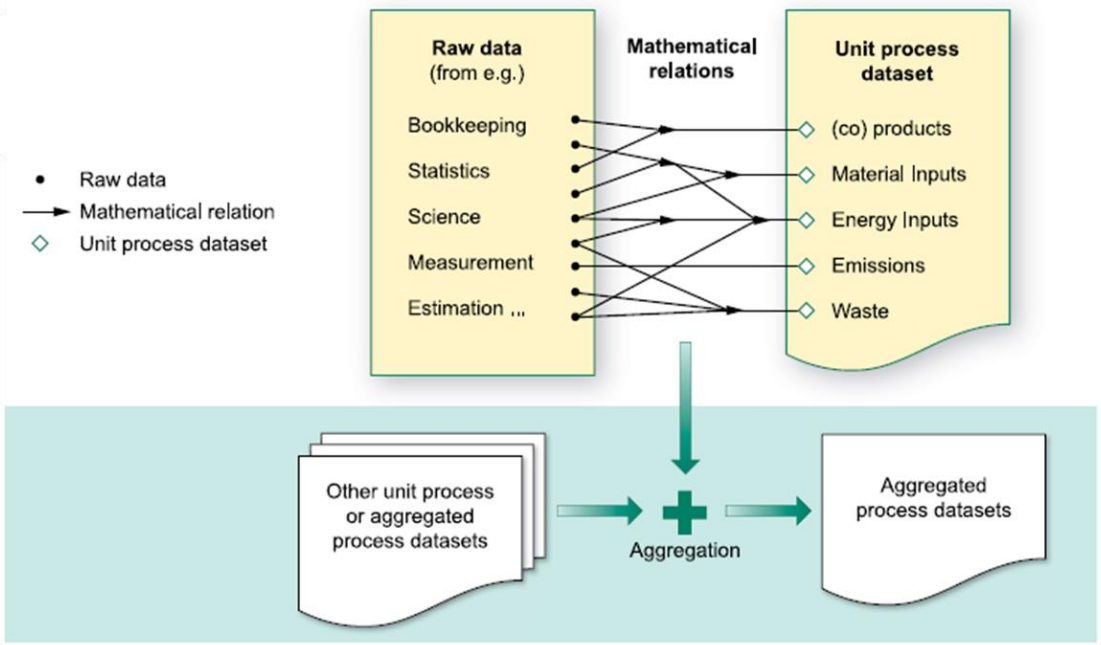


Figure 1: Definition of a unit process dataset and an aggregated process dataset

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

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".

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 (definition adapted from ISO 14071/2014, point 3.4).

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.

Comparative assertion – An environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (adapted from ISO 14025:2006).

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of a PEF study and supporting PEFCRs or the comparison of one or more products against the benchmark, based on the results of a PEF study and supporting PEFCRs.

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.

Direct elementary flows (also named elementary flows) – All output emissions and input resource use that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite. See Figure 2.

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

EF communication vehicles – It includes all the possible ways that can be used to communicate the results of the EF study to the stakeholders. The list of EF communication vehicles includes, but it is not limited to, labels, environmental product declarations, green claims, websites, infographics, etc.

EF report – Document that summarises the results of the EF study. For the EF report the template provided as annex to the PECFR Guidance shall be used. In case the commissioner of the EF study decides to communicate the results of the EF study (independently from the communication vehicle used), the EF report shall be made available for free through the commissioner's website. The EF report shall not contain any information that is considered as confidential by the commissioner, however the confidential information shall be provided to the verifier(s).

EF study – Term used to identify the totality of actions needed to calculate the EF results. It includes the modelisation, the data collection, and the analysis of the results.

Electricity tracking[3] – Electricity tracking is the process of assigning electricity generation attributes to electricity consumption.

Elementary flow - Material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation.

Environmental aspect – Element of an organization's activities or products or services that interacts or can interact with the environment (ISO 14001:2015)

External Communication – Communication to any interested party other than the commissioner or the practitioner of the study.

Foreground elementary flows - Direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.

Independent external expert – Competent person, not employed in a full-time or part-time role by the commissioner of the EF study or the practitioner of the EF study, and not involved in defining the scope or conducting the EF study (adapted from ISO 14071/2014, point 3.2).

[3] https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii

Input flows – Product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products (ISO 14040:2006).

Intermediate product - An intermediate product is a product that requires further processing before it is saleable to the final consumer.

Lead verifier – Verifier taking part in a verification team with additional responsibilities compared to the other verifiers in the team.

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

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.

Material-specific – It refers to a generic aspect of a material. For example, the recycling rate of PET.

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).

Partially disaggregated dataset - A dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield a complete aggregated LCI data set. We refer to a partially disaggregated dataset at level 1 in case the LCI contains elementary flows and activity data, while all complementing underlying dataset are in their aggregated form (see an example in Figure 2).

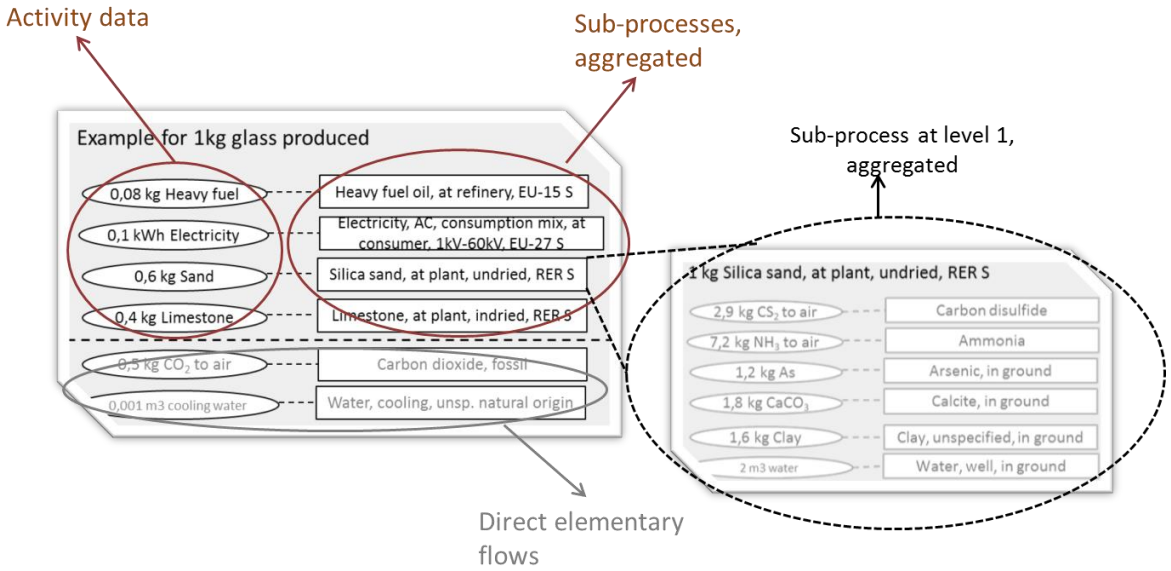


Figure 2: An example of a partially disaggregated dataset, at level 1. The activity data and direct elementary flows are to the left, and the complementing sub-processes in their aggregated form are to the right. The grey text indicates elementary flows

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.

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.

PEF screening – A preliminary study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the product category/sub-categories in scope, and any other major requirement to be part of the final PEFCR.

Population - Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study.

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 (adapted from ISO 14071/2014, point 3.6).

Primary data[4] - 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 Guidance, primary data is synonym of "company-specific data" or "supply-chain specific data".

Product category – Group of products (or services) that can fulfil equivalent functions (ISO 14025:2006).

Product Category Rules (PCR) – Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories (ISO 14025:2006).

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.

[4] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 20011).

Refurbishment – It is the process of restoring components to a functional and/or satisfactory state to the original specification (providing the same function), using methods such as resurfacing, repainting, etc. Refurbished products may have been tested and verified to function properly.

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. A PEFCR may include more than one representative product if appropriate.

Representative sample – A representative sample with respect to one or more variables is a sample in which the distribution of these variables is exactly the same (or similar) as in the population from which the sample is a subset

Sample – A sample is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.

Secondary data[5] - It 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.

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

Sub-population – In this document this term indicates any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study that constitutes a homogenous sub-set of the whole population. Sometimes the word "stratum" can be used as well.

Sub-processes - Those processes used to represent the activities of the level 1 processes (=building blocks). Sub-processes can be presented in their (partially) aggregated form (see Figure 2).

Sub-sample - In this document this term indicates a sample of a sub-population.

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.

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.

[5] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 20011)

Type III environmental declaration – An environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information (ISO 14025:2006). The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044.

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” (ILCD Handbook).

Validation statement – Conclusive document aggregating the conclusions from the *verifiers* or the verification team regarding the EF study. This document is mandatory and shall be electronically or physically signed by the *verifier or in case of a* verification panel, by the lead verifier. The minimum content of the validation statement is provided in this document.

Verification report – Documentation of the verification process and findings, including detailed comments from the *Verifier(s)*, as well as the corresponding responses. This document is mandatory, but it can be confidential. However, it shall be signed, electronically or physically, by the *verifier or in case of a* verification panel, by the lead verifier.

Verification team – Team of verifiers that will perform the verification of the EF study, of the EF report and the EF communication vehicles.

Verifier – Independent external expert performing a verification of the EF study and eventually taking part in a verification team.

5 Rationale

The Product Environmental Footprint (PEF) is a Life Cycle Assessment (LCA) based method to quantify the relevant environmental impacts of products (goods or services). It builds on existing approaches and international standards. The aim of the PEF is to set the basis for better reproducibility and comparability of the results. However, comparability is only possible if the results are based on the same Product Environmental Footprint Category Rules (PEFCR).

In recent years, the increasing demand for LCA based product declarations, such as Environmental Product Declarations have generated a need for rules for making declarations on products within the same category. These rules are defined as Product Category Rules (PCRs) in ISO 14025, Product Rules in the GHG Protocol Product Life Cycle Accounting and Reporting Standard and Supplementary Requirements in PAS 2050. Other standards such as BP-X30 (France), SMRS (Sustainability Consortium), TS 0100 (Japan), and the technical specification ISO/TS 14067:2013 also require the use of PCRs for making comparative product declarations. (For the complete reference to these documents please refer to section 5.3 of this Guidance)

All these initiatives indicate the growing demand for such information from both public and private actors, but also represent a challenge as the PCR are not fully consistent.

The objective of making the different methods, data requirements and supporting tools converge is shared by many stakeholders involved at different levels in the LCA world (e.g. the GLAD initiative led by UN Environment). This PEFCR Guidance represents a contribution towards this goal.

By having a unique set of requirements for developing PEFCRs at European level the overall methodological landscape related to this important element can be greatly simplified and made more consistent.

5.1 Terminology: shall, should and may

This Guidance uses precise terminology to indicate the requirements, the recommendations and options that could be chosen when developing a PEFCR.

The term “shall” is used to indicate what is required in order for a PEFCR to be in conformance with this PEFCR Guidance.

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 PEFCR and made transparent.

The term “may” is used to indicate an option that is permissible. Whenever options are available, the PEFCR shall include adequate argumentation to justify the chosen option.

5.2 Definition and purpose of a PEFCR

PEFCRs provide specific guidance for calculating products' life cycle potential environmental impacts.

Rules analogous to PEFCRs exist in standards for other types of life cycle-based product claims, such as ISO 14025:2006 (type III environmental declarations). PEFCRs were named differently in order to prevent confusion with other analogous rules and uniquely identify rules under the PEF Guide.

Based on an analysis carried out by JRC in 2010[6], the Commission came to the conclusion that existing life cycle-based standards do not provide sufficient specificity to ensure that the same assumptions, measurements and calculations are made to support comparability of environmental claims across products delivering the same function. PEFCRs aim at increasing reproducibility, relevance and consistency of PEF studies.

PEFCRs should be developed and written in a format that persons with technical knowledge (in LCA as well as with regard to the considered product category) can understand it and use it to conduct a PEF study. Acronyms and technical jargons should be avoided as much as possible. The PEFCRs shall implement the materiality principle, meaning that a PEF study shall focus on those aspects and parameters that are the most relevant in determining the environmental performance of a given product. By doing this the time, efforts and costs necessary to carry out the analysis are reduced.

Each PEFCR shall specify the minimum list of processes (called mandatory processes) that shall always be covered by company-specific data. The purpose is to avoid that an applicant without access to the relevant company-specific primary data is allowed to perform a PEF study and communicate its results by only applying default data. The PEFCR shall define this mandatory list of processes based on their relevance and the possibility to have access to company-specific data. A PEFCR shall further specify requirements made in the general PEF Guide and shall add new requirements where the PEF Guide provides several choices or where the PEF Guide does not cover sufficiently the particularity of life cycle of a specific product category.

PEFCRs shall be developed according to the latest version available of this Guidance. Whenever there are conflicting requirements between this Guidance and the most recent version of the PEF Guide adopted by the Commission, the former prevails over the latter. In the absence of an approved PEFCR a PEF study shall be carried out in compliance with the most recent version of the PEF Guide adopted by the Commission and this PEFCR Guidance.

For PEFCRs with Representative Products concerning food, feed, and drinks, the most recent version of the ENVIFOOD Protocol shall be used as complementary guidance to the requirements in the PEF Guide and this PEFCR Guidance. In case of conflicting requirements between the PEF Guide (or the PEFCR Guidance) and the ENVIFOOD Protocol, the first prevail over the second.

5.3 Relationship to other methods and standards

This PEFCR Guidance includes several elements taken from other relevant documents such as:

- PEF Guide, Annex to Commission Recommendation 2013/179/EU on the use of common methods to measure and communicate the life cycle environmental performance of

[6] Analysis of Existing Environmental Footprint Methodologies for Products and Organizations: Recommendations, Rationale, and Alignment (2010), available at: http://ec.europa.eu/environment/eussd/smgp/dev_methods.htm

products and organisations (April 2013) and available at http://ec.europa.eu/environment/eussd/smgp/index.htmhttp://ec.europa.eu/environment/eussd/smgp/index.htm

- ISO 14025:2006 - Environmental labels and declarations – Type III environmental declarations – Principles and procedures (ISO)
- BP X30-323-0:2011 - Principes généraux pour l'affichage environnemental des produits de grande consommation (AFNOR, France)
- Greenhouse Gas Product Accounting and Reporting Standard (GHG Protocol, 2011)
- PAS 2050 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services (BSI, 2011)
- ISO 14020:2000 Environmental labels and declarations – General principles
- ISO 14021:1999 Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling)
- ISO 14040:2006 Environmental management — Life cycle assessment —Principles and framework
- ISO 14044:2006 Environmental management — Life cycle assessment —Requirements and guidelines
- ISO 14050:2006 Environmental management — vocabulary
- ISO/TS 14067:2013 Greenhouse gases -- Carbon footprint of products -- Requirements and guidelines for quantification and communication
- ISO 17024:2003 Conformity assessment – General requirements for bodies operating certification of persons.
- ISO/TS 14071:2014 Environmental management — Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006
- ISO 14046:2014 Environmental management -- Water footprint -- Principles, requirements and guidelines
- ENVIFOOD PROTOCOL - Food SCP RT (2013), ENVIFOOD Protocol, Environmental Assessment of Food and Drink Protocol, European Food Sustainable Consumption and Production Round Table (SCP RT), Working Group 1, Brussels, Belgium.

5.4 Intended audience

The intended audience of this Guidance document includes:

- stakeholders participating in the development of PEFCRs;
- stakeholders implementing an approved PEFCR;
- stakeholders carrying out a PEF study for product groups not covered by an approved PEFCR.

6 Governance and procedures

6.1 Organisational structure of the EF pilot phase

The participation to the EF pilot phase is a pro bono activity carried out by all stakeholders interested in a specific product category or sector. In order to organise and coordinate the work in the best way possible the following structure is considered to be necessary:

- A Steering Committee (SC)
- A Technical Advisory Board (TAB)
- A Technical Secretariat (TS)
- An EF technical helpdesk
- An EF virtual consultation Forum (EF Wiki) (https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/)

6.1.1 EF Pilot Steering Committee (SC)

For the whole duration of the EF pilot phase a Steering Committee is set up.

The composition of the Steering Committee and its rules for procedure are available at: https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Steering+Committee+workspace

The Commission chairs the meetings and is responsible for all activities related to its organisation and management.

The role of the Steering Committee is:

a) Approve the scope and the definition of the representative product/ organisation for each PEFCR developed within the EF pilot phase. When relevant, the opinion expressed by the Technical Advisory Board on these documents will be taken in consideration by the Steering Committee;
b) Monitor the progress in each PEFCR/ OEFSR pilot;
c) Exchange information about challenges and lessons learnt in each pilot;
d) Decide on review requirements for the EF pilot phase;
e) Express an opinion on the second draft of a PEFCR before starting the supporting studies and the communication phase;
f) Approve the final PEFCR;
g) Contribute, review, comment on the development of the "footprint weighting method" as developed by JRC-IES;
h) Solve any conflicts that might arise during the implementation of the environmental footprint pilot exercise

When the decision of the Steering Committee might have an impact on the general requirements included in the PEF or OEF Guides, these changes shall be preventively agreed with the Commission.

6.1.2 The EF Technical Advisory Board (TAB)

Each member of the EF Pilot Steering Committee may appoint up to 1 expert to be member of the Technical Advisory Board to the Steering Committee. The Commission chairs the meetings and is responsible for all activities related to its organisation and management.

The role of the Technical Advisory Board member is (non-exhaustive list) to:

a) Provide support to the Steering Committee members that have appointed them on the scope of the product category or sector for each PEFCR developed within the EF pilot phase;
b) Check and advise the Steering Committee members on consistency of approaches among different PEF pilot category rules, including but not limited to how to identify the representative product/organisation and how to develop benchmarks;
c) Provide technical advice to the Steering Committee members about draft PEFCRs (based on the results of the screening);
d) Provide technical advice to the Steering Committee members in case of issues related to the implementation of PEF requirements;
e) Provide support to the Steering Committee members on decision related to review and verification;
f) Express an opinion to the Steering Committee members on the final PEFCR before approval.

Furthermore, the TAB expresses its opinion and input to the Commission on technical issues that are of cross-cutting relevance to several EF pilots.

6.1.3 The Technical Secretariat (TS)

For each pilot there shall be a Technical Secretariat. The Technical Secretariat is responsible for the following activities:

a) Overall drafting of the PEFCR proposal;
b) Preparing, maintaining and communicating all instructions related to the PEFCR development process;
c) Facilitating harmonisation with existing PCRs;
d) Organising the physical consultation meetings, including preparation of the agenda, sending the invitation, drafting supporting documents, taking minutes during the meetings;
e) Organising the consultation periods according to the rules and timing specified in 6.6.2. This task includes the drafting of the PEFCR chapters, collection and analysis of the comments received, and the drafting of the document analysis how the comments have been addressed;
f) Supporting the management of the EF consultation Forum. This activity includes tasks such as the drafting of publicly available explanatory materials related to their EF pilot category rules activities and the publication of the names of the organizations (not individual names) involved as stakeholders in the PEFCR development process;
g) Ensuring that the PEF screening is performed, the representative model developed and all the PEF calculations necessary run as requested in this Guidance;
h) Periodically updating in the EF virtual consultation Forum a list of all the documents consulted during the PEFCR development process;

i) Ensuring the selection of and appointment of competent independent PEFCR review panel members.

During the EU PEF Pilot study the role of Technical Secretariat may be played by a single company, an industrial association, an NGO, a Member State, or a national or an international Institution (e.g. the Commission), a university or research institute. The preferable option would be that the Technical Secretariat is constituted by a mix of the previously mentioned organisations.

The Technical Secretariat shall appoint a chair and will identify a Product Category Coordinator. The chair shall coordinate the different tasks of the Technical Secretariat and chair the physical consultation meetings, whilst the Product Category Coordinator represents the Technical Secretariat in the Steering Committee.

6.1.4 The EF Technical Helpdesk

For the whole duration of the EF pilot phase the Commission has made an external technical helpdesk available. The role of this helpdesk is to:

- Support the Commission in the revision of any document released by the Technical Secretariats (e.g. the representative product model, draft PEFCR, etc.),
- support the activities of each category rule/sectoral rule pilot providing technical assistance related to the application of the PEF/OEF Guide,
- provide explanations and support on specific steps of the PEFCR/OEFSR development process,
- provide specific training sessions during the EF pilot phase,
- manage the virtual consultation Forum.

6.1.5 The EF consultation forum

A dedicated website (wiki pages) has been created and it will be maintained during the whole duration of the Environmental Footprint (EF) pilot phase. It is available at: https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/.

The EF virtual consultation Forum is the location where all documents related to the PEF/OEF pilot category rules/sectoral rules are stored, where each consultation step is carried out, where the periodic communication on the pilots' advancements are taking place. A separate working space is available for each OEFSR and PEFCR pilot.

The virtual consultation Forum is managed by the Commission with the active involvement of the EF Technical Helpdesk and each Technical Secretariat.

6.2 Stakeholders involved in PEFCR development

The process of developing PEFCRs shall be open and transparent and shall include an open consultative format with relevant stakeholders.

The stakeholders should be involved following a supply chain approach. The relevant stakeholders for a PEFCR may include, but are not limited to, material suppliers, manufacturers, trade associations, purchasers, users, consumers, government representatives, non-governmental

organizations (NGOs), public agencies and, when relevant, independent parties and certification bodies.

6.3 PEFCR scope definition

The primary objective of a PEFCR is to fix a consistent set of rules to calculate the relevant environmental information of products within the same category. An equally important objective is to enable comparisons and comparative assertions in all cases when this is considered feasible, relevant and appropriate.

The granularity of the scope, the number of representative products chosen and the approach to identify the benchmarks are key decisions that shall be identified and justified in an extensive and transparent way in the PEFCR document (see chapter 7 and Annex B for more info on the content of a PEFCR).

Meaningful comparisons can only be made when products are capable of fulfilling the same function (as expressed in the functional unit). Therefore, the scope of a PEFCR should be based on a function-based approach, whenever feasible and appropriate. This approach also enables to link the product category with the CPA/NACE codes and is line with the definition of a product category by ISO 14025:2006 (i.e. a group of products that can fulfil equivalent functions)[7]. However, intermediate products can fulfil multiple functions, therefore a more traditional, material-based approach might be the best choice there (named also declared unit).

Pilot testers are advised to define an as broad as possible scope for the PEFCR, including all products that are capable of fulfilling the same function. A too narrow (small) product category definition would result in a very large number of PEFCRs, diminishing the usefulness of the developed PEFCRs. In its extreme, it could lead to meaningless PEFCRs.

6.4 Modularity in PEFCRs

The decision on how wide or narrow the scope of a PEFCR should be is a mix of a political and technical decision.

The first issue that should be clarified is if the product in focus is a final product (meaning something that is bought and used as it is, without requesting any further significant processing, like drinks, paints, apparel, etc.) or an intermediate product (e.g. paper pulp, some construction products). This difference is important because it entails further methodological differences at a later stage. For example whilst for a final product it may be allowed to focus the communication of the environmental performance only on the most relevant impacts, processes and life cycle stages, this is not possible for intermediate products, as such cut-offs would introduce important biases in the assessment of any further products using the intermediate one.

In case of intermediate products the PEFCR becomes a “module” to be used when developing PEFCRs for products further down that supply chain. This is equally applicable if the intermediate product can be used in different supply chains (e.g., metal sheets). The development of “modules” is essential to keep the number of PEFCRs to a manageable number. Moreover, they allow for a higher level of consistency among different supply chains that are using such modules as part of their life

[7] However, first the scope of the product category shall be defined and only after in the PEFCR it has to be listed which are corresponding CPA codes.

cycle assessment. The possibility to build such modules should always be considered also for final products, especially for those products that share part of the production chain till a certain moment and then differentiate due to different functions (e.g. detergents).

When developing PEFCR of products different in nature (e.g. based on different materials) but having the same functional unit (e.g. thermal insulation products) a suggested approach consists in developing a PEFCR having a common set of horizontal rules (applicable to all materials) combined with vertical set of rules, specific to each material.

Available PEFCRs shall always be used as modules when developing new PEFCRs or revising existing ones. As a general rule, the scope of a PEFCR is to rule on the specific processes of the participating industry and only in so far as they are reasonably expected to be usually operated by the PEF applying companies (situation 1 in the Data Need matrix, see chapter 7.19.4 for more information). Any exception to this general rule shall be adequately justified by the TS developing the new/revised PEFCR and be subject to stakeholder consultation. For example, many food-related pilots rely on a sometime long list of "ingredients". The standard approach would require that the PEFCR refers to secondary datasets for all the ingredients that are not produced by the company expected to apply the PEFCR. If the TS decide differently, they shall try to involve the ingredients' producers to confirm that the modelling rules proposed are consistent with the current practice. Once a PEFCR on one of these ingredients becomes available, they shall be used in new or revised PEFCRs using that ingredient. It is therefore important that the final representative product(s) are delivered as PEF-compliant (see Annex I) LCI datasets, including meta-data information.

6.5 Steps to carry out before the creation of a new PEFCR

There are many existing PCRs for several product categories. Before starting the development of a new PEFCR, the Technical Secretariat shall carry out a thorough search to identify if PCRs[8] for the same product category have been developed[9].

If no PCRs for the product category of interest are found suitable to be used as basis for the PEFCR, the Technical Secretariat shall move forward to develop its own PEFCR "from scratch". However, when the Technical Secretariat finds that a PCR exists for the same or overlapping product category in one or more other program(s), the Technical Secretariat shall perform an analysis identifying the consistency of the existing PCR(s) against the criteria set in this Guidance and in the PEF Guide. Existing PCRs need to be evaluated only up to the point where a decision can be made whether they should be used as a basis for the development of a PEFCR or not. Only those PCRs identified as suitable basis for a PEFCR need to be evaluated further with the necessary detail.

If, based on the results of this analysis, the existing PCR is completely in line with the PEF requirements, the existing PCR shall be used as PEFCR for the same product category, complementing it with any additional elements as appropriate (e.g. additional environmental information). If there are a number of deviations, then the Technical Secretariat shall document the major differences in a report to be uploaded in the EF virtual consultation Forum. The PEFCR

[8] The term "PCR" used here comprise any set of specific rules or guidelines for a product category. It is not limited to the PCRs following the ISO 14025.

[9] For example a PCR repository exists at http://pcr-library.edf.org.tw/index.asp

development process will then adapt the existing PCR(s) and make the PCR(s) fully consistent with the PEF requirements and the requirements of this Guidance document[10].

In particular, this alignment process needs to occur across the following principle elements: (1) data alignment, (2) the PEF and additional requirements for the generation of the PEFCR; and (3) PEFCR-related procedures.

(1) Data alignment. Data needs to fulfil requirements defined in chapter 7.19. This is both valid for primary data (rules on data collection) and secondary data. The specificities related to geographical areas, time representativeness, and technologies shall also be acknowledged and dealt with in the PEFCRs.

(2) Rule alignment. All rules for the existing PCRs shall be consistent with the PEF Guidance, for example specification of the functional unit, scope of the study, life cycle inventory, any allocation rules, impact assessment, specific modelling requirements (e.g. electricity, end of life), and rules for additional information.

(3) Procedural alignment. Requirements for PCR creation and review shall be equivalent, if not identical, to PEFCR requirements.

When a PCR exists for a product category in one or more other program(s), the other program operator(s) shall be contacted and invited by the Technical Secretariat to join the PEFCR development process.

6.6 The process of developing a PEFCR

The development of a PEFCR shall be based on an open and transparent consultation process involving all interested stakeholders. Reasonable efforts should be made to achieve a consensus throughout the process (ISO 14020:2000).

The inclusion of a virtual consultation and involvement process aids in ensuring that the opportunity exists for any and all stakeholders to contribute actively to the PEFCR development process or to provide comments regarding the PEFCR being developed, thus creating a development process which takes into account all relevant expertise with the utmost transparency.

6.6.1 Timing of the process

The PEFCRs shall be finalised (including the approval of the Steering Committee) by the 20th of April 2018. PEFCRs shall be submitted to the Steering Committee for approval no later than the 19th of March 2018.

A final draft PEFCR missing one or more essential element (i.e. clear calculation rules, benchmark values, verification rules and, where appropriate and relevant, classes of performance) or including requirements in conflict with the PEF method or the latest version of this Guidance document, may not be put forward for the final approval of the Steering Committee.

[10] The adapted PEFCR should reference the original PCR and program.

6.6.2 The consultation process

The Commission published the list of all PEFCRs under development[11].

Each Technical Secretariat shall identify and invite all the relevant stakeholders to participate in the PEFCR development by a virtual consultation process, and shall ensure that the role of the different stakeholders in the process is made clear and open to enable their participation.

Each Technical Secretariat shall create and maintain a log of those stakeholders that have been communicated with and responded to. A virtual consultation procedure shall be prepared in such a manner as to support the usage of an internet-based participatory process making use of the EF virtual consultation Forum.

An open internet-based consultation via the EF virtual consultation Forum serves the role of broadening the participation of stakeholders from different parts of the world. The use of the EF virtual consultation Forum also has the advantage that it facilitates participation from interested parties having difficulties to attend meetings, e.g. NGOs, SMEs, stakeholders from non-EU or developing countries and environmental groups.

Interested parties shall be given adequate time for review and access the details and sources of information used. The consultation process shall also ensure that interested parties, who provide comments, will receive consideration of, and response to, their comments. In particular the Technical Secretariat should, at the end of each consultation period and in any case before opening the final consultation step, produce and make public in the EF virtual consultation Forum, a document describing the major comments received and how they have been addressed.

Virtual consultations and the period for commenting on documents shall last at least 4 calendar weeks.

6.6.3 Representativeness of a PEFCR

A PEFCR is considered to be representative of a specific product category when all the following conditions are met:

1) The Technical Secretariat in charge of a specific product category has invited to contribute to the PEFCR development process all the major competitors, or their representatives (i.e. via industry associations) covering for at least 75% of the EU market (in terms of yearly turnover or production). All companies contributing to more than 10% to the EU market (in terms of yearly turnover or production) have been invited.
2) The industry stakeholders (producers/importers, either as single companies and/or as business associations) participating to the whole process cover at least 51% of the EU market (in terms of yearly turnover or production). The participation of stakeholders will be judged on the basis of their inputs to the process and/or participation to meetings. The 51% target has to be achieved by the end of the pilot phase. This means that it is not a requirement for the Technical Secretariats themselves to fulfil.

[11] This information is available at: http://ec.europa.eu/environment/eussd/smgp/product_footprint.htm

3) The Technical secretariat has invited and involved in the PEFCR development process a wide range of stakeholders, with particular reference to SMEs, consumers' and environmental associations.

In cases where all these conditions are not met by the time a final draft PEFCR is ready, the document will not be put forward to the final approval of the Steering Committee.

6.6.4 Structure of the PEFCR

The PEFCR shall follow the structure in Annex B to this guidance. Any deviation from the structure shall be justified and agreed with the Commission.

6.6.5 Procedure for the development of a PEFCR

There are a number of steps that shall be followed when preparing a PEFCR. Whilst the way to perform each step is under the technical responsibility of each Technical Secretariat, all steps shall be part of at least one consultation step with the relevant stakeholders.

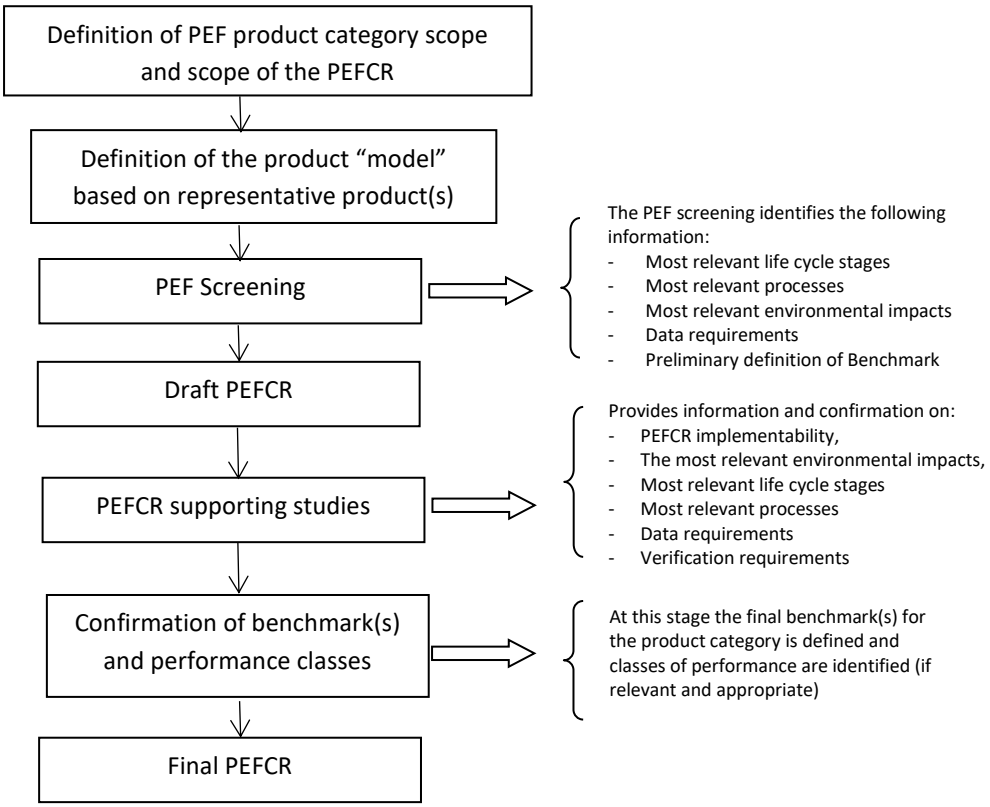


Figure 3. Steps to be followed for the development of PEFCRs.

One PEF screening and at least one PEFCR supporting study shall be performed per each representative product(s)/sub-categories included in the PEFCR.

6.6.6 Product scope and classification

By similarity with what is stated in ISO 14025, a PEFCR shall include a product category definition and description. This should include a description of the product(s), the function of the product(s),

unless it concerns intermediate product(s), and a description of the technical performance, the use and EoL stage of the product(s) if known (see section 3). It is important to be as specific as possible when defining a product category to ensure comparability of results. As recommended in ISO 14044, if additional functions of any of the systems or if some products that fulfil the same function are not taken into account in the comparison of the functional unit, then these omissions shall be explained and documented.

The PEFCR shall clearly state the product category for which the PEFCRs apply by using descriptive language. Once the scope has been finalised the corresponding relevant CPA codes shall be listed. Products that are not covered by the PEFCR shall be clearly listed (as a clarification when products are similar). In some cases, accessory products that are typically sold together are not covered by the PEFCR. This should also be stated.

Products having similar functions and applications should be grouped under one product category. However, within a single PEFCR sub-categories of products/applications can be identified. For example, it could be appropriate to develop a PEFCR on batteries (wide scope) which then could include a number of sub-categories linked to the different types of applications (batteries for cars, batteries for mobile phones, batteries for computers, etc.).

The basis for assigning a group of products to a product category shall be that the same functional unit shall be applied across all the products that are to be categorized under one product category. A declared unit, for example, mass (kilogram), volume (cubic meter), should be applied for intermediate products, where a functional unit cannot be assigned due to the fact that the whole life cycle of the product is either not accounted for or cannot be stated (i.e. cradle-to-gate). The use of a declared unit might also be the most straightforward (but not necessarily the most correct) choice when dealing with food products.

Technical Secretariat shall choose one of the following options:

A. The scope is limited, there is a single main application/function and all products/technologies covered are very similar (e.g. liquid laundry detergents, packed water) – see box 1.
B. The scope is wide, there is a single main function but different applications/technologies/materials (e.g. batteries, dairy products) – see box 2;
C. The scope is relatively narrow, there is a single main function, but alternative technologies/materials delivering the same function are available (e.g. hot & cold water pipe systems, paints) – see box 3;

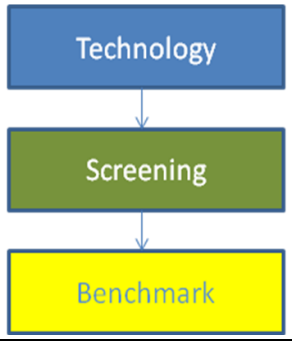
The most relevant options shall be clearly indicated and justified in the scope section of the PEFCR template. The proposed scope shall be discussed and agreed by the end of the first consultation phase.

Once the scope has been clearly identified the Technical Secretariat shall decide if more than one sub-category is needed and if the functional unit shall be refined for the subcategories. If a single functional unit is used, the benchmark (and classes of performance if relevant and appropriate) is chosen at the functional unit level (see box 3). In case the PEFCR includes sub-categories with appropriate functional unit, then the benchmark (and classes of performance if relevant and

appropriate) can only be defined at the sub-category level (see box 2). In case there are no sub-categories then the situation is more straightforward (see box 1).

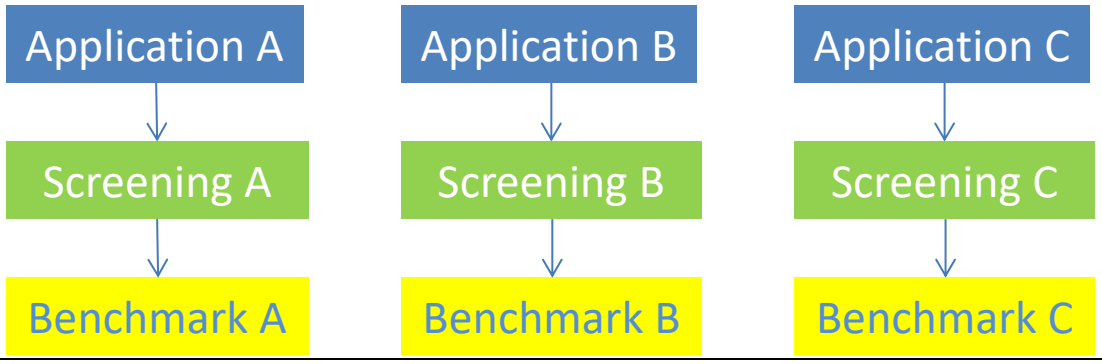
Box 1 – PEFCR including one single product category.

When the scope is narrow and or the technologies delivering the function are all very similar, then it is possible to use a single benchmark of the product category. In the context of the on-going EF pilot phase this is for example the case of "liquid laundry detergents".



Box 2 – PEFCR including more sub-categories for different applications.

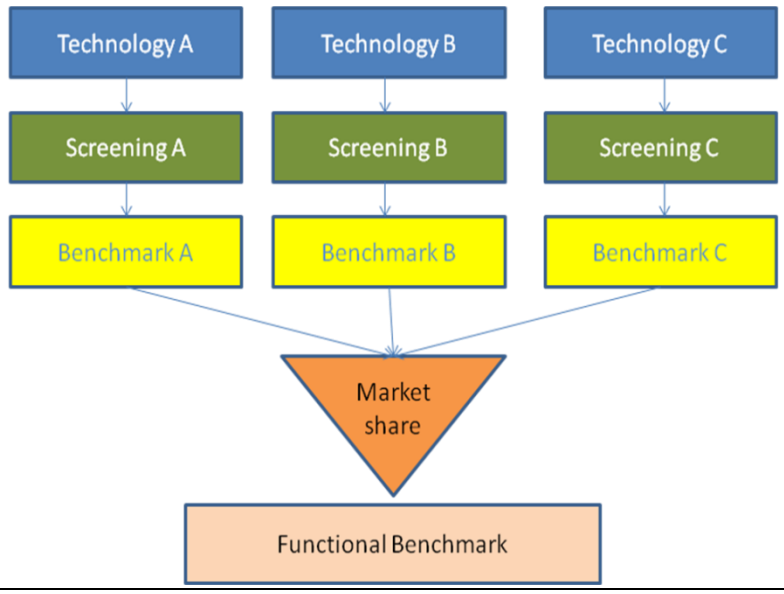
When the scope of a PEFCR is wide it could be preferable to identify sub-categories based on different applications. In the context of the on-going EF pilot phase this is, for example, the case of "battery" products, which all provide electricity but for very distinct applications varying from electro-bicycles to mobile phones. The screening shall be carried out on each technology option. The results of the screening identify the hotspots (in terms of life cycle stages, process, elementary flows) and provide the first element to identify the benchmark. In such cases the benchmark shall be fixed with reference each subcategory/application.



Box 3 – PEFCR including more sub-categories but the same function/application.

There are product categories where it is possible to identify the same function delivered by very different products/technologies. In the context of the on-going EF pilot phase this is for example the case of "hot & cold water pipe systems". The screening shall be carried out on each technology option. The results of the screening identify the hotspots (in terms of life cycle stages, process, and elementary flows) and provide the first element to identify the benchmark. In such cases the benchmark might be fixed with reference to the functional unit (same function performed by each

technology). Alternatively, the Technical Secretariat might decide to define the benchmark for each sub-category part of the PEFCR.



6.6.7 The PEF screening

The PEF screening is necessary because it helps focussing data collection activities and data quality priorities for the PEFCR supporting study. The screening shall be carried out by the Technical Secretariat based on the "representative product" and in compliance with the procedure in chapter 7.4.

The objective of the screening is to pre-identify the following key information:

- Most relevant life cycle stages;
- Most relevant processes and elementary flows;
- Preliminary indication about the most relevant life cycle impact categories;
- Data quality needs;
- Preliminary indication about the definition of the benchmark for the product category/sub-categories in scope.

The Technical Secretariat is encouraged to also perform the screening study by using top-down approaches, like for example Environmentally Extended Input Output (EEIO). In such cases, or for any alternative approach for screening proposed by the Technical Secretariat, a screening study shall also be done with the baseline approach as described in the PEF Guide) and the results of the two studies shall be compared.

The PEF screening can be based on readily available generic data (life cycle inventory databases, e.g. from commercial databases) fulfilling the data quality requirements as defined in the most updated version of the PEF Guide. In particular, for the screening step a minimum "fair" quality data rating is

required for data contributing to at least 90% of the impact estimated for each EF impact category, as assessed via a qualitative expert judgement. In an iterative approach with communication and feedback from the Technical Secretariat to all the participating stakeholders, the accuracy and representativeness of the model and data shall be improved. The model can be adjusted by introducing new processes/activities to be included. Generic data used in the first round can be replaced with specific data and other more representative (specific) databases along the process.

The results of the screening should be subject to sensitivity analysis and be also part of the PEFCR review process.

6.6.8 The screening report

Each Technical Secretariat shall send for review to the Commission a screening report and the "model" developed through an LCA software. The objective of this review is to support the work of the Technical Secretariats helping them to identify at an early stage any deviation from the requirements of included in the PEF Guide or in the most updated version of this PEFCR Guidance document.

The screening report shall contain following information:

- Definition of the functional unit and reference flow;
- Flow diagram for each life cycle stage with a clear link between all processes involved and one global system boundary diagram;
- Identification of the foreground and background data;
- For each life cycle stage, a table with all processes involved with a clear identification of the source of the Life Cycle Inventory and calculation of the reference flow for each process ;
- Assumption about the use, re-use (if appropriate) and end-of-life scenario including the way the EoL formula is applied;
- Treatment of any multi-functionality issues encountered in the PEF modelling activity;
- Results of the sensitivity analysis with a clear identification of the minimum-maximum values used to perform it;
- Results for each EF impact category with a split per life cycle stage.

In case the Commission identifies any relevant issue, it will address them bilaterally with the concerned Technical Secretariat. If there are divergent opinions that cannot be reconciled, the issue will be raised at Technical Advisory Board level and, if necessary at Steering Committee level.

The detailed screening report shall be considered confidential by the Commission, thus it will be shared only within the Commission EF Teams and any reviewer contracted to support this task.

The decision from a Technical Secretariat not to produce such report or to produce incomplete reports would imply the application of chapter 6.7.

The software model used for the screening should be released by each TS to the Commission and remain freely accessible to any user also after the pilot phase is concluded. The Commission services will update the models by recalculating the results (including the benchmarks) based on the PEF-compliant secondary datasets that will be tendered in the last part of the pilot phase (re-modelling).

6.6.9 The draft PEFCR

Based on the results of the PEF screening and the related consultation, the Technical Secretariat shall produce a draft PEFCR.

The draft PEFCR is the guiding document to carry out the PEFCR supporting studies. It shall be drafted according to the requirements included in the PEF Guide and the Template provided for this purpose.

In the draft PEFCR all impact categories shall be included (and therefore used in the PEFCR supporting study). The draft PEFCR shall be revised based on the results of the PEFCR supporting studies.

6.6.10 Documents to be submitted to the first consultation

The documents to be submitted to the first consultation are:

- PEF screening report, and
- First draft PEFCR (no data sources specified)

The PEF screening report, apart from the quantification of the screening results, shall include the following information:

- description of the supply chain (processes) and scenarios (upstream, downstream, transport),
- results of the sensitivity analysis on allocation options,
- where and why generic data are to be preferred to specific data in the foreground system (if relevant),
- the environmental impact category selection process,
- additional environmental information (if needed),
- data gaps,
- life cycle inventories and characterised results for the representative product (for each impact category and life cycle stage).

After the approval of the document by the Steering Committee, the Technical Secretariat shall upload on the Stakeholder Workspace of the EF Wiki a table analysing the results of the consultation (comments received and how they have been dealt with).

6.6.11 The PEFCR supporting studies

The Technical Secretariat shall encourage the participants/stakeholders to carry out at least 3 PEF studies (and at least one for each sub-category covered by the PEFCR) compliant with the latest version available of the PEF Guide, the latest version available of this Guidance at the time of starting the supporting study, and with any specific requirement included in the draft PEFCR[12], comprising however all environmental impact categories and having a full coverage in terms of life

[12] In case of conflicting requirements between the PEF Guide and this Guidance, the latter prevails over the former.

cycle stages and processes. These studies are referred hereafter as PEFCR supporting studies. They shall be based on existing products as currently sold in the European market. A template that should be followed for PEFCR supporting studies is available in Annex E. Even if the template is not followed, the PEFCR supporting study shall include all content included in the Annex E template.

PEFCR supporting studies as well as PEF studies based on a PEFCR shall contain a reference to the PEFCR or the version of the related EF Guidance that they comply with.

The goal of the PEFCR supporting studies shall clearly state that it is done as supporting evidence to the PEFCR development and the intended audience. The studies should always be done under the assumption that their result would be used to contribute to the development of a PEFCR that could support comparisons or comparative assertions intended to be disclosed to the public.

The PEFCR supporting studies will be used to test the pertinence and implementability of the draft PEFCR including, but not limited to, the identified most relevant environmental impacts, issues related to data collection and quality, verification requirements. For this reason, each PEFCR supporting study shall implement the procedures explained in chapters 7.4 and 7.19[13]. Moreover, the uncertainty analysis carried out on the results of the PEFCR supporting studies may contribute to the identification of appropriate performance classes (where relevant and appropriate).

The results of the supporting study (including confidential information) will be accessed only by the external verifiers, the PEFCR reviewers, and the EF Team in DG ENV and JRC IES. Otherwise it shall remain confidential, unless differently agreed by the company performing the study. The company performing the study can grant access to other stakeholders upon request.

Beside the confidential report (template in Annex E in its full version), a second report shall be produced that describes the main outcomes of the PEFCR supporting study without disclosing confidential information. For this, chapter 5.1 and 9 of the template can be removed from the report, while chapter 6 on the results can be replaced by a non-confidential summary. This second report will be made available to the Technical Secretariat, the Technical Advisory Board and the Steering Committee.

The second report (without confidential information) or a condensed version thereof can be used in the communication phase. For example, report or background information to a label.

The information included in the supporting study reports shall only be used for activities related to the implementation of the EF pilot phase in the period 2013-2018.

6.6.11.1 Identification of the most relevant impact categories

The identification of the most relevant impact categories shall be done according to the procedure explained in chapter 7.4.

[13] The implementation of the procedure in Annex E shall be guaranteed in at least 1 supporting study per pilot.

6.6.12 Disclosure and communication

The references to communication included in this section are only valid during the environmental footprint pilot phase (2013-2018) and as part of the tests carried out by the pilots and the Commission on different communication vehicles.

The results of a PEF study carried out in compliance with the PEF Guide or, where existing, with a specific PEFCR, are called "PEF-Profile". Whenever a PEFCR exists for a certain product category, then its requirements shall be fulfilled if the information included in the PEF-profile is meant to be used for communication purposes.

Each PEFCR shall specify the minimum list of processes that shall be covered by company-specific data. The purpose is to avoid that an applicant without access to any primary data is able to perform a PEF study and communicate it results by only applying default datasets. Each PEFCR shall define what is mandatory based on the relevance and the possibility to have access to primary data.

The PEF-profile could be communicated in different forms, depending on the typology of communication (B2B or B2C) and the objective of the communication. A description of some communication vehicles (non-exhaustive list) is provided in the background document for the testing of communication vehicles in the Environmental Footprint pilot phase[14].

For final products the pilots shall communicate at least on 3 impact categories among those identified in the PEFCR as "most relevant".

For intermediate products the pilots shall communicate on all impact categories identified in the PEFCR as "most relevant".

Independently from the vehicle chosen, when environmental footprint information is used for communication purposes, the results for all impact categories (characterised, normalised, and weighted) shall be available to the public through freely accessible information sources (e.g. website).

The chosen communication vehicles shall be tested at least by the companies carrying out the PEFCR supporting studies during the last phase of the pilot phase. The testing may be organised horizontally by the Technical Secretariat. The length of the testing period should be proportionate to the approach used. For a brick-and-mortar (real market) test it is suggested to run the test for at least 6 months. For focus groups or online tests a duration of 2-3 months is considered sufficient.

Communication shall be tested when the results of the supporting studies are available. More details about this element are available in the background document for the testing of communication vehicles in the Environmental Footprint pilot phase.

6.6.13 Verification of the PEFCR supporting studies

The PEFCR review and the independent verification of the supporting studies are two separate processes (for the PEFCR review see chapter 6.6.16).

[14] http://ec.europa.eu/environment/eussd/smgp/pdf/Comm_bgdoc_v1.1.pdf

The verification of the PEFCR supporting studies will be conducted before their public release. Due to limited resources available (the costs of the verifiers will be covered by the Commission), only about 1/3 of all supporting studies will be the object of verification. At least 1 PEFCR supporting study per each pilot will be verified. It will be the Commission to decide which supporting study will be verified, and inform the companies concerned directly.

The verifications will take place in several ways, for example by on-site checking, reviewing calculations, mass balance calculations, or cross-checks with other sources. Different approaches will be tested in order to identify the optimal balance between completeness of verification and costs.

The objectives of the verification are:

- To assess compliance of the PEFCR supporting study and its results with the PEF Guide, the latest version of this Guidance at the time when the supporting study was started, and the reference PEFCR;
- To verify the traceability and validity of the information/data, both primary data of the organisation carrying out the study or of its suppliers, and other forms of secondary data used in the supporting studies. This task might involve cross-check comparison of documents (e.g. invoices, bills of sale, etc.) both provided by the organisation producing the PEF profile and the suppliers. For the most relevant data it might also be required to perform on-site document checks and inspections at the place where the supplier is located.
- The presentation of environmental performance included in the PEF profile;
- Other additional environmental information included in the PEF profile, if any.

In verifying the underlying data of the life cycle inventory, the verifier will examine that:

- The unit processes are defined as specified in the reference PEFCR;
- The source of input and output data (that is, referenced literature, vendor-supplied databases, and LCI databases) used for a unit process/module of specified unit processes are at least of the quality requested in the reference PEFCR;
- All relevant information is documented for each unit process, i.e. being consistent and understandable to enable an independent evaluation of the relevance of the data in accordance to the reference PEFCR. In particular the verifier should check that any additional documentation of the LCA process data (sources, correspondence, traceable references to origin, and so forth) is provided, especially if this information influenced LCA process data selection;
- The Data Quality Requirements are met.

In case of existence of secondary data in the results which have been already verified according to rules in the PEF Guide, these shall not be subject for further verification regarding the criteria methodological consistency, completeness and uncertainty. However, the appropriateness of the use of these data for the specific product needs to be verified. This verifications needs to cover the aspects of time, geographical and technological representativeness of the secondary data for the use in the specific PEF profile.

In verifying the results from the impact assessment, the verifier shall check that the calculations are made in a correct way based on the life cycle inventory and recommended characterisation, normalisation and weighting factors.

With regard to checking information of the life cycle inventory, the verifier shall make use of sample checks for the unit processes/information modules/PEFCR modules to check their conformance to original data sources. The organisation shall provide the verifier with information about the underlying data and calculations carried out upon request.

Sample checks may preferably be carried out for those unit processes/information modules/PEFCR modules having a significant influence on the life cycle inventory, and randomly chosen unit processes/information modules/PEFCR modules.

When a large variety of products (e.g. series of products) are subject for verification, sampling methods for the LCA study shall be used. If a specific sampling method has been developed by an organisation, this method shall be verified by a third party verifier and specified in the PEF profile.

The results of the preparatory study on this issue[15] and the details of the verification approaches tested during the EF pilot phase are available here[16].

6.6.14 Competences of the verifier

Please refer to the PEF Guide, section 9.3. During the EF pilot phase, the verifier qualifications shall be considered as indicative only.

6.6.15 Time validity of the PEFCR

The validity of any PEFCR developed during the pilot phase is 31st December 2020.

6.6.16 The PEFCR review

The Technical Secretariat shall set up an independent third party review panel composed of a minimum of three members (i.e., a chair and two members) for the PEFCR review. The panel should comprise of at least one LCA expert (preferably with a background on the product category under consideration and product-related environmental aspects), one representative from NGOs, and one industry expert. One member shall be selected as the chair. The panel members shall not have conflicts of interests on branded products and cannot be members of the Technical Secretariat.

6.6.16.1 Reviewer qualifications

Please refer to the PEF Guide, section 9.3. During the EF pilot phase, the reviewer qualifications shall be considered as indicative only.

6.6.16.2 Procedure for review

With the assistance of the Technical Secretariat, the PEFCR Review Panel shall meet to discuss the PEFCR and perform its review. Comments shall be generated and may be general, editorial or

[15] *Investigating options for different compliance systems for PEF and OEF declarations*, http://ec.europa.eu/environment/eussd/smgp/pdf/Compliance_finalreport.pdf

[16] http://ec.europa.eu/environment/eussd/smgp/ef_pilots.htm#verification

technical. The general comments apply to overarching issues affecting the entire PEFCR whereas editorial and technical comments may apply to specific sections within the PEFCR.

Within a time period agreed upon by the PEFCR Review Panel and the Technical Secretariat not to exceed 30 days, the PEFCR Review panel shall meet to generate their comments that are compiled in the Review Report.

The Review Report shall be sent to the Technical Secretariat for their review and discussion. A copy of the report shall also be sent to the PEF Pilot Steering Committee.

6.6.16.3 Review criteria

The reviewers shall investigate whether the PEFCR has been developed in accordance with the requirement provided in this Guidance and supports creation of credible and consistent PEF profiles. In addition, the following criteria shall also apply:

- The PEFCR is consistent with the guidelines provided in the PEF Guide and the latest version available of this Guidance and deviations are justified,
- Functional unit, allocation and calculation rules are adequate for the product category under consideration,
- Primary and secondary datasets used in the screening and the supporting studies are relevant, representative, and reliable,
- 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 this Guidance and the PEF Guide,
- The benchmark and performance classes are correctly defined or the lack of performance classes is appropriately justified
- 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.

6.6.16.4 Review report

A review report should be drafted based on all the comments made by the review panel with proposal for changes.

6.6.16.5 Addressing reviewers' comments

The Technical Secretariat shall review the PEFCR Review Panel's comments/proposals and develop a response for each. Using the PEFCR Review Report, the Technical Secretariat generates responses that may include:

- Acceptance of the proposal: change draft PEFCR to reflect proposal,
- Acceptance of the proposal: change draft PEFCR with modification to original proposal,
- Supporting commentary why the Technical Secretariat did not agree with the proposal,
- Return to PEFCR Review Panel with further questions on the comments/proposals.

If any response by the Technical Secretariat is not accepted by the PEFCR Review Panel, then the review panel report and the response of the Technical Secretariat shall be sent to the PEF Pilot Technical Advisory Board and to the Steering Committee and the issues will be resolved at that level.

6.6.17 Documents to be drafted before the final consultation

The Technical Secretariat shall submit the final draft of the PEFCR into the final consultation. This document should be drafted according to the template provided in Annex B.

The PEFCR shall be complete, with the exception of the following elements:

- PEF-compliant dataset(s) of the representative product(s) as modelled in the screening and eventually modified based on the supporting studies results[17]. The datasets will be provided in the context of the remodelling project, tendered by the European Commission and shall be ready for the final PEFCR.
- Final list of secondary datasets to be used by the applicant. These will be available for the final PEFCR.

A table or report with changes based on the final consultation and the PEFCR review shall be included for the Technical Advisory Board and Steering Committee to prepare the examination of the documents.

After the approval of the document by the Steering Committee, the Technical Secretariat shall upload on the Stakeholder Workspace of the EF wiki a table analysing the results of the final consultation (comments received and how they have been dealt with).

6.6.18 Documents to be drafted before final approval by the SC

The PEFCR shall contain all elements required in the template in Annex B.

Furthermore, an EF-compliant dataset (aggregated and disaggregated) for each Representative Product shall be available.

6.7 Conditions to close a pilot

A pilot can be closed due to one of the following circumstances:

a) It becomes evident during the process that the representativeness conditions (see 6.6.3) will not be achievable. In this case the decision to stop the pilot is taken by the Commission without further consultation with the Steering Committee.
b) In case relevant deviations from the methodological mandatory requirements foreseen in the PEF Guide or the most updated version of this Guidance document are identified by the Commission and not solved through a bilateral dialogue with the relevant pilots. In this case the Commission can propose to the Steering Committee to stop the work of the pilot till the requirements are met.

[17] The dataset(s) developed for each representative product(s) shall be available for free to any user till 31st December 2020 and distributed through a specific node created by the EC in the ELCD Data Network.

7 Technical specifications

7.1 Functional unit and reference flow

The functional unit (FU) is the quantified performance of a product system, to be used as a reference unit (e.g., the FU of paint could be described as providing protection of 1m^2 of substrate for 50 years with a minimum 98% opacity). Meaningful comparisons shall only be made when products can fulfil the same function. Therefore, the FU of a PEFCR should describe qualitatively and quantitatively the function(s) and duration of the product, according to the four aspects reported in Table 1. The table includes additional requirements for food and non-food PEFCRs that shall be adopted by the respective PEFCRs.

Table 1. Four aspects of the FU with additional requirements for food and non-food PEFCRs.

Elements of the FU	Food products	Non-food products
1. The function(s)/service(s) provided: "**what**"	The FU shall be measured at product consumption level and should exclude inedible parts[18].	PEFCR specific
2. The extent of the function or service: "**how much**"	The FU shall be mass or volume based. Any derogation shall be discussed and approved on a case by case basis by the EC.	PEFCR specific
3. The expected level of quality: "**how well**"	The "*How well*" feature is not always sufficiently taken into account so far. This item requires future developments	Not always possible to incorporate: Requires further developments
4. The duration/life time of the product: "**how long**"	Shall be quantified if shelf-life (reported for example as "best before date" or "use by date") is indicated on the packaging (e.g. number of months)	Shall be quantified if technical standards or agreed procedures at sectoral level exist

The PEFCR shall explain and document any omission of the functions of the product in the definition of the functional unit.

For intermediate products, the FU is more difficult to define because they can often fulfil multiple functions and the whole life cycle of the product is not known. Therefore, a declared unit should be applied, for example, mass (kilogram) or volume (cubic meter).

The PEFCR shall describe (i) how each aspect of the functional unit can affect the environmental footprint of the product, (ii) how to include this effect in the EF calculations and (iii) how an

[18] The term 'inedible parts' shall be defined by the TS in the PEFRC.

appropriate reference flow[19] shall be calculated. In case applicable standards exist when defining the FU, they shall be used and cited in the PEFCR.

For example, the type of packaging might affect the amount of salad wasted at retail and at the use stage. As a consequence, the type of packaging affects the amount of salad which is needed to fulfil the "how long" and "how much" described in the FU. The PEFCR shall describe the potential effects of food waste and provide a table with the % of salad waste per packaging type applied. Finally, the PEFCR shall describe how the % of salad waste from the table is integrated in the reference flow and added to the FU of 1kg of salad consumed. All quantitative input and output data collected in the analysis shall be calculated in relation to this reference flow of 1kg+x% waste.

7.2 How to define the representative product(s)

Once the scope and the functional unit of the PEFCR has been agreed, the Technical Secretariat (TS) shall develop a "model" of the representative product (RP) sold in the EU market and belonging to the product category at hand.

At least one RP shall be defined for each PEFCR as it forms the basis for the modelling of the PEF screening. When within a product category several different applications are supported, multiple RPs may need to be identified. When defining the "representative product" model, the TS should include the following elements to the extent possible:

- Bill of materials (BoM) or ingredients, as relevant;
- A flow diagram (system boundary) covering the entire life cycle;
- Assumptions related to transportation systems;
- Assumptions related to use scenario (if relevant);
- Assumptions related to End-of-Life scenario, including recycling and recovery as relevant.

When modelling the representative product, the TS shall use processes disaggregated at level-1. The RP(s) should be established at a level where it enables a meaningful comparison between products delivering the same function. For B2C scenario, the RP(s) should be established in order to enable informed consumer choice, i.e., to capture the differences between products within the same product category.

The RP(s) as the basis of the PEF screening study aims at:

1. Identifying the most relevant impact categories, life cycle stages, processes and direct elementary flows;
2. Facilitating the comparison between products that fall within the same RP;
3. Calculate the benchmarks (the EF-profile of a representative product is the benchmark)
4. Define the classes of performance (if appropriate).

There are two options for defining the representative product(s):

1. It could be a virtual (non-existing) product. This is probably the best option when the market is made up of different technologies/materials and there is sufficient market and technical

[19] The reference flow is the amount of product needed to fulfil the defined functional unit.

information available. The virtual product shall be calculated based on average sales-weighted characteristics of all existing technologies/materials covered by the scope of the PEFCR. In addition to the sales-weighted average, other weighting sets may be used, for example weighted average based on mass (ton of material) or weighted average based on product units (pieces);

2. It could be a real product. This is probably the best option when the market is made up of different technologies, but incomplete market and/or technical information are available. A real product sold at EU market level may be chosen as representative product.

The TS shall provide information about all the steps taken to define the “representative product” model(s) in the screening study and report the information gathered taking the most appropriate measure to preserve the confidentiality of data (if this is required).

Business data, gathered during the PEFCR development, could be of confidential nature because of competitive business aspects, intellectual property rights or similar legal restrictions. Such confidential data shall not be made public under any circumstances; this is under the full responsibility of the TS.

The "representative product(s)" shall be presented and discussed with the relevant stakeholders. The model and the modelling assumptions are the basis for the screening exercise which provides insight into the relevant life cycle stages, processes and impact categories of the product category (including the identification of processes for which primary data are requested).

7.3 List of EF impact categories, normalisation factors and weighting factors

The PEFCR shall list the 16 impact categories to be used to calculate the PEF profile, as listed in Table 2. Out of these 16 impact categories, the PEFCR shall list those that are most relevant for the product group in scope (see next chapter).

The three toxicity-related impact categories are temporarily excluded from the procedure to identify the most relevant impact categories, life cycle stages, processes and elementary flows. Also, their characterised results shall not be presented in the benchmark values of the PEFCR. This decision will be reconsidered at the end of the transition phase (2020), after the finalisation of the ongoing work done in collaboration between the Commission and ECHA agency in Helsinki on developing new CF based with REACH data. A PEF study carried out in compliance with a PEFCR shall still calculate and include in the PEF report the characterised results for the three toxicity impact categories, but these results shall not be used for other communication purposes and are not taken into consideration in the benchmark and for the identification of the most relevant life cycle stages, processes, and foreground direct elementary flows. If the TS decides to add toxicity as a most relevant IC and present toxicity related impact results in their PEFCR, this shall be done in an additional chapter named "Other impact results" (see PEFCR template) and the existing limitations of the underlying method shall be clearly mentioned.

Table 2. List of recommended models at midpoint, together with their indicator, unit and source. In red text: the differences compared to the PEF guide (2013)

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
Climate change[20]	Radiative forcing as Global Warming Potential (GWP100)	kg $CO_{2\ eq}$	Baseline model of 100 years of the IPCC (based on IPCC 2013)	EC-JRC, 2017[21]	I
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	Steady-state ODPs as in (WMO 1999)	EC-JRC, 2017	I
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Human toxicity, non-cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum	EC-JRC,	III/interim

[20] Three additional sub-indicators may be requested for reporting, depending on the PEFCR. The sub-indicators are further described in section 7.9.

[21] The full list of characterization factors (EC-JRC, 2017a) is available at this link http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
			et al, 2008)	2017	
Particulate matter	Impact on human health	disease incidence	PM method recomended by UNEP (UNEP 2016)	EC-JRC, 2017	I
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)	EC-JRC, 2017	II
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008	EC-JRC, 2017	II
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Ecotoxicity, freshwater*	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	USEtox model, (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
Land use	• Soil quality index[22] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production • kg soil • m^3 water • m^3 groundwater	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	EC-JRC, 2017	III
Water use#	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq}$	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	EC-JRC, 2017	III
Resource use[23], minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.		III
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[24]	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	EC-JRC, 2017	III

*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 might be overestimated and shall therefore be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR/OEFSR 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, but occurred during the technical development of some of the datasets. The PEFCR/OEFSR 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/OEFSR accordingly, if seen necessary.*

The list of normalization factors and weighting factors are available in Annex A.

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

[23] The indicator "biotic resource intensity" was initially recommended under the additional environmental information. It will be further worked upon and explored during the transition phase.

[24] In the ILCD flow list, and for the current recommendation, Uranium is included in the list of energy carriers, and it is measured in MJ.

The full list of characterization factors (EC-JRC, 2017a) is available at this link http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

7.4 Identification of most relevant impact categories, life cycle stages, processes and elementary flows

The identification of most relevant impact categories, life cycle stages, processes, direct elementary flows, benchmark, and classes of performance shall be based on the screening study.

There is an important operational difference between most relevant impact categories, and life cycle stages on one hand and most relevant processes, and direct elementary flows on the other. In particular, most relevant impact categories and life cycle stages are mainly relevant in the context of the "communication" part of PEF. They might serve the purpose of "warning" an organisation about the area where they should focus their attention in order to look deeper on how to improve the environmental performance of their product.

The identification of the most relevant processes and direct elementary flows is more important for the engineers/designers to identify actions for improving the overall footprint e.g. by-pass or change a process, further optimise a process, apply antipollution technology etc. This is in particular relevant for internal studies. However, and this is specific to the PEFCR development process, the identification of the most relevant processes and direct elementary flows has a key role in the decision process to identify data-related requirements (see section below on data quality requirements for further information).

7.4.1 Procedure to identify the most relevant impact categories

The identification of the most relevant impact categories shall be based on the normalised and weighted results of the representative product(s) as recalculated after the remodelling. At last three relevant impact categories shall be considered. The most relevant impact categories shall be identified as all impact categories that cumulatively contribute to at least **80%** of the total environmental impact (excluding toxicity related impact categories). This should start from the largest to the smallest contributions. The TS may add more impact categories to the list of the most relevant ones but none shall be deleted.

7.4.2 Procedure to identify the 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. This should start from the largest to the smallest contributions. The TS may add more life cycle stages to the list of the most relevant ones but none shall be deleted.

In order to guarantee a minimum level of harmonisation among different PEFCRs, the default life cycle stages presented in the PEFCR shall be as a minimum:

- Raw material acquisition and pre-processing (including production of parts and unspecific components);
- Production of the main product;
- Product distribution and storage;
- Use stage (if in scope);
- End-of-life (including product, recovery / recycling, if in scope).

The TS may decide to split or add additional life cycle stages if there are good reasons for and this shall be justified in the PEFCR. E.g., the life cycle stage 'Raw material acquisition and pre-processing' may be split into 'Raw material acquisition', 'pre-processing', and 'raw materials supplier transport'.

If the use stage accounts for more than 50% of the total impact then the procedure shall be re-run by excluding the use stage. In this case, the list of most relevant life cycle stages shall be those selected through the latter procedure plus the use stage.

7.4.3 Procedure to identify the most relevant processes

Each most relevant impact category shall be further investigated to identify the most relevant processes used to model each life cycle stage. The processes shall be modelled as disaggregated at level-1. Similar/identical processes taking place in different life cycle stages (e.g. transportation) shall be accounted for separately. The identification of the most relevant processes shall be done according to Table 3 below.

Table 3. Criteria to select at which life cycle stage level to identify the most relevant processes.

Contribution of the use stage to the total impact	Most relevant processes identified at the level of
≥ 50%	· Whole life cycle excluding use stage, and · Use stage
< 50%	· Whole life cycle

The most relevant processes are those that collectively contribute at least with **80%** to any of the most relevant impact categories identified. The TS may add more processes to the list of the most relevant ones but none shall be delete.

In most cases, vertically aggregated datasets may be identified as representing relevant processes. In such cases it may not be obvious which process is responsible for contributing to an impact category. The metadata accompanying the data should be analysed by the TS and used to identify the most relevant processes. If this is not possible, the TS may decide whether to seek further disaggregated data or to treat the aggregated dataset as a process for the purposes of identifying relevance[25].

[25] In this last case, if an aggregated dataset is relevant, everything in it is automatically relevant

7.4.4 Procedure to identify the most relevant direct elementary flows

For each most relevant process, the identification of the most relevant direct elementary flows is important to define which direct emissions or resource use should be requested as company-specific data (i.e. the foreground elementary flows within the processes listed in the PEFCR as mandatory company-specific).

The most relevant direct elementary flows are defined as those direct elementary flows contributing cumulatively at least with **80%** to the total impact of the direct elementary flows of the process, for each most relevant impact category. The analysis shall be limited to the direct emissions of the level-1 disaggregated datasets. This means that the 80% cumulative contribution shall be calculated against the impact caused by the direct emissions only, and not against the total impact of the process. The TS may add more elementary flows to the list of the most relevant ones but none shall be delete.

During the pilot phase, this is excluded from the procedures and no most relevant direct elementary flows shall be identified. During the transition phase the inclusion of this procedure will be reconsidered.

7.4.5 Dealing with negative numbers

When identifying the percentage impact contribution for any life cycle stage, process or flow, it is important that absolute values are used (i.e. the minus sign is ignored). This allows the relevance of any credits (e.g., from recycling) to be identified. In case of flows with a negative impact score, (i) you should consider those flows to have a plus sign, namely a positive score, (ii) the total impact score needs to be recalculated including the converted negative scores, (iii) the total impact score is set to 100% and (iv) the percentage impact contribution for any life cycle stage, process or flow is assessed to this new total.

7.4.6 Specific instructions about aggregating elementary flows

Metal resource flows are not specified per origin of ore type in the source files of the ILCD recommended methods. However, in several background databases, metal resource flows are differentiated (for example, Silver, Ag 4.6E-5%, Au 1.3E-4%, in ore, Silver, Ag 4.2E-3%, Au 1.1E-4%, in ore, Silver, Ag 2.1E-4%, Au 2.1E-4%, in ore, etc.). Therefore, the specified flows were added to the ILCD method in LCA software packages with the same characterization factors as for the unspecified metals. When doing a contribution analysis of the metal resource flows, the flows per metal (silver, copper, nickel, etc.) shall be aggregated

There are five different fossil energy resource flows specified in the source files of the ILCD recommended methods (brown coal; 11.9 MJ/kg, crude oil; 42.3 MJ/kg, hard coal; 26.3 MJ/kg, natural gas; 44.1 MJ/kg, peat; 8.4 MJ/kg). However, in several background databases, fossil energy resource flows are specified with different calorific values (for example, Gas, natural, 46.8 MJ per kg, Gas, natural, 36.6 MJ per m3, Gas, natural, 35 MJ per m3, Gas, natural, 30.3 MJ per kg, etc.[26]). Therefore, the specified flows were added to the ILCD method in LCA software packages with characterization factors related to the factors in the original source, taking the different calorific value into account. When doing a contribution analysis of the

[26] These different flows can appear due the inconsistency between different databases.

fossil energy resource flows the flows based on the 5 original flows (brown coal, crude oil, hard coal, natural gas and peat) shall be aggregated.

7.4.7 Conclusions

In Table 4 the requirements to define most relevant contributions are summarized.

Table 4. Summary of requirements to define most relevant contributions.

Item	At what level does relevance need to be identified?	Threshold
Most relevant impact categories	Normalised and weighted results	Impact categories cumulatively contributing at least **80%** of the total environmental impact (excluding toxicity related impact categories)
Most relevant life cycle stages	For each most relevant impact category	All life cycle stages contributing cumulatively more than **80%** to that impact category
Most relevant processes	For each most relevant impact category	All processes contributing cumulatively more than **80%** to that impact category
Most relevant elementary flows (excluded for the pilot phase)	For each most relevant process and most relevant impact category	All direct elementary flows contributing cumulatively at least to **80%** to the impact (caused by the direct elementary flows only)

7.4.8 Example

What follows is a fictitious example, not based on any specific PEF study results.

Most relevant impact categories

Table 5. Contribution of different impact categories based on normalised and weighted results

Impact category	Contribution to the total impact (%)	Contribution % (excluding toxicity impact categories)
Climate change	21.5	28.0
Ozone depletion	3.0	3.9
Human toxicity, cancer	8.3	-
Human toxicity, non-cancer	14.9	-

Impact category	Contribution to the total impact (%)	Contribution % (excluding toxicity impact categories)
Particulate matter	0.1	0.1
Ionizing radiation, human health	0.5	0.7
Photochemical ozone formation, human health	2.4	3.1
Acidification	1.5	2.1
Eutrophication, terrestrial	1.0	1.3
Eutrophication, freshwater	1.0	1.3
Eutrophication, marine	0.1	0.1
Ecotoxicity, freshwater	0.1	-
Land use	14.3	18.6
Water use	18.6	24.2
Resource use, minerals and metals	6.7	8.8
Resource use, fossils	6.0	7.8

Based on the normalised and weighted results, and excluding the toxicity related impacts, the most relevant impact categories are: climate change, water use, land use, and resource use (minerals and metals and fossils) for a cumulative contribution of 87.4% of the total impact.

Most relevant life cycle stages

Table 6. Contribution of different life cycle stages to the climate change impact category (based on the characterised inventory results)

Life cycle stage	Contribution (%)
Raw material acquisition and pre-processing	50.3
Production of the main product	21.2
Product distribution and storage	16.5
Use stage (if in scope)	5.9
End-of-life	6.1

The three life cycle stages in yellow will be the ones identified as "most relevant" for climate change as they are contributing to more than 80%. Ranking shall start from the highest contributors. This procedure shall be repeated for all the selected most relevant EF impact categories.

Most relevant processes

Table 7. Contribution of different processes to the climate change impact category (based on the characterised inventory results)

Life cycle stage	Unit process	Contribution (%)
Raw material acquisition and pre-processing	Process A	8.9
	Process B	41.4
Production of the main product	Process C	18.4
	Process D	2.8
Product distribution and storage	Process E	16.5
Use stage	Process F	5.9
End-of-life	Other processes	6.1

According to the proposed procedure the processes B, C and E shall be selected as “most relevant”. However, the TS could consider deciding that process D, even if only contributing to 2.8% (and therefore not contributing more than Process A which is not relevant) is considered as most relevant to their sector, maybe because is the one of those expected to be in situation 1 of the DNM. They may therefore decide to add that process to the list of the most relevant that therefore would become: Process **B**, **C**, **D** and **E**.

This procedure shall be repeated for all the selected most relevant impact categories.

Most Relevant direct elementary flows (excluded for the pilot phase)

Table 8. Example of impact assessment results - contribution of each elementary flow to a specific process (climate change, results expressed in gCO_{eq}).

Inventory flow	Substance 1	Substance 2	Substance 3	Substance 4	Substance 5	Total
Process B	1100	600	500	450	50	2700
Process C	300	250	20	30	430	1030
Process E	64	1	1	1	1	68
Total	1464	856	521	481	436	3798

Table 9. Most relevant direct elementary flows contributing to climate change (based on the inventory results before normalisation and weighting) – process level.

Inventory flow	Substance 1	Substance 2	Substance 3	Substance 4	Substance 5	Total
Process B	41%	22%	19%	17%	2%	100%
Process C	29%	24%	2%	3%	42%	100%
Process E	94%	1%	1%	1%	1%	100%

In this case the PEFCR shall require the reporting of the direct emissions in blue for each of the three most relevant processes. This procedure shall be repeated for all the selected most relevant impact categories.

7.5 Sampling procedure

In some cases, a sampling procedure is needed by the applicant of a PEFCR in order to limit the data collection only to a representative sample of plants/farms etc. Examples of cases when the sampling procedure may be needed are in case multiple production sites are involved in the production of the same SKU. E.g., in case the same raw material/input material comes from multiple sites or in case the same process is outsourced to more than one subcontractor/supplier.

There exist different procedures to derive a representative sample. For PEFCRs a stratified sample shall be used, i.e. one that ensures that sub-populations (strata) of a given population are each adequately represented within the whole sample of a research study. With this type of sampling, it is guaranteed that subjects from each sub-population are included in the final sample, whereas simple random sampling does not ensure that sub-populations are represented equally or proportionately within the sample.

Using a stratified sample will always achieve greater precision than a simple random sample, provided that the sub-populations have been chosen so that the items of the same sub-population are as similar as possible in terms of the characteristics of interest. In addition, a stratified sample guarantees better coverage of the population. The researcher has control over the sub-populations that are included in the sample, whereas simple random sampling does not guarantee that sub-populations (strata) of a given population are each adequately represented within the final sample. However, one main disadvantage of stratified sampling is that it can be difficult to identify appropriate sub-populations for a population.

The following procedure shall be applied in order to select a representative sample as a stratified sample:

1) define the population
2) define homogenous sub-populations (stratification)
3) define the sub-samples at sub-population level
4) define the sample for the population starting from the definition of sub-samples at sub-population level.

7.5.1 How to define homogenous sub-populations (stratification)

Stratification is the process of dividing members of the population into homogeneous subgroups (sub-populations) before sampling. The sub-populations should be mutually exclusive: every element in the population shall be assigned to only one sub-population.

Aspects at least to be taken into consideration in the identification of the sub-populations:

- Geographical distribution of sites
- Technologies/farming practices involved
- Production capacity of the companies/sites taken into consideration

Additional aspects to be taken into consideration may be added by the TS for a specific product category.

The number of sub-populations may be identified as:

$$Nsp = g * t * c \qquad \text{[Equation 1]}$$

- Nsp: number of sub-populations
- g : number of countries in which the sites/plants/farms are located
- t : number of technologies/farming practices
- c : number of classes of capacity of companies

In case additional aspects are taken into account, the number of sub-populations is calculated using the formula just provided and multiplying the result with the numbers of classes identified for each additional aspect (e.g., those sites which have an environmental management or reporting systems in place).

Example 1

Identify the number of sub-populations for the following population:

350 farmers located in the same region in Spain, all the farmers have more or less the same annual production and are characterized by the same harvestings techniques.

In this case:

- g=1 : all the farmers are located in the same country
- t=1 : all the framers are using the same harvesting techniques
- c=1 : the capacity of the companies is almost the same (i.e. the have the same annual production)

$$Nsp = g * t * c = 1 * 1 * 1 = 1$$

Only one sub-population may be identified that coincides with the population.

Example 2

350 farmers are distributed in three different countries (100 in Spain, 200 in France and 50 in Germany). There are two different harvesting techniques that are used that differ in a relevant way (Spain: 70 technique A, 30 technique B; France: 100 technique A, 100 technique B; Germany: 50 technique A). The capacity of the farmers in term of annual production varies between 10000t and 100000t. According to expert judgement/relevant literature, it has been estimated that farmers with an annual production lower than 50000t are completely different in terms of efficiency compared to the farmers with an annual production higher than 50000t. Two classes of companies are defined based on the annual production: class 1, if production is lower than 50000 and class 2, if production if higher than 50000. (Spain: 80 class 1, 20 class 2; France: 50 class 1, 150 class 2; Germany: 50 class 1). In Table 10 are included the details about the population.

Table 10. Identification of the sub-population for Example 2.

Sub-population	Country		Technology		Capacity	
1	Spain	100	Technique A	70	Class 1	50
2	Spain		Technique A		Class 2	20
3	Spain		Technique B	30	Class 1	30
4	Spain		Technique B		Class 2	0
5	France	200	Technique A	100	Class 1	20
6	France		Technique A		Class 2	80
7	France		Technique B	100	Class 1	30
8	France		Technique B		Class 2	70
9	Germany	50	Technique A	50	Class 1	50
10	Germany		Technique A		Class 2	0
11	Germany		Technique B	0	Class 1	0
12	Germany		Technique B		Class 2	0

In this case:

- g=3 : three countries
- t=2 : two different harvesting techniques are identified
- c=2 : two classes of production are identified

$$Nsp = g * t * c = 3 * 2 * 2 = 12$$

It is possible to identify maximum 12 sub-populations that are summarized in Table 11 :

Table 11. Summary of the sub-population for example 2.

Sub-population	Country	Technology	Capacity	Number of companies in the sub-population
1	Spain	Technique A	Class 1	50
2	Spain	Technique A	Class 2	20

Sub-population	Country	Technology	Capacity	Number of companies in the sub-population
3	Spain	Technique B	Class 1	30
4	Spain	Technique B	Class 2	0
5	France	Technique A	Class 1	20
6	France	Technique A	Class 2	80
7	France	Technique B	Class 1	30
8	France	Technique B	Class 2	70
9	Germany	Technique A	Class 1	50
10	Germany	Technique A	Class 2	0
11	Germany	Technique B	Class 1	0
12	Germany	Technique B	Class 2	0

7.5.2 How to define sub-sample size at sub-population level

Once the sub-populations have been identified, for each sub-population the size of sample shall be calculated (the sub-sample size). Two approaches are possible:

1) based on the total production of the sub-population
2) based on the number of sites/farms/plants involved in the sub-population

The chosen approach shall be specified in the PEFCR. The same approach shall be used for all the sub-populations selected.

7.5.2.1 First approach

In case the first approach is chosen the PEFCR shall establish the unit of measure for the production, if t, m^3, m^2, value). The PEFCR shall identify the percentage of production to be covered by each sub-population. The percentage of production to be covered by each sub-population shall not be lower than 50%, expressed in the relevant unit. This percentage determines the sample size within the sub-population.

7.5.2.2 Second approach

In case the second approach is chosen:

The required sub-sample size shall be calculated using the square root of the sub-population size.

$$n_{SS} = \sqrt{n_{SP}} \qquad \text{[Equation 2]}$$

- n_{SS}: required sub-sample size
- n_{SP}: sub-population size

Example

Table 12. Example – how to calculate the number of companies in each sub-sample.

Sub-population	Country	Technology	Capacity	Number of companies in the sub-population	Number of companies in the sample (sub-sample size, [n_{SS}])
1	Spain	Technique A	Class 1	50	7
2	Spain	Technique A	Class 2	20	5
3	Spain	Technique B	Class 1	30	6
4	Spain	Technique B	Class 2	0	0
5	France	Technique A	Class 1	20	5
6	France	Technique A	Class 2	80	9
7	France	Technique B	Class 1	30	6
8	France	Technique B	Class 2	70	8
9	Germany	Technique A	Class 1	50	7
10	Germany	Technique A	Class 2	0	0
11	Germany	Technique B	Class 1	0	0
12	Germany	Technique B	Class 2	0	0

7.5.3 How to define the sample for the population

The representative sample of the population corresponds to the sum of the sub-samples at sub-population level.

7.5.4 What to do in case rounding is necessary

In case rounding is necessary, the general rule used in mathematics shall be applied:

- If the number you are rounding is followed by 5, 6, 7, 8, or 9, round the number up.
- If the number you are rounding is followed by 0, 1, 2, 3, or 4, round the number down.

7.5.5 Requirements for the PEFCR

The TS shall decide if sampling is allowed or not allowed in its PEFCR. The TS may explicitly prohibit the use of sampling procedures in the PEFCR, in this case sampling won't be allowed for PEF studies. If the TS allows sampling, the PEFCR shall contain a sentence like: "In case sampling is needed, it shall be conducted as specified in this PEFCR. However, sampling is not mandatory and any applicant of this PEFCR may decide to collect the data from all the plants or farms, without performing any sampling".

In case the PEFCR allows the use of sampling in PEF studies, the PEFCR shall:

- list the aspect to be taken into consideration in the selection of the sample for data collection;
- identify and list aspects that shall be taken into consideration when identifying the sub-populations, in addition to the three proposed by default in this document (if appropriate);
- identify which of the two approaches shall be used to define the size of sub-samples at sub-population level in case the applicant needs a sampling procedure, if the approach based on the

total production of the sub-population of the approach based on the number of sites/farms/plants involved in the sub-population;

- in case approach 1) is chosen, define the percentage of representativeness and how this percentage shall be calculated by the applicant of the PEFCR. The percentage shall not be lower than the minimum identified in this document, e.g. 50% of the production;
- the PEFCR shall define the requirements for reporting by the user of the PEFCR. Description of the population and of the selected sample used for the EF study shall be clearly described in the EF report. E.g., the % of the total production or % of number of sites, following the requirements stated in the PEFCR.

7.6 Cut-Off

Any cut-off shall be avoided in the screening study and supporting studies. However, based on the results of the screening study and if confirmed by the supporting study results, the PEFCR may identify and list the processes excluded from the modelling by applying the following rule:

- 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. This rule is valid for both intermediate and final products. To calculate a 1% cut-off order the processes starting from the less relevant to the most relevant one. The processes that in total account less than 1% of the environmental impact for each impact category may be excluded from PEF studies (starting from the less relevant). In case the pilot decides to apply the cut-off rule, the PEFCR shall list the processes that may be excluded based on the cut-off.

- Human toxicity-Cancer effect, Human toxicity-non Cancer effect and Freshwater Ecotoxicity shall not be taken into account when selecting processes that may be excluded based on the cut-off rule. In other words, it means that if a process accounts for less than 1% for all the impact categories with the only exception of toxicity-related ICs, this process may be cut-off.
- In case the processes identified following this procedure starting from the results of the screening study are not confirmed by the supporting studies, these cannot be excluded based on the cut-off rule.

Only the processes identified following this procedure starting from the results of the screening study and confirmed by the supporting studies may be listed in the PEFCR and excluded according to the cut off rule. No additional cut-offs are allowed for PEF studies in addition to those listed in the PEFCR.

7.7 Handling multi-functional processes

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. Systems involving multi-functionality of processes shall be modelled in accordance with the following decision

hierarchy, with additional guidance provided by PEFCRs if available. However, for activities at farm, and activities at slaughterhouse, and electricity use the allocation approach to be used shall be the one described in sections 7.10, 7.11, and 7.13 respectively.

Decision hierarchy

I) Subdivision or system expansion

Wherever possible, subdivision or system expansion should be used to avoid allocation. Subdivision refers to disaggregating multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output. System expansion refers to expanding the system by including additional functions related to the co-products. It shall be investigated first whether the analysed process can be subdivided or expanded. Where subdivision is possible, inventory data should be collected only for those unit processes[27] directly attributable[28] to the goods/services of concern. Or if the system can be expanded, the additional functions shall be included in the analysis with results communicated for the expanded system as a whole rather than on an individual co-product level.

II) Allocation based on a relevant underlying physical relationship

Where subdivision or system expansion cannot be applied, allocation should be applied: the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects relevant underlying physical relationships between them. (ISO 14044:2006, 14)

Allocation based on a relevant underlying physical relationship refers to partitioning the input and output flows of a multi-functional process or facility in accordance with a relevant, quantifiable physical relationship between the process inputs and co-product outputs (for example, a physical property of the inputs and outputs that is relevant to the function provided by the co-product of interest). Allocation based on a physical relationship can be modelled using direct substitution if a product can be identified that is directly substituted[29].

Can a direct substitution-effect be robustly modelled? This can be demonstrated by proving that (1) there is a direct, empirically demonstrable substitution effect, AND (2) the substituted product can be modelled and the resource use and emissions profile data subtracted in a directly representative manner: If yes (i.e. both conditions are verified), model the substitution effect.
Or

Can input/output flows be allocated based on some other relevant underlying physical relationship that relates the inputs and outputs to the function provided by the system? This can be demonstrated by proving that a relevant physical relationship can be defined by which to allocate the flows attributable to

[27] A unit process is the smallest element considered in the Resource Use and Emissions Profile for which input and output data are quantified. (based on ISO 14040:2006)

[28] Directly attributable refers to a process, activity or impact occurring within the defined system boundary.

[29] See below for an example of direct substitution.

the provision of the defined function of the product system[30]: If yes, allocate based on this physical relationship.

III) Allocation Based on Some Other Relationship

Allocation based on some other relationship may be possible. For example, economic allocation refers to allocating inputs and outputs associated with multi-functional processes to the co-product outputs in proportion to their relative market values. The market price of the co-functions should refer to the specific condition and point at which the co-products are produced. Allocation based on economic value shall only be applied when (I and II) are not possible. In any case, a clear justification for having discarded I and II and for having selected a certain allocation rule in step III shall be provided, to ensure the physical representativeness of the PEF results as far as possible.

Allocation based on some other relationship can be approached in one of the following alternative ways:

Can an indirect substitution[31] effect be identified? AND can the substituted product be modelled and the inventory subtracted in a reasonably representative manner? If yes (i.e. both conditions are verified), model the indirect substitution effect.

Or

Can the input/output flows be allocated between the products and functions on the basis of some other relationship (e.g. the relative economic value of the co-products)? If yes, allocate products and functions on the basis of the identified relationship

Dealing with multi-functionality of products is particularly challenging when recycling or energy recovery of one (or more) of these products is involved as the systems tend to get rather complex. The Circular Footprint Formula (see section 7.18.1) provides an approach that shall be used to estimate the overall emissions associated to a certain process involving recycling and/or energy recovery. These moreover also relate to waste flows generated within the system boundaries.

The PEFCR shall further specify multi-functionality solutions for application within the defined system boundaries and, where appropriate, for upstream and downstream stages. If feasible/appropriate, the PEFCR may further provide specific factors to be used in the case of allocation solutions. All such multi-functionality solutions specified in the PEFCR shall be clearly justified with reference to the PEF multi-functionality solution hierarchy.

- Where subdivision is applied, the PEFCR shall specify which processes are to be sub-divided and the principles that such subdivision should adhere to.

[30] A product system is the collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product (ISO 14040:2006)

[31] Indirect substitution occurs when a product is substituted but you don't know by which products exactly.

- Where allocation by physical relationship is applied, the PEFCR shall specify the relevant underlying physical relationships to be considered and list allocation values (which shall be fixed for all studies applying the PEFCR).
- Where allocation by some other relationship is applied, the PEFCR shall specify this relationship and list the allocation values (which shall be fixed for all studies applying the PEFCR).

7.8 Extended product lifetime

Extended product lifetime, due to reuse or refurbishment of a product, can be split into two situations:

1. Into a product with original product specifications (providing the same function)
2. Into a product with different product specifications (providing another function)

In situation 1, the product lifetime is extended into a product with original product specifications (providing the same function) and shall be included in the FU and reference flow. The PEFCR shall describe how reuse or refurbishment is included in the calculations of the reference flow and full life cycle model, taking into account the "how long" of the FU. Default values for extended lifetime shall be provided in the PEFCR or shall be listed as mandatory company-specific information to be collected.

In situation 2, the reuse/refurbishment of a product results into a product with different product specifications (providing another function). This shall be considered as part of the CFF, as a form of recycling (see section 7.18.23). Also, old parts that have been changed during refurbishment shall be modelled under the CFF.

7.8.1 Reuse rates

Reuse rate is the number of times a material is used at the factory. This is often also called trip rates, reuse time or number of rotations. This may be expressed as the absolute number of reuse or as % of reuse rate. For example: a reuse rate of 80% equals 5 reuses. Equation 3 describes the conversion:

$$\text{Number of reuse} = \frac{1}{100\% - \%\ reuse\ rate} \qquad \text{[Equation 3]}$$

The number of reuse applied here refers to the total number of uses during the life of the material. It includes both the first use and all the following reuses.

Specific calculation rules for reusable packaging as well as average reuse rates for company or third party operated packaging pools can be found in section 7.16.2.

7.8.2 How to apply 'reuse rate' (situation 1)

The number of times a material is reused affects the environmental profile of the product at different life cycle stages. The following 5 steps explain how the different life cycle stages with reusable materials shall be modelled, using packaging as an example:

1) Raw material acquisition: The reuse rate determines the quantity of packaging material consumed per product sold. The raw material consumption shall be calculated by dividing the actual weight of the packaging by the number of times this packaging is reused. For example: A 1l glass bottle weights 600 grams and is reused 10 times. The raw material use per litre is 60 gram (= 600 gram per bottle / 10 reuses).

2) Transport from packaging manufacturer to the product factory (where the products are packed): The reuse rate determines the quantity of transport that is needed per product sold. The transport impact shall be calculated by dividing the one-way trip impact by the number of times this packaging is reused. One way transport distances shall be provided by the PEFCR.

3) Transport from product factory to final client and back: additional to the transport needed to go to the client, the return transport shall also be taken into account. To model the total transport, section 7.14 on modelling transport shall be followed.

4) At product factory: once the empty packaging is returned to the product factory, energy and resource use shall be accounted for cleaning, repairing or refilling (if applicable).

5) Packaging End-of-Life: the reuse rate determines the quantity of packaging material (per product sold) to be treated at End-of-Life. The amount of packaging treated at End-of-Life shall be calculated by dividing the actual weight of the packaging by the number of times this packaging was reused.

7.9 Climate change modelling

The impact category 'climate change' covers three sub-categories:

1. Climate change – fossil
2. Climate change – biogenic
3. Climate change – land use and land transformation

To provide all necessary information for developing the PEFCR, the PEFCR screening study shall always calculate the three climate change sub-categories separately. If climate change is identified as a most-relevant impact category, the PEFCR shall (i) always request to report the total climate change as the sum of the three sub-categories, and (ii) shall request the reporting of the sub-categories 'Climate change - biogenic' and 'Climate change - land use and land transformation' separately if the screening study shows a contribution of more than 5%[32] each to the total score. The PEFCR shall clarify the reason for reporting or not reporting the two sub-categories.

The PEF guide indicates that credits from 'temporary carbon storage' are excluded. This means that emissions emitted within a limited amount of time after their uptake shall be counted for as emitted "now" and there is no discounting of emissions within that given time frame (also in line with ISO/TS14067). The

[32]For example, if 'Climate change - biogenic' contributes with 7% (using absolute values) to the total climate change impact and 'Climate change – land use and land transformation' contributes with 3% to the total climate change impact. In that case the Total climate change impact and the 'Climate change – biogenic' shall be reported. It is up to the TS to decide where and how to report the latter ('Climate change – biogenic').

term 'limited amount of time' is here defined as 100 years, in line with other guiding documents such as in ILCD handbook (JRC 2016) and PAS2050:2011. Therefore, biogenic carbon emitted later than 100 years after its uptake is considered as permanent carbon storage.

7.9.1 Sub-category 1: Climate change – fossil

This category covers greenhouse gas (GHG) emissions to any media originating from the oxidation and/or reduction of fossil fuels by means of their transformation or degradation (e.g. combustion, digestion, landfilling, etc.). This impact category includes emissions from peat and calcination/carbonation of limestone.

Modelling requirements: The flows falling under this definition should be modelled consistently with the most updated EF list of elementary flows[33]. The names ending with '(fossil)' (e.g., 'carbon dioxide (fossil)'' and 'methane (fossil)') shall be used if available.

7.9.2 Sub-category 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 aboveground 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 above ground plant residues such as litter and dead wood. Carbon exchanges from native forests[34] shall be modelled under sub-category 3 (including connected soil emissions, derived products or residues).

Modelling requirements: the flows falling under this definition shall be modelled consistently with the most updated ILCD list of elementary flows and using the flow names ending with '(biogenic)'. The allocation rules used for all other elementary flows shall also apply to model the biogenic carbon flows. A simplified modelling approach should be used where only those flows that influence the climate change impact results (namely biogenic methane emissions) are modelled. This option is often used by food LCAs as it avoids modelling human digestion while deriving eventually at a zero balance. The following rules apply:

i. Only the emission 'methane (biogenic)' is modelled
ii. No further biogenic emissions and uptakes from atmosphere are modelled
iii. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane

In case all emissions and removals are modelled separately, note that the corresponding characterisation factors for biogenic CO_2 uptakes and emissions are set to zero. Complementary characterisation factors

[33] http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

[34] 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. In principle this definition excludes short term forests, degraded forests, managed forest, and forests with short-term or long-term rotations.

shall be applied in case these flows are to be used to calculate additional information. In that case, the PEFCR shall describe how the additional information shall be calculated and which complementary characterisation factors shall be applied.

For cradle to grave assessments of final products with a lifetime beyond 100 years, a carbon credit shall be modelled. For cradle to grave assessments of final products with a lifetime below 100 years, the carbon storage time is co-determined by the storage time in the forest system (at plant uptake). Annex I describes in detail how the carbon storage time shall be calculated in this case. This could be the case for example for olive trees or cork trees.

Carbon credits shall be modelled as an emission uptake as 'resource from air' using the elementary flow 'carbon dioxide (biogenic-100yr)'. Please note that any carbon credit shall be properly allocated among the different by-products the system delivered over the full timeframe. For example, in case cork plantations last for 300 years, the amount to carbon stored during 200 years may be credited but shall be allocated over the different products the cork plantation delivers. The PEFCR shall request concrete proof of these carbon storages in order to get the credits.

For intermediate products (cradle to gate) the lifetime of the final product is not known. Therefore, no carbon credits shall be modelled at this point in the life cycle. The biogenic carbon content at factory gate (physical content and allocated content) shall always be reported as 'additional technical information'.

7.9.3 Sub-category 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 (including 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[35] and residues), while their CO_2 uptake is excluded.

Modelling requirements: the flows falling under this definition shall be modelled consistently with the most updated ILCD list of elementary flows and using the flow names ending with '(land use change)'. Biogenic carbon uptakes and emissions have to be inventoried separately for each elementary flow.

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

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

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[36].

1) 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.

2) 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):

1. *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);*
2. *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);*

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

3. *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.

Intermediate products (cradle to gate) derived from native forest shall always report as meta-data (in the 'additional technical information' section of the PEF study) (i) their carbon content (physical content and allocated content) and (ii) that corresponding carbon emissions shall be modelled with '(land use change)' elementary flows.

For **soil carbon stock**: soil carbon emissions shall be included and modelled under this sub-category (e.g., from rice fields). Soil carbon emissions derived from aboveground residues (except from native forest) shall be modelled under sub-category 2, such as the application of non-native forest residues or straw. Soil carbon uptake (accumulation) shall be excluded from the footprint results as it is highly questionable how the long term uptakes (beyond 100 years) can be guaranteed in practice. For example, from grasslands or improved land management through tilling techniques or other management actions taken in relation to agricultural land. Soil carbon storage may be included in the PEFCR as additional environmental information when proof is provided. For example, when legislation has different modelling requirements for the sector, such as the EU greenhouse gas accounting directive from 2013 (Decision 529/2013/EU) which indicate carbon stock accounting.

7.9.4 Characterisation factors of methane, carbon dioxide and carbon monoxide

Within the current PEF method, the global warming potentials of the third assessment report of IPCC (2007) are applied. The GWPs shall be updated using the Fifth assessment report of IPCC (2013), including climate-change carbon feedbacks for both CO_2 and non-CO_2 substances (following the UNEP/SETAC recommendations of the Pellston Workshop, January 2016). The values with feedbacks are applied to ensure consistency, as feedbacks are already included for CO_2. The GWPs of well-mixed GHGs can be found in chapter 8 of the Scientific basis report, Tables 8.7 and 8.SM.16. The GWPs for near term GHGs are not recommended for use due to their complexity and high uncertainty. Near term GHGs refer to substances that are not well-mixed once emitted to the atmosphere because of their very rapid decay (black carbon, organic carbon, nitrogen oxides, sulphur oxides, volatile organic compounds, and carbon monoxide).

The third assessment IPCC report (2007) estimated the global warming potential for methane at 25 for a time period of 100 years. This value factors in the indirect climate effects of methane emissions (such as the positive feedback on the methane lifetime and on the concentrations of ozone and stratospheric water vapour) but excludes the oxidation of methane into carbon dioxide. The Fifth assessment report of IPCC (2013) reports a global warming potential for methane at 34, still with the exclusion of methane oxidation into carbon dioxide and which is valid for biogenic methane only (IPCC 2013, Table 8.7). IPCC (2013) refers

to Boucher et al. (2009) to add the methane oxidation for fossil methane, resulting in a GWP of 36. The added value of +2 includes only a partial oxidation of methane into CO_2. Boucher et al. (2009), calculated an upper limit of +2.5 when considering that all methane is converted into CO_2 and up to +2.75 with a longer time horizon. Within the context of the environmental footprint a simple stoichiometric calculation is used to compensate the avoided CO_2 uptake within the released methane (+2.75). It can be discussed which correction factor should be applied, (i) +2 following IPCC, (ii) +2.5 following the upper margin of Boucher et al. (2009) for a time horizon of 100 years or (iii) +2.75 using the stoichiometric balance (all emissions happens "now"). The last approach is chosen, as a GWP of 36.75 reassures the same outcome between a detailed modelling (modelling all carbon uptakes and releases) and a simplified modelling approach (only modelling the CH_4 release). Within the EF context, the same result between a detailed modelling approach or the EF proposed simplified modelling approach is considered to be essential. This means that for fossil methane a GWP of 36.75 shall be used.

For biogenic carbon modelling the list of ILCD elementary flows and CFs in Table 13 shall be applied:

Table 13. CFs (in CO_2-equivalents, with carbon feedbacks).

Substance	Compartment	GWP_{100}
Carbon dioxide (fossil)	Air emission	1
Methane (fossil)	Air emission	36.75
Carbon monoxide (fossil)	Air emission	1.57 [37]
Carbon dioxide (biogenic)	Resources from air	0
Carbon dioxide (biogenic-100yr)	Resources from air	-1
Carbon dioxide (biogenic)	Air emission	0
Methane (biogenic)	Air emission	34
Carbon monoxide (biogenic)	Air emission	0
Carbon dioxide (land use change)	Resources from air	-1
Carbon dioxide (land use change)	Air emission	1
Methane (land use change)	Air emission	36.75
Carbon monoxide (land use change)	Air emission	1.57

[37] The effects of near term climate forcers are uncertain and therefore excluded (following the UNEP/SETAC recommendations of the Pellston Workshop, January 2016). The GWP presented here represents only the effects from degradation of CO into CO_2 (stoichiometric calculation).

7.10 Agricultural modelling

For agricultural products the PEFCR shall provide clear modelling guidelines for agricultural activities. The modelling guidelines in this chapter shall be followed by the PEFCRs. Any exception to these rules shall be agreed with the Commission before being implemented.

7.10.1 Handling multi-functional processes

The rules described in the LEAP Guideline shall be followed: 'Environmental performance of animal feeds supply chains (pages 36-43), FAO 2015, available at http://www.fao.org/partnerships/leap/publications/en/.

7.10.2 Crop type specific and country-region-or-climate specific data

Crop type specific and country-region-or-climate specific data for yield, water and land use, land use change, fertiliser (artificial and organic) amount (N, P amount) and pesticide amount (per active ingredient), per hectare per year, should be used.

7.10.3 Averaging data

Cultivation data shall be collected over a period of time sufficient to provide an average assessment of the life cycle inventory associated with the inputs and outputs of cultivation that will offset fluctuations due to seasonal differences. This shall be undertaken as described in the LEAP guidelines[38], set out below:

- For annual crops, an assessment period of at least three years shall be used (to level out differences in crop yields related to fluctuations in growing conditions over the years such as climate, pests and diseases, et cetera). Where data covering a three-year period is not available i.e. due to starting up a new production system (e.g. new greenhouse, newly cleared land, shift to other crop), the assessment may be conducted over a shorter period, but shall be not less than 1 year. Crops/plants grown in greenhouses shall be considered as annual crops/plants, unless the cultivation cycle is significantly shorter than a year and another crop is cultivated consecutively within that year. Tomatoes, peppers and other crops which are cultivated and harvested over a longer period through the year are considered as annual crops.
- For perennial plants (including entire plants and edible portions of perennial plants) a steady state situation (i.e. where all development stages are proportionally represented in the studied time period) shall be assumed and a three-year period shall be used to estimate the inputs and outputs[39].

[38] Environmental performance of animal feeds supply chains, FAO 2015, available at http://www.fao.org/partnerships/leap/publications/en/.

[39] The underlying assumption in the cradle to gate life cycle inventory assessment of horticultural products is that the inputs and outputs of the cultivation are in a 'steady state', which means that all development stages of perennial crops (with different quantities of inputs and outputs) shall be proportionally represented in the time period of cultivation that is studied. This approach gives the advantage that inputs and outputs of a relatively short period can

- Where the different stages in the cultivation cycle are known to be disproportional, a correction shall be made by adjusting the crop areas allocated to different development stages in proportion to the crop areas expected in a theoretical steady state. The application of such correction shall be justified and recorded. The life cycle inventory of perennial plants and crops shall not be undertaken until the production system actually yields output.
- For crops that are grown and harvested in less than one year (e.g. lettuce produced in 2 to 4 months) data shall be gathered in relation to the specific time period for production of a single crop, from at least three recent consecutive cycles. Averaging over three years can best be done by first gathering annual data and calculating the life cycle inventory per year and then determine the three years average.

7.10.4 Pesticides

Pesticide emissions shall be modelled as specific active ingredients. The USEtox life cycle impact assessment method has a build in multimedia fate model which simulates the fate of the pesticides starting from the different emission compartments. Therefore, default emission fractions to environmental emission compartments are needed in the LCI modelling (Rosenbaum et al., 2015). As temporary approach, the pesticides applied on the field shall be modelled as 90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water (based on expert judgement due to current limitations[40]). More specific data might be used if available.

A robust model to assess the link between the amount applied on the field and the amount ending up in the emission compartment is still missing today. The PESTLCI model might fill in this gap in the future, but is currently still under testing.

7.10.5 Fertilisers

Fertiliser (and manure) emissions shall be differentiated per fertilizer type and cover as a minimum:

- NH_3, to air (from N-fertiliser application)
- N_2O, to air (direct and indirect) (from N-fertiliser application)
- CO_2, to air (from lime, urea and urea-compounds application)
- NO_3, to water unspecified (leaching from N-fertiliser application)

---

be used for the calculation of the cradle-to-gate life cycle inventory from the perennial crop product. Studying all development stages of a horticultural perennial crop can have a lifespan of 30 years and more (e.g. in case of fruit and nut trees).

[40] Several databases consider a 100% emitted to soil out of simplification (e.g. Agribalyse and Ecoinvent). It is recognized that emissions to freshwater and air do occur. However, emission fractions vary significantly depending on the type of pesticide, the geographical location, time of application and application technique (ranging from 0% to 100%). Especially the % emitted to water can be strongly debated, however, overall it seems that 1% indicates a reasonable average (e.g. WUR-Alterra 2016: Emissies landbouwbestrijdingsmiddelen). Please note that these are temporary values until future modelling fills this gap.

- PO_4, to water unspecified or freshwater (leaching and run-off of soluble phosphate from P-fertiliser application)
- P, to water unspecified or freshwater (soil particles containing phosphorous, from P-fertiliser application).

The impact assessment model for freshwater eutrophication should start (i) when P leaves the agricultural field (run off) or (ii) from manure or fertiliser application on agricultural field. Within LCI modelling, the agricultural field (soil) is often seen as belonging to the technosphere and thus included in the LCI model. This aligns with approach (i) where the impact assessment model starts after run-off, i.e. when P leaves the agricultural field. Therefore, within the EF context, the LCI should be modelled as the amount of P emitted to water after run-off and the emission compartment 'water' shall be used. When this amount is not available, the LCI may be modelled as the amount of P applied on the agricultural field (through manure or fertilisers) and the emission compartment 'soil' shall be used. In this case, the run-off from soil to water is part of the impact assessment method and included in the CF for soil.

The impact assessment marine Eutrophication starts after N leaves the field (soil). Therefore, N emissions to soil shall not be modelled. The amount of emissions ending up in the different air and water compartments per amount of fertilisers applied on the field shall be modelled within the LCI. Nitrogen emissions shall be calculated from Nitrogen applications of the farmer on the field and excluding external sources (e.g. rain deposition). To avoid strong inconsistencies among different PEFCRs, within the EF context it is decided to fix a number of emission factors by following a simplified approach. For nitrogen based fertilisers, the Tier 1 emissions factors of IPCC 2006 (*Table 2-4)* should be used, as presented in Table 14. Note that the values provided shall not be used to compare different types of synthetic fertilizers. More detailed modelling shall be used for that. In case better data is available, a more comprehensive Nitrogen field model may be used by the PEFCR, provided (i) it covers at least the emissions requested above, (ii) N shall be balanced in inputs and outputs and (iii) it shall be described in a transparent way.

Table 14. Tier 1 emission factors of IPCC 2006 (modified).

Emission	Compartment	Value to be applied
N_2O (synthetic fertiliser and manure; direct and indirect)	Air	0.022 kg N_2O/ kg N fertilizer applied
NH_3 (synthetic fertiliser)	Air	kg NH_3= kg N * FracGASF= 1*0.1* (17/14)= 0.12 kg NH_3/ kg N fertilizer applied
NH_3 (manure)	Air	kg NH_3= kg N*FracGASF= 1*0.2* (17/14)= 0.24 kg NH_3/ kg N manure applied
NO_3^- (synthetic fertiliser and manure)	Water	kg NO_3^- = kg N*FracLEACH = 1*0.3*(62/14) = 1.33 kg NO_3^-/ kg N applied

It is recognized that the above nitrogen field model has its limitations and shall be improved in the future. Therefore, any PEFCR developed within the EF transition phase (2018-2020) and which has agricultural modelling in scope shall test (as minimum) the following alternative approach:

The N-balance is calculated using the parameters in Table 15 and the formula below. The total NO_3-N emission to water is considered a variable and its total inventory shall be calculated as:

"Total NO_3-N emission to water" = "NO_3^- base loss" + "additional NO_3-N emissions to water", with

"Additional NO_3-N emissions to water" = "N input with all fertilisers" + "N_2 fixation by crop" – "N-removal with the harvest" – "NH_3 emissions to air" – "N_2O emissions to air" – "N_2 emissions to air" - "NO_3- base loss".

If in certain low-input schemes the value for "additional NO_3-N emissions to water" be negative, the value is to be set to "0". Moreover, in such cases the absolute value of the calculated "additional NO_3-N emissions to water" is to be inventoried as additional N-fertiliser input into the system, using the same combination of N-fertilisers as employed to the analysed crop. This serves to avoid regarding fertility-depleting schemes by capturing the N-depletion by the analysed crop that is assumed to lead to the need for additional fertiliser later on to keep the same soil fertility level.

Table 15. Alternative approach for nitrogen modelling.

Emission	Compartment	Value to be applied
NO_3^- base loss (synthetic fertiliser and manure)	Water	kg NO_3^-= kg N*FracLEACH = 1*0.1*(62/14) = 0.44 kg NO_3^-/ kg N applied
N_2O (synthetic fertiliser and manure; direct and indirect)	Air	0.022 kg N_2O/ kg N fertilizer applied
NH_3 - Urea (synthetic fertiliser)	Air	kg NH_3= kg N * FracGASF= 1*0.15* (17/14)= 0.18 kg NH_3/ kg N fertilizer applied
NH_3 - Ammonium nitrate (synthetic fertiliser)	Air	kg NH_3= kg N * FracGASF= 1*0.1* (17/14)= 0.12 kg NH_3/ kg N fertilizer applied
NH_3 - others (synthetic fertiliser)	Air	kg NH_3= kg N * FracGASF= 1*0.02* (17/14)= 0.024 kg NH_3/ kg N fertilizer applied
NH_3 (manure)	Air	kg NH_3= kg N*FracGASF= 1*0.2* (17/14)= 0.24 kg NH_3/ kg N manure applied
N_2-fixation by crop		For crops with symbiotic N_2-fixation: the fixed amount is assumed to be identical to the N-content in the harvested crop
N_2	Air	0.09 kg N_2 / kg N applied

7.10.6 Heavy metal emissions

Heavy metal emissions from field inputs shall be modelled as emission to soil and/or leaching or erosion to water. The inventory to water shall specify the oxidation state of the metal (e.g., Cr^{+3}, Cr^{+6}). As crops assimilate part of the heavy metal emissions during their cultivation clarification is needed on how to model crops that act as a sink. Two different modelling approaches are allowed:

- The final fate of the heavy metals elementary flows are not further considered within the system boundary: the inventory does not account for the final emissions of the heavy metals and therefore shall not account for the uptake of heavy metals by the crop. For example, heavy metals in agricultural crops cultivated for human consumption end up in the plant. Within the EF context human consumption is not modelled, the final fate is not further modelled and the plant acts as a heavy metal sink. Therefore, the uptake of heavy metals by the crop shall not be modelled.
- The final fate (emission compartment) of the heavy metal elementary flows is considered within the system boundary: the inventory does account for the final emissions (release) of the heavy metals in the environment and therefore shall also account for the uptake of heavy metals by the crop. For example, heavy metals in agricultural crops cultivated for feed will mainly end up in the animal digestion and used as manure back on the field where the metals are released in the environment and their impacts are captured by the impact assessment methods. Therefore, the inventory of the agricultural stage shall account for the uptake of heavy metals by the crop. A limited amount ends up in the animal (=sink), which may be neglected for simplification.

7.10.7 Rice cultivation

Methane emissions from rice cultivation shall be included based on the calculation rules of IPCC (2006) (Volume 4, Chapter 5.5, page 44-53).

7.10.8 Peat soils

Drained peat soils shall include carbon dioxide emissions on the basis of a model that relates the drainage levels to annual carbon oxidation.

7.10.9 Other activities

The following activities shall be included in agricultural modelling, if applicable:

- Input of seed material (kg/ha),
- Input of peat to soil (kg/ha + C/N ratio),
- Input of lime (kg $CaCO_3$/ha, type),
- Machine use (hours, type) (to be included if there is high level of mechanisation),
- Input N from crop residues that stay on the field or are burned (kg residue + N content/ha). Including emissions from residues burning.

Drying and storage of products shall always be included, unless its exclusion is clearly justified in the PEFCR.

Unless it is clearly documented that operations are carried out manually, field operations shall be accounted for through total fuel consumption or through inputs of specific machinery, transports to/from the field, energy for irrigation, etc.

7.11 Cattle, sheep, goat, and pork modelling

DISCLAIMER: The content of section 7.11 is based on the best information made available during the pilot phase. This information will be used mainly to carry out the re-modelling step of the PEFCRs developed in the context of the EF pilot phase (2013-2018).

It is acknowledged that there are wide margins for improvements both in terms of allocation approaches and underlying data. This work will be continued during the transition phase (2018-2020).

This section includes instructions on how to model issues related to farm, slaughterhouse and rendering modules for the animals involved in the pilot phase and namely cattle, pig, sheep and goat. In particular, instructions will be provided on:

1. Allocation of upstream burdens at farm level among outputs leaving the farm
2. Allocation of upstream burdens (linked to live animals) at slaughterhouse among outputs leaving the slaughterhouse.

7.11.1 Allocation within the farm module

At farm module, subdivision shall be used for processes that can be directly attributed to certain outputs (e.g. energy use and emissions related to milking processes). When the processes cannot be subdivided due to the lack of separate data or because technically impossible, the upstream burden, e.g. feed production, shall be allocated to farm outputs using a biophysical allocation method. Default values shall be provided for each type of animal and these default values shall be included in the PEFCR and used by PEF/OEF studies unless company-specific data are collected. The change of allocation factors is allowed only when company-specific data are collected and used for the farm module. In case generic data are used for the farm module, no change of allocation factors is allowed and the ones included in this document shall be used.

7.11.2 Allocation within the farm module for cattle

The IDF 2015[41] allocation method between milk, cull cows and surplus calves shall be used. Dead animals and all the products coming from dead animals shall be regarded as waste and the Circular Footprint Formula (CFF) shall be applied. In this case, however, the traceability of the products coming from dead animals shall be granted in order for this aspect to be taken into consideration into PEF studies.

[41] IDF 2015. A common carbon footprint approach for dairy sector: The IDF guide to standard life cycle assessment methodology. Bulletin of the International Dairy Federation 479/2015.

Manure exported to another farm shall be considered as

- **Residual (default option):** when manure does not have an economic value at the farm gate, it is regarded as residual without allocation of an upstream burden. The emissions related to manure management up to farm gate are allocated to the other outputs of the farm where manure is produced.
- **Co-product**: when exported manure has economic value at farm gate, an economic allocation of the upstream burden shall be used for manure by using the relative economic value of manure compared to milk and live animals at the farm gate. Biophysical allocation based on IDF rules shall nevertheless be applied to allocate the remaining emissions between milk and live animals.
- **Manure as waste**: when manure is treated as waste (e.g. landfilled), the CFF shall be applied.

The allocation factor (AF) for milk shall be calculated using the following equation:

$$AF = 1 - 6.04 * \frac{M_{meat}}{M_{milk}}$$ [Equation 4]

Where M_{meat} is the mass of live weight of all animals sold including bull calves and culled mature animals per year and M_{milk} is the mass of fat and protein corrected milk (FPCM) sold per year (corrected to 4% fat and 3.3% protein). The constant 6.04 describes the causal relationship between the energy content in feed in relation to the milk and live weight of animals produced. The constant is determined based on a study that collected data from 536 US dairy farms[42]. Although based on US farms, IDF considers that the approach is applicable to the European farming systems.

The FPCM (corrected to 4% fat and 3.3% protein) shall be calculated by using the following formula:

[Equation 5]

$$FPCM\left(\frac{kg}{yr}\right) = Production\left(\frac{kg}{yr}\right) * (0.1226 * True\ Fat\ \% + 0.0776 * True\ Protein\ \% + 0.2534)$$

When a default value of 0.02 kg_{meat}/kg_{milk} for the ratio of live weight of animals and milk produced in Equation 4 is used, the equation yields default allocation factors of 12% to live weight of animals and 88% to milk (Table 16). These values shall be used as default values for allocating the upstream burdens to milk and live weight of animals for cattle when secondary datasets are used. When company-specific data are collected for the farming stage, the allocation factors shall be changed using the equations included in this section.

[42] Thoma et al. (2013). A biophysical approach to allocation of life cycle environmental burdens for fluid milk supply chain analysis. International Dairy Journal 31 (2013)

Table 16: Default allocation factors for cattle at farming.

Co-product	Allocation factor
Animals, live weight	12%
Milk	88%

7.11.3 Allocation within the farm module for the sheep and goat

A biophysical approach shall be used for the allocation of upstream burdens to the different co-products for sheep and goat. The 2006 IPPC guidelines for national greenhouse gas inventories[43] contain a model to calculate energy requirements that shall be used for sheep and, as a proxy, for goats. This model is applied in the present document.

Dead animals and all the products coming from dead animals shall be regarded as waste and the Circular Footprint Formula (CFF) shall be applied. In this case, however, the traceability of the products coming from dead animals shall be granted in order for this aspect to be taken into consideration into EF studies.

The use of the default allocation factors included in this document is mandatory whenever secondary datasets are used for the life cycle stage of farming for sheep and goat. If company specific data are used for this life cycle stage, then the calculation of the allocation factors with the company specific data shall be performed using the equations provided.

The allocation factors shall be calculated as follows[44]:

$$\%\ wool = \frac{[\text{Energy for wool } (NE_{wool})]}{[(\text{Energy for wool } (NE_{wool}) + \text{Energy for milk } (NE_l) + \text{Energy for meat } (NE_g)]} \quad \text{[Equation 6]}$$

$$\%\ milk = \frac{[\text{Energy for milk } (NE_l)]}{[(\text{Energy for wool } (NE_{wool}) + \text{Energy for milk } (NE_l) + \text{Energy for meat } (NE_g)]} \quad \text{[Equation 7]}$$

$$\%\ meat = \frac{[\text{Energy for meat } (NE_g)]}{[(\text{Energy for wool } (NE_{wool}) + \text{Energy for milk } (NE_l) + \text{Energy for meat } (NE_g)]} \quad \text{[Equation 8]}$$

For the calculation of energy for wool (NE_{wool}), energy for milk (NE_l) and energy for meat (NE_g) with company specific data, the equations included in IPPC[45] and reported below shall be used. In case secondary data are used instead, the default values for the allocation factors provided in this document shall be used.

[43] Dong, H., Mangino, J., McAllister, T.A., Hatfield, J.L., Johnson, D.E., Lassey, K. R.,… Romanoskaya, A. (2006). Chapter 10 Emissions From Livestock And Manure Management. In H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES.

[44] The same naming as used in "Dong, H., Mangino, J., McAllister, T.A., Hatfield, J.L., Johnson, D.E., Lassey, K. R.,… Romanoskaya, A. (2006). Chapter 10 Emissions From Livestock And Manure Management. In H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES" is used.

[45] Dong, H., Mangino, J., McAllister, T.A., Hatfield, J.L., Johnson, D.E., Lassey, K. R.,… Romanoskaya, A. (2006). Chapter 10 Emissions From Livestock And Manure Management. In H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES

Energy for wool, NE_{wool}

$$NE_{wool} = \frac{(EV_{wool} \cdot Production_{wool})}{365}$$ [Equation 9]

NE_{wool} = net energy required to produce wool, MJ day^{-1}

EV_{wool} = the energy value of each kg of wool produced (weighed after drying but before scouring), MJ kg^{-1}. A default value of 157 MJ kg^{-1} (NRC, 2007[46]) shall be used for this estimate.47

$Production_{wool}$ = annual wool production per sheep, kg yr^{-1}

Default values to be used for the calculation of NE_{wool} and the resulting net energy required are reported in Table 17.

Table 17: Default values to be used for the calculation of NEwool for sheep.

Parameter	Value	Source
EV_{wool} - sheep	157 MJ kg^{-1}	NRC, 2007
$Production_{wool}$ - sheep	7.121 kg	Average of the four values provided in Table 1 of "Application of LCA to sheep production systems: investigating co-production of wool and meat using case studies from major global producers. Wiedemann et al, Int J. of LCA 2015.
NE_{wool} - sheep	3.063 MJ/d	Calculated using Eq. 9
NE_{wool} - goat	2.784 MJ/d	Calculated from NE_{wool} – sheep using Eq. 12

Energy for milk, NEl

$$NE_l = Milk \cdot EV_{milk}$$ [Equation 10]

NE_l = net energy for lactation, MJ day^{-1}

Milk = amount of milk produced, kg of milk day^{-1}

EV_{milk} = the net energy required to produce 1 kg of milk. A default value of 4.6 MJ/kg (AFRC, 1993) shall be used which corresponds to a milk fat content of 7% by weight.

[46] NRC. 2007. Nutrient requirements of small ruminants: Sheep, goats, cervids, and new world camelids. National Research Council. Washington DC, National Academies Press.

[47] The default value of 24 MJ kg^{-1} originally included in the IPPC document has been modified into 157 MJ kg^{-1} following the indication of FAO - Greenhouse gas emissions and fossil energy demand from small ruminant supply chains Guidelines for quantification, draft for public review, 2014.

Table 18: Default values to be used for the calculation of NEl for sheep.

Parameter	Value	Source
EV_{milk} - sheep	4.6 MJ kg^{-1}	AFRC, 1993
$Milk$ - sheep	2.08 kg/d	Estimated milk production 550 lbs of sheep milk per year (average value), milk production estimated for 120 days in one year.
NE_l - sheep	9.568 MJ/d	Calculated using Eq. 10
NE_l - goat	8.697 MJ/d	Calculated from NE_l – sheep using Eq. 12

Energy for meat, NE_g

$$NE_g = WG_{lamb} \cdot \frac{a+0.5b(BW_i+BW_f)}{365}$$ [Equation 11]

NE_g = net energy needed for growth, MJ day^{-1}

WG_{lamb} = the weight gain (BW_f – BW_i), kg yr^{-1}

BW_i = the live bodyweight at weaning, kg

BW_f = the live bodyweight at 1-year old or at slaughter (live-weight) if slaughtered prior to 1 year of age, kg

a, b = constants as described in Table 19.

Note that lambs will be weaned over a period of weeks as they supplement a milk diet with pasture feed or supplied feed. The time of weaning should be taken as the time at which they are dependent on milk for half their energy supply. The NE_g equation used for sheep includes two empirical constants (a and b) that vary by animal species/category (Table 19).

Table 19: Constants for use in calculating NEg for sheep[48].

Animal species/category	a (MJ kg^{-1})	b (MJ kg^{-2})
Intact males	2.5	0.35
Castrates	4.4	0.32
Females	2.1	0.45

In case company specific data are used for the farming stage, the allocation factors shall be recalculated. In this case, the parameter "a" and "b" shall be calculated as weighted average when more than one animal category is present.

[48] This table corresponds to Table 10.6 in Dong, H., Mangino, J., McAllister, T.A., Hatfield, J.L., Johnson, D.E., Lassey, K. R.,… Romanoskaya, A. (2006). Chapter 10 Emissions From Livestock And Manure Management. In H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES.

Table 20: Default values to be used for the calculation of NEg for sheep.

Parameter	Value	Source
WG_{lamb} - sheep	26.2-15=11.2 kg	Calculated
BW_i - sheep	15 kg	It is assumed that the weaning happens at six weeks. Weight at six weeks read from Figure 1 in "A generic model of growth, energy metabolism and body composition for cattle and sheep", Johnson et al, 2015 – Journal of Animal Science.
BW_f - sheep	26.2 kg	Average of the values for weight at slaughter, sheep as provided in Appendix 5, Greenhouse gas emissions and fossil energy demand from small ruminant supply chains, FAO 2014.
a - sheep	3	Average of the three values provided in Table 19**Table 19**
b - sheep	0.37	Average of the three values provided in Table 19
NE_g - sheep	0.326 MJ/d	Calculated using Eq. 11
NE_g - goat	0.296 MJ/d	Calculated from NE_g – sheep using Eq. 12

The default allocation factors to be used in PEFCR and in EF studies for sheep and goat are reported in Table 21 together with the calculations. The same equations[49] and default values used for the calculation of the energy requirements for sheep are used for the calculation of the energy requirements for goats after application of a correction factor.

Net energy requirement, goat = [(goat weight) / (sheep weight)]$^{0.75}$ • Net energy requirement,sheep

Sheep weight: 64.8 kg, average of male and female sheeps for different regions in the world, data from Appendix 5, Greenhouse gas emissions and fossil energy demand from small ruminant supply chains, FAO 2014.

Goat weight: 57.05 kg, average of male and female goats for different regions in the world, data from Appendix 5, Greenhouse gas emissions and fossil energy demand from small ruminant supply chains, FAO 2014.

Net energy requirement, goat = [(57.05) / (64.8)]$^{0.75}$ • Net energy requirement, sheep [Equation 12]

[49] Page 10.24 of Dong, H., Mangino, J., McAllister, T.A., Hatfield, J.L., Johnson, D.E., Lassey, K. R.,… Romanoskaya, A. (2006). Chapter 10 Emissions From Livestock And Manure Management. In H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe (Eds.), 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES

Table 21: Default allocation factors to be used in PEFCR and in EF studies for sheep and goat at farming stage.

	Sheep	Goat[50]
Allocation factor, meat	$\%\ meat = \frac{[(NE_g)]}{[(NE_{wool}) + (NE_l) + (NE_g)]}$ = 2.52%	2.51 %
Allocation factor, milk	$\%\ milk = \frac{[(NE_l)]}{[(NE_{wool}) + (NE_l) + (NE_g)]}$ = 73.84%	73.85%
Allocation factor, wool	$\%\ wool = \frac{[\ (NE_{wool})]}{[(NE_{wool}) + (NE_l) + (NE_g)]}$ = 23.64%	23.64%

7.11.4 Allocation within the farm module for pig

Allocation at farming stage between piglets and sows shall be made applying economic allocation. The default allocation factors to be used are reported below (data from the meat screening study).

Table 22: Allocation at farming stage between piglets and sows

	Unit	Price	Allocation factors
Piglets	24.8 p	0.95 €/kg live weight	92.63%
Sow to slaughter	84.8 kg	40.80 €/pig	7.37%

7.11.5 Allocation within the slaughterhouse

Slaughterhouse and rendering processes produce multiple outputs going to the food and feed chain or to other non-food or feed value chains as the leather industry or chemical or energy recovery chains.

At the slaughterhouse and rendering module, subdivision shall be used for processes that can be directly attributed to certain outputs. When the processes cannot be subdivided, the remaining (e.g. excluding that already allocated to milk for milk producing system and/or to wool for wool producing system) upstream burden shall be allocated to slaughterhouse and rendering outputs using the economic allocation method. Default values for prices and mass fractions are provided for cattle, pigs and small ruminants (sheep, goat) and these default values shall be included in relevant PEFCRs and used by PEF studies and PEF supporting studies. No change of allocation factors is allowed.

7.11.6 Allocation within the slaughterhouse for cattle

At the slaughterhouse the allocation factors are established for the categories reported in

[50] Allocation factors for goat are calculated starting from the net energy requirements for goat estimated from the net energy requirements for sheep and considering: sheep weight= 64.8 kg and goat weight= 57.05 kg.

Table 23. If allocation factors to subdivide the impact of the carcass among the different cuts are desired, they shall be defined in the relevant PEFCR.

The by-products from slaughterhouse and rendering can be classified in three categories:

- **Category 1**: Risk materials, e.g. infected/contaminated animals or animal by-products
    - Disposal and use: incineration, co-incineration, landfill, used as biofuel for combustion, manufacture of derived products
- **Category 2**: Manure and digestive tract content, products of animal origin unfit for human consumption
    - Disposal and use: incineration, co-incineration, landfill, fertilisers, compost, biofuels, combustion, manufacture of derived products
- **Category 3**: Carcases and parts of animals slaughtered and which are fit for human consumption but are not intended for human consumption for commercial reasons, include skins and hides going for leather industry (note that hides and skins can also belong to other categories depending on the condition and nature that is determined by the accompanying sanitary documentation)
    - Disposal and use: incineration, co-incineration, landfill, feed, pet food, fertilisers, compost, biofuels, combustion, manufacture of derived products (e.g. leather), oleo-chemicals and chemicals

The upstream burden to slaughterhouse and rendering outputs shall be allocated as follows:

- **Food grade materials**: product with allocation of an upstream burden
- **Cat 1 material**: default no allocation of upstream burdens as it is seen as animal by-product treated as waste according to the CFF
- **Cat 2 material**: default no allocation of upstream burdens as it is seen as animal by-product treated as waste according to the CFF
- **Cat 3 material going the same way as cat 1 and cat** 2 (for fat – to be burned, or bone and meat meal) and does not have an economic value at the slaughterhouse gate: default no allocation of upstream burdens as it is treated as waste according to the CFF
- **Cat 3 skins and hides** (unless they are classified as waste and/or following the same way as cat 1 and cat2): product with allocation of an upstream burden
- **Cat 3 materials, not included in previous categories**: product with allocation of an upstream burden

The default values in

Table 23 shall be used in PEFCR, supporting studies and PEF studies. The change of allocation factors is not allowed.

Table 23: Economic allocation ratios for beef (data already included in the CMWG Report)

	Mass faction (F)	Price (P)	Economic allocation (EA)	Allocation ratio* (AR)
	%	€/kg	%	
a) Fresh meat and edible offal	49.0	3.00	92.9[51]	1.90
b) Food grade bones	8.0	0.19	1.0	0.12
c) Food grade fat	7.0	0.40	1.8	0.25
d) Cat. 3 slaughter by-products	7.0	0.18	0.8	0.11
e) Hides and skins	7.0	0.80	3.5	0.51
f) Cat 1/2 material and waste	22.0	0.00	0.0	0.00

*Allocation ratio (AR) have been calculated as 'Economic allocation' divided by 'Mass fraction'

Allocation ratios (AR) shall be used to calculate the environmental impact of a unit of product by using Equation 13.

$$EI_i = EI_w * AR_i \qquad \text{[Equation 13]}$$

Where, EI_i is the environmental impact per mass unit of product *i* , (*i* = a slaughterhouse output listed in Table 1), EI_w is the environmental impact of the whole animal divided by live weight mass of the animal and AR_i is the allocation ratio for product *i* (calculated as economic value of *i* divided by mass fraction of i).

EI_w shall include upstream impacts, slaughterhouse impacts that cannot be directly attributed to any specific products and impacts of waste management. The default values for AR_i as shown in Table 1 shall be used for the EF studies to represent the European average situation.

7.11.7 Allocation within the slaughterhouse for pigs

The default values in

Table 24 shall be used in PEFCR, supporting studies and PEF studies dealing with allocation within the slaughterhouse for pigs. The change of allocation factors based on company-specific data is not allowed. The mass fractions and the prices are taken from the screening study provided by the meat pilot.

2394 **Table 24: Economic allocation ratios for pigs (from the meat screening study)**

	Mass fraction (F)	Price (P)	Economic allocation (EA)	Allocation ratio* (AR)
	%	€/kg	%	
a) Fresh meat and edible offal	67.0[52]	1.08	98.67[53]	1.54
b) Food grade bones	11.0	0.03	0.47	0.04
c) Food grade fat	3.0	0.02	0.09	0.03
d) Cat. 3 slaughter by-products	19.0	0.03	0.77	0.04
e) Hides and skins (categorized in cat.3 products)	0.0	0.00	0	0
Total	100.0		100.0	

2395 ### 7.11.8 Allocation within the slaughterhouse for sheep and goat

2396 The default values in Table 25 shall be used in PEFCR, supporting studies and PEF studies dealing with
2397 allocation within the slaughterhouse for sheep and goat. The change of allocation factors based on
2398 company-specific data is not allowed. The mass fractions and the prices are taken from the screening study
2399 made by the meat pilot. Until more reliable data on mass fractions and price for goats are made available,
2400 the same allocation factors for the sheep shall be used also for goat.
2401
2402 **Table 25: Economic allocation ratios for sheep (from the meat screening study). The same allocation factors shall be used**
2403 **also for goat.**

	Mass fraction (F)	Price (P)	Economic allocation (EA)	Allocation ratio* (AR)
	%	€/kg	%	
a) Fresh meat and edible offal	44.0	7	97.8[54]	2.22
b) Food grade bones	4.0	0.01	0.0127	0.0032
c) Food grade fat	6.0	0.01	0.0190	0.0032

[52] The data in the screening do not sum up to 100%, but to 96%. We have recalculated the percentages to arrive at 100%. To be checked with the meat pilot what happened to the missing 4%

d) Cat. 3 slaughter by-products	13.0	0.15	0.618	0.05
e) Hides and skins (categorized in cat.3 products)	14.0	0.35	1.6	0.11
f) cat ½ material and waste	19	0	0	0
	100		100	

7.12 Biodiversity

The current PEF method includes no impact category named "biodiversity". However, the current PEF method includes at least 6 impact categories that have an effect on biodiversity (i.e., climate change, eutrophication aquatic freshwater, eutrophication aquatic marine, acidification, water use, land use). As biodiversity is an important topic on the political agenda, when developing a PEFCR, biodiversity shall be addressed separately (besides the PEF impact categories) through the procedure below:

1. When performing the screening study the TS shall make an assessment about the relevance of biodiversity on the product group in scope of the PEFCR. This assessment shall be independent from the results of the PEF impact assessment method and clearly explained in a dedicated section of the screening.
2. The PEFCR shall clearly explain in the section on "EF impact assessment" whether biodiversity is considered relevant or not. If the TS determine that there are significant impacts on biodiversity, then they shall describe in this section of the PEFCR how biodiversity impacts shall be assessed and reported by the applicant. The biodiversity results shall be reported under "additional environmental information".

While the TS is free to determine how biodiversity shall be assessed and reported (if relevant), the following suggestions are offered:

- To express the (avoided) impact on biodiversity as the percentage of material that comes from ecosystems that have been managed to maintain or enhance conditions for biodiversity, as demonstrated by regular monitoring and reporting of biodiversity levels and gains or losses (e.g. less than 15% loss of species richness due to disturbance, but the pilots may set their own level provided this is well justified). The assessment should refer to materials that end up in the final products and to materials that have been used during the production process. For example, charcoal that is used in steel production processes, or soy that is used to feed cows that produce dairy etc.
- To report additionally the percentage of such materials for which no chain of custody or traceability information can be found.
- To use a certification system as a proxy. The TS shall determine which certification schemes provide sufficient evidence for ensuring biodiversity maintenance and describe the criteria used. A useful overview of standards can be found on http://www.standardsmap.org/.

7.13 Electricity modelling

The guidelines in this section shall only be used for those processes where company-specific information is collected (situation 1 / Option 1 & situation 2 / Option 1 of the Data Needs Matrix) and shall not be applied by PEFCRs that cover electricity as main product (e.g., pilot on photovoltaic system).

7.13.1 General guidelines

In PEF studies the following electricity mix shall be used in hierarchical order:

(i) Supplier-specific electricity product[55] 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:
  (i) available, and
  (ii) the set of minimum criteria 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.

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.

7.13.2 Set of minimal criteria to ensure contractual instruments from suppliers

The PEFCR shall prescribe that 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 electricity consumption-mix shall be used in the modelling.

[55] See. ISO 14067

The proposed list of criteria below is based on the criteria from the GHG Protocol Scope 2 Guidance – An amendment to the GHG Protocol Corporate Standard – Mary Sotos – World Resource Institute. A contractual instrument used for electricity modelling shall:

Criterion 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.

Criterion 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).

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

Table 26 gives guidance on how to fulfil each criterion.

Table 26: Minimal criteria to ensure contractual instruments from suppliers

Criterion 1	**CONVEY ENVIRONMENTAL ATTRIBUTES AND GIVE EXPLANATION ABOUT THE CALCULATION METHOD** • Convey the energy type mix (or other related environmental attributes) associated with the unit of electricity produced. • Give explanation about the calculation method used to determine this mix
Context	Each program or policy will establish their own eligibility criteria and the attributes to be conveyed. These criteria specify energy resource type and certain energy generation facility characteristics, such as type of technologies, facility ages, or facility locations (but differ from one program/policy to another one). These attributes specify the energy resource type and sometimes some energy generation facility characteristics.
Conditions for satisfying the criterion	1) Convey the energy mix: If there is no energy type mix specified in the contractual instruments, ask your supplier to receive this information or other environmental attributes (GHG emission rate…). If no answer is received, use the 'country-specific residual grid mix, consumption mix'. If an answer is received, go to step 2).

	2) Give explanation about the calculation method used: Ask your supplier to receive calculation method details in order to ensure he follow the above principle. If no information is received, apply the supplier-specific electricity mix, include the information received and document it was not possible to check for double counting.
Criterion 2	**UNIQUE CLAIMS** • Be the only instrument that carry the environmental attribute claim associated with that quantity of electricity generation. • 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).
Context	Certificates generally serve four main purposes, including[3] (i) supplier disclosure, (ii) supplier quotas for the delivery or sales of specific energy sources, (iii) tax exemption, (iv) voluntary consumer programs. Each program or policy will establish their own eligibility criteria. These criteria specify certain energy generation facility characteristics, such as type of technologies, facility ages, or facility locations (but differ from one program/policy to another one). Certificates must come from facilities meeting these criteria in order to be eligible for use in that program. In addition, individual country markets or policy-making bodies may accomplish these different functions using a single certificate system or a multi-certificate system.
Conditions for satisfying the criterion	1. Is the plant located in a country with no tracking system? Consult the following report – Table 2: http://www.reliable-disclosure.org/upload/161-RE-DISS_2014_Residual_Mix_Results_2015-05-15_corrected2.pdf. - If yes, use the 'country-specific residual grid mix, consumption mix' - If no, go to the second question 2. Is the plant located in a country with a part of untracked consumption > 95%? - If yes, use the 'country-specific residual grid mix, consumption mix' as the best data available to approximate the residual consumption mix - If no, go to the 3rd question 3. Is the plant located in a country with a single certificate system or a multi-certificate system? Consult the following report : https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii Then : - If the plant is located in a region/country with a single certificate system the unique claim criteria is met. Use energy type mix mentioned on the contractual instrument. - If the plant is located in a region/country with a multi-certificate system, the unique claim is not ensured. Contact the country-specific Issuing Body (The European organization which governs the European Energy Certificate System, http://www.aib-net.org) to identify if there is a need to ask for more than one contractual instrument(s) to be sure there is no risk of double counting

	○ If more than one contractual instruments is needed, request all contractual instruments at the supplier to avoid double counting ○ If it is not possible to avoid double counting, report this risk of double counting in the PEF study and use the 'country-specific residual grid mix, consumption mix'.
Criteria 3	**Be issued and redeemed as close as possible to the period of electricity consumption to which the contractual instrument is applied.**

7.13.3 How to model '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, the alternative dataset shall be chosen according to the procedure described in section 7.19.5. 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.

7.13.4 A single location with multiple products and more than one electricity mix

How to proceed if only a part of the electricity use is covered by a supplier-specific mix or on-site electricity generation and how to attribute the electricity mix among products produced at the same location? In general, the subdivision of electricity supply used among multiple products is based on a physical

relationship (e.g. number of pieces or kg of product). 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:

a. 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.
b. 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.
c. 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.

7.13.5 For multiple locations producing one product

In case a product is produced in different locations or sold in different countries, the electricity mix shall reflect *the* ratios of production or 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). For PEF studies, where such data are not available, the average EU residual consumption mix (EU-28 +EFTA), or region representative residual mix, shall be used. The same general guidelines mentioned above shall be applied.

7.13.6 Electricity use at the use stage

For the use stage the consumption grid 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 mix (EU-28 +EFTA), or region representative consumption mix, shall be used.

7.13.7 How to deal with on-site electricity generation?

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

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

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 may 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[56].
- Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.

7.13.8 Electricity modelling for benchmark calculations

In benchmark calculations the following electricity mix shall be used in hierarchical order:

(i) Sector specific information on the use of green electricity shall be used if:
   a. available, and
   b. the set of minimum criteria to ensure the contractual instruments are reliable is met.
   This can be combined with the remaining electricity to be modelled with the residual grid mix.

(ii) In case no sector specific information is available, the consumption grid mix shall be used.

In case the benchmark is produced in different locations or sold in different countries, the electricity mix shall reflect the ratios of production or 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 mix (EU-28 +EFTA), or region representative consumption mix, shall be used.

7.14 Modelling transport

The PEFCR shall provide default transport scenarios to be used in case these data are not listed as mandatory company-specific information and supply-chain specific information is not available. The default transport scenarios shall reflect the European average transport, including all different transport options within the current product category (e.g., home delivery). Future transport options (not existing yet today at real scale) shall be excluded. In case no PEFCR-specific data is available the default scenarios and values outlined below shall be used.

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

Replacement of the default values below with PEFCR-specific values shall be clearly mentioned and justified in the PEFCR.

The (final and intermediate) client of the product shall be defined in the PEFCR[57]. The final client may be a consumer (i.e. a person who purchases goods and services for personal use) or a company that uses the product for final use, such as restaurants, professional painters, or a construction site. Re-sellers and importers are intermediate clients and not final clients.

7.14.1 How to allocate the transport burdens

7.14.1.1 Truck transport

LCA datasets for truck transport are per tkm (tonne*km) expressing the environmental impact for 1 tonne of product that drives 1km in a truck with certain load. The transport payload (=maximum mass allowed) is indicated in the dataset. For example, a truck of 28-32t has a payload of 22t. The LCA dataset for 1tkm (fully loaded) expresses the environmental impact for 1 ton of product that drives 1km within a 22t loaded truck. The transport emissions are allocated based on the mass of the product transported and you get only 1/22 share of the full emissions of the truck. When the mass of a full freight is lower than the load capacity of the truck (e.g., 10t), the transport of the product may be considered volume limited. In this case, the truck has less fuel consumption per total load transported and the environmental impact per ton of product is 1/10 share of the total emissions of the volume limited truck. Within the EF-compliant transport datasets available at http://lcdn.thinkstep.com/Node/, the transport payload is modelled in a parameterised way through the utilisation ratio. The utilisation ratio is calculated as the kg real load divided by the kg payload and shall be adjusted upon the use of the dataset. In case the real load is 0 kg, a real load of 1 kg shall be used to allow the calculation. Note that default truck volumes cannot be provided as this strongly depends on the type of material transported. In case truck volumes are needed to calculate the volume limited transport load, PEFCR-specific data should be used.

The PEFCR shall specify the utilisation ratio to be used for each truck transport modelled, as well clearly indicate whether the utilisation ratio includes empty return trips.

- If the load is mass limited: a default utilisation ratio of 64%[58] shall be used. This utilisation ratio includes empty return trips. Therefore, empty returns shall not be modelled separately. The PEFCR shall list the truck dataset as indicated on the node, together with the utilisation factor to be used (64%). The PEFCR shall clearly indicate that the user shall check and adapt the utilisation factor.
- If the load is volume limited **and the full volume is used:** the PEFCR shall indicate the company-specific utilisation ratio calculated as the kg real load/kg payload of the dataset and indicate how empty returns shall be modelled.

[57] A clear definition of the final client facilitates a correct interpretation of the PEFCR by practitioners which will enhance the comparability of results.

[58] Eurostat 2015 indicates that 21% of the kms truck transport are driven with empty load and 79% are driven loaded (with an unknown load). In Germany only, the average truck load is 64%.

- If the load is delicate (e.g. flowers): the full truck volume might not be used. The PEFCR shall evaluate the most appropriate load factor to be applied.
- Bulk transport (e.g., gravel transport from mining pit to concrete plant) shall be modelled with a default utilisation ratio of 50% (100% loaded outbound and 0% loaded inbound).
- Reusable products and packaging shall be modelled with PEFCR-specific utilisation ratios. The default value of 64% (including empty return) cannot be used because the return transport is modelled separately for reusable products.

7.14.1.2 Van transport

Vans are often used for home delivery products like books and clothes or home delivery from retailers. For vans the mass is never a limiting factor, but rather the volume, where often the van is half empty. Therefore, a default utilisation ratio of 50% shall be used[59]. A lorry of <7.5t shall be used as approximation, with an utilisation ratio of 20%. A lorry of <7.5t with a payload of 3.3t and an utilisation ratio of 20%, comes to the same load as a van with payload of 1.2t and utilisation ratio of 50%.

7.14.1.3 Consumer transport

LCA datasets for consumer transport (typically, passenger car) are per km. In the PEF context the allocation of the car impact shall be based on volume. The maximum volume to be considered for consumer transport is 0.2 m^3 (around 1/3 of a trunk of 0.6 m^3). For products larger than 0.2 m^3 the full car transport impact shall be considered. For products sold through supermarkets or shopping malls, the product volume (including packaging and empty spaces such as between fruits or bottles) shall be used to allocate the transport burdens over the product transported. The allocation factor shall be calculated as the volume of the product transported divided by 0.2 m^3. For simplification, all other types of consumer transport (like buying in specialised shops or using combined trips) shall be modelled as through supermarket. The PEFCR shall prescribe the default allocation value to be used.

7.14.2 From supplier to factory

The PEFCR shall specify default transport distance to be used for the transport of product from supplier to factory. If specific data are not included in the PEFCR, then the default data provided below shall be used.

<u>For suppliers located within Europe:</u>

For packaging materials from manufacturing plants to filler plants (beside glass; values based on Eurostat 2015[60]), the following scenario shall be used:

- 230 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio; and

[59] as no EF-compliant dataset for van transport (with payload of ± 1.2t) is currently available at http://lcdn.thinkstep.com/Node/).

[60] Calculated as the mass weighted average of the goods categories 06, 08 and 10 using the Ramon goods classification for transport statistics after 2007. The category 'non-metallic mineral products' are excluded as they can double count with glass.

- 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).

For transport of empty bottles (communication from FEVE[61]), the following scenario shall be used:

- 350 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio; and
- 39 km by train (average freight train; UUID 02e87631-6d70-48ce-affd-1975dc36f5be); and
- 87 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

For all other products from supplier to factory (values based on Eurostat 2015[62]), the following scenario shall be used:

- 130 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio; and
- 240 km by train (average freight train; UUID 02e87631-6d70-48ce-affd-1975dc36f5be); and
- 270 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

For all suppliers located outside Europe, the following scenario shall be used:

- 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. PEFCR specific utilisation ratio; 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 producers country (origin) is known: the adequate distance for ship and airplane should be determined using http://www.searates.com/services/routes-explorer or https://co2.myclimate.org/en/flight_calculators/new

In case it is unknown if the supplier is located within or outside Europe, the transport shall be modelled as supplier being located outside Europe.

7.14.3 From factory to final client

The transport from factory to final client (including consumer transport) shall be included in the distribution stage of the PEFCR. This helps fair comparisons between products delivered through traditional shops as well as delivered at home.

[61] Based on the peer reviewed LCA study of the European container glass, FEVE 2016. Primary data collected among 84% of the European container glass manufactures.

[62] Calculated as the mass weighted average of the goods of all categories.

In case no PEFCR-specific transport scenario is available, the default scenario outlined below shall be used as a basis (see Figure 3) together with a number of PEFCR-specific values:

- Ratio between products sold through retail, distribution centre (DC) and directly to the final client;
- For factory to final client: Ratio between local, intracontinental and international supply chains;
- For factory to retail: distribution between intracontinental and international supply chains;

The PEFCR-specific values may be replaced by supply-chain-specific information following the Data Needs Matrix (DNM).

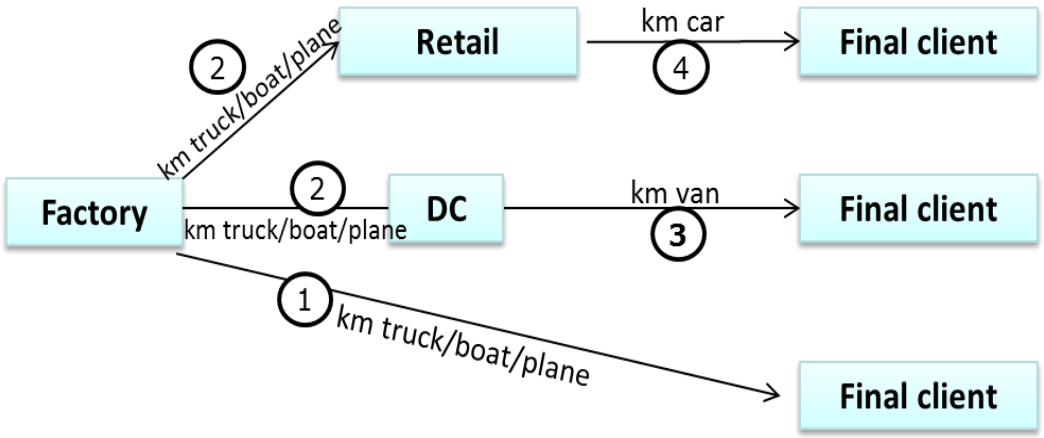


Figure 3: default transport scenario.

(1) X% (PEFCR specific) from factory to final client:

- X% (PEFCR specific) local supply chain: 1'200 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio.
- X% (PEFCR specific) intracontinental supply chain: 3'500 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio.
- X% (PEFCR specific) international supply chain: 1'000 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio 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.

(2) X% (PEFCR specific) from factory to retail/DC:

- X% (PEFCR specific) local supply chain: 1'200 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio.
- X% (PEFCR specific) intracontinental supply chain: 3'500 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57) (Eurostat 2014), PEFCR specific utilisation ratio.
- X% (PEFCR specific) international supply chain: 1'000 km truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), PEFCR specific utilisation ratio 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.

(3) X% (PEFCR specific) from DC to final client:

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

(4) X% (PEFCR specific) from retail to final client:

- 62%: 5 km, by passenger car (average; UUID 1ead35dd-fc71-4b0c-9410-7e39da95c7dc), PEFCR specific allocation
- 5%: 5 km round trip, by van (lorry <7.5t, EURO 3 with utilisation ratio of 20%[6]; UUID aea613ae-573b-443a-aba2-6a69900ca2ff)
- 33%: no impact modelled

Note that for reusable products the return transport from retail/DC to factory shall be modelled in addition to the transport needed to go to retail/DC. The same transport distances as from product factory to final client shall be used (see above), however the truck utilisation ratio might be volume limited depending on the type of product. The PEFCR shall indicate the utilisation ratio to be used for the return transport.

7.14.4 From EOL collection to EOL treatment

The transport from collection place to EOL treatment is included in the landfill, incineration and recycling datasets tendered by the EC. However, there are some cases, where additional default data might be needed by the PEFCR. The following values shall be used in case no better data is available:

- Consumer transport from home to sorting place: 1 km by passenger car (UUID 1ead35dd-fc71-4b0c-9410-7e39da95c7dc)[63]
- Transport from collection place to methanisation: 100 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57)
- Transport from collection place to composting: 30 km by truck (lorry <7.5t, EURO 3 with UUID aea613ae-573b-443a-aba2-6a69900ca2ff)

7.14.5 Transport processes for cooled and frozen product

Note that the transport processes from factory to final client, DC and retail suggested above are for products at ambient temperature only. Products frozen or cooled are to be transported in freezers or coolers. These datasets are available at http://lcdn.thinkstep.com/Node/.

[63] Assumption (Justification: 75% of households do not need to "move" their waste, or can simply do it by walking. However 25% of the households do about 4 km by car to bring their waste to a local collection place (whether for trash or for recycling), which corresponds in average for all waste to 1 km by car).

7.15 Modelling infrastructure and equipment

For screening all processes shall be included in the modelling without applying any cut-off. For the screening studies, where appropriate, the following default modelling approaches shall be used in case no better data is available. Note that the below data and values are based on assumptions (except indicated otherwise). For all other infrastructures and equipment not included below, the modelling assumptions and secondary datasets used shall be clearly documented.

7.15.1 Distribution centre (DC)

- Infrastructure and building: a distribution centre is a 30000 m^2 building, 5 m high, and with a 30000 m^2 parking. Fridges and freezers equipment (production and end-of-life) shall be considered for DCs that contains cooling systems. Default data for fridge or freezer production of 1m^3 external volume and an internal storage space of 210 L (15 years lifetime): 20 kg iron, 1.5 kg aluminium, 7.8 kg compressor, 0.01 kg copper, 0.06 kg cables, 0.3 kg glass, 6 kg plastic, 1 kg oil, 4 kg insulating foam, 1.1 kg water, 0.04 kg pollutant (using mercury as proxy) (Swiss Energy, October 2012). Packaging: 4 kg cardboard, 0.5 kg plastic film (LDPE), along with a 50 g paper notice.
- Energy consumption: the storage energy consumption is 30 kWh/m^2·year and 360 MJ bought (= burnt in boiler) or 10 Nm^3 natural gas/m^2·year (if using the value per Nm^3, do not forget to consider emissions from combustion and not only production of natural gas). For DCs that contain cooling systems an additional energy use for the chilled or frozen storage is 40 kWh/m^3·year (with an assumption of 2 m high for the fridges and freezers). For DCs with both ambient and cooled storage: 20% of the area of the DC is chilled or frozen. Note: the energy for chilled or frozen storage is only the energy to “keep cool”.
- Refrigerant gases consumption and leakages for DCs that contains cooling systems: gas content in fridges and freezers is 0.29 kg R404A per m^2 (retail PEFCR). A 10% annual leakage is considered (Palandre 2003). For the portion of refrigerant gases remaining in the equipment at end-of-life, 5% is emitted at end-of-life and the remaining fraction is treated as hazardous waste.
- Water: 365 m^3 of water is used per year for activities such as cleaning, lawn irrigation, etc. The production of this amount of tap water as well as its treatment in wastewater treatment plant shall be considered.
- Allocation of the DC space-time per product: The distribution centre impact per product is calculated using an allocation based on the total storage capacity of the distribution centre. An average distribution centre can store 60000 m^3 of product, being 48’000 m^3 for ambient storage and 12000 m^3 for chilled or frozen storage (assuming 50% of the 30000 m^2 building is dedicated to storage on 4 m high). Storage during 52 weeks, i.e., 3120000 m^3-weeks/year. The total storage capacity shall be allocated with the following storage volumes and times:
    - For ambient products: 4 times the product volume * stored 4 weeks
    - For chilled products: 3 times the product volume * stored 1 week
    - For frozen products: 2 times the product volume * stored 4 weeks

7.15.2 Retail space

In case there is no specialization of retail, the default data presented below shall be used in the modelling.

- Infrastructure: A retail centre shall be modelled as a 2000 m^2 building with 4000 m^2 parking (the value for parking includes both employees and clients parking as well as all infrastructures such as the access road, area for delivery, etc.)
- Fridges and freezers in case of cooling: 60 m^2 fridges and 60 m^2 freezer, 2 m high, i.e., 240 m^3 fridges measured as external volume with 50% being "internal storage volume" (= 120 m^3). Default data for fridge or freezer production of 1m^3 external volume and an internal storage space of 210 L (15 years lifetime): 20 kg iron, 1.5 kg aluminium, 7.8 kg compressor, 0.01 kg copper, 0.06 kg cables, 0.3 kg glass, 6 kg plastic, 1 kg oil, 4 kg insulating foam, 1.1 kg water, 0.04 kg pollutant (using mercury as proxy) (Swiss Energy, October 2012). Packaging: 4 kg cardboard, 0.5 kg plastic film, along with a 50 g paper notice.
- Energy consumption[64]: A general energy consumption of 300 kWh/m^2·year for the entire building surface. For retail specialized in non-food/non-beverage products: 150 kWh/m^2·year for the entire building surface. For retail specialized in food/beverage products: 400 kWh/m^2·year for the entire building surface plus energy consumption for chilled and frozen storage of 1900 kWh/m^2·year and 2700 kWh/m^2·year respectively.
- Refrigerant gases: Gas content in fridges and freezers is 0.29 kg R404A per m^2. The production and end-of-life, as well as the leakages shall be considered and 10% annual leakage (Palandre 2003). For the portion of refrigerant gases remaining in the equipment at end-of-life, 5% are assumed to be emitted at end-of-life and the remaining fraction is treated as hazardous waste.
- Water: 3'650 m^3 of water is used per year for activities such as cleaning, customer bathrooms, lawn irrigation, etc. The production of this amount of tap water as well as its treatment in wastewater treatment plant shall be considered.
- Allocation of the retail space-time per product: A retail place can store 2'000 m^3 of products (assuming 50% of the 2'000 m^2 building is covered by shelves of 2 m high) during 52 weeks, i.e., 104000 m^3-weeks/year. The total storage capacity shall be allocated with the following storage volumes and times:
    - For ambient products: 4 times the product volume * stored 4 weeks
    - For chilled products: 3 times the product volume * stored 2 weeks
    - For frozen products: 2 times the product volume * stored 4 weeks
- Repacking: consuming about 3 t plastic film (LDPE) per supermarket per year. The production and end-of-life (100% recycling) of LDPE packaging film shall be considered. This represents a default value of 0.47 g LDPE film / kg of product[65].

[64]Derived from table 17, p. 59, of the PERIFEM and ADEME "Guide sectorial 2014: Réalisation d'un bilan des emissions de gaz à effet de serre pour distribution et commerce de detail".

[65]The virtual retailer considered for the OEF retail screening sells about 6370 tons products per supermarket per year.

7.15.3 Fridge

- Fridge size: assumed to 1 m^3 (external volume, measured as a rectangular cuboid including space lost due to protuberances, for example to calculate its space use in a DC or in a truck during delivery) and with an internal storage space of 210 L.
- Material composition: 20 kg iron, 1.5 kg aluminium, 7.8 kg compressor, 0.01 kg copper, 0.06 kg cables, 0.3 kg glass, 6 kg plastic, 1 kg oil, 4 kg insulating foam, 1.1 kg water, 0.04 kg pollutant (using mercury as proxy) (Swiss Energy, October 2012). Packaging is assumed to be made of 4 kg cardboard, 0.5 kg plastic film, along with a 50 g paper notice.
- Fridge maintenance: assumed to be 12 washings per year (with 1 L water and 1 g soap for each washing).
- Refrigerant gas: about 100 g R134a/fridge and 1% leakage (IPCC/TEAP 2005) (note that when the fridge is used as a proxy for cooling infrastructure in DCs and retailer, the refrigerant gas production and leakage should be removed to avoid double counting with the values used directly in the modelling of DCs and retailer).

7.15.4 Dishwasher

- Material composition: 10 kg plastic, 20 kg steel, 15 kg aluminium, 3 kg electronic components, 0.1 kg printed wiring board. Packaging is assumed to be 10 kg cardboard and 2 kg plastic.
- A fraction of a cycle is allocated depending on the dish size (assumptions):
    - 20% for a pot, a baking dish or a frying pan
    - 14.3% for a medium pan
    - 10% for a small pan or a vase
    - 5% for a drip filter decanter, a pet food dish or an ashtray
    - 3.3% for a bowl
    - 2.5% for a glass, a mug, a tea cup or a normal plate
    - 1.67% for a small plate or an espresso cup
    - 0.5% for each cutlery piece

7.15.5 Small equipment to be considered

- Frying pan: 1 kg steel and 200 g plastic. Lifetime: 500 uses
- Cooking pot: 1 kg steel and 100 g plastic. Lifetime: 1500 uses
- Glass: 260 g glass. Lifetime: 365 uses
- Baking sheet: 200 g steel. Lifetime: 780 uses
- Cup: 260 g ceramic. Lifetime: 365 uses
- Pet food dish: 200 g plastic. Lifetime: 3650 uses

- Polypropylene plastic bag for general trash: 6.7g PP per kg of waste (35 g plastic for a 35 L bag, own measurement; average municipal solid waste density is 150 kg/m^3) [66]
- Polypropylene plastic bag for recycled green waste and food waste: 2.5g PP per kg of waste (35 g plastic for a 35 L bag, own measurement). The average green/food waste density is 400 kg/m^3) [67]

7.16 Packaging modelling

7.16.1 Packaging datasets

A large number of EF-compliant packaging related datasets are available on the node (http://lcdn.thinkstep.com/Node). These European average packaging datasets shall be used in case the PEFCR doesn't request the use of primary data, no supplier-specific information is available or the packaging is not relevant. Although the default secondary datasets shall be listed in the PEFCR to be used by the applicants, for some multi-material packaging the PEFCR should or shall provide additional information to allow the applicant to perform a correct modelling. This is the case for beverage cartons and bag-in-box packaging.

Beverage cartons are made out of LDPE granulates and liquid packaging board, with or without aluminium foil. The amount of LDPE granulates, board and foil (also called the bill of material of beverage cartons) depends on the application of the beverage carton and shall be defined in the PEFCR (e.g., wine cartons, milk cartons). Beverage cartons shall be modelled by combining the prescribed amounts of material datasets with the beverage carton conversion dataset.

Bag in box is made out of corrugated board and packaging film. The PEFCR should define the amount of corrugated board, as well as the amount and type of packaging film. If this is not prescribed by the PEFCR, the applicant applying the PEFCR shall use the default dataset for bag-in-box.

7.16.2 Packaging reuse rates

Reuse rate is the number of times a packaging material is used (e.g., filled) at the factory. This is often also called trip rates, reuse time or number of rotations. This may be expressed as the absolute number of reuse or as % of reuse rate. For example: a reuse rate of 80% equals 5 reuses. Equation 14 describes the conversion:

$$\text{Number of reuse} = \frac{1}{100\% - \%\ reuse\ rate} \qquad \text{[Equation 14]}$$

[66] http://www.senat.fr/rap/o98-415/o98-4151.html, http://www.ic.gc.ca/eic/site/csr-rse.nsf/eng/rs00181.html, http://www.ijastnet.com/journals/Vol._1_No._3;_June_2011/8.pdf, http://www.academia.edu/3013719/Comprehensive_Characteristics_of_the_Municipal_Solid_Waste_Generated_in_the_Faculty_of_Engineering_UKM, http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/RO/Latin_A/Topic_g.asp

[67] http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/~/media/Files/bus/EREP/docs/wastematerials-densities-data.pdf

The number of reuse applied here refers to the total number of uses during the life of a packaging. It includes both the first use and all the following reuses.

A packaging return system can be organized by the company owning the packaging material (company owned pools) or can be organized at a higher level by a third party e.g., the government or a pooler (third party operated pools). This may have an influence on the lifetime of the material as well as the data source to be used. Therefore, it is important to separate these two return systems.

For company owned packaging pools the reuse rate shall be calculated using supply-chain-specific data. Depending on the data available within the company, two different calculation approaches may be used (see Option a and b presented below). Returnable glass bottles are used as example but the calculations also apply for other company owned reusable packaging.

Option a: The use of supply-chain-specific data, based on accumulated experience over the lifetime of the previous glass bottle pool. This is the most accurate way to calculate the reuse rate of bottles for the previous bottle pool and can be a proper estimate for the current bottle pool. The following supply-chain-specific data is collected (see wiki page 'Access to documents of common interest' https://webgate.ec.europa.eu/fpfis/wikis/display/ EUENVFP/):

- Number of bottles filled during the lifetime of the bottle pool (#Fi)
- Number of bottles at initial stock plus purchased over the lifetime of the bottle pool (#B)

$$\text{Reuse rate of the bottle pool} = \frac{\#\ F_i}{\#B} \qquad \text{[Equation 15]}$$

$$\text{The net glass use (kg glass/l beverage)} = \frac{\#B \times (kg\ glass/bottle)}{\#F_i} \qquad \text{[Equation 16]}$$

This calculation option shall be used:

i. With data of the previous bottle pool when the previous and current bottle pool are comparable. Meaning, the same product category, similar bottle characteristics (e.g., size), comparable return systems (e.g., way of collection, same consumer group and outlet channels), etc.
ii. With data of the current bottle pool when future estimations/extrapolations are available on (i) the bottle purchases, (ii) the volumes sold, and (iii) the lifetime of the bottle pool.

The data shall be supply-chain-specific and shall be verified by an external verification, including the reasoning of this method choice.

Option b: When no real data is tracked the calculation shall be done partly based on assumptions. This option is less accurate due to the assumptions made and therefore conservative/safe estimates shall be used. The following data is needed:

- Average number of rotations of a single bottle, during one calendar year (if not broken). One loop consists of filling, delivery, use, back to brewer for washing (#Rot)
- Estimated lifetime of the bottle pool (LT, in years)
- Average percentage of loss per rotation. This refers to the sum of losses at consumer and the bottles scrapped at filling sites (%Los)

$$\text{Reuse rate of the bottle pool} = \frac{LT}{(LT \times \%Los) + \left(\frac{1}{\#Rot}\right)} \qquad \text{[Equation 17]}$$

This calculation option shall be used when option a) is not applicable (e.g., the previous pool is not usable as reference). The data used shall be verified by an external verification, including the reasoning of this method choice.

7.16.2.1 Average reuse rates for company owned pools

The following average reuse rates shall be used within the screening studies and to calculate the benchmark (corresponding to the representative product) for those PEFCRs that have company owned reusable packaging pools in scope, unless data of better quality is available:

- Glass bottles: 20 trips for beer and water bottles[68], 2 trips for wine[69]
- Plastic crates for bottles: 30 trips[70]
- Plastic pallets: 30 trips (Nederlands Instituut voor Bouwbiologie en Ecologie, 2014[71])

If the TS decide to use other values within their PEF screening study or benchmark calculation, they shall clearly justify why and provide the data source. In case a specific packaging type is not present in the list above, sector-specific data shall be used. New values shall be subject to the PEFCR review.

7.16.2.2 Average reuse rates for third party operated pools

Average reuse rates provided by literature vary a lot, are not usable as such or too country specific. Some data sources are outdated (more than 15 years old) and thus not representative for the current situation (http://ec.europa.eu/environment/waste/studies/reuse.htm). Some others are biased due to a significant change in consumer behaviour. For example, the return rate of beer bottles in Denmark is higher than 100% due to a decrease of this packaging in sales (Årsrapport, 2013). One recent study is valid for Germany only and provides reuse rates for reusable glass bottles in third party operated pools and company owned pools (Deloitte, 2014).

[68] Agreement from packaging working group members (including beer and packed water pilot).

[69] Estimation: http://ec.europa.eu/environment/waste/studies/packaging/belgium.pdf

[70] Technical approximation as no data source could be found. Technical specifications guarantee a lifetime of 10 years. A return of 3 times per year (between 2 to 4) is taken as first approximation.

[71] Most conservative number is used.

The following reuse rates shall be used by those PEFCRs that have third party operated reusable packaging pools in scope, unless data of better quality is available:

- Glass bottles: 30 trips for beer and water[72], 5 trips for wine[73]
- Plastic crates for bottles: 30 trips[74]
- Plastic pallets: 50 trips (Nederlands Instituut voor Bouwbiologie en Ecologie, 2014)[75]
- Wooden pallets: 25 trips (Nederlands Instituut voor Bouwbiologie en Ecologie, 2014)[76]

If the TS decides to use other values within their final PEFCR, they shall clearly justify why and provide the data source. In case a specific packaging type is not present in the list above, sector-specific data shall be collected and included in the PEFCR. New values shall be subject to the PEFCR review.

7.17 Use stage modelling

The use stage is a life cycle stage that can result in a high overall environmental contribution for many PEFCRs. As the use stage is calculated based on many modelling assumptions, the real contribution is affected by potentially very high uncertainties.

For the PEF screening study and supporting studies the use stage shall always be included for final products by following the guidelines outlined below. The use stage shall be excluded for intermediate products.

7.17.1 Definition of the use stage

The use stage describes how the product is expected to be used by the end user (e.g., the consumer). The use stage starts at the moment the end user uses the product, till (and excluded) it leaves its place of use and enters the end-of-life life cycle stage (e.g., recycling or final treatment), including the necessary transports.

[72]The reuse rates for third party operated glass bottle pools was largely discussed within the packaging working group. Literature provides values between 5 and 50 reuse rates, but is mainly outdated. The study of Deloitte (2014) is most recent but provides values within the German context only. It can be questioned if these results are directly applicable for the European context. However, the study provides results for both company owned pools (23 trips, considering all foreign bottles as exchanged) and third party operated pools (36 trips, considering all foreign bottles as exchanged). It shows that the reuse rates for third party operated pools are ±1.5 times higher than for company owned pools. As first approximation the packaging working group proposes to use this ratio to extrapolate the average reuse rates for company owned pools (20 trips) towards average reuse rates for third party operated pools (20*1.5= 30 trips).

[73]Assumption based on monopoly system of Finland. http://ec.europa.eu/environment/waste/studies/packaging/finland.pdf

[74] Technical approximation as no data source could be found. Technical specifications guarantee a lifetime of 10 years. A return of 3 times per year (between 2 to 4) is taken as first approximation.

[75] The less conservative number is used.

[76] Half of plastic pallets is used as approximation.

The use stage includes all activities and products that are needed for a proper use of the product (i.e. the provision of the original function is kept throughout its lifetime, see Figure 4). For example, the provision of tap water and wastewater treatments when cooking pasta; the manufacturing, distribution and waste management of paper filters for coffee; manufacturing, distribution and waste of materials needed for maintenance, repair or refurbishment (e.g. spare parts needed to repair the product, the coolant production and waste management due to losses). The following additional requirements shall be followed:

(i) The waste of the product in use (e.g., food waste, primary packaging, or the product left at its end of use) is excluded and shall be part of the End-of-Life stage of the product.

(ii) If a product is reused, the processes needed to collect the product and make it ready for the new use cycle are excluded (e.g. the impacts from collection and cleaning reusable bottles).

(iii) Transport from retail to consumer home shall be excluded from the use stage and may be included in the distribution stage.

Figure 4: Processes included and excluded from the use stage.

The use stage often involves multiple processes. A distinction shall be made between (i) product independent and (ii) product dependent processes.

(i) ***Product independent processes*** have no relationship with the way the product is designed or distributed. The use stage process impacts will remain the same for all products in this product (sub) category even if the producer changes the product's characteristics. Therefore, they don't contribute to any form of differentiation between two products or might even hide the difference. Examples are the use of a glass for drinking wine (considering that the product doesn't determine a difference in glass use); frying time when using olive oil; energy use for boiling one litre of water to be used for preparing coffee made from bulk instant coffee; the washing machine used for heavy laundry detergents (capital good).

(ii) ***Product dependent processes*** are directly or indirectly determined or influenced by the product design or are related to instructions for use of the product. These processes depend on the product characteristics and therefore contribute to differentiation between two products. All instructions provided by the producer and directed towards the consumer (through labels, websites or other media) shall be considered as product dependent. Examples of instruction are indications on how long the food must be cooked, how much water must be used, or in the case of drinks the recommended serving temperature and storage

conditions. An example of a direct dependent process is the energy use of electric equipment when used in normal conditions.

7.17.2 Main function approach or Delta approach

Modelling of the use stage may be done in different ways. Very often the related impacts and activities are modelled fully. For example, the total electricity consumption when using a coffee machine, or the total cooking time and related gas consumption when boiling pasta. In these cases, the use stage processes for drinking coffee or eating pasta are related to the main function of the product (referred to as "main function approach").

In some cases, the use of one product can influence the environmental impact of another product. Some examples:

i. A toner cartridge is not held responsible for the paper it prints. But if remanufactured toner cartridge works less efficient and causes more paper loss compared to an original cartridge, the additional paper loss should be considered. In that case, the paper loss is a dependent process of the use stage of a remanufactured cartridge. The use stage involves processes and activities which are not 100% related to the product.
ii. The energy consumption during the use stage of the battery/charger system is not related to the amount of energy stored and released from the battery. It only refers to the energy loss in each loading cycle. That energy loss can be caused by the loading system or the internal losses in the battery.

In these cases, only the additional activities and processes should be allocated to the product (e.g. paper and energy of remanufactured toner cartridge and battery). The allocation method consists in taking all associated products in the system (here paper and energy), and allocating the excess consumption of these associated products to the product which is considered responsible for this excess. This requires a reference consumption to be defined for each associated product in the PEFCR (e.g., of energy and materials). The reference consumption refers to the minimum consumption that is essential for providing the function. The consumption above this reference (the delta) will then be allocated to the product. This approach is also named "Delta approach" by ADEME[77].

In case the Delta approach is used, the PEFCR shall state the minimum consumption (reference) to be used when calculating the additional consumption allocated to the product. This approach should only be used for increasing impacts and to account for additional consumptions above the reference. To define the reference situation, the following shall be considered when existing:

- Regulations applicable to the product category
- Standards or harmonised standards
- Recommendations from manufacturers or manufacturers' organisations

[77] Specifications for drafting and revising product category rules (10.12.2014), ADEME.

- Use agreements established by consensus in sector-specific working groups.

It is up to the TS to decide which approach is taken and shall describe in the PEFCR which approach shall be applied (main function approach or Delta approach).

7.17.3 Modelling the use stage

For all processes belonging to the use stage (both most relevant and the others):

i. The PEFCR shall indicate which use stage processes are *product dependent and product independent* (as described above).
ii. The PEFCR shall identify for which processes default data shall be provided by following the modelling guidelines Table 27. In case modelling is optional the TS shall decide whether this is included in the system boundary of the PEFCR calculation model.
iii. Per process to be modelled: the TS shall decide and describe in the PEFCR whether the main function approach or Delta approach shall be applied.
    a. Main function approach: The default datasets presented in the PEFCR shall reflect as much as possible the reality of market situations.
    b. In case of the Delta approach, the PEFCR shall provide the reference consumption to be used.
iv. The PEFCR shall follow the modelling and reporting guidelines in Table 27.

Table 27: PEFCR guidelines for the use stage.

Is the use stage process…		Actions to be taken by the TS	
Product dependent?	**Most relevant?**	**Modelling guidelines**	**Where to report**
Yes	Yes	To be included in the PEFCR system boundary. Provide default data	Mandatory: PEF report, reported separately*
	No	Optional: May be included in the PEFCR system boundary when the uncertainty can be quantified (provide default data)	Optional: PEF study, reported separately*
No	Yes/No	Excluded from the PEFCR system boundary	Optional: qualitative information

*Use stage results for final products shall be reported separately from other life cycle stages and not as additional environmental/technical information.

Annex G provides default data to be used by the TS to model use stage activities that might be crosscutting for several pilots. The TS shall always apply the following guidelines in hierarchical order:

1. First, the guidelines on data requirements and procedure to identify the most relevant contributions shall be followed (see section 7.4);
2. Second, the guidelines indicated in Table 27 apply;
3. Last, the default data provided in Annex F shall be used to fill in the data gaps and assure consistency among PEFCRs. Better data may be used but shall be justified in the PEFCR.

7.17.4 Example: pasta

Table 28 presents the processes used for modelling the use stage of 1kg dry pasta (boiling time according to instructions, for instance: 10 minutes; amount of water, according to the instructions, for instance 10 litres). Among the 4 processes, electricity and heat use are the most relevant one. Within this example, all 4 processes are product dependent. The amount of water use and cooking time is in general indicated on the packaging. The manufacturer can change the recipe in order to increase or reduce the cooking time, and therefore the energy use. Within the PEFCR default data is provided on all four processes, as indicated in Table 29 (activity data + LCI dataset to be used). Following the reporting guidelines, the EF as a total of all 4 processes is reported as separate information.

Table 28: Processes of the use stage of dry pasta (taken from the screening study report, and to be used as example). The most relevant processes are indicated in the green box.

Is the use stage process is …?		Pasta processes	Actions taken by the TS:	
(ii) Product dependent?	**(iii) Most relevant?**		**Modelling**	**Reporting**
Yes	Yes	Electricity and Heat	Modelled as main function approach. Default data provided (total energy use).	In the PEF study, reported separately
	No	Tap water Waste water	Modelled as main function approach. Default data provided (total water use).	In the PEF study, reported separately
No	Yes/No		Excluded from the PEFCR calculation (impact categories)	Optional: qualitative information

Table 29: Example activity data and secondary datasets to be used.

Materials/fuels	Value	Unit
Tap water, at user/RER U	10	kg
Electricity mix, AC, consumption mix, at consumer, <1kV EU-27 S	0.5	kWh

Materials/fuels	Value	Unit
Heat, from resid. Heating systems from NG, consumption mix, at consumer, temperature of 55C EU-27 S	2.3	kWh
Waste to treatment	Value	Unit
Waste water treatment, domestic waste water according to the Directive 91/271/EEC concerning urban waste water treatment plant EU-27 S	10	kg

7.17.5 Example: energy using products

The operating, servicing and maintenance conditions may be product dependant. In that case, they shall be specified by the manufacturer and include the following:

i. The maintenance operation frequency where applicable;
ii. The parts, products and solvents used to maintain/service the reference product (e.g., batteries, light sources and any substance covered by a Safety Data Sheet);
iii. The consumables required for operation: ink, etc.

For those processes that are not relevant, their inclusion in the PEFCR calculation model is to be decided by the TS.

7.18 End-of-Life modelling

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 product. Overall, this should be modelled and reported at the life cycle stage where the waste occurs. For example, the EoL of the wastes generated during manufacturing should be modelled and reported at the manufacturing life cycle stage. The end-of-life of the main product in scope is mostly to be modelled in the End-of-Life stage of the life cycle. For waste at use stage the specific rules to be followed are in section 7.17.3. The End-of-Life stage is a life cycle stage that in general includes the waste of the product in scope, such as the food waste, the product left at its end of use and the primary packaging of the product. For intermediate products, the End-of-Life of the product in scope shall be excluded. Default loss rates per type of product during distribution and at consumer are provided in - Default loss rates per type of product and shall be used in case no PEFCR-specific information is available.

The current PEF Guide (Recommendation 2013/179/EU) require the use of a formula to model product waste, commonly known as End-of-Life (EoL) formula, available in the Annex V of the PEF Guide, to deal with multi-functionality in recycling, re-use and energy recovery situations.

The initial feedbacks received by some pilots participating to the EF pilot phase and the further experience gathered during three years of pilot phase, led the Commission to re-consider the EoL formula available in the Annex V and, together with interested stakeholders, to come up with an alternative proposal.

The new formula has been renamed to “Circular Footprint Formula” (CFF) and shall be used in the EF-context instead of the original "End-of-Life" formula. The following sections describe the formula and parameters to be used, while the last sections describe how the formula and parameters shall be applied to final products (see section 7.18.11), to intermediate products (see section 7.18.12) and to construction products (see section 7.18.13).

7.18.1 The Circular Footprint Formula

The CFF 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 $(1 - R_2 - R_3) \times E_D$

Equation 18 – The Circular Footprint Formula (CFF)

The modular form of the Circular Footprint Formula

The CFF can be arranged in a modular way, to fit for example the structure of the EN 15804 standard.

Equation 19 is the CFF re-arranged in different modules. The acronym for this formula is **CFF-M**.

Production burdens	$(1 - R_1)E_V + R_1 \times E_{recycled}$	**Cradle-to-gate**
Burdens and benefits related to secondary materials input	$-(1 - A)R_1 \times \left(E_{recycled} - E_V \times \frac{Q_{Sin}}{Q_P}\right)$	
Burdens and benefits related to secondary materials output	$(1 - A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$	**Additional information from the EoL stage**
Energy recovery	$(1 - B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$	
Disposal	$(1 - R_2 - R_3) \times E_D$	

Equation 19 **– Modular form of the Circular Footprint Formula (CFF-M)**[2]

7.18.2 The parameters of the Circular Footprint Formula (CFF and CFF-M)

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.

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.

E_{ER}: 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.

7.18.3 The A factor

The A factor allocates burdens and credits between two life cycles and it aims to reflect market realities.

In PEF studies the A factor values shall be in the range **0.2 ≤ A ≤ 0.8**, to always capture both aspects of recycling (recycled content and recyclability at end-of-life).

The driver to determine the values of the A factor is the analysis of the market situation. This means:

- **A=0.2.** Low offer of recyclable materials and high demand: the formula focus on recyclability at End-of-Life**.**
- **A=0.8.** High offer of recyclable materials and low demand: the formula focus on recycled content.
- **A=0.5.** Equilibrium between offer and demand: the formula focuses both on recyclability at EoL and recycled content. This value applies to all materials for which no A value is available in Annex C.

The list of A values is available in Annex C. This table is cross-cutting and shall be used by all PEFCRs. Proposals to include new or updated values of A will be evaluated by the EC. The list of A values in the Annex C will be periodically reviewed and updated by the Commission.

The list of A values to be used shall be clearly listed in the PEFCR, with a reference to Annex C. The following procedure shall be applied by the TS to select the value of A to be included in the PEFCR:

- Check in Annex C the availability of an application specific A value which fits the PEFCR,
- If an application specific A value is not available, the material specific A value in Annex C shall be used,
- If a material specific A value is not available, the A value shall be set equal to 0.5.

The same procedure shall be applied by the applicant in case a specific A value is missing in the PEFCR.

7.18.4 The B factor

The B factor is used as an allocation factor of energy recovery processes. It applies both to burdens and credits. Credits refer to the amount of heat and electricity sold, not to the total produced, taking into account relevant variations over a 12-months period, e.g. for heat.

In PEF studies and benchmark calculations the B value shall be equal to 0 as default.

To avoid double-counting between the current and the subsequent system in case of energy recovery, the subsequent system shall model its own energy use as primary energy.

Proposals to include new or updated values of B in Annex C will be evaluated by the Commission. The list of B values will be periodically reviewed and updated by the Commission.

7.18.5 The point of substitution

It is necessary to determine the point of substitution to apply the "material" part of the formula. The point of substitution corresponds to the point in the value chain where secondary materials substitute primary materials.

The point of substitution shall be identified in correspondence to the process where input flows are coming from 100% primary sources and 100% secondary sources (level 1 in Figure 5). In some cases the point of substitution may be identified after some mixing of primary and secondary material flows has occurred (level 2 in Figure 5). The identification of the point of substitution shall be made depending on the Situations and Options of the DNM.

- **Point of substitution at level 1**: it shall be applied in Situation 1/ Option 1, and in Situation 2/Option 1 of the DNM (See Table 30). This point of substitution corresponds to e.g. metal scrap/glass and cullet/pulp input to the process.
- **Point of substitution at level 2**: it shall be applied in Situation 1,/Option2, Situation 2/Option 2, Situation 2/Option 3 and Situation 3 of the DNM (See Table 30). This point of substitution corresponds to e.g. metal ingots, glass, paper.
- The point of substitution at this level may be applied only if the datasets used to model e.g. E_{rec} and E_v take into account the real (average) flows regarding primary and secondary materials: for example, if E_{rec} corresponds to the "production of 1 t of secondary material" (see Figure 5) and it has an average input of 10% from primary raw materials, the amount of primary materials, together with their environmental burdens, shall be included in the E_{rec} dataset.

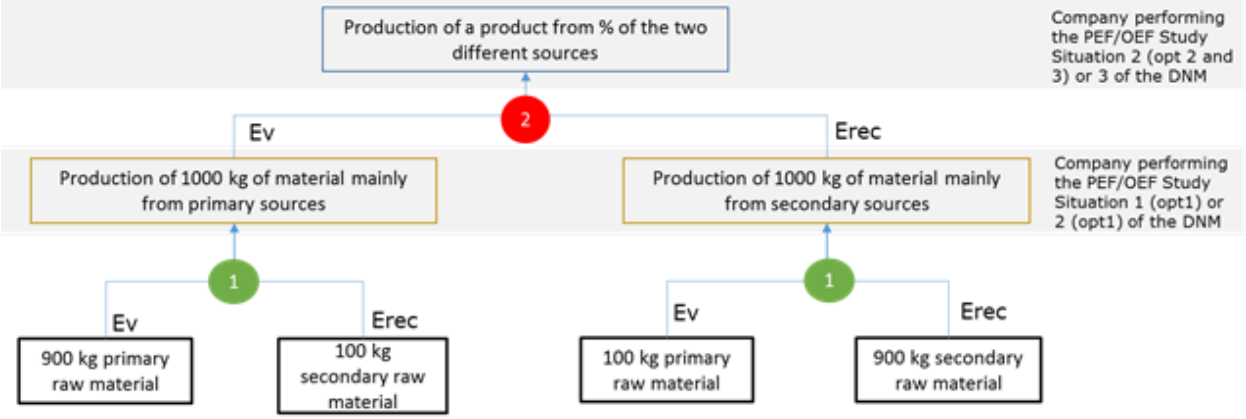


Figure 5: Point of substitution at level 1 and at level 2.

Figure 5 is a schematic representation of a generic situation (flows are 100% primary and 100% secondary). In practice in some situations, more than one point of substitution can be identified at different steps in the value chain, as represented in Figure 6, where e.g. scrap of two different qualities is processed at different steps.

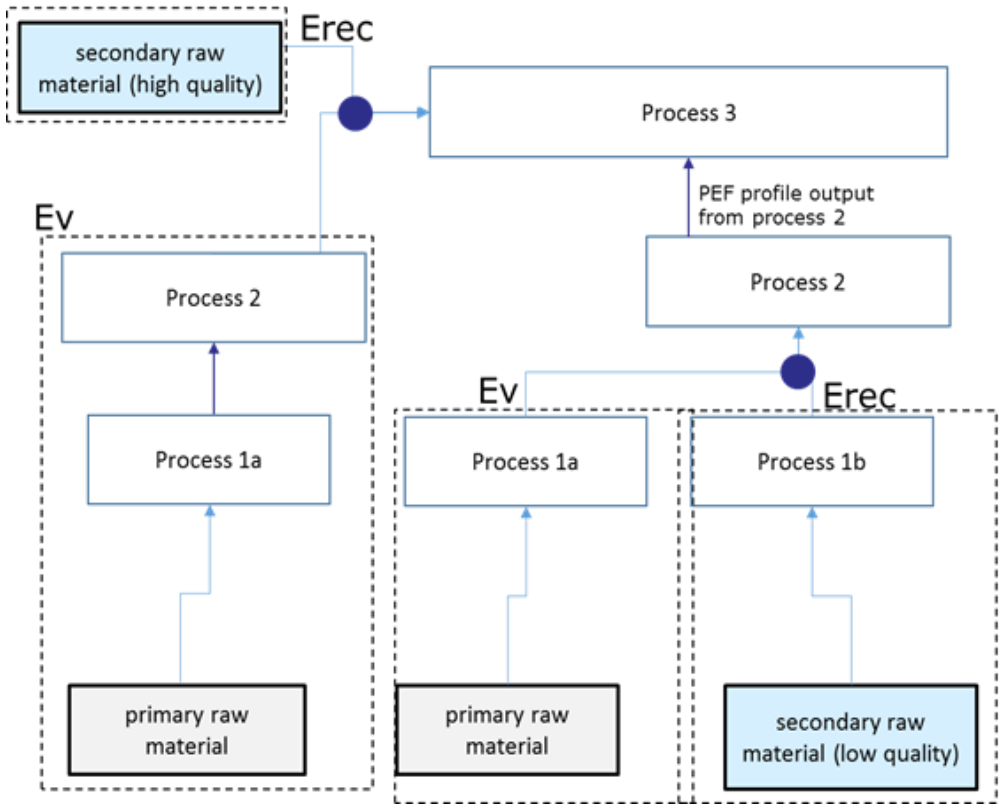


Figure 6: Example of point of substitutions at different steps in the value chain.

7.18.6 The quality ratios: Qs_{in}/Qp and Qs_{out}/Qp

Two quality ratios are used in the CFF, to take into account the quality of both the ingoing and the outgoing recycled materials.

Two further cases can be distinguished:

a) If Ev=E*v the two quality ratios are needed: Qs_{in}/Qp associated to the recycled content, and Qs_{out}/Qp associated to recyclability at EoL; the quality factors are there to capture downcycling of a material compared to the original primary material and, in some cases, may capture the effect of multiple recycling loops.

b) If Ev≠E*v one quality ratio is needed: Qs_{in}/Qp associated to the recycled content. In this case E*v refers to the functional unit of the material substituted in a specific application. For example, plastic recycled to produce a bench modelled via substitution of cement, shall take into account also how much, how long, how well. Therefore, the E*v parameter indirectly integrates the Qs_{out}/Qp parameter, and therefore the Qs_{out} and Qp parameters are not part of the CFF.

The quality ratios shall be determined at the point of substitution and per application or material. The quality ratios are PEFCR specific, except for packaging materials (see section 7.18.24).

The quantification of the quality ratios shall be based on:

- Economical aspects: i.e. price ratio of secondary compared to primary materials at the point of substitution. In case the price of secondary materials is higher than the primary ones, the quality ratios shall be set equal to 1.
- When economic aspects are less relevant than physical aspects, the latter may be used.

7.18.7 Recycled content (R_1)

The R_1 values applied shall be supply-chain or application specific, in relation with the DNM. The R_1 value shall be set to 0% when no application-specific data is available. Material-specific values based on supply market statistics are not accepted as a proxy.

The applied R_1 values shall be subject to the PEFCR review (if applicable) or PEF study verification (if applicable).

7.18.7.1 Relation with the Data Needs Matrix (DNM)

The choice for ' default R_1 values' or 'company-specific R_1 values' shall be based on the rules of the DNM (see Table 30).

This means that company-specific values shall be used when:

- the process is identified in the PEFCR as being most relevant and is run by the company applying the PEFCR,

or:

- the process is listed by the PEFCR as obligatory to be covered by company-specific data.

In all other cases 'default secondary R_1 values' may be used: for example, when R_1 is in situation 2, option 2 of the DNM. In this case company-specific data is not mandatory and default secondary data should be used by the company applying the PEFCR.

Table 30: Requirements regarding R_1 values in relation with the DNM.

		Most relevant process	**Other process**
Situation 1: process run by the company applying the PEFCR	**Option 1**	Supply-chain specific R1 value	
	Option 2		Default (application-specific) R1 value
Situation 2: process not run by the company applying the PEFCR but with access to company-specific information	**Option 1**	Supply-chain specific R1 value	
	Option 2	Default (application-specific) R1 value	
	Option 3		Default (application-specific) R1 value

Situation 3: process not run by the company applying the PEFCR and without access to company-specific information	**Option 1**	Default (application-specific) R1 value	
	Option 2		Default (application-specific) R1 value

7.18.7.2 Guidelines when using supply-chain specific R_1 values

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.
- Industry- or company-owned traceability systems may be applied as long as they cover the general guidelines outlined above. If not, they shall be supplemented with the general guidelines above.

7.18.7.3 Guidelines when using default R1 values

Default R_1 values are available in Annex C and are application specific. Default R_1 values shall be used if there is an application specific value available in Annex C. If no application-specific value is available in Annex C, the R_1 value shall be set equal to 0.

The PEFCR shall (i) prescribe the list of R_1 values which shall be used by the applicant in case no company-specific values are available and (ii) shall make a reference to Annex C.

7.18.7.4 Guidelines on how to deal with pre-consumer scrap

When dealing with pre-consumer scrap, two options may be applied. Each TS shall identify and include in the PEFCR which option shall be used when modelling pre-consumer scrap.

- **Option 1**: the impacts to produce the input material that lead to the pre-consumer scrap in question have to be allocated to the product system that generated this scrap. Scrap is claimed as pre-consumer recycled content.
- Process boundaries and modelling requirements applying the Circular Footprint Formula are shown in Figure 7.

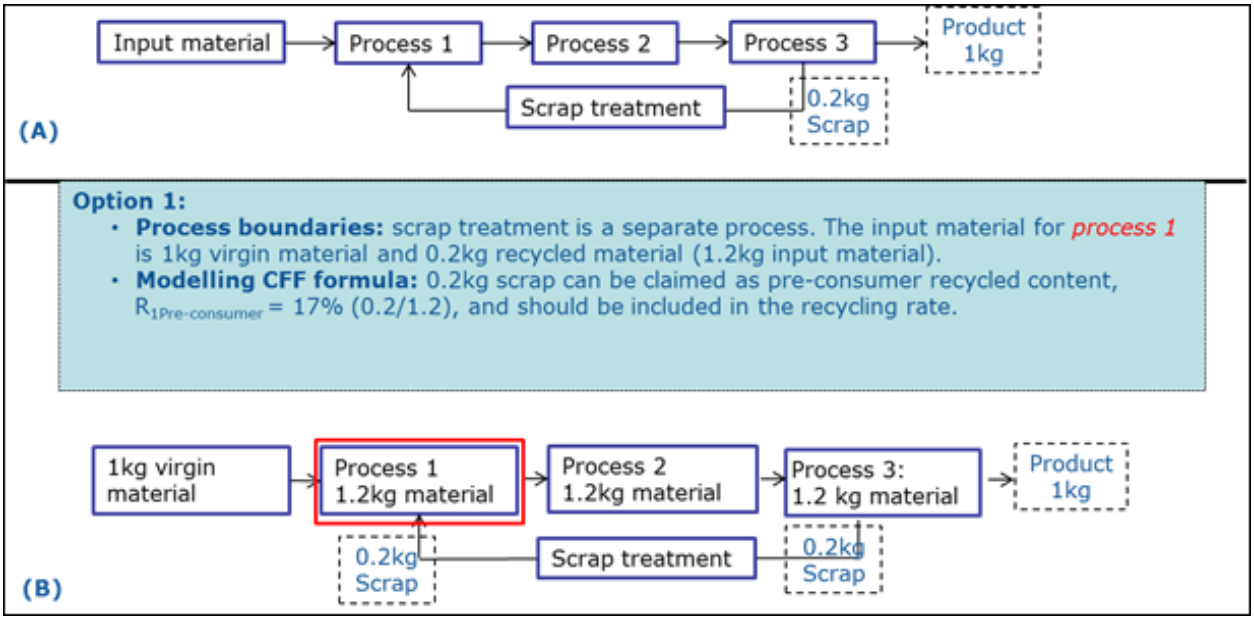


Figure 7: Modelling option when pre-consumer scrap is claimed as pre-consumer recycled content.

- **Option 2**: Any material that circulates within a process chain or pool of process chains is excluded from being defined as recycled content and it is not included in R_1. Scrap is not claimed as pre-consumer recycled content.
- Process boundaries and modelling requirements applying the Circular Footprint Formula are shown in Figure 8.

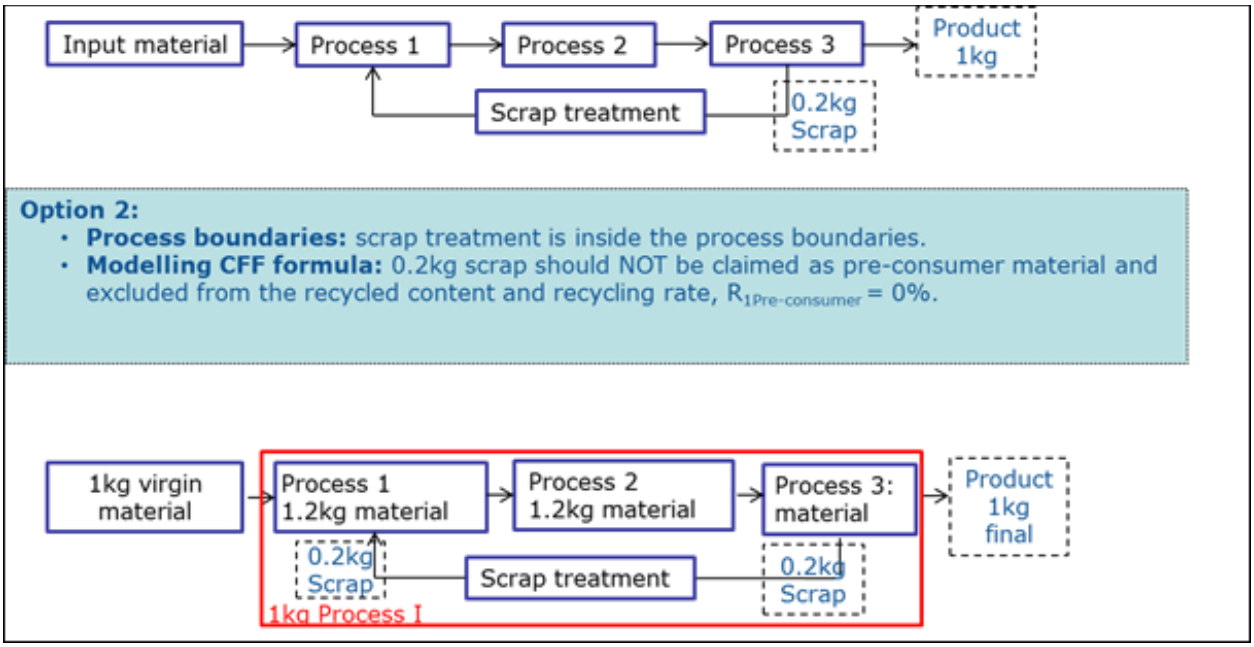


Figure 8: Modelling option when pre-consumer scrap is not claimed as pre-consumer recycled content.

7.18.8 Recycling output rate (R2)

Default R_2 values are available in – List of default values for A, R1, R2, R3 and Qs/Qp. The PEFCR shall list the default R_2 values (with reference to – List of default values for A, R1, R2, R3 and Qs/Qp) to be used by the applicant in case no company-specific values are available. If an R_2 value is not available for a specific application in – List of default values for A, R1, R2, R3 and Qs/Qp, the PEFCR shall list the R_2 values of the material (e.g. materials average). In case no R_2 values are available in – List of default values for A, R1, R2, R3 and Qs/Qp, R_2 shall be set equal to 0 or new statistics may be generated by the TS in order to assign an R_2 value. Proposals to include new or updated values of R_2 in – List of default values for A, R1, R2, R3 and Qs/Qp will be evaluated by the Commission. The list of R_2 values in the – List of default values for A, R1, R2, R3 and Qs/Qp will be periodically reviewed and updated by the Commission.

The following procedure shall be followed by the applicant to select the right R_2 value:

- Company-specific values 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 PEFCR,
    - 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.

A visual representation of the output recycling rate is given in Figure 9. Often, values are available for point 8 in Figure 9, therefore such values shall be corrected to the actual output recycling rate (point 10). In Figure 9 the output recycling rate (R2) is in correspondence of point 10.

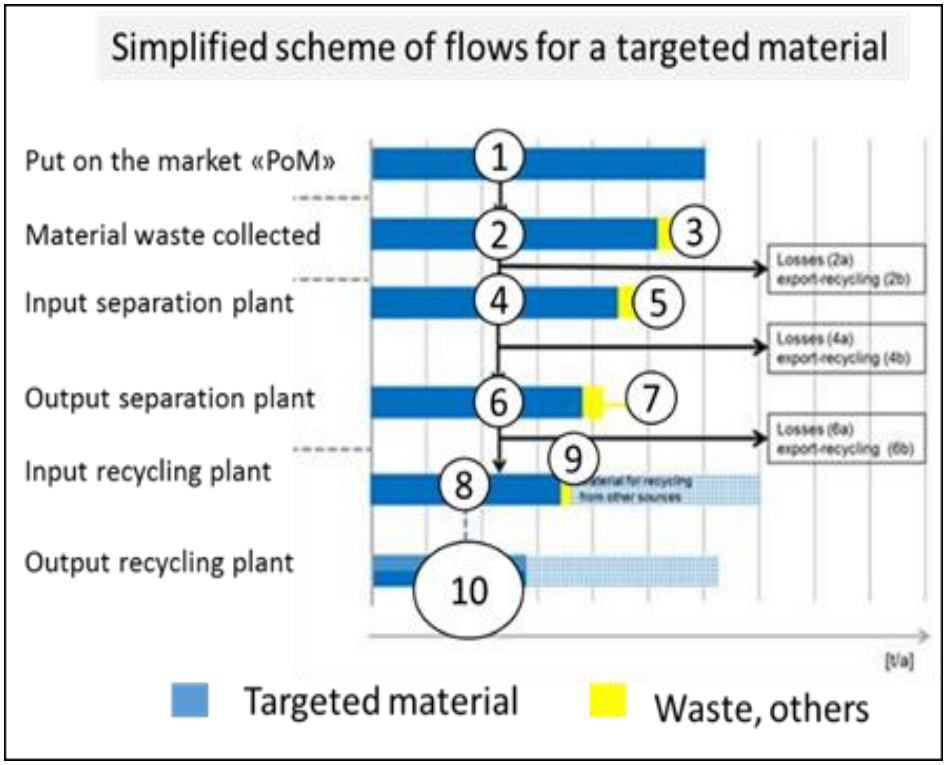


Figure 9: Simplified collection recycling scheme of a material.

The product design and composition will determine if the material in the specific product is actually suitable for recycling and thus falls within the values available in – List of default values for A, R1, R2, R3 and Qs/Qp. Therefore, 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 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[78].

Following the evaluation for recyclability, the appropriate R_2 values (supply-chain specific or provided in the – List of default values for A, R1, R2, R3 and Qs/Qp) shall be used.

If one criterion is not fulfilled or the sector-specific recyclability guidelines indicate a limited recyclability: an R_2 value of 0% shall be applied.

7.18.9 $E_{recycled}$ and $E_{recyclingEoL}$

The system boundary of E_{rec} and E_{recEoL} shall consider all the emissions and resources consumed starting from collection up to the defined point of substitution.

If the point of substitution is identified at "level 2" E_{rec} and E_{recEoL} shall be modelled using the real input flows. Therefore, if a portion of the input flows are from primary raw materials, they shall be included in the datasets used to model E_{rec} and E_{recEoL}.

In some cases E_{rec} can correspond to E_{recEoL}, for example in cases where close loops occurs.

The PEFCR shall list the default datasets that shall be used by the applicant to model E_{rec} and E_{recEoL}.

7.18.10 The E*v

When default E*v equals Ev, it is assumed that a recyclable material at end-of-life is replacing the same virgin material than where the recyclable material is produced from (at input side).

In some cases E*v will be different from Ev, when evidence is provided that a recyclable material is substituting a different virgin material than where the recyclable material is produced from,.

When E*v ≠ Ev, E*v represents the actual amount of virgin material substituted by the recyclable material. In such cases E*v is not multiplied by Qs_{out}/Qp, because this parameter is indirectly taken into account when calculating the "actual amount" of virgin material substituted: such amount shall be calculated taking into account that the virgin material substituted and the recyclable material fulfil the same function, in terms of "how long" and "how well". E*v shall be determined based on evidence of actual substitution of the selected virgin material.

The PEFCR shall list the default datasets that shall be used by the applicant to model of E*v and Ev.

7.18.11 How to apply the formula to final products (cradle-to-grave studies)

When the formula is applied to final products, the PEFCR shall prescribe:

- The use of Equation 18 (CFF)

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

- Default A values of the specific application or material.

7.18.12 How to apply the formula to intermediate products (cradle-to-gate studies)

In cradle-to-gate PEF studies the parameters related to the end-of-life of the product (i.e. recyclability at end-of-life, energy recovery, disposal) shall not be accounted for, unless the PEFCR requires to calculate additional information from the EoL stage.

When the formula is applied in PEF studies with intermediate products (cradle-to-gate studies), the PEFCR shall prescribe:

- The use of Equation 18 (CFF)
- To exclude the end-of-life by setting the parameters R_2, R_3, and E_d equal to 0.
- The default A values of possible specific applications for the product in scope.
- To use and report the results with two A values for the product in scope:
    - Setting A = 1: to be used as default in the PEF profile calculation.
    - Setting A = the application- or material-specific default values as listed in the PEFCR: These results shall be reported as 'additional technical information' and to be used when creating EF compliant datasets.

When developing the PEFCR, the A value of the product in scope shall be set to 1 for the hotspot analysis. This to allow the focus of the hotspot on the actual system. This shall be documented in the PEFCR.
When developing the EF compliant datasets, A shall be set to the application- or material-specific default value. This to allow the use of the correct A value when the dataset is used in future modelling. This shall be documented in the PEFCR.

7.18.13 How to apply the formula to construction products

When the formula is applied to the full life cycle of a construction product, the PEFCR shall prescribe:

- The use of Equation 18 (CFF) or Equation 19 (CFF-M),
- Default A values of the specific application or material.

When the formula is applied to intermediate construction products, the PEF profile shall be calculated as follows:

- The “production burdens” part of Equation 19 (CFF-M) shall be used.
- The PEF report shall include the profile of the “Burdens and benefits related to secondary materials input” part of Equation 19 (CFF-M), using the default A value of the specific application or material.

7.18.14 Summary table on how to apply the Circular Footprint Formula

Table 31 provides a summary on how to apply the CFF, depending on a study focusing on final products, intermediate products or construction products.

3359 **Table 31: Summary table on how to apply the CFF in different situations.**

Formula		Products apart from construction products		Construction products	
		Final products	*Intermediates*	*Full life cycle*	*Intermediates*
1) CFF					
	A = 1		X (hotspot and PEF profile)		
	A = default	X	X (Additional technical info. And EF compliant dataset)		
2) CFF-M					
	A= default (All modules)			X	
	Production burdens				X
	Burdens and benefits related to secondary materials input, A=default				X

3360 ### 7.18.15 How to deal with specific aspects

3361 ### 7.18.16 Biogenic carbon

3362 When modelling bio-based products, biogenic carbon shall be modelled according to the requirements
3363 listed in section 7.9.2.

3364 ### 7.18.17 Recovery bottom ashes/slag from incineration

3365 Recovery of bottom ashes/slag shall be included in the R_2 value (recycling output rate) of the original
3366 product/material. Their treatment is within the ErecEoL.

3367 ### 7.18.18 Landfill and incineration with energy recovery

3368 Whenever a process, such as landfill with energy recovery or municipal solid waste incineration with
3369 energy recovery, is leading to an energy recovery it shall be modelled under the “energy” part in Equation
3370 18 (CFF). The credit is calculated based on the amount of output energy that is sold.

7.18.19 Municipal solid waste

Default values per country are provided in – List of default values for A, R1, R2, R3 and Qs/Qp and shall be used to quantify the share to landfill and the share to incineration, unless supply-chain specific values are available.

7.18.20 Compost and anaerobic digestion/sewage treatment

Compost, including digestate coming out of the anaerobic digestion, shall be treated in the "material" part (Equation 18) like a recycling with A = 0.5. The energy part of the anaerobic digestion shall be treated as a normal process of energy recovery under the "energy" part of Equation 18 (CFF).

7.18.21 Waste materials used as a fuel

When a waste material is used as a fuel (e.g. waste plastic used as fuel in cement kilns), it shall be treated as an energy recovery process under the "energy" part of Equation 18 (CFF).

7.18.22 Modelling complex products

When considering complex products (e.g. printed wiring boards PWB) with complex end-of-life management, the default datasets for end-of-life treatment processes should already implement the Circular Footprint Formula. The default values of the parameters shall refer to the ones in – List of default values for A, R1, R2, R3 and Qs/Qp and shall be available as metadata information in the dataset. The Bill of Material (BoM) should be taken as a starting point for calculations if no default data is available.

7.18.23 Reuse and refurbishment

If the reuse/refurbishment of a product results into a product with different product specifications (providing another function), this shall be considered as part of the CFF, as a form of recycling (see section 7.8). Also, old parts that have been changed during refurbishment shall be modelled under the CFF.

In this case, reuse/refurbishment activities are part of the E_{recEoL} parameter, while the alternative function provided (or the avoided production of parts or components) fall under the E*v parameter.

7.18.24 Packaging

Qs/Qp values for packaging

Quality ratios are always PEFCR specific, except for packaging. The packaging materials used by industry are often the same within different sectors and product groups. Therefore, consistency is also needed in the quality ratios used within the CFF. "– List of default values for A, R_1, R2, R3 and Qs/Qp" provides one worksheet with Qs/Qp values applicable only to packaging materials. The values are derived from the document "PEF-OEF_EOL DefaultData_V1.2_uploaded", used within the pilot phase. These values are based on user experiences and have no literature references.

Each PEFCR should use the default values provide here. The TS may decide to change the default values if this is justified in the PEFCR.

Recycled content (R_1) for packaging

When using supply-chain-specific R_1 values, traceability throughout the supply chain is necessary and supplementary information is required. For the packaging industry, the following industry-specific guidelines are recommended:

- For the container glass industry (FEVE - The European Container Glass Federation): the European Commission regulation no 1179/2012. This regulation requests a statement of conformity delivered by the cullet producer.
- For the paper industry: European Recovered Paper Identification System (CEPI, 2008). This document prescribes rules and guidance on necessary information and steps, with a delivery note that shall be received at the reception of the mill.
- For beverage cartons no recycled content is used so far and thus sector specific rules are redundant so far. However, if needed, the same guidelines as paper shall be used as being most suitable (beverage cartons are covered by a recovered paper grade category under EN643).
- For the plastics industry: EN standard 15343:2007. This standard prescribes rules and guidelines on traceability. The supplier of the recyclate is requested to provide specific information.

Recycling output rate (R_2) for packaging

Background information used to calculate R_2 values for packaging is reported in – Background information to calculate R2 for packaging materials. It presents, per packaging application, the corresponding material and default R_2 data source to be used, as available in – List of default values for A, R1, R2, R3 and Qs/Qp and Qs/Qp. The R_2 values may only be used after making an evaluation for recyclability based on three criteria (as described by ISO 14021:1999 and in section 7.18.8). Sector-specific recyclability guidelines may be used to show that a certain product is collected and recycled. For PET bottles the EPBP guidelines should be used (epbp.org/design-guidelines), while for generic plastics the recyclability by design should be used (www.recoup.org).

Table 32: Data source for R2 per packaging application.

Packaging application	Material	Data source R_2 (see Annex C)
Bag in Box - High barrier EVOH	Packaging film	Generic plastic packaging
Bag in Box - High barrier EVOH	HDPE tap	PET bottle
Bag in Box - High barrier EVOH	Corrugated board	Paper and cardboard
Aseptic beverage carton	Aluminium foil	Aluminium, Liquid beverage carton

Packaging application	Material	Data source R_2 (see Annex C)
Aseptic beverage carton	LDPE film	Generic plastics, Liquid beverage carton
Aseptic beverage carton	Liquid Packaging Board	Paper and cardboard, Liquid beverage carton
Beverage carton	LDPE film	Generic plastics, Liquid beverage carton
Beverage carton	Liquid Packaging Board	Paper and cardboard, Liquid beverage carton
Closure - Plastic cap PP	PP granulates	Generic plastic packaging
Closure - Plastic cap HDPE	HDPE granulates	PET bottle
Closure - Alu-Ring pull	Aluminium sheet	Aluminium cans
Closure - Alu-Screw cap	Aluminium foil	Aluminium cans
Closure - Tin plated steel	Tin plated steel (ETP)	Steel for packaging
Closure - ESSC steel-Pry off	Tin free steel (ECCS)	Steel for packaging
Closure - plastic cork stopper	LDPE cork	Generic plastic packaging
Crates - Plastic, HDPE	HDPE granulates	Generic plastic packaging
Crates - Plastic, PP	PP granulates	Generic plastic packaging
Packaging film - High barrier	PET/ALU/PE film	Generic plastic packaging
Packaging film - Medium barrier	PP film PP film	Generic plastic packaging
Packaging film - Low barrier	PP film PP film	Generic plastic packaging
Packaging film - High barrier PE/EVOH/PE	PE film EVOH film LDPE film	Generic plastic packaging
Flexible paper packaging	Kraft paper - uncoated	Paper and cardboard
Glass bottle, unspecified colour	Glass, unspecified colour	Container glass, unspecified colour
Glass bottle, colourless (flint)	Glass, unspecified colour	Container glass, colourless (flint)
Glass bottle, green colour	Glass, unspecified colour	Container glass, green colour

Packaging application	Material	Data source R_2 (see Annex C)
Glass bottle, amber colour	Glass, unspecified colour	Container glass, amber colour
Label - Plastic self adhesive	PP film	PET bottle
Label - Plastic wrap around	OPP film	PET bottle
Label - Alu label Neck Foil	Aluminium foil	Aluminium cans
Label - Paper	Kraft paper - uncoated	Paper and cardboard
Label - Plastic	PE film	Generic plastic packaging
Plastic - Shrink Sleeve PET	PET film	PET bottle
Plastic - Shrink Sleeve PVC	PVC film	PET bottle
Plastic - Shrink Sleeve OPS	PS film	PET bottle
Can beverage - sanitary end aluminium	Aluminium sheet	Aluminium cans
Can beverage - body aluminium	Aluminium sheet	Aluminium cans
Can beverage - body steel	Tin plated steel (ETP)	Steel for packaging
Can Food - sanitary end aluminium	Aluminium sheet	Aluminium cans
Can Food - sanitary end tin plated steel	Tin plated steel (ETP)	Steel for packaging
Can Food - body ESSC	Tin free steel (ECCS)	Steel for packaging
Can Food - body aluminium	Aluminium sheet	Aluminium cans
Can Food - body tin plated steel	Tin plated steel (ETP)	Steel for packaging
Can - body ECCS PET coated	Tin free steel (ECCS)	Steel for packaging
Can - sanitary end ECCS PET coated	Tin free steel (ECCS)	Steel for packaging
Can non food - body tin plated steel - coated	Tin plated steel (ETP)	Steel for packaging
Can non food - sanitary end tin plated steel	Tin plated steel (ETP)	Steel for packaging
Can non food - body tin plated steel	Tin plated steel (ETP)	Steel for packaging
Aluminium tray	Aluminium foil	Aluminium cans
Pallet - Plastic, 80x120	HDPE granulates	Generic plastic packaging
Pallet - Plastic, 100x120	HDPE granulates	Generic plastic packaging

Packaging application	Material	Data source R_2 (see Annex C)
Pallet - Plastic, half	HDPE granulates	Generic plastic packaging
Paper sack	Sack kraft paper	Paper, Paper sack
Paper bag	Kraft paper - uncoated	Paper, Paper bag
Carton - box / inserts	Cartonboard	Paper, Carton - box / inserts
Solid board box	Solid board	Paper, Solid board box
Solid board box - bleached	Solid bleached board	Paper, Solid board box - bleached
Corrugated - pads / box / inserts	Corrugated board	Paper, Corrugated - pads / box / inserts
PET bottle transparent	PET granulates, bottle grade	PET bottle
PET Preform transparent	PET granulates, bottle grade	PET bottle
Plastic film - PET	PET film	Generic plastic packaging
Plastic film - PE	PE film	Generic plastic packaging
Plastic film - PP	PP film	Generic plastic packaging
Plastic film - OPP	PP film	Generic plastic packaging
Plastic film - PP strapping	PP film	Generic plastic packaging
Plastic film - PE wrapping	PE film	Generic plastic packaging
Plastic - Shrink wrap	LDPE film	Generic plastic packaging
Plastic - Stretch film	LLDPE film	Generic plastic packaging
Plastic bag - PE bag	PE film	Generic plastic packaging
Plastic bag - Dry food	PP film	Generic plastic packaging
Plastic bag - Dry food	LDPE film	Generic plastic packaging
Slipsheet / Plastic divider	LDPE granulates	Generic plastic packaging
Plastic Can - body PP	PP granulates	Generic plastic packaging
Plastic Can - sanitary end PP	PP granulates	Generic plastic packaging
Plastic Can - body HDPE	HDPE granulates	Generic plastic packaging

Packaging application	Material	Data source R_2 (see Annex C)
Plastic Can - sanitary end HDPE	HDPE granulates	Generic plastic packaging
Plastic tray - Polypropylene	PP granulates	Generic plastic packaging
Corner foam - polyethylene	LDPE granulates	Generic plastic packaging
Corner foam - polystyrene	EPS beads	Generic plastic packaging
HDPE tap	HDPE granulates	Generic plastic packaging

7.19 Data requirements and quality requirements

7.19.1 The materiality approach

One of the main features of the PEF Guide is the attempt to operationalise the "materiality" approach, i.e. focusing where it really matters. In the PEF context, the materiality approach is developed around two main areas:

- **Impact categories, life cycle stages, processes and elementary flows**: the PEFCR shall identify the most relevant ones. These should be the contributions where companies, stakeholders, consumers, and policy makers should focus (see section 7.4);
- **Data requirements**: as the most relevant processes are those driving the environmental profile of a product, these shall be assessed by using data with higher quality compared to the less relevant processes, independently from where these processes happen in the life cycle of the product.

Once the model(s) for the representative product(s) is developed, the TS shall address the following two questions:

1. Which are the processes that are driving the environmental profile of the product (most relevant processes)?
2. Which are the processes for which company-specific information is mandatory?

7.19.2 DQR formula

Within the EF context, 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 4 data quality criteria:

$$DQR = \frac{TeR+GR+TiR+P}{4} \quad \text{[Equation 20]}$$

where TeR is the Technological-Representativeness, GR is the Geographical-Representativeness, TiR is the Time-Representativeness, and 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 PEFCR shall provide tables with the criteria to be used for the semi-quantitative assessment of each criteria. The PEFCR may specify more stringent data quality requirements if appropriate for the sector in question and specify additional criteria for the assessment of data quality.

When a company-specific dataset is created, the data quality of the company-specific activity data, the company specific emission data and the secondary sub-processes shall be assessed separately. The DQR of the newly developed dataset shall be calculated as follow:

1) Select the most relevant 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 TeR, TiR, GR and P for each most relevant process and each most relevant direct elementary flow. The values of each criteria shall be assigned based on the table on how to assess the value of the DQR criteria for the processes provided in the PEFCR.

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, the applicant of the PEFCR shall 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.

2.c) Considering that the data for the mandatory processes shall be company specific, the score of P cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (The DQR score shall be ≤1.6).

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 criteria 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 Equation 21, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \bar{P}$ are the weighted average calculated as specified in point (4).

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\bar{P}}{4} \quad \text{[Equation 21]}$$

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 $\overline{\mathrm{Te_R}}, \overline{\mathrm{G_R}}, \overline{\mathrm{Ti_R}}, \overline{\mathrm{P}}$ and the total DQR shall be multiplied with 1.375.

7.19.2.1 DQR tables for processes with company-specific data:

To allow the evaluation of the DQR of processes for which company-specific data are used, the PEFCR shall include at least one table on how to assess the value of the DQR criteria for these processes. The table(s) to be included in the PEFCR shall be based on

Table 33. Only the reference years criteira Ti_R (**$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$** and **$Ti_{R\text{-}SD}$**) might be adapted by the TS. It is not allowed to modify the text for the other criteria.

Table 33: How to assign the values to DQR criteria when using company-specific information.

	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ 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
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

P_{EF}: Precision for elementary flows; **P_{AD}**: Precision for activity data; **$Ti_{R\text{-}EF}$**: Time Representativeness for elementary flows; **$Ti_{R\text{-}AD}$**: Time representativeness for activity data; **$Ti_{R\text{-}SD}$**: Time representativeness for secondary datasets; **$Te_{R\text{-}EF}$**: Technology representativeness for elementary flows; **$Te_{R\text{-}SD}$**: Technology representativeness for secondary datasets**;** **$G_{R\text{-}EF}$**: Geographical representativeness for elementary flows; **$G_{R\text{-}SD}$:** Geographical representativeness for secondary datasets.

7.19.2.2 DQR tables for processes for which secondary datasets are used

To allow the applicant to assess the context-specific DQR criteria Te_R, Ti_R and G_R of most relevant processes, the PEFCR shall include at least one table on how to assess the criteria. The assessment of the Te_R, Ti_R and G_R criteria shall be based on Table 34. Only the reference years for criteria Ti_R might be adapted by the TS, per process. It is not allowed to modify the text for the other criteria.

Table 34: How to assign the values to DQR criteria when using secondary datasets.

	Ti_R	Te_R	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

	Ti_R	Te_R	G_R
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

Ti_R: Time representativeness; **Te_R**: Technology representativeness; **G_R:** Geographic representativeness.

7.19.3 List of mandatory company-specific data

The list of mandatory company-specific data refers to the activity data and (unit) processes for which company-specific data shall be collected. This list defines the minimum requirements to be fulfilled by companies that apply the PEFCR. The purpose is to avoid that an applicant without access to the relevant company-specific data is able to perform a PEF study and communicate its results by only applying default data and datasets. The PEFCR shall define the list of mandatory data.

For the selection of the mandatory data, the TS shall consider its relevance within the EF profile, the level of effort needed to collect these data (especially for SMEs) and the overall quantity of data / time required to collect all mandatory company-specific data. This is very important and has two consequences: (i) companies may perform a PEF study by only searching for these data and using default data for everything outside this list, while (ii) companies who don't have company-specific data for one listed cannot establish a PEFCR-compliant EF profile of the product in scope.

For each process for which company-specific data is mandatory the developed dataset shall be EF compliant and the PEFCR shall provide the following information:

1. the list of the activity data to be declared by the applicant together with the default secondary datasets to be used. The list of activity data shall be as specific as possible in terms of unit of measures and any other characteristics that could help the applicant in implementing the PEFCR;

2. the list of foreground elementary flows to be declared by the applicant. This is the list of most relevant direct emissions. For each emission the PEFCR shall specify the frequency of measurements, the measurement methods and any other technical information necessary to ensure that the calculations of the PEF-profile are comparable.

Considering that the data for the mandatory processes shall be company specific, the score of P cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (the DQR score shall be ≤1.6). To assess the DQR , follow the requirements of

Table 33.

For mandatory processes selected as to be modelled with company-specific information, the PEFCR shall follow the requirements set out in this section. For all other processes, the applicant shall apply the Data Needs Matrix as explained in section 7.19.4.

7.19.4 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific shall be evaluated using the Data Needs Matrix (see Table 35). The next section includes the rules to be followed when developing a PEFCR, while section 7.19.4.2 includes the rules for the applicant of the PEFCR. The options indicated for each situation are not listed in hierarchical order.

7.19.4.1 Rules to be followed when developing a PEFCR

The PEFCR shall include the following information for all processes outside the list of mandatory company-specific data:

1. for all processes outside the list of mandatory company-specific processes, provide the list of default secondary datasets to be used within the scope of the PEFCR, dataset name together with the UUID of the aggregated version[79] and the node web address;
2. report the default DQR values (for each criteria) as provided in their meta data, for all default EF datasets listed;
3. indicate the most relevant processes;
4. provide one or more DQR table(s) for the most relevant processes;
5. indicate the processes expected to be in situation 1;
6. for those processes expected to be in situation 1, provide the list of activity data and elementary flows to be declared by the applicant. This list shall be as specific as possible in terms of unit of measurement, averaging data and any other characteristics that could help the applicant in implementing the PEFCR.

7.19.4.2 Rules for the applicant

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.

[79] Each EF compliant dataset tendered by the EC is available in both an aggregated and disaggregated (at level-1) form.

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.

A company implementing the PEFCR shall:

1. determine the level of influence (Situation 1, 2 or 3 described below) the company has for each process in its supply chain. This decision determines which of the options in Table 35 is pertinent for each process;
2. follow the rules of Table 35 for the most relevant processes and for the other processes.
3. Calculate/re-evaluate the DQR values (for each criterion + total) for all the datasets used for the most relevant processes and the new ones created. For all remaining 'other processes' the DQR values reported in the PEFCR shall be used.
4. if one or more processes are not included in the list of default processes in the PEFCR, then the applicant shall identify a suitable dataset according to requirements provided in section 7.19.5.

Table 35: Data Needs Matrix (DNM) – Requirements for the applicant of the PEFCR. The options indicated for each situation are not listed in hierarchical order.

		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 level 1 (DQR≤1.6) Calculate the DQR values (for each criterion + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR≤3.0) Use the default DQR values
Situation 2: process <u>not</u> 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 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 EF 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 EF compliant datasets (DQR≤4.0) Use the default DQR values
Situation 3: process <u>not</u> run by the company applying the PEFCR and without access to company-specific information	**Option 1**	Use default secondary data set in aggregated form (DQR≤3.0) Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary data set in aggregated form (DQR≤4.0) Use the default DQR values

7.19.4.3 DNM, 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 7.19.2 while using the PEFCR specific DQR tables.

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 in the PEFCR.

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.

7.19.4.4 DNM, situation 2

When a process is in situation 2 (i.e. the company applying the PEFCR is not running the process but has access to company-specific data) 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 (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 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 7.19.2 while using the PEFCR specific DQR tables.

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 recalculate the DQR criteria for the processes in Situation 2, Option 2. It shall make the DQR context-specific by re-evaluating Te_R and Ti_R using the table(s) provided in the PEFCR (adapted from

Table 33). The criteria G_R shall be lowered by 30%[80] 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.

7.19.4.5 DNM, situation 3

When a process is in situation 3 (i.e. the company applying the PEFCR is not running the process and this 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 take the DQR values from the PEFCR.

If the default dataset used for the process is not listed in the PEFCR, the applicant of the PEFCR shall make the DQR criteria context-specific by re-evaluating Te_R, Ti_R and G_R using the table(s) provided in the PEFCR (adapted from

[80] 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.

Table 33). The parameter 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.

7.19.5 Which datasets to use?

For the PEFCR screenings and supporting studies: the TS shall use EF-compliant datasets when available. In case an EF-compliant dataset does not exist, an EF-compliant proxy shall be used and if not available, a non-EF compliant dataset may be used.

For the final PEFCR representative product calculations, the following rules shall be followed in hierarchical order:

- An EF-compliant proxy is available: it shall be included in the list of default processes of the PEFCR and stated within the limitations chapter (B.3.6).
- An ILCD-entry level-compliant (EL) proxy is freely available: it shall not be included in the list of default processes of the PEFCR. The proxy shall be listed in the data gaps of the PEFCR (chapter B.5.3) using the following text: "These datasets are used as proxy within the calculations of the representative product. However, the applicant of the PEFCR shall apply an EF-compliant dataset if available (following the rules layout in chapter B.5.6 on which dataset to use). If this is not available, the applicant shall use these proxies."
- If no EF-compliant or ILCD-entry level-compliant proxy is freely available: it shall be excluded from the model. This shall be clearly stated in the PEFCR as a data gap (chapter B.5.3).

Exception: Among the EF tendered datasets integrated modelling inconsistencies may arrive (e.g., glass default dataset uses 50/50 at input side, but then is modelled with CFF at output side; while plastics is fully modelled with CFF). The aim for consistency within the PEFCR is preferred. An ILCD- entry level-compliant dataset or proper modelling proxy may be chosen above an EF-compliant dataset to achieve consistency. This shall be justified in the PEFCR.

For the PEFCR applicant, the secondary datasets to be used are those listed in the PEFCR. Whenever a dataset needed to calculate the PEF-profile is not among those listed, the following rules shall be followed 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*

- 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.

7.19.6 The DQR of the study

The PEFCR shall require the *delivery of an EF-compliant dataset of the product in scope (meaning, the EF study). The* DQR of this dataset shall be calculated and the EF report shall report it.

In order to calculate the DQR of the EF study, the applicant shall calculate separately the TeR, TiR, GR 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 detailed DQR calculation rules of section 7.19.2 shall be followed.

7.20 Benchmark

The benchmark calculation is only applicable for final products. It shall be provided for each RP and shall correspond to the PEF profile modelled after the supporting studies results are taken into consideration.

The benchmark shall be provided in the PEFCR both as characterised, normalised and weighted results for each of the EF impact categories (not only the most relevant ones, and climate change sub-categories if relevant) and as a single score based on the weighting factors provided in Annex A. In all cases the three toxicity related impact categories shall be excluded. However, the TS may add an additional chapter to the PEFCR (outside the benchmark) where it displays the toxicity results of the selected ICs and clearly describes the existing limitations of the underlying method.

No benchmarking is allowed for intermediate products. The reporting of the characterised results calculated for each intermediate RP is optional in the PEFCR, but mandatory in the PEF study and PEF report.

7.21 Classes of performance

Within the pilot phase, the PEFCRs shall not include information on classes of performance.

8 Verification and validation of EF studies, reports, and communication vehicles

8.1 Defining the scope of the verification

Verification and validation of the EF study is mandatory whenever the EF study, or part of the information therein, is used for any type of external communication (i.e. communication to any interested party other than the commissioner or the practitioner of the study).

Verification means the conformity assessment process carried out by an environmental footprint verifier to demonstrate whether the EF study has been carried out in compliance with the PEFCR it declares compliance with and/or the most updated version of the PEF method adopted by the Commission.
Validation means the confirmation by the environmental footprint verifier who carried out the verification, that the information and data included in the EF study, EF report and the communication vehicles are reliable, credible and correct.

The verification and validation shall cover the following three areas:

1. the EF study (including, but not limited to, the data collected, calculated, and estimated and the underlying model)
2. the EF report
3. the technical content of the communication vehicles.

The verification of the **EF study** shall ensure that:

- the EF study is conducted in compliance with the most recent PEFCR, if available;
- if a PEFCR is not available, the EF study is conducted in compliance with the most recent version of the PEFCR Guidance and the PEF method, all EF methodological requirements, including the use of the predefined characterisation, normalisation and weighting factors, are fulfilled;

The validation of information in the EF study shall ensure that:

- the data and information used for the EF study are consistent, reliable and traceable;
- the calculations performed do not include mistakes.

The verification and validation of the **EF report** shall ensure that:

- the EF report is complete, consistent, and compliant with the EF study template provided in the most recent version of the PEFCR Guidance;

- the information and data included are consistent, reliable and traceable;
- the mandatory information and sections are included and appropriately filled in;
- All the technical information that could be used for communication purposes, independently from the communication vehicle to be used, are included in the report;

Note: whilst confidential information may be excluded from the EF report, this information shall be subject to validation.

The validation of the **communication vehicle** content shall ensure that**:**

- The technical information and data included are reliable and consistent with the information included in the EF study and in the EF report.

8.2 Verification procedure

The verification procedure covers the following steps:

- First, the commissioner shall select the verifier or verification team following the rules outlined in section 8.3.1;
- Second, the verification is performed following the verification process described in section 8.4;
- Third, the verifier communicates to the commissioner any misstatements, non-conformities and need for clarifications (section 8.3.2), and drafts the validation statement (section 8.5.2);
- Fourth, the commissioner responds to the verifier's comments and introduces necessary corrections and changes (if needed) to ensure the final compliance of the EF study, EF report and EF communication vehicles. If, in the verifier's judgement, the commissioner does not respond appropriately within a reasonable time period, the verifier shall issue a modified validation statement or withdraw from the verification process;
- Fifth, the final validation statement is provided, considering (if needed) the corrections and changes introduced by the commissioner;
- Sixth, surveillance of the EF study respective the EF report is provided during the validity of the EF report (as defined in 8.5.3).

If a matter comes to the verifier's attention that causes the verifier to believe in the existence of fraud or noncompliance with laws or regulations, the verifier shall communicate this immediately to the commissioner of the study.

8.3 Verifier(s)

The verification/validation may be performed by a single verifier or by a verification team. In line with ISO 14025, the verifier(s) may be internal or external. In particular:

- for business to consumer (B2C) communications, the independent verifier(s) shall be external to the organisation that conducted the EF study;
- for business to business (B2B) communications, the independent verifiers may be either internal or external to the organisation that conducted the EF study.

In any case the independency of the verifiers shall be guaranteed (i.e. they shall fulfil the intentions in the requirements of ISO/IEC 17020:2012 regarding a 3th party verifier, they shall not have conflicts of interests on concerned products and cannot include members of the Technical Secretariat or of the consultants involved in previous part of the work - screening studies, supporting studies, PEFCR review, etc). The minimum requirements and score for the verifier(s) as specified below shall be fulfilled. If the verification/validation is performed by a single verifier, he/she shall satisfy all the minimum requirements and the minimum score; if the verification/validation is performed by a team, the team as a whole shall satisfy all the minimum requirements and the minimum score. The documents proving the qualifications of the verifier(s) shall be provided as annex to the verification report or they shall be made available electronically.

In case a verification team is established, one of the members of the verification team shall be appointed as lead verifier.

8.3.1 Minimum requirements for verifier(s)

The assessment of the competences of verifier/verification team is based on a scoring system that takes into account (i) verification and validation experience, (ii) EF/LCA methodology and practice, and (iii) knowledge of relevant technologies, processes or other activities included in the product(s)/organization(s) in scope of the study. Table 36 presents the scoring system for each relevant competence and experience topic.

Unless otherwise specified in the context of the intended application, the verifier's self- based declaration on the scoring system constitutes the minimum requirement. Verifier(s) shall provide a self-declaration of their qualifications (e.g. university diploma, working experience, certifications, etc), stating how many points they achieved for each criterion and the total points achieved. This self-declaration shall form part of the EF verification report.

A verification of an EF study shall be conducted as per the requirements of the intended application. Unless otherwise specified, the minimum necessary score to qualify as a verifier or a verification team is six points, including at least one point for each of the three mandatory criteria (i.e. verification and validation practice, EF/LCA methodology and practice, and knowledge of technologies or other activities relevant to the EF study).

Table 36: Scoring system for each relevant competence and experience topic for the assessment of the competences of verifier(s)

			Score (points)				
	Topic	**Criteria**	**0**	**1**	**2**	**3**	**4**
Mandatory criteria	Verification and validation practice	Years of experience (1)	<2	2 ≤ x < 4	4 ≤ x < 8	8≤ x < 14	≥14
		Number of verifications (2)	≤5	5 < x ≤ 10	11 ≤ x ≤ 20	21 ≤ x ≤ 30	>30
	LCA methodology and practice	Years of experience (3)	<2	2 ≤ x < 4	4 ≤ x < 8	8≤ x < 14	≥14
		Number of LCA studies or reviews	≤5	5 < x ≤ 10	11 ≤ x ≤ 20	21 ≤ x ≤ 30	>30

			Score (points)				
	Topic	**Criteria**	**0**	**1**	**2**	**3**	**4**
		(4)					
	Knowledge of the specific sector	Years of experience (5)	<1	1 ≤ x < 3	3 ≤ x < 6	6≤ x < 10	≥10
Additional criteria	Review, verification/validation practice	Optional scores relating to verification/validation	— 2 points: Accreditation as third party verifier for EMAS — 1 point: Accreditation as third party reviewer for at least one EPD Scheme, ISO 14001, or other EMS				

(1) Years of experience in the field of environmental verifications and/or review of LCA/PEF/EPD studies.

(2) Number of verifications for EMAS, ISO 14001, International EPD scheme or other EMS.

(3) Years of experience in the field of LCA modelling. Eventual work done during master and bachelor degrees shall be excluded. Work done during a relevant Ph.D./Doctorate course shall be accounted for. Experience in LCA modelling includes, among others:

- LCA modelling in commercial and non-commercial software
- Datasets and database development

(4) Studies compliant with one of the following standards/methods: PEF, OEF, ISO 14040-44, ISO 14067, ISO 14025

(5) Years of experience in a sector related to the studied product(s). The experience in the sector can be gained through LCA studies or through other types of activities. . The LCA studies shall be done on behalf of and with access to primary data of the producing/operating industry. The qualification of knowledge about technologies or other activities is assigned according to the classification of NACE codes (*Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities - NACE Revision 2*). Equivalent classifications of other international organisations may also be used. Experience gained with technologies or processes in a whole sector are considered valid for any of its sub-sectors..

8.3.2 Role of the lead verifier in the verification team

The lead verifier is a team member with additional tasks. The lead verifier shall:

— distribute the tasks to be fulfilled between the team members according to the specific competencies of the team members, in order to get the full coverage of the tasks to be done and to use in the best manner the specific competencies of the team members;

— coordinate the whole verification/validation process and ensure that all team members have a common understanding of the tasks they need to fulfil;

— assemble all comments and ensure they are communicated to the commissioner of the EF study in a clear and comprehensible way;

— resolve any conflicting statements between team members;

— ensure that the verification report and validation statement are generated and are signed by each member of the verification team.

8.4 Verification/validation requirements

The verifier(s) shall describe all the outcomes related to the verification of the EF study, EF report and EF communication vehicles and give the commissioner of the EF study the opportunity to improve the work, if necessary. Depending on the nature of the outcomes, additional iterations of comments and responses may be necessary. Any changes made in response to the verification outcomes shall be documented in the verification report.

The verification/validation shall be done as a combined documental review and a model validation.

- the documental review includes the EF report, the technical content of any communication vehicle, and the data used in the calculations (through requested underlying documents). Verifier(s) may organise the documental review either as an "on desk" or "on site" exercise, or as a mix of the two. The verification of the company-specific data shall always be organised through a visit of the production site(s) the data refer to.
- the validation of the model may take place at the production site of the commissioner of the study or be organised remotely. The verifier(s) shall access the model in order to verify its structure, the data used, and its consistency with the EF report. The details about how the verifier(s) accesses the model shall be agreed by the commissioner of the EF study and the verifier(s).

The verification may take place at the end of the EF study or in parallel (concurrent) to the study.

8.4.1 Requirements for the verification/validation when a PEFCR is available

The verifier(s) shall verify that the EF report, EF communication (if any) and EF study is in compliance with the following standards/guidance documents:

a) most recent version of PEFCR applicable for the specific product/sector in scope.
b) conformance with the latest official version of the PEF method;
c) conformance with the ISO 14040 series of standards, for any requirement not covered in the PEF method or in the PEFCR guidance. In case of conflicting requirements, the EF ones prevail;
d) conformance with the ISO 14020 series of standard for communication vehicles, if applicable.

Moreover, the verifier(s) shall ensure that data verification/validation includes:

e) coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;
f) plausibility, quality and accuracy of the LCA-based data;
g) quality and accuracy of additional environmental information;
h) quality and accuracy of the supporting information.

The validation of the EF report and EF communication shall be carried out by checking enough information to provide reasonable assurance that the EF report and communication fulfils all the conditions listed in section 8.4.1.1.

The verification and validation of the EF study shall be carried out by following the minimum requirements listed below and the additional PEFCR-specific requirements specified by the TS and documented in the PEFCR section "Verification".

8.4.1.1 Minimum requirements for the verification and validation of the EF study

The verifier(s) shall validate the accuracy and reliability of the quantitative information used in the calculation of the study. As this may 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[81];
- all the newly created datasets shall be checked on their EF compliancy (for the meaning of EF compliant datasets refer to Annex I of the Guidance). 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 including 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.

The selection of the processes to be validated 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.

For all processes to be validated, it shall be checked if the DQR satisfies the minimum DQR as specified in the PEFCR.

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

[81] Available at: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

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.

8.4.1.2 Additional requirements for the validation of the EF study

The PEFCR may specify additional requirements for the validation that should be added to the minimum requirements stated in this document. The verifier(s) shall check that all the minimum and additional requirements are satisfied during the verification process.

8.4.2 Requirements for the verification and validation where no PEFCR is available

During the transition phase or until a European policy regulating EF-based information is adopted by the Commission, it is not recommended to carry out any communication of the environmental profile of a product or organisation in absence of a valid PEFCR[82].

In any case, if and when such a study is carried out, it shall be subject to an independent third party review carried out in accordance to ISO 14044, ISO 14071 and all complementary requirements included in this Guidance with reference to review of PEFCRs.

8.4.3 Verification and Validation techniques

The verifier shall assess and confirm whether the calculation methodologies applied are of acceptable accuracy, reliable, are appropriate and performed in accordance to these guidelines. The verifier shall confirm the correct application of conversion of measurement units.
The verifier shall check if applied sampling procedures are in accordance with the sampling procedure defined in the guidance document and PEFCR if available. The data reported shall be checked against the source documentation in order to check their consistency.
The verifiers shall evaluate whether the methods for making estimates are appropriate and have been applied consistently.
The verifier may assess alternatives to estimations or choices made, in the assertion to determine whether a conservative choice has been selected.
The verifier may identify uncertainties that are greater than expected and assess the effect of the identified uncertainty on the final EF results.

8.4.4 Data confidentiality

Data for validation shall be presented in a systematic and comprehensive way, all the project documentation supporting the validation of an EF study shall be provided to the verifier(s), including the EF

[82] A PEFCR is considered valid if it is included in the list available on DG ENV website at http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm (this page will be available once the final PEFCRs are delivered)

model, the confidential information and data. This data and information shall be treated as confidential and shall be used only during the verification process.

Confidential information may be excluded from the report, provided that:

- the request for non-disclosure only cover input-information, not any output information;
- the commissioner of the EF study provides the verifier with sufficient information of the nature of the data and information, and the reason for the request of excluding the data or information from the study report;
- the verifier accept the non-disclosure and include in the verification report the reasons for doing so;
- the commissioner of the EF study keep a file of the non-disclosed information for possible future re-evaluation of the decision of non-disclosure.

Business data could be of confidential nature because of competitive business aspects, intellectual property rights or similar legal restrictions. Therefore, business data identified as confidential and provided during validation process shall be kept confidential. Hence, verifiers shall not disseminate or otherwise retain for use, without the permission of the organisation, any information disclosed to them during the course of the review work. The Commissioner of the EF study may ask to the verifier(s) to sign a Non-Disclosure Agreement (NDA).

8.5 Outputs of the verification/validation process

8.5.1 Content of the verification and validation report

The verification and validation report shall include all findings of the verification/validation process, the actions taken from the commissioner in order to answer to the comments of the verifier(s), and the final conclusion. The report is mandatory, but may be confidential.

The final conclusion may be of different nature:

- "compliant" if the documental or onsite information proves that the requirements of this chapter are fulfilled.
- "not compliant" if the documental or onsite information proves that the requirements of this chapter are not fulfilled.
- "complementary information needed" if the documental or onsite information cannot allow the verifier to conclude on the compliancy. It may happen if the information is not transparently or sufficiently documented or registered.

8.5.2 Content of the validation statement

The validation statement is mandatory and shall always be provided as annex of the public EF report. As a consequence, from each communication vehicles it shall be possible to have access to the complete public EF report, including the validation statement.

The following elements and aspects shall be included in the validation statement as a minimum:

- title of the EF study under verification/validation, together with the exact version of the report to which the validation statement belongs;
- the commissioner of the EF study;
- the practitioner of the EF study;
- the verifier(s) or, in the case of a verification team, the team members with the identification of the lead verifier;
- absence of conflicts of interest of the verifier(s) with respect to concerned products and any involvement in previous work (PEFCR development, Technical Secretariat membership, consultancy work carried out for the applicant during the last three years);
- a description of the objective of the verification/validation;
- a statement of the result of the verification/validation;
- Any limitations of the verification/validation outcomes;
- date in which the validation statement has been issued;
- signature by the verifier(s).

8.5.3 Validity of the verification and validation report and the validation statement

A verification and validation report and a validation statement shall refer only to one specific EF report. The verification and validation report and a validation statement shall unambiguously identify the specific EF study under verification (e.g. by including the title, the commissioner of the EF study, the practitioner of the EF study, etc.), together with the explicit version of the final EF report to which the verification and validation report and a validation statement apply (e.g. by including the report date, the version number, etc.).

Both the verification and validation report and the validation statement shall be completed on the basis of the final EF report, after the implementation of all the corrective actions requested by the verifier(s). They shall be signed, physically or electronically, by the verifier(s).

The maximum validity of the verification and validation report and of the validation statement shall not exceed three years starting from their first issue date.

During the validity period of the verification, surveillance follow up shall be agreed between the commissioner of the EF study and the verifier(s) in order to evaluate if the content is still consistent with the current situation (the suggested periodicity for this follow up is once per year).

The periodic checks shall focus on the parameters that according to the verifiers might lead to relevant changes in the results of the EF study. A non-exhaustive list of such parameters is:

- bill of material/ bill of components;
- energy mix used for processes in situation 1;
- change of packaging;
- changes in the suppliers (materials/geography);
- changes in the logistics;
- relevant technological changes in the processes in situation 1.

At the time of the periodic check the reasons for non-disclosure of information shold also be reconsidered. The surveillance verification may be organised as a documental check and/or through on-site inspections. Regardless of the validity, the EF study (and consequently the EF report) shall be updated during the surveillance period if one of the impact categories indicators communicated has worsened by more than 10.0% compared with the verified data, or if the total aggregated score has worsened by more than 5.0% compared with the verified data.
If these changes impact also in the communication content, they shall be updated accordingly.

9 References

ANIA and ADEME. (2012). Projet de référentiel transversal d'évaluation de l'impact environnemental des produits alimentaires (mainly annexe 4) (« GT1 »), 23/04/12.

Årsrapport (2013). Dansk retursystem.

Beck, T., Bos, U., Wittstock, B., Baitz, M., Fischer, M., Sedlbauer, K. (2010). 'LANCA Land Use Indicator Value Calculation in Life Cycle Assessment – Method Report', Fraunhofer Institute for Building Physics.

Bos U., Horn R., Beck T., Lindner J.P., Fischer M. (2016). LANCA® - Characterisation Factors for Life Cycle Impact Assessment, Version 2.0, 978-3-8396-0953-8Fraunhofer Verlag, Stuttgart.

Boucher, O., P. Friedlingstein, B. Collins, and K. P. Shine, (2009). The indirect global warming potential and global temperature change potential due to methane oxidation. Environ. Res. Lett., 4, 044007.

BSI (2011). PAS 2050:2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. London, British Standards Institution.

BSI (2012). PAS 2050-1:2012. Assessment of life cycle greenhouse gas emissions from horticultural products - Supplementary requirements for the cradle to gate stages of GHG assessments of horticultural products undertaken in accordance with PAS 2050. London, British Standards Institution.

CEPI (2008). European Recovered Paper Identification System.

Decision 529/2013/EU. European Parliament and the Council: "Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities." Official Journal of the European Union: L 165/180 - 197.

Deloitte (2014). Trippage rates and transportation distances in the beverage industry. Commissioned by the Federation of German Food and Drink Industries and the Association of German Retailers.

Dreicer, M., Tort, V., Manen, P. (1995). ExternE, Externalities of Energy, Vol. 5 Nuclear, Centr d'étude sur l'Evaluation de la Protection dans le domaine nucléaire (CEPN), edited by the European Commission DGXII, Science, Research and development JOULE, Luxembourg.

EC-JRC, (2017a). Environmental footprint characterisation factors. Available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

EC-JRC, (2017b). Life cycle impact assessment methods and characterisation factors for Environmental Footprint. Technical details on the characterisation factors implementation. JRC technical report, forthcoming

EN standard (2007). 15343:2007: Plastics — Recycled Plastics — Plastics recycling traceability and assessment of conformity and recycled content.

European Commission - Joint Research Centre - Institute for Environment and Sustainability (2010-2016). "International Reference Life Cycle Data System (ILCD) handbook." Retrieved 17 Oct 2016, 2016, from http://eplca.jrc.ec.europa.eu/?page_id=140. ILCD

European Commission (2012). Regulation no 1179/2012: Establishing criteria determining when glass cullet ceases to be waste under Directive 2008/98/EC of the European Parliament and of the Council.

European Commission (2013). "Annex II: Product Environmental Footprint (PEF) Guide in Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (2013/179/EU)." Official Journal of the European Union 56(L 124): 6-106.

Fantke, P., Evans, J., Hodas, N., Apte, J., Jantunen, M., Jolliet, O., McKone, T.E. (2016). Health impacts of fine particulate matter. In: Frischknecht, R., Jolliet, O. (Eds.), Global Guidance for Life Cycle Impact Assessment Indicators: Volume 1. UNEP/SETAC Life Cycle Initiative, Paris, pp. 76-99. Retrieved Jan 2017 from www.lifecycleinitiative.org/applying-lca/lcia-cf/.

Frischknecht, R., Braunschweig, A., Hofstetter P., Suter P. (2000), Modelling human health effects of radioactive releases in Life Cycle Impact Assessment. Environmental Impact Assessment Review, 20 (2) pp. 159-189.

Guinée, J.B. (Ed.), Gorrée, M., Heijungs, R., Huppes, G., Kleijn, R., de Koning, A., Van Oers, L., Wegener Sleeswijk, A., Suh, S.,. Udo de Haes, H.A, De Bruijn, J.A., Van Duin R., Huijbregts, M.A.J. (2002). Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards. Series: Eco-efficiency in industry and science. Kluwer Academic Publishers. Dordrecht (Hardbound, ISBN 1-4020-0228-9; Paperback, ISBN 1-4020-0557-1).

IPCC (2013). IPCC Climate Change Fifth Assessment Report: Climate Change 2013. http://www.ipcc.ch/ipccreports/assessments-reports.htm

IPCC (2006). Guidelines for National Greenhouse Gas Inventories.

IPCC (2007). Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn,G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (2013). Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forc-ing. In: Climate Change 2013: The Physical Science Basis.

Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Nederlands Instituut voor Bouwbiologie en Ecologie (2014). Vergelijkend LCA onderzoek houten en kunststof pallets.

Palandre et al. (2003). Estimation of the world-wide fleets of refrigerating and air-conditioning equipment in order to determine forecasts of refrigerant emissions.

PERIFEM and ADEME "Guide sectorial 2014: Réalisation d'un bilan des emissions de gaz à effet de serre pour distribution et commerce de detail".

Posch, M., Seppälä, J., Hettelingh, J.P., Johansson, M., Margni M., Jolliet, O. (2008). The role of atmospheric dispersion models and ecosystem sensitivity in the determination of characterisation factors for acidifying and eutrophying emissions in LCIA. International Journal of Life Cycle Assessment (13) pp.477–486

Rosenbaum, R.K., Anton, A., Bengoa, X. et al. 2015. The Glasgow consensus on the delineation between pesticide emission inventory and impact assessment for LCA. International Journal of Life Cycle Assessment, 20: 765).

Rosenbaum, R.K., Bachmann, T.M., Gold, L.S., Huijbregts, M.A.J., Jolliet, O., Juraske, R., Köhler, A., Larsen, H.F., MacLeod, M., Margni, M., McKone, T.E., Payet, J., Schuhmacher, M., van de Meent, D., Hauschild, M.Z. (2008): USEtox - The UNEPSETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in Life Cycle Impact Assessment. International Journal of Life Cycle Assessment, 13(7): 532-546, 2008

Seppälä, J., Posch, M., Johansson, M., Hettelingh, J.P. (2006). Country-dependent Characterisation Factors for Acidification and Terrestrial Eutrophication Based on Accumulated Exceedance as an Impact Category Indicator. International Journal of Life Cycle Assessment 11(6): 403-416

Struijs, J., Beusen, A., van Jaarsveld, H. and Huijbregts, M.A.J. (2009). Aquatic Eutrophication. Chapter 6 in: Goedkoop, M., Heijungs, R., Huijbregts, M.A.J., De Schryver, A., Struijs, J., Van Zelm, R. (2009). ReCiPe 2008 A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Report I: Characterisation factors, first edition.

Tassou, S.A., De-Lille, G., and Ge, Y.T. (2009). Food transport refrigeration – Approaches to reduce energy consumption and environmental impacts of road transport. Applied Thermal Engineering, 29, 1467-1477.

UNEP (2016) Global guidance for life cycle impact assessment indicators. Volume 1. ISBN: 978-92-807-3630-4. Available at: http://www.lifecycleinitiative.org/life-cycle-impact-assessment-indicators-and-characterization-factors/

van Oers L, de Koning A, Guinee JB, Huppes G (2002). Abiotic Resource Depletion in LCA. Road and Hydraulic Engineering Institute, Ministry of Transport and Water, Amsterdam

Van Zelm, R., Huijbregts, M.A.J., Den Hollander, H.A., Van Jaarsveld, H.A., Sauter, F.J., Struijs, J., Van Wijnen, H.J., Van de Meent, D. (2008). European characterizationfactors for human health damage of PM10 and ozone in life cycle impact assessment. Atmospheric Environment 42, 441-453

WMO (1999). Scientific Assessment of Ozone Depletion: 1998. Global Ozone Research and Monitoring Project - Report No. 44, ISBN 92-807-1722-7, Geneva

Annex A – List of EF impact categories, normalisation and weighting factors

List of recommended models at midpoint, together with their indicator, unit and source. In red text: the differences compared to the PEF guide (2013)

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
Climate change[83]	Radiative forcing as Global Warming Potential (GWP100)	kg $CO_{2\ eq}$	Baseline model of 100 years of the IPCC (based on IPCC 2013)	EC-JRC, 2017[84]	I
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	Steady-state ODPs as in (WMO 1999)	EC-JRC, 2017	I
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Human toxicity, non- cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Particulate matter	Impact on human health	disease incidence	PM method recomended by UNEP (UNEP 2016)	EC-JRC, 2017	I
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)	EC-JRC, 2017	II
Photochemical ozone formation,	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van	EC-JRC, 2017	II

[83] Three additional sub-indicators may be requested for reporting, depending on the PEFCR. The sub-indicators are further described in section 7.9.

[84] The full list of characterization factors (EC-JRC, 2017a) is available at this link http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
human health			Zelm et al, 2008) as implemented in ReCiPe 2008		
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	fresh water: kg P $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	fresh water: kg N $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Ecotoxicity, freshwater*	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	USEtox model, (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Land use	• Soil quality index[85] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production • kg soil • m^3 water • m3 groundwater/	• Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	EC-JRC, 2017	III
Water use#	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq}$	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	EC-JRC, 2017	III
Resource use, minerals and	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	CML 2002 (Guinée et al.,		III

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

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness**
metals			2002) and van Oers et al. 2002.		
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[86]	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	EC-JRC, 2017	III

*Long-term emissions (occurring beyond 100 years) are 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 might be overestimated and shall therefore be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR/OEFSR 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, but occurred during the technical development of some of the datasets. The PEFCR/OEFSR 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/OEFSR accordingly, if seen necessary.*

The full list of characterization factors (EC-JRC, 2017a) is available at this link
http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

Global normalisation factors for Environmental Footprint

Impact category	Model	Unit	global NFs for PEF	Person NF for PEF	Robustness of ILCD for the PEF impact assessment	Inventory coverage completeness	Inventory robustness	Comment
Climate change	IPCC, 2013	kg $CO_{2\ eq}$	5.35E+13	7.76E+03	I	II	I	
Ozone depletion	World Metereological Organisation (WMO), 1999	kg CFC-11 $_{eq}$	1.61E+08	2.34E-02	I	III	II	

[86] In the ILCD flow list, and for the current recommendation, Uranium is included in the list of energy carriers, and it is measured in MJ.

Human toxicity, cancer	USEtox (Rosenbaum et al., 2008)	CTUh	2.66E+05	3.85E-05	II/III	III	III	
Human toxicity, non-cancer	USEtox (Rosenbaum et al., 2008)	CTUh	3.27E+06	4.75E-04	II/III	III	III	
Particulate matter	UNEP, 2016	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	Frischknecht et al., 2000	kBq U^{235}-eq	2.91E+13	4.22E+03	II	II	III	
Photochemical ozone formation, human health	Van Zelm et al., 2008, as applied in ReCiPe, 2008	kg NMVOC eq	2.80E+11	4.06E+01	II	III	I/II	
Acidification	Posch et al., 2008	mol H+ eq	3.83E+11	5.55E+01	II	II	I/II	
Eutrophication, terrestrial	Posch et al., 2008	mol N eq	1.22E+12	1.77E+02	II	II	I/II	
Eutrophication, freshwater	Struijs et al., 2009	kg P eq	1.76E+10	2.55E+00	II	II	III	
Eutrophication, marine	Struijs et al., 2009	kg N eq	1.95E+11	2.83E+01	II	II	II/III	
Land use	Bos et al., 2016 (based on)	pt	9.20E+15	1.33E+06	III	II	I I	The NF is built by means of regionalised CFs.
Ecotoxicity, freshwater	USEtox (Rosenbaum et al., 2008)	CTUe	8.15E+13	1.18E+04	II/III	III	III	
Water use	AWARE 100 (based on; UNEP, 2016)	m^3 world eq	7.91E+13	1.15E+04	III	I	II	The NF is built by means of regionalise

								d CFs.
Resource use, fossils	ADP fossils (van Oers et al., 2002)	MJ	4.50E+14	6.53E+04	III	I	II	
Resource use, minerals and metals	ADP ultimate reserve (van Oers et al., 2002)	kg Sb $_{eq}$	3.99E+08	5.79E-02	III			

4175

4176 # Weighting factors for Environmental Footprint

WITH TOX CATEGORIES (not applied in pilot phase)	Aggregated weighting set (50:50)	Robustness factors (scale 1-0.1)	Calculation	**Final weighting factors**
	A	B	C=A*B	C scaled to 100
Climate change	12.9	0.87	11.18	**21.06**
Ozone depletion	5.58	0.6	3.35	**6.31**
Human toxicity, cancer	6.8	0.17	1.13	**2.13**
Human toxicity, non-cancer	5.88	0.17	0.98	**1.84**
Particulate matter	5.49	0.87	4.76	**8.96**
Ionizing radiation, human health	5.7	0.47	2.66	**5.01**
Photochemical ozone formation, human health	4.76	0.53	2.54	**4.78**
Acidification	4.94	0.67	3.29	**6.2**
Eutrophication, terrestrial	2.95	0.67	1.97	**3.71**
Eutrophication, freshwater	3.19	0.47	1.49	**2.8**
Eutrophication, marine	2.94	0.53	1.57	**2.96**
Ecotoxicity, freshwater	6.12	0.17	1.02	**1.92**
Land use	9.04	0.47	4.22	**7.94**
Water use	9.69	0.47	4.52	**8.51**
Resource use, minerals and metals	6.68	0.6	4.01	**7.55**
Resource use, fossils	7.37	0.6	4.42	**8.32**

WITHOUT TOX CATEGORIES (applied in the pilot phase)	Aggregated weighting set (50:50)	Robustness factors (scale 1-0.1)	Calculation	**Final weighting factors**
	A	B	C=A*B	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**

Annex B - PEFCR TEMPLATE

Note: the text included in *italics* in each section shall not be modified when drafting the PEFCR, except for references to tables, figures and equations. References shall be revised and linked correctly. Further text may be added if relevant.

The text included in [] are instructions for the PEFCR developers.

The order of sections and their titles shall not be modified.

[The first page shall include at least the following information:

- The product category for which the PEFCR is valid
- Version number
- Date of publication
- Time validity (31st December 2020)]

Table of contents

Acronyms

[List in this section all the acronyms used in the PEFCR. Those already included in the latest version of the PEF Guide or the PEFCR Guidance shall be copied in their original form. The acronyms shall be provided in alphabetical order.]

Definitions

[List in this section all the definitions that are relevant for the PEFCR. Those already included in the latest version of the PEF Guide or the PEFCR Guidance shall be copied in their original form. The definitions shall be provided in alphabetical order.]

B.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 B.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 could 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.*

B.2 General information about the PEFCR

B.2.1 Technical secretariat

[The list of the organizations in the TS at the time of final vote shall be provided. For each one, the type of organization shall be reported (industry, academia, NGO, consultant, etc), as well as the starting date of participation. The TS may decide to include also the names of the members of the persons involved for each organization]

Name of the organization	*Type of organization*	*Name of the members (not mandatory)*

B.2.2 Consultations and stakeholders

[For each public consultation the following information shall be provided:

- Opening and closing date of the public consultation
- Number of comments received
- Names of organizations that have provided comments
- Link to the wiki page]

B.2.3 Review panel and review requirements of the PEFCR

[This section shall include the names and affiliations of the members of the review panel. The member that is chairing the review panel shall be identified.]

Name of the member	***Affiliation***	***Role***

Name of the member	*Affiliation*	*Role*

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

- *The PEFCR has been developed in accordance with the requirement provided in the PEFCR Guidance* [indicate the version the PEFCR is in conformance with]*, 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* [indicate the version the PEFCR is in conformance with] *and the most recent approved version of the PEF Guide,*
- *The benchmark(s) is(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 TS may add additional review criteria as appropriate]

The detailed review report is provided in Annex 3 of this PEFCR.

B.2.4 Review statement

This PEFCR has been developed in compliance with Version [indicate the version the PEFCR is in conformance with] *of the PEFCR Guidance, and with the PEF Guide adopted by the Commission on* [indicate the date of approval of the latest version available].

The representative product(s) correctly describe the average product(s) sold in Europe for the product group in scope of this PEFCR.

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 (see chapter on limitations). [the last part of this statement shall be deleted in case the PEFCR is for intermediate product(s)].

[The review statement shall be completed by the reviewer.]

B.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 consumed/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.

B.2.6 Language

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

B.2.7 Conformance to other documents

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

PEFCR Guidance [add the version of the Guidance the PEFCR is in conformance with]*"*

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

[The PEFCR shall list additional documents, if any, with which the PEFCR is in conformance with.]

B.3 PEFCR scope

[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]

B.3.1 Product classification

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

[Based on the product category, provide the corresponding Classification of Products by Activity (CPA) (minimum two-digit, based on the latest CPA list version available). Where multiple production routes for similar products are defined using alternative CPAs, the PEFCR shall accommodate all such CPAs. Identify the sub-categories not covered by the CPA, if any]

B.3.2 Representative product(s)

[The PEFCR shall include a description of the representative product(s) and how it has been derived].

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.

B.3.3 Functional unit and reference flow

The FU is … [to be filled in]. *Table B. 1defines the key aspects used to define the FU.*

Table B. 1. *Key aspects of the FU*

What?	[to be filled in. Note that in case the PEFCR uses the term 'inedible parts' a definition shall be provided by the TS]
How much?	[to be filled in]
How well?	[For food products only, it might include the following statement: *This aspect could not be incorporated so far. This limitation is recognized and requires further developments in order to improve fair comparisons*.] [for non-food product: describe how well, if possible.]
How long?	[to be filled in]

The reference flow is the amount of product needed to fulfil the defined function and shall be measured in … [fill in the units]. *All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.*

[The PEFCR shall describe how the appropriate reference flow shall be determined/calculated. In case calculation parameters are needed, the PEFCR shall provide default values or shall request these parameters in the list of mandatory company-specific information. A calculation example shall be provided.]

B.3.4 System boundary

[This section shall include a system diagram clearly indicating the processes and life cycle stages that are included in the product system. The diagram shall include an indication of the processes for which company-specific data are required.]

The following life cycle stages and processes shall be included in the system boundary:

Table B. 2. Life cycle stages

Life cycle stage	*Short description of the processes included*

According to this PEFCR, the following processes may be excluded based on the cut-off rule: [include the list of processes that shall be excluded based on the cut off rule] OR *According to this PEFCR, no cut-off is applicable*.

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.

B.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 below. [The TS shall indicate in the table if the sub-categories for climate change shall be calculated separately.

Table B. 3. List of the impact categories to be used to calculate the PEF profile

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 [strikethrough if not to be reported upon]			
- Climate change – land use and land transformation [strikethrough if not to be reported upon]			
Ozone depletion	*Ozone Depletion Potential (ODP)*	*kg CFC-11 $_{eq}$*	*Steady-state ODPs 1999 as in WMO assessment*

Impact category	***Indicator***	***Unit***	***Recommended default LCIA method***
*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*[87] • *Biotic production* • *Erosion resistance* • *Mechanical filtration* • *Groundwater replenishment*	• *Dimensionless (pt)* • *kg biotic production*[88] • *kg soil* • *m^3 water* • *m3 groundwater*	• *Soil quality index based on LANCA (EC-JRC)*[89] • *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*

*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.

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

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

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

#*The results for water use might be overestimated and shall therefore be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR/OEFSR 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, but occurred during the technical development of some of the datasets. The PEFCR/OEFSR 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/OEFSR accordingly, if seen necessary.*

The full list 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

B.3.6 Limitations

[This section shall include the list of limitations a PEF study will have even if carried out in accordance with this PEFCR. It shall also include the conditions under which a comparison or comparative assertion may be made].

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

[In case the PEFCR has no sub-categories] *The most relevant impact categories for the product group in scope of this PEFCR are the following*:

[In case the PEFCR has multiple sub-categories, per sub-category] *The most relevant impact categories for the sub-category [name] in scope of this PEFCR are the following*:

- [list the most relevant impact categories per sub-category if appropriate. If climate change is selected as a relevant impact category, the PEFCR shall (i) always request to report the total climate change as the sum of the three sub-indicators, and (ii) for the sub-indicators 'Climate change - biogenic' and 'Climate change - land use and land transformation', request separate reporting for those contributing more than 5% each to the total score. A footnote shall be added, explaining why or why not the two sub-indicators shall be (i) or not be (ii) reported separately:]

  (i)The sub-indicators 'Climate change - biogenic' and 'Climate change - land use and land transformation' shall be reported separately because their contribution to the total climate change impact, based on the benchmark results, is more than 5% each.

  (ii)The sub-indicators 'Climate change - biogenic' and 'Climate change - land use and land transformation' shall not be reported separately because their contribution to the total climate change impact, based on the benchmark results, is less than 5% each.

[In case the PEFCR has no sub-categories] *The most relevant life cycle stages for the product group in scope of this PEFCR are the following:*

[In case the PEFCR has multiple sub-categories] *The most relevant life cycle stages for the sub-cateogyr [name] in scope of this PEFCR are the following:*

- [list the most relevant life cycle stages per sub-category]

The most relevant processes for the product group in scope of this PEFCR are the following [this Table shall be filled in based on the final results of the representative product(s). Provide one table per sub-category, if appropriate.]

Table B. 4. List of the most relevant processes

Impact category	***Processes***
Most relevant impact category 1	· Process A (from life cycle stage X)
	· Process B (from life cycle stage Y)
Most relevant impact category 2	· Process A (from life cycle stage X)
	· Process B (from life cycle stage X)
Most relevant impact category n	· Process A (from life cycle stage X)
	· Process B (from life cycle stage X)

B.5 Life cycle inventory

All newly created processes shall be EF-compliant, as defined in the PEFCR guidance this document is conform with.

[The PEFCR shall indicate if sampling is allowed. If the TS allows sampling, the PEFCR shall describe the sampling procedure as described in the guidance and contain a sentence like:] *In case sampling is needed, it shall be conducted as specified in this PEFCR. However, sampling is not mandatory and any applicant of this PEFCR may decide to collect the data from all the plants or farms, without performing any sampling.*

B.5.1 List of mandatory company-specific data

[The TS shall here indicate the list of mandatory company-specific activity data and list the processes to be modelled with company specific data]

Process a

[Provide a short description of process a. List all the activity and foreground elementary flows that shall be collected and the sub-processes linked to the activity data within process a. Use the table below to

introduce minimum one example in the PEFCR. In case not all processes are introduced here, the full list of all processes shall be include in an excel file.]

Data collection requirements for mandatory process A

Requirements for data collection purposes			**Requirements for modelling purposes**								**Remarks**
Activity data to be collected	*Specific requirements (e.g. frequency, measurement standard, etc)*	*Unit of measure*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	*TiR*	*TeR*	*GR*	*P*	*DQR*	
Inputs:											
[Example: yearly electricity use]	[Example: 3 year average]	[Example: kWh/year]	[Example: Electricity grid mix 1kV-60kV/AT]	[Example: http://lcdn.thinkstep.com/Node/]	[Example: 0af0a6a8-aebc-4eeb-99f8-5ccf2304b99d]	[Example: 1.6]					
Outputs:											
…	…	…	…	…	…	…					

[List all the emissions and resources that shall be modelled with company-specific information within process a.]

Direct elementary flow collection requirements for mandatory process A

Emissions/resources	**Elementary flow**	**Frequency of measurement**	**Default measurement method[90]**	**Remarks**

[90] Unless specific measurement methods are foreseen in a country specific legislation

See excel file named "[Name PEFCR_version number] - *Life cycle inventory" for the list of all company-specific data to be collected, downloadable at*:
http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm.

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

The following processes are expected to be run by the company applying the PEFCR:

- *Process X*
- *Process Y*
- *…*

Process X:

[Provide a short description of process x. List all the activity data and direct elementary flows that shall be collected and the sub-processes linked to the activity data within process X. Use the table below to introduce minimum one example in the PEFCR. In case not all processes are introduced here, the full list of all processes shall be include in an excel file.]

Data collection requirements for process X:

Requirements for data collection purposes			**Requirements for modelling purposes**								**Remarks**
Activity data to be collected	*Specific requirements (e.g. frequency, measurement standard, etc)*	*Unit of measure*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	*TiR*	*GR*	*TeR*	*P*	*DQR*	
Inputs:											
[Example: yearly electricity use]	[Example: 3 year average]	[Example: kWh/year]	[Example: Electricity grid mix 1kV-60kV/AT]	[Example: http://lcdn.thinkstep.com/Node/]	[Example: 0af0a6a8-aebc-4eeb-99f8-5ccf2304b99d]	[Example: 1.6]					
Outputs:											
…	…	…	…	…	…	…					

Direct elementary flow collection requirements for process X

Emissions/resources	Elementary flow	Frequency of measurement	Default measurement method[91]	Remarks

See excel file named "[Name PEFCR_version number] - *Life cycle inventory" for the list of all processes to be expected in situation 1, downloadable at* http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm.

B.5.3 Data gaps

[This section shall include:

- The list of data gaps on the company-specific data to be collected that most frequently are encountered by companies in the specific sectors and how these data gaps may be solved in the context of the PEF;
- The list of data gaps in default datasets listed in the PEFCR;
- The list of processes excluded from the PEFCR due to missing datasets that shall not be filled in by the applicant;
- The of processes for which proxies are to be used by PEF studies.

The TS may decide to indicate in the LCI excel file for which processes no datasets are available and therefore are considered data gaps and for which processes proxies are to be used]

B.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:

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\overline{P}}{4} \qquad \textit{[Equation B.1]}$$

where TeR is the Technological-Representativeness, GR is the Geographical-Representativeness, TiR is the Time-Representativeness, and 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.

[91] Unless specific measurement methods are foreseen in a country specific legislation

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.

[The PEFCR may specify more stringent data quality requirements and specify additional criteria for the assessment of data quality.]

B.5.4.1 Company-specific datasets

The score of criterion P cannot be higher than 3 while the score for TiR, TeR, and GR 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 TeR, TiR, GR 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 B.5.

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} in Table B.5. 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 the total DQR of the newly developed dataset using the equation B.2, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \bar{P}$ are the weighted average calculated as specified in point 4).

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\bar{P}}{4} \qquad \textit{[Equation B.2]}$$

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.*

Table B.5. How to assess the value of the DQR criteria for datasets with company-specific information

[Please, note that the reference years for criterion TiR in the table B.7 may be adapted by the TS]

[Please, note that more than one table may be included in the PEFCR].

	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ 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}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
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*

B.5.5 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific (listed in section B.5.1) shall be evaluated using the Data Needs Matrix (see Table B.6). 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.*

Table B. 6. Data Needs Matrix (DNM)[92]. *Disaggregated datasets shall be used.

[92] The options described in the DNM are not listed in order of preference

		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 criteria + 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

B.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 B.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.

B.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[93] (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 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 B.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.

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

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(s) provided. The criteria G_R shall be lowered by 30%[94] 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.

Table B.7. How to assess the value of the DQR criteria when secondary datasets are used.

[More than one table may be included in the PEFCR and entered in the section on life cycle stages]

	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*

B.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:

[94] 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.

- *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.

B.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*
- *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.*

B.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 TeR, TiR, GR 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 chapter B.5.4 shall be used.

B.5.8 Allocation rules

[The PEFCR shall report which allocation rules shall be used by PEF studies and how the modelling/calculations shall be made. In case of economic allocation is used, the allocation factors shall be fixed and provided in the PEFCR. The following template shall be used:]

Table B. 8. ***Allocation rules***

Process	***Allocation rule***	***Modelling instructions***
[Example: Process A]	[Example: Physical allocation]	[Example: The mass of the different outputs shall be used. …]
…	…	

B.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 1of 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.*

[The TS may provide more information following the guidance]

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 B.5.8. 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 PEFCR shall report which physical relationship shall be used by PEF studies: (i) to subdivide the electricity consumption among multiple products for each process (e.g. mass, number of pieces, volume…) and (ii) to reflect the ratios of production/ratios of sales between EU countries/regions when a product is produced in different locations or sold in different countries. Where such data are not available, the average EU mix (EU-28 +EFTA), or region representative mix, shall be used. The following template shall be used:]

Table B. 9. *Allocation rules for electricity.*

Process	***Physical relationship***	***Modelling instructions***
Process A	*Mass*	
Process B	*N of pieces*	
…	*…*	

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:

a. 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.

d. 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.

e. 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[95].*
- *Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.*

B.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*

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

exchanges from native forests[96] shall be modelled under sub-category 3 (incl. 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: [to be answered by the TS: Yes/No] [If yes, the following text shall be included in the PEFCR: "*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."*] [If no, the following text shall be included: "*All biogenic carbon emissions and removals shall be modelled separately. However, note that the corresponding characterisation factors for biogenic CO_2 uptakes and emissions within the EF impact assessment method are set to zero.*" [The PEFCR shall provide complementary characterisation factors to be applied in case these flows are to be used to calculate additional environmental information and shall describe how the additional environmental information shall be calculated.]

[For final products only:]

Does the product life cycle or part of the life cycle has a carbon storage beyond 100 years and therefore credits from biogenic carbon storage shall be modelled: [to be answered by the TS: Yes/No] [If yes, the following text shall be included: "*Carbon credits shall be modelled by including an emission uptake as 'resource from air' using the elementary flow 'carbon dioxide (biogenic-100yr)'. Carbon credits shall be properly allocated among the different byproducts the system delivered over the full timeframe (see respective chapters for more information).*" The PEFCR shall specify which proof needs to be provided in order to get the credits.]

[For intermediate products only:]

The biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.

3. C*limate 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[97] 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

[96] 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.

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

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[98].

1) 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.

2) 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):

1. *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*

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

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);

2. *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);*
3. *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 be modelled, calculated and reported as additional environmental information: [to be answered by the TS: Yes/No] *[If yes, the PEFCR shall specify which proof needs to be provided and include the modelling rules.]*

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

The sub-category 'Climate change-biogenic' shall be reported separately: [to be answered by the TS: Yes/No]

The sub-category 'Climate change-land use and land transformation' shall be reported separately: [to be answered by the TS: Yes/No]

B.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 overall modelling of the life cycle of the organisation. Overall, this should 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.

[For final products:]

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

[For construction products:]

The Circular Footprint Formula is used to model the End-of-Life of products as well as the recycled content:

Production burdens	$(1 - R_1)E_V + R_1 \times E_{recycled}$	**Cradle-to-gate**
Burdens and benefits related to secondary materials input	$-(1 - A)R_1 \times \left(E_{recycled} - E_V \times \frac{Q_{Sin}}{Q_P}\right)$	
Burdens and benefits related to secondary materials output	$(1 - A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$	**Additional information from the EoL stage**
Energy recovery	$(1 - B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$	
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.*

[Within the respective chapters, the following parameters shall be provided in the PEFCR:

- all A values to be used shall be listed, together with a reference to the guidance and Annex C.
- all quality ratios to be used, those that are PEFCR specific and those used for packaging.
- default R1 values for all default material datasets (in case no company-specific values are available), together with a reference to the guidance and Annex C. They shall be set to 0% when no application-specific data is available.
- default R2 values to be used in case no company-specific values are available, together with a reference to the guidance and Annex C]

B.6 Life cycle stages

B.6.1 Raw material acquisition and pre-processing

[The PEFCR shall list all technical requirements and assumptions to be used by the applicant. Furthermore, it shall list all processes taking place in this life cycle stage (according to the model of the RP) according to the table provided below (transport in separate table). The Table may be adapted by the TS as appropriate.]

Table B. 10. ***Raw material acquisition and processing (capitals indicate those processes expected to be run by the company)***

Process name*	***Unit of measurement (output)***	***Default***				***UUID***	***Default DQR***				***Most relevant process [Y/N]***
		R_1	***Amount per FU***	***Dataset***	***Dataset source***		*P*	*TiR*	*GR*	*TeR*	

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

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

[Packaging should be modelled as part of the raw material acquisition stage of the life cycle.]

[PEFCRs that include the use of beverage cartons or bag-in-box packaging shall/should provide information on the amounts input materials (also called the bill of material) and state that these packagings shall/should be modelled by combining the prescribed amounts of the material datasets with the prescribed conversion dataset.]

[PEFCRs that include reusable packaging from third party operated pools shall provide default reuse rates. PEFCRs with company owned packaging pools shall specify that the reuse rate shall be calculated using supply-chain-specific data only. The two different modelling approaches as presented in the PEFCR guidance shall be used and copied in the PEFCR (see chapter 2). The PEFCR shall include the following: "*The raw material consumption of reusable packaging shall be calculated by dividing the actual weight of the packaging by the reuse rate."]*

[For the different ingredients transported from supplier to factory, the PEFCR applicant needs data on (i) transport mode, (ii) distance per transport mode, (iii) utilisation ratios for truck transport and (iv) empty return modelling for truck transport. The PEFCR shall provide default data for these or request these data in the list of mandatory company-specific information. The default values provided in the guidance shall be applied unless PEFCR-specific data is available. In case the guidance is not applied, the reasoning shall be clearly explained and justified. The table below shall be used.]

Table B. 11. ***Transport (capitals indicate those processes expected to be run by the company)***

Process name*	***Unit of measurement (output)***	***Default (per FU)***			***Default data set***	***Data set source***	***UUID***	***Default DQR***				***Most relevant [Y/N]***
		Distance	***Utilisation ratio****	***Empty return***				*P*	*TiR*	*GR*	*TeR*	

*The applicant of this PEFCR shall always check the utilisation ratio applied in the default dataset and adapt it accordingly.

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

[PEFCRs that include reusable packaging shall include the following: "*The reuse rate affects the quantity of transport that is needed per FU. The transport impact shall be calculated by dividing the one-way trip impact by the number of times this packaging is reused.*"]

Modelling the recycled content (if applicable)

[If applicable the following text shall be included:]

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 above, 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.*

[Industry systems can be applied as long as they cover the general guidelines outlined above. In that case, the text above can be replaced by those industry specific rules. If not, they shall be supplemented with the general guidelines above.]

[Default parameters for A , Q_{sin}/Q_p and $E_{recycled}$ shall be selected by the TS from Annex C, at the point of substitution and per application or material, and shall be listed in a table in this section.]

[For intermediate products only:]

The PEF profile shall be calculated and reported using A equal to 1.
Under additional technical information the results shall be reported for different applications with the following A values:

Application	***A value to be used***

[For intermediate construction products only:]

The PEF profile shall be calculated and reported using the following formula:

$$(1 - R_1)E_V + R_1 \times E_{recycled}$$

The profile of the "Burdens and benefits related to secondary materials input" shall be calculated and reported under 'additional technical information' using the following A value [fill in].

Burdens and benefits related to secondary materials input:

4961 $$-(1-A)R_1 \times \left(E_{recycled} - E_V \times \frac{Q_{Sin}}{Q_p}\right)$$

4962

4963 [The default A values to be used shall be provided in the PEFCR.]

4964 ### B.6.2 Agricultural modelling (to be included only if applicable)

4965 [In case agricultural production is part of the scope of the PEFCR the following text shall be included.
4966 Sections that are not relevant can be removed.]

4967 *Handling multi-functional processes: The rules described in the LEAP Guideline shall be followed:*
4968 *'Environmental performance of animal feeds supply chains (pages 36-43), FAO 2015, available at*
4969 *http://www.fao.org/partnerships/leap/publications/en/'.*

4970 *Use of crop type specific and country-region-or-climate specific data for yield, water and land use, land use*
4971 *change, fertiliser (artificial and organic) amount (N, P amount) and pesticide amount (per active*
4972 *ingredient), per hectare per year, if available.*

4973 *Cultivation data shall be collected over a period of time sufficient to provide an average assessment of the*
4974 *life cycle inventory associated with the inputs and outputs of cultivation that will offset fluctuations due to*
4975 *seasonal differences:*

4976 - *For annual crops, an assessment period of at least three years shall be used (to level out differences*
4977 *in crop yields related to fluctuations in growing conditions over the years such as climate, pests and*
4978 *diseases, et cetera). Where data covering a three-year period is not available i.e. due to starting up*
4979 *a new production system (e.g. new greenhouse, newly cleared land, shift to other crop), the*
4980 *assessment may be conducted over a shorter period, but shall be not less than 1 year. Crops/plants*
4981 *grown in greenhouses shall be considered as annual crops/plants, unless the cultivation cycle is*
4982 *significantly shorter than a year and another crop is cultivated consecutively within that year.*
4983 *Tomatoes, peppers and other crops which are cultivated and harvested over a longer period*
4984 *through the year are considered as annual crops.*
4985 - *For perennial plants (including entire plants and edible portions of perennial plants) a steady state*
4986 *situation (i.e. where all development stages are proportionally represented in the studied time*
4987 *period) shall be assumed and a three-year period shall be used to estimate the inputs and outputs*[99].

[99] The underlying assumption in the cradle to gate life cycle inventory assessment of horticultural products is that the inputs and outputs of the cultivation are in a 'steady state', which means that all development stages of perennial crops (with different quantities of inputs and outputs) shall be proportionally represented in the time period of cultivation that is studied. This approach gives the advantage that inputs and outputs of a relatively short period can be used for the calculation of the cradle-to-gate life cycle inventory from the perennial crop product. Studying all development stages of a horticultural perennial crop can have a lifespan of 30 years and more (e.g. in case of fruit and nut trees).

- *Where the different stages in the cultivation cycle are known to be disproportional, a correction shall be made by adjusting the crop areas allocated to different development stages in proportion to the crop areas expected in a theoretical steady state. The application of such correction shall be justified and recorded. The life cycle inventory of perennial plants and crops shall not be undertaken until the production system actually yields output.*
- *For crops that are grown and harvested in less than one year (e.g. lettuce produced in 2 to 4 months) data shall be gathered in relation to the specific time period for production of a single crop, from at least three recent consecutive cycles. Averaging over three years can best be done by first gathering annual data and calculating the life cycle inventory per year and then determine the three years average.*

Pesticide emissions shall be modelled as specific active ingredients. As default approach, the pesticides applied on the field shall be modelled as 90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water.

Fertiliser (and manure) emissions shall be differentiated per fertilizer type and cover as a minimum:

- *NH_3, to air (from N-fertiliser application)*
- *N_2O, to air (direct and indirect) (from N-fertiliser application)*
- *CO_2, to air (from lime, urea and urea-compounds application)*
- *NO_3, to water unspecified (leaching from N-fertiliser application)*
- *PO_4, to water unspecified or freshwater (leaching and run-off of soluble phosphate from P-fertiliser application)*
- *P, to water unspecified or freshwater (soil particles containing phosphorous, from P-fertiliser application).*

The LCI for P emissions should be modelled as the amount of P emitted to water after run-off and the emission compartment 'water' shall be used. When this amount is not available, the LCI may be modelled as the amount of P applied on the agricultural field (through manure or fertilisers) and the emission compartment 'soil' shall be used. In this case, the run-off from soil to water is part of the impact assessment method.

The LCI for N emissions shall be modelled as the amount of emissions after it leaves the field (soil) and ending up in the different air and water compartments per amount of fertilisers applied. N emissions to soil shall not be modelled. The nitrogen emissions shall be calculated from Nitrogen applications of the farmer on the field and excluding external sources (e.g. rain deposition).

[For nitrogen based fertilisers, the PEFCR shall describe the LCI model to be used. The Tier 1 emissions factors of IPCC 2006 should be used. A more comprehensive Nitrogen field model can be used by the PEFCR provided (i) it covers at least the emissions requested above, (ii) N is balanced in inputs and outputs and (iii) it is described in a transparent way.]

Table B. 12. Parameters to be used when modelling nitrogen emission in soil.

Emission	***Compartment***	***Value to be applied***
N_2O (synthetic fertiliser and manure; direct and indirect)	*Air*	*0.022 kg N_2O/ kg N fertilizer applied*
NH_3 (synthetic fertiliser)	*Air*	*kg NH_3= kg N * FracGASF= 1*0.1* (17/14)= 0.12 kg NH_3/ kg N fertilizer applied*
NH_3 (manure)	*Air*	*kg NH_3= kg N*FracGASF= 1*0.2* (17/14)= 0.24 kg NH_3/ kg N manure applied*
NO_3^- (synthetic fertiliser and manure)	*Water*	*kg NO_3^-= kg N*FracLEACH = 1*0.3*(62/14) = 1.33 kg NO_3^-/ kg N applied*
P based fertilisers	*Water*	*0.05 kg P/ kg P applied*

[For TS, note that the values provided shall not be used to compare different types of synthetic fertilizers. More detailed modelling shall be used for that.]

Heavy metal emissions from field inputs shall be modelled as emission to soil and/or leaching or erosion to water. The inventory to water shall specify the oxidation state of the metal (e.g., Cr+3, Cr+6). As crops assimilate part of the heavy metal emissions during their cultivation clarification is needed on how to model crops that act as a sink. The following modelling approach shall be used:

[The TS shall select one of the two modelling approaches to be used]

- *The final fate of the heavy metals elementary flows are not further considered within the system boundary: the inventory does not account for the final emissions of the heavy metals and therefore shall not account for the uptake of heavy metals by the crop. For example, heavy metals in agricultural crops cultivated for human consumption end up in the plant. Within the EF context human consumption is not modelled, the final fate is not further modelled and the plant acts as a heavy metal sink. Therefore, the uptake of heavy metals by the crop shall not be modelled.*
- *The final fate (emission compartment) of the heavy metal elementary flows is considered within the system boundary: the inventory does account for the final emissions (release) of the heavy metals in the environment and therefore shall also account for the uptake of heavy metals by the crop. For example, heavy metals in agricultural crops cultivated for feed will mainly end up in the animal digestion and used as manure back on the field where the metals are released in the environment and their impacts are captured by the impact assessment methods. Therefore the inventory of the*

agricultural stage shall account for the uptake of heavy metals by the crop. A limited amount ends up in the animal (= sink), which may be neglected for simplification.

Methane emissions from rice cultivation shall be included on basis of IPCC 2006 calculation rules.

Drained peat soils shall include carbon dioxide emissions on the basis of a model that relates the drainage levels to annual carbon oxidation.

The following activities shall be included [The TS shall select what shall be included following the PEFCR guidelines]:

- *Input of seed material (kg/ha)*
- *Input of peat to soil (kg/ha + C/N ratio)*
- *Input of lime (kg $CaCO_3$/ha, type)*
- *Machine use (hours, type) (to be included if there is high level of mechanisation)*
- *Input N from crop residues that stay on the field or are burned (kg residue + N content/ha)*
- *Crop yield (kg/ha)*
- *Drying and storage of products*
- *Field operations through …[to be filled in]*

B.6.3 Manufacturing

[The PEFCR shall list all technical requirements and assumptions to be used by the applicant. Furthermore, it shall list all processes taking place in this life cycle stage, according to the table provided below. The table may be adapted by the TS as appropriate.]

Table B. 13. ***Manufacturing (capitals indicate those processes expected to be run by the company)***

Name of the process*	***Unit of measurement (output)***	***Default amount per FU***	***Default dataset to be used***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant process [Y/N]***
						P	Ti_R	G_R	Te_R	

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

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

[PEFCRs that include reusable packaging shall account for the additional energy and resource used for cleaning, repairing or refilling.]

The waste of products used during the manufacturing shall be included in the modelling. [Default loss rates per type of product and how these shall be included in the reference flow shall be described.]

B.6.4 Distribution stage

The transport from factory to final client (including consumer transport) shall be modelled within this life cycle stage. The final client is defined as … [to be filled in]*.*

In case supply-chain-specific information is available for one or several transport parameters, they may be applied following the Data Needs Matrix.

[A default transport scenario shall be provided by the TS in the PEFCR. In case no PEFCR-specific transport scenario is available the transport scenario provided in the guidance shall be used as a basis together with (i) a number of PEFCR-specific ratios, (ii) PEFCR-specific utilisation ratios for truck transport, and (iii) PEFCR-specific allocation factor for consumer transport. For reusable products, the return transport from retail/DC to factory shall be added in the transport scenario. For cooled or frozen products, the default truck/van transport processes should be changed. The PEFCR shall list all processes taking place in scenario (according to the model of the RP) using the table below. The table may be adapted by the TS as appropriate]

Table B. 14. ***Distribution (capitals indicate those processes expected to be run by the company)***

Process name*	***Unit of measurement (output)***	***Default (per FU)***			***Default dataset***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant [Y/N]***
		Distance	***Utilisation ratio***	***Empty return***				*P*	*TiR*	*GR*	*TeR*	

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

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

The waste of products during the distribution and retail shall be included in the modelling. [Default loss rates per type of product and how these shall be included in the reference flow shall be described. The PEFCR shall follow the guidance Annex F in case no PEFCR-specific information is available.]

B.6.5 Use stage [to be included if applicable]

[The PEFCR shall provide a clear description of the use stage and list all processes taking place (according to the model of the RP) according to the table provided below. The table may be adapted by the TS as appropriate]

Table B. 15. Use stage *(capitals indicate those processes expected to be run by the company)*

Name of the process*	***Unit of measurement (output)***	***Default amount per FU***	***Default dataset to be used***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant process [Y/N]***
						P	*TiR*	*GR*	*TeR*	

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

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

[In this section the PEFCR shall also list all technical requirements and assumptions to be used by the applicant. The PEFCR shall state if a delta approach is used for certain processes. In case the Delta approach is used, the PEFCR shall state the minimum consumption (reference) to be used when calculating the additional consumption allocated to the product.]

For the use stage the consumption grid 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 mix (EU-28 +EFTA), or region representative consumption mix, shall be used.

The waste of products during the use stage shall be included in the modelling. [Default loss rates per type of product and how these shall be included in the reference flow shall be described. The PEFCR shall follow the guidance Annex F in case no PEFCR-specific information is available.]

B.6.6 End of life [to be included if applicable]

The End-of-Life stage is a life cycle stage that in general includes the waste of the product in scope, such as the food waste, primary packaging, or the product left at its end of use.

[The PEFCR shall list all technical requirements and assumptions to be used by the applicant. Furthermore, it shall list all processes taking place in this life cycle stage (according to the model of the RP) according to the table provided below. The table may be adapted by the TS as appropriate. Please note that the transport from collection place to EOL treatment is included in the landfill, incineration and recycling datasets tendered by the EC. However, there might be some cases, where additional default transport data is needed and thus shall be included here. The guidance provide default values to be used in case no better data is available.]

Table B. 16. ***End of Life (capitals indicate those processes expected to be run by the company)***

Name of the process*	***Unit of measurement (output)***	***Default amount per FU***	***Default dataset to be used***	***Dataset source***	***UUID***	***Default DQR***				***Most relevant process [Y/N]***
						P	Ti_R	G_R	Te_R	

[Please write in CAPITAL LETTERS the name of those processes expected to be run by the company]

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 formula and guidance provided in chapter 'End of life modelling' of this PEFCR together with the default parameters listed in the table below.

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 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[100]*.*

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 below,

- *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.

[The PEFCR shall list in a table all the parameters to be used by the applicant to implement the CFF, distinguishing between those who have a fixed value (to be provided in the same Table; from the guidance or PEFCR-specific) and those who are PEF study-specific (including R_2, A, $E_{recyclingEOL}$, …). Furthermore, the PEFCR shall include additional modelling rules derived from the guidance if applicable (e.g., on packaging). Within this table, the B value shall be equal to 0 as default.]

[PEFCRs that include reusable packaging shall include the following*: "The reuse rate determines the quantity of packaging material (per product sold) to be treated at end of life. The amount of packaging treated at end of life shall be calculated by dividing the actual weight of the packaging by the number of times this packaging was reused."*]

B.7 PEF results

B.7.1 Benchmark values

[Here the TS shall report the results of the benchmark for each representative product. The results shall be provided characterised, normalised, and weighted (as absolute values), each in a different table, according to the template provided below]

***Table* [introduce number of table]** - *Characterised benchmark values for* [introduce name of the representative product]

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

Impact category	Unit	Life cycle excl. use stage	Use stage
Climate change, total	kg $CO_{2\ eq}$		
Climate change - biogenic			
Climate change – land use and land transformation			
Ozone depletion	kg CFC-11 $_{eq}$		
Particulate matter	disease incidence		
Ionising radiation, human health	kBq U^{235} $_{eq}$		
Photochemical ozone formation, human health	kg NMVOC $_{eq}$		
Acidification	mol $H+$ $_{eq}$		
Eutrophication, terrestrial	mol N $_{eq}$		
Eutrophication, freshwater	kg P $_{eq}$		
Eutrophication, marine	kg N $_{eq}$		
Land use	Dimensionless (pt)		
Water use	m^3 world $_{eq}$		
Resource use, minerals and metals	kg Sb $_{eq}$		
Resource use, fossils	MJ		

***Table* [introduce number of table]** - *Normalised benchmark values for* [introduce name of the representative product]

Impact category	Life cycle excl. use stage	Use stage
Climate change, total		
Ozone depletion		
Particulate matter		
Ionising radiation, human health		
Photochemical ozone formation, human health		
Acidification		
Eutrophication, terrestrial		
Eutrophication, freshwater		
Eutrophication, marine		
Land use		
Water use		
Resource use, minerals and metals		
Resource use, fossils		

***Table* [introduce number of table]** - *Weighted benchmark values for* [introduce name of the representative product]

Impact category	Life cycle excl. use stage	Use stage
Climate change, total		
Ozone depletion		
Particulate matter		
Ionising radiation, human health		
Photochemical ozone formation, human health		
Acidification		
Eutrophication, terrestrial		
Eutrophication, freshwater		
Eutrophication, marine		
Land use		
Water use		
Resource use, minerals and metals		
Resource use, fossils		
Total result		

B.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.

B.7.3 Additional technical information

[The TS shall list the additional technical information to be reported]:

-

[For Intermediate products:]

- *The biogenic carbon content at factory gate (physical content and allocated content) shall be reported. If derived from native forest, it shall report that the corresponding carbon emissions shall be modelled with the elementary flow '(land use change)'.*
- *The recycled content (R1) shall be reported.*

- *Results with application-specific A-values, if relevant.*

B.7.4 Additional environmental information

[Specify which additional environmental information shall/should be reported (provide units). Avoid if possible the use of should. Reference all methods used to report additional information.]

Biodiversity is considered as relevant for this PEFCR:… [YES/No]

[If biodiversity is relevant, the PEFCR shall describe how biodiversity impacts shall be assessed by the applicant.]

B.7.5 Other impact results

[This chapter is optional and may only be included in the PEFCR when the TS decides to add one or two toxicity impact categories to the list of most relevant impact categories. In this case, the TS may decide to display here the characterised results from the selected ICs toxicity.]

B.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 [enter version number] *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[101];*
- *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 Guidance). 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/);*

[101] Available at: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

- *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 including 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.

[The PEFCR may specify additional requirements for the verification that should be added to the minimum requirements stated in this document].

B.9 References

[List the references used in the PEFCR.]

ANNEX B.1 – List of EF normalisation and weighting 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	
Land use	pt	9.20E+15	1.33E+06	III	II	I I	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			

5259

5260 ## Weighting factors for Environmental Footprint

	Aggregated weighting set	Robustness factors	Calculation	**Final weighting factors**
WITHOUT TOX CATEGORIES	(50:50)	(scale 1-0.1)		
	A	B	C=A*B	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**

5261

ANNEX B.2 - check-list for the PEF study

[The PEFCR shall report as an annex the checklist listing all the items that shall be included in PEF studies. The following template shall be used. The item already included are mandatory for every PEFCR, in addition each TS can decide to add additional points to the checklist.]

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

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
[This column shall list all the items that shall be included in PEF studies. One item per row shall be listed. This column shall be completed by the TS]	[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			
Diagram with system boundary and indication of the situation according to DNM			
List and description of processes included in the system boundaries			

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
List of co-products, by-products and waste			
List of activity data used			
List of secondary datasets used			
Data gaps			
Assumptions			
Scope of the study			
(sub)category to which the product belongs			
DQR calculation of each dataset used for the most relevant processes and the new ones created.			
DQR (of each criteria and total) of the study			

5268

5269

ANNEX B.3 - Critical review report of the PEFCR

[Insert here the critical review panel report of the PEFCR, including all findings of the review process and the actions taken from TS to answer the comments of the reviewers]

ANNEX B.4 - Other Annexes

[The TS can decide to add other Annexes that are considered important]

Annex C – List of default values for A, R_1, R2, R3 and Qs/Qp

The list of default values for A, R1 and R2 is available in the Excel file "CFF_Default_Parameters_March2018.xlsx" downloadable at http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm.

Annex D – Background information to calculate R2 for packaging materials

The table D.1 below presents per packaging sector (i) the data source to calculate R2, (ii) where in the collection-recycling scheme these data are collected (see Figure 9 *in section 7.18.7.4) and (iii) the applied correction factor towards the output of the recycling process.*

Table D.1 - Recycling rates for different packaging categories, including the source, the data collection point and the recommended correction factor. Please note that the data sources used for the correction factor are not always reviewed reports but may also be surveys or standards.

Packaging sector	Data source	Reference year	Data collection point (Figure 9)	Correction factor*	Source for correction factor
Liquid beverage carton[b]	ACE	2014	8	Liquid packaging board: 92% Aluminium foil: 97% Plastic: 72%	No data source: The correction factors of paper and cardboard, aluminium cans, and generic plastics are recommended as proxy.
Aluminium cans	EA, + bottom ashes[p]	2013	6[†]	97%	Reviewed LCA: http://european-aluminium.eu/media/1329/environmental-profile-report-for-the-european-aluminium-industry.pdf (p58); Boin and Bertram 2005, Melting Standardized Aluminum Scrap: A Mass Balance Model for Europe.
PET bottle	PETCORE	2014	2	73%	Survey: Post-consumer PET recycling in Europe 2014 and prospects to 2019. Prepared on behalf of PETCORE Europe by PCI Ltd. 2015. http://www.pcipetpackaging.co.uk/
Container	FEVE	2013	8	90%	Reviewed LCA: Life Cycle

Packaging sector	Data source	Reference year	Data collection point (Figure 9)	Correction factor*	Source for correction factor
glass					Assessment of Container Glass in Europe (Prepared on behalf of FEVE by RDC Environment), 2016. http://feve.org/new-life-cycle-assessment-proves-industry-success-reducing-environmental-footprint/
Steel for packaging	APEAL, + bottom ashes[ᵖ]	2013	6[†]	98%	Standard: Canadian standards' Life cycle assessment of auto parts. http://shop.csa.ca/en/canada/life-cycle-assessment/spe-14040-14/invt/27036702014
Generic plastic packaging	PlasticsEurope	2014	8	73%	LCA report: Increased EU Plastics Recycling Targets: Environmental, Economic and Social Impact Assessment. Prepared by Deloitte on behalf of Plastic Recyclers Europe. 2015 (See Table 7, value of 2012).
Paper and cardboard	CEPI	2014	8	92%	Reviewed LCA: European Database for Corrugated Board Life Cycle Studies" (2015, FEFCO, CE Containerboard)

**Expressed as percentage of material (%) at the output of the recycling plant when considering a 100% input at data collection point. The proposed correction factors are sector specific and to be used for correcting the European average and country specific recycling rates. It is recognized that this is an over simplification as the correction depends on the installations and market in place. However, the data available today asks for this simplification. Some values are rounded.*

[ᵖ]The recycling rates for aluminium cans and steel for packaging include bottom ash recovery.

[†]R_2 provided by the national collection systems excludes impurities from the overall mass estimate of metal packaging. Impurities are excluded from the correction factor.

[b] For liquid beverage carton three different material flows leave the recycling process at level Š. Therefore, three correction factors are introduced, each to be used with the respective material flow.

Annex E – PEFCR supporting study template

IMPORTANT: The supporting studies shall be based on a version of the draft PEFCR that includes all the information that a person not involved in its drafting would need to carry out the study. If the version of the draft PEFCR approved by the Steering Committee is missing such information (e.g. the list of secondary datasets to be used, the tables to recalculate the DQR values for the secondary datasets, or other information related to the application of the Data Need Matrix), than the TS shall make available to the companies performing the supporting study an updated version of the PEFCR. It is important to send this version also to the Commission as this will be one of the documents used by the verifiers for their checks.

General guidelines and instructions

The information included in this template is what the Commission expects to find in a supporting study. However, the use of a different template (with different chapters) is allowed provided that the information listed in this template is available in the report.

- Any information written in the referenced PEFCR shall not be repeated in this report.
- Any additional instructions (e.g., impact assessments methods used, default background datasets and parameters used) shall be included in the PEFCR and not in the supporting study report.
- In principle no deviations from the draft PEFCR are allowed. In case of deviation, the details about the deviation shall be described in the related chapter (meaning, when there is a deviation on the scope, this shall be described in the scope chapter).
- The supporting study report (including confidential information) will be accessed only by the external verifiers (Ernst & Young), the PEFCR reviewers, and the EF Team in DG ENV and JRC IES.
- The supporting study report (including confidential information) shall remain confidential, unless differently agreed by the company performing the study. The company performing the study can grant access to other stakeholders upon request.
- Beside the confidential report (this template in its full version), a second report shall be produced that describes the main outcomes of the PEFCR supporting study without disclosing confidential information. For this, chapter C.0 and C.9 can be removed from the report, while chapter C.6 on the results can be replaced by a non-confidential summary. This second report will be made available to the Technical Secretariat, the Technical Advisory Board and the Steering Committee.
- The second report (without confidential information) or a condensed version thereof can be used in the communication phase. If the communication phase concerns real life tests, then the characterized results shall be available to the public at least for the Impact Categories identified as "most relevant" in the PEFCR.

Product Environmental Footprint

Supporting Study

[Insert product name here]

E.1 Summary

[The summary includes the following elements:

- The goal and scope of the supporting study
- Relevant statements about data quality, assumptions, value judgments and limitations
- The main results from the impact assessment
- Recommendations made and conclusions drawn

To the extent possible the Summary should be written with a non-technical audience in mind and should not be longer than 3-4 pages.

E.2 General

[The information below should ideally be placed on the front-page of the study:

- Name of the product (including a photo)
- Product identification (e.g. model number)
- Product classification (CPA) based on the latest CPA list version available
- Company presentation (name, geographic location)
- Date of publication of supporting study (write out the date e.g. 25 June 2015 to avoid confusion of the date format)
- Geographic validity of the supporting study (countries where the product is consumed/sold)
- List the reference PEFCR the supporting study is in conformance with (incl. version number)
- An indication whether this report underwent a critical review process (critical review of the supporting study is not a mandatory requirement)]

[The following statements shall be included:

"The current document endeavours to be compliant with the requirements of the 'Product Environmental Footprint (PEF) Guide' (Annex II to Recommendation (2013/179/EU), the "Guidance for the implementation of the EU PEF during the EF Pilot Phase" (version no. 5.0.) and the PEFCR … add title, version and publication date".

"This study follows / does not follow the requirements regarding data collection and data quality assessment procedure described in the Annex E of the "Guidance for the implementation of the EU PEF during the EF Pilot Phase" (version no. 5.0.)]

[Indicate the level of confidentiality of this report. The report will be public if it is used for communication purposes. The paragraph below can be used/adapted.

"*This supporting study report (in its full version) is confidential and will be accessed only by the external verifiers, the PEFCR reviewers, and the EF Team in DG ENV and JRC IES*"]

E.3 Goal of the study

[The following text shall be included:
"The supporting study is part of the PEF/OEF pilot phase and includes the following goals:
(i) To test the draft PEFCR
(ii) To validate the outcomes of the screening study (such as the selection of relevant impact categories, life cycle stages, processes and elementary flows)
(iii) To help defining performance classes where possible
(iv) To perform supplementary analysis listed in the draft PEFCR
(v) To provide results that can be used as the basis for communicating the PEF profile"]

[Include any additional intended application.]

E.4 Scope of the study

E.4.1 Functional/declared unit and reference flow

[Provide the functional unit and reference flow, as described in PEFCR]

E.4.2 System boundaries

[This section shall include as a minimum:

- List all attributable life-cycle stages and processes that are part of the product system. The co-products, by-products and waste streams of at least the foreground system shall be clearly identified.
- Provide a system diagram clearly indicating the system boundaries, the processes that are included and those excluded, highlight those activities which falls respectively under situation 1, 2, and 3 of the Data Need Matrix[102], and highlight where primary activity data / primary life cycle inventory data is used. In case a supporting study is not implementing Annex E, then the system diagram shall clearly indicate which are the processes in the company foreground system (where they have operational control) and which are those in the company background system]

E.4.3 Supplementary analysis

[Describe any supplementary analysis made, e.g.:

- Scenario sensitivity and uncertainty analysis
- Any other supplementary analysis listed in the draft PEFCR that needs further testing
- The use of impact assessment methods, end of life formulas or datasets other than those recommended in the PEFCR]

[102] *"Guidance for the implementation of the EU PEF during the EF Pilot Phase" (version no. 5.0.), Annex E*

E.5 Life Cycle Inventory analysis

E.5.1 Data collection and quality assessment (CONFIDENTIAL IF RELEVANT)

[This section shall include as a minimum:

- Description and documentation of all primary data collected[103]
  - per life cycle stage, e.g., raw material acquisition, production, distribution and storage, use stage, end of life
  - list of activity data used
  - Detailed Bill of Materials/ingredients, including substance names, units and quantities, including information on grades/purities and other technically and/or environmentally relevant characterisation of these
  - List of primary and secondary datasets used
  - modelling parameters derived from primary data or additional to those described in the PEFCR (e.g. transportation distance, re-use rate for packaging, etc)
- Primary data collection/estimation/calculation procedures
- Sources of published literature
- Validation of data, including documentation
- Justification of allocation procedures used
- Report the data quality assessment scoring per process in accordance with the PEFCR requirements[104]]

E.5.2 Data gaps

[Specify data gaps and the way in which these gaps were filled. Data gaps could refer to absolute gaps (e.g. a dataset or a relevant flow is missing) or it could refer to qualitative data gaps (e.g. a dataset is available but its DQR is higher than the minimum requested). This section is preferably empty and if not so, shall give recommendations to the final PEFCR development.]

E.5.3 Supplementary analysis

[This section shall describe more in detail the supplementary analysis made.

- Calculation procedure, assumptions, data sources used, etc.]

[103] A description on system level is required, i.e. the whole life cycle be described focussing on the most relevant parts thereof, resulting in e.g. 1-2 page summary. This is what the ILCD format foresees in the field "Technology description including background system". Generally, it is requierd a documentation that can directly be used to fill in the respective fields in the ILCD format for the resulting LCI results data set..

[104] At least one supporting study per pilot TS shall apply the data collection and data quality assessment procedure described in the issue paper "Data requirements in Product Environmental Footprint Category Rules (PEFCR)" Version 1.0 12 May 2015. The supporting studies not applying this approach shall follow the baseline approach described in the PEF method, Table 4.

E.6 Impact assessment results (CONFIDENTIAL IF RELEVANT)

E.6.1 PEF results

[This section shall include as a minimum:

- List of the most relevant life cycle stages, processes and elementary flows based on the approach explained in Annex D to this Guidance (using normalization and weighting).
- Characterised results per life cycle stage and impact category (all 15 PEF impact categories shall be calculated in the supporting study)
- Normalised and weighted results
- If included in PEFCR, the required additional environmental information
- Limitation of the EF results relative to the defined goal and scope of the PEF study

In case alternative impact assessment methods and/or normalisation factors and/or weighting systems are used, the results shall be calculated separately for the baseline PEF approach and for each of the alternative options included.]

E.6.2 Supplementary analysis

[This section shall include as a minimum:

- Results or conclusions of any supplementary analysis made]

E.7 Interpreting PEF results

E.7.1 PEF results

[This section shall include as a minimum:

- Comparison of the supporting study results against those of the screening study (relevant impact categories, life cycle stages, processes and elementary flows). Differences shall be described and explained;
- Any feedback on the draft PEFCR used, including suggestions for improvements, changes, additions;
- Assessment of the degree of accuracy (technology, time, geography) for the newly created datasets;
- Average DQR for the supporting study (expressed as mathematical average of the DQR of all datasets used in the study);
- Uncertainty (at least a qualitative description)].

E.7.2 Comparison to the benchmark

[This section shall quantitatively report how the product scores against the benchmark defined at PEFCR level (in case no benchmark is explicitly stated in the PEFCR, the characterised results of the representative

product are to be taken as benchmark) and following the same calculation rules. In any case, for the supporting studies, this comparison shall be done at least for each of the 16 impact categories[105]].

E.7.3 Performance class

[This section should only be filled in case the draft PEFCR includes a proposal for performance classes. If that is the case, here it should be reported how the specific product would score].

Annex I

[The Annex serves to document supporting elements to the main report which are of a more technical nature. It could include:

- Bibliographic references;
- Additional results that have been shown to be not relevant;
- Life Cycle Inventory analysis (optional if considered sensitive and communicated separately in the Confidential annex, see below)]

Annex II: Confidential

[The Confidential annex is an optional chapter that shall contain all those data (including raw data) and information that are confidential or proprietary and cannot be made externally available.]

[105] After the supporting studies, for communication purposes, the benchmark per impact category may be defined solely for the selected relevant impact categories.

Annex F - Default data for modelling the use stage

The following tables shall be used by the PEFCRs unless better data is available. The data provided is based on assumptions, except if specified otherwise.

Product	*Use stage assumptions per product category*
Meat, fish, eggs	*Chilled storage. Cooking: 10 minutes in frying pan (75% on gas and 25% electricity), 5 gram sunflower oil (incl. its life cycle) per kg product. Dishwashing of frying pan.*
Milk	*Chilled storage, drunk cold in 200 ml glass (i.e., 5 glasses per L milk), incl. glass life cycle and dishwashing.*
Pasta	*Per kg pasta cooked in pot with 10 kg water, 10 min boiling (75% on gas and 25% electricity). Boiling phase: 0.18 kWh per kg of water, Cooking phase: 0.05 kWh per minute of cooking.*
Frozen dishes	*Frozen storage. Cooked in oven 15 minutes at 200°C (incl. a fraction of a stove, a fraction of a baking sheet). Baking sheet rinsing: 5 L water.*
Roast and ground coffee	*7 g roast and ground coffee per cup* *Filter coffee preparation in a filter coffee machine: machine production and end-of-life (1.2 kg, 4380 uses, with 2 cups/use), paper filter (2 g/use), electricity consumption (33 Wh/cup) and water consumption (120 ml/cup).* *Machine rinsing/washing: 1 L cold water per use, 2 L hot water per 7 uses, decanter dishwashing (every 7 uses)* *Cup (mug) production and end-of-life and dishwashing* *Source: based on PEFCR Coffee (draft as of Feb 1, 2015)*
Beer	*Cooling, drunk in 33 cl glass (i.e., 3 glasses per L beer), glass production, end-of-life and dishwashing. For now: glass is excluded in the beer PEFCR.*
Bottled water	*Chilled storage. Storage duration: 1 day. 2.7 glasses per L water drunk, 260 gram glass production, end-of-life and dishwashing.*
Pet food	*Pet food dish production, end-of-life and dishwashing*
Goldfish	*Electricity and water use and treatment for the aquarium (43 kWh and 468 L per year). Goldfish feed production (1 g/day, assumed 50% fish meal, 50% soybean meal). Lifetime of the goldfish assumed to be 7.5 years.*

Product	*Use stage assumptions per product category*
T-shirt	*Washing machine, tumble dryer use and ironing. 52 washing at 41 degree, 5.2 tumble drying (10%) and 30 times ironing per T-shirt.* *Washing machine: 70 kg, 50% steel, 35% plastic, 5% glass, 5% aluminium, 4% copper, 1% electronics, 1560 cycles (=loads) within its lifetime. 179 kWh and 8700 L water for 220 cycles at 8 kg load (based on http://www.bosch-home.com/ch/fr/produits/laver-et-s%C3%A9cher/lave-linge/WAQ28320FF.html?source=browse) being 0.81 kWh and 39.5 L/cycle, as well as 70 ml laundry detergent/cycle.* *Tumble dryer: 56 kg, same composition share and lifetime as for washing machine assumed. 2.07 kWh/cycle for 8 kg clothes load.*
Paint	*Paint brush production, sand paper, … (see PEFCR of paints).*
Cell phone	*2 kWh/year for the charge, 2 years lifetime.*
Laundry detergent	*Use of a washing machine (see T-shirt data for washing machine model). 70 ml laundry detergent assumed per cycle, i.e., 14 cycles per kg detergent.*
Automotive oil	*10% losses during use assessed as hydrocarbons emissions to water.*

5505 *Default assumptions for storage (always based on assumptions, except if specified otherwise).*

Product	*Assumptions common for several product categories*
Ambient storage (at home)	*Ambient storage at home is considered, for the sake of simplification, as having no impact.*
Chilled storage (in a fridge, at home)	*Storage time: product dependent. As default 7 days storage in fridge (ANIA and ADEME 2012).* *Storage volume: assumed to be 3x the actual product volume* *Energy consumption: 0.0037 kWh/L (i.e., "the storage volume") - day (ANIA and ADEME 2012).* *Fridge production and end-of-life considered (assuming 15 years of lifetime).*
Chilled storage (at the pub/restaurant)	*The fridge at the pub is assumed to consume 1400 kWh/ yr (Heineken green cooling expert, 2015). 100% of this energy consumption is assumed to be for the cooling of beer. The throughput of the fridge is assumed to be 40hl/ yr. This means 0.35 kWh/ l for pub / supermarket*

Product	*Assumptions common for several product categories*
	cooling for the full storage time. *Fridge production and end-of-life considered (assuming 15 years of lifetime).*
Frozen storage (in a freezer, at home)	*Storage time: 30 days in freezer (based on ANIA and ADEME 2012).* *Storage volume: assumed to be 2x the actual product volume.* *Energy consumption: 0.0049 kWh/L (i.e., "the storage volume") - day (ANIA and ADEME 2012).* *Freezer production and end-of-life considered (assuming 15 years of lifetime): assumed similar to fridge.*
Cooking (at home)	*Cooking: 1 kWh/h use (derived from consumptions for induction stove (0.588 kWh/h), ceramic stove (0.999 kWh/h) and electric stove (1.161 kWh/h) all from (ANIA and ADEME 2012).* *Backing in oven: electricity considered: 1.23 kWh/h (ANIA and ADEME 2012).*
Dishwashing (at home)	*Dishwasher use: 15 L water, 10 g soap and 1.2 kWh per washing cycle (Kaenzig and Jolliet 2006).* *Dishwasher production and end-of-life considered (assuming 1500 cycle per lifetime).* *When dishwashing is done by hand, one assumes an equivalent of 0.5 L of water and 1 g of soap for the value above of 2.5% (with a scaling in terms of water use and soap, using the % above). The water is assumed to be warmed by natural gas, considering a delta T of 40 °C and an efficiency of energy from natural gas heating to water heat of 1/1.25 (meaning that to heat the 0.5 L of water one needs to use 1.25 * 0.5 * 4186 * 40 = 0.1 MJ of "Heat, natural gas, at boiler").*

5506

Annex G - Default loss rates per type of product

Default loss rates per type of product during distribution and at consumer (including restaurant, etc.) (assumptions if not specified otherwise). Out of simplification, the values for restaurant are considered the same as for consumer at home.

Retail trade sector	*Category*	*Loss rate (incl. broken products but not products returned to manufacturer) during distribution (overall consolidated value for transportation, storage and retail place)*	*Loss rate at consumer (including restaurant, etc.)*
Food	*Fruits and vegetables*	*10% (FAO 2011)*	*19% (FAO 2011)*
	Meat and meat alternatives	*4% (FAO 2011)*	*11% (FAO 2011)*
	Dairy products	*0.5% (FAO 2011)*	*7% (FAO 2011)*
	Grain products	*2% (FAO 2011)*	*25% (FAO 2011)*
	Oils and fats	*1% (FAO 2011)*	*4% (FAO 2011)*
	Prepared/processed meals (ambient)	*10%*	*10%*
	Prepared/processed meals (chilled)	*5%*	*5%*
	Prepared/processed meals (frozen)	*0.6% (primary data based on Picard – oral communication from*	*0.5% (primary data based on Picard – oral communication from*

Retail trade sector	*Category*	*Loss rate (incl. broken products but not products returned to manufacturer) during distribution (overall consolidated value for transportation, storage and retail place)*	*Loss rate at consumer (including restaurant, etc.)*
		Arnaud Brulaire)	*Arnaud Brulaire)*
	Confectionery	*5%*	*2%*
	Other foods	*1%*	*2%*
Beverages	*Coffee and tea*	*1%*	*5%*
	Alcoholic beverages	*1%*	*5%*
	Other beverages	*1%*	*5%*
Tobacco		*0%*	*0%*
Pet food		*5%*	*5%*
Live animals		*0%*	*0%*
Clothing and textile		*10%*	*0%*
Footwear and leather goods		*0%*	*0%*
Personal accessories	*Personal accessories*	*0%*	*0%*
Home and professional supplies	*Home hardware supplies*	*1%*	*0%*
	Furniture, furnishings and decor	*0%*	*0%*

Retail trade sector	*Category*	*Loss rate (incl. broken products but not products returned to manufacturer) during distribution (overall consolidated value for transportation, storage and retail place)*	*Loss rate at consumer (including restaurant, etc.)*
	Electrical household appliances	*1%*	*0%*
	Kitchen merchandise	*0%*	*0%*
	Information and communication equipment	*1%*	*0%*
	Office machinery and supplies	*1%*	*0%*
Cultural and recreational goods	*Books, newspapers and paper/paper supplies*	*1%*	*0%*
	Music and videos	*1%*	*0%*
	Sporting equipment and gadgets	*0%*	*0%*
	Other cultural and recreational goods	*1%*	*0%*
Healthcare		*5%*	*5%*
Cleaning/hygiene products, cosmetics and toiletries		*5%*	*5%*
Fuels, gases, lubricants and oils		*1%*	*0%*
Batteries and power		*0%*	*0%*

Retail trade sector	*Category*	*Loss rate (incl. broken products but not products returned to manufacturer) during distribution (overall consolidated value for transportation, storage and retail place)*	*Loss rate at consumer (including restaurant, etc.)*
Plants and garden supplies	*Flowers, plants and seeds*	*10%*	*0%*
	Other garden supplies	*1%*	*0%*
Other goods		*0%*	*0%*
Gas station	*Gas station products*	*1%*	*0%*

5512

5513 *Food losses at distribution center, during transport and at retail place, and at home: assumed to be 50%*
5514 *trashed (i.e., incinerated and landfilled), 25% composting, 25% methanisation.*

5515 *Product losses (excluding food losses) and packing/repacking/unpacking at distribution center, during*
5516 *transport and at retail place: Assumed to be 100% recycled.*

5517 *Other waste generated at distribution center, during transport and at retailer (outside food and product*
5518 *losses) such as repacking/unpacking are assumed to follow the same EoL treatment as for home waste.*

5519 *Liquid food wastes (as for instance milk) at consumer (including restaurant, etc.) are assumed to be poured*
5520 *in the sink and therefore treated in the wastewater treatment plant.*

5521

5522

Annex H - When is carbon stored > 100 years?

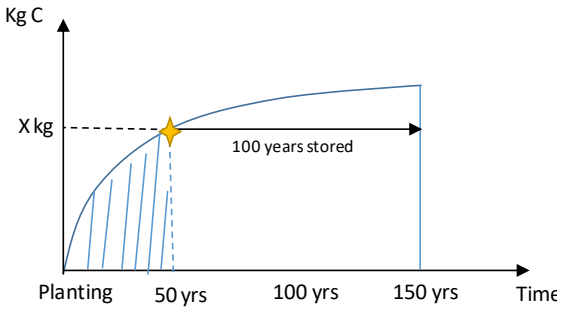
When is carbon stored > 100 years and credits from biogenic carbon can be accounted for ? Principle: Carbon storage time starts from the moment carbon is taken up by the plant through photosynthesis and lasts till its release back into the atmosphere through e.g., degradation or incineration.

If X kg CO^2 is stored over 100 years, a -X kg CO_2 equivalents (minus X) can be accounted for and is also called carbon credit. This -X kg CO_2 equivalents is modelled by including an emission uptake as 'resource from air' using the elementary flow 'carbon dioxide (biogenic-100yr)'.

Situation 1. At the forest system: carbon storage starts at uptake by the plant.

Figure 10: Three examples for better understanding of the forest system.

A) Sustainable managed cork plantation of 150 years. Cork extraction every 10 years.



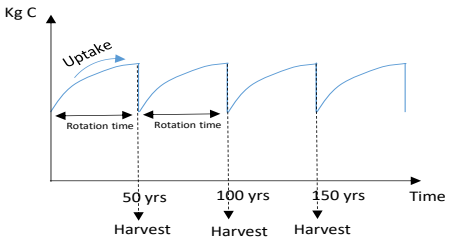
X kg C stored by the cork tree/by the system, over 100 years.

X kg C shall be allocated over all outputs of the total system (meaning, over 150 years)

B) Sustainable managed forest: Long-term rotation of 50 years

Sustainable managed reflects here in a stable carbon balance: C uptake = harvested C

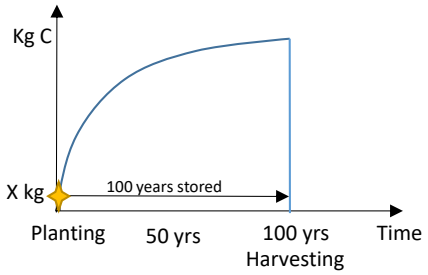
Rotation time = carbon storage time = 50 years



No carbon stored by the system over 100 years

The carbon storage time is co-determined by the product LT (see step 3)

C) Sustainable managed forest: wood harvested after 100 years.



Only X kg C in the tree is stored over 100 years. X kg is the amount after one year growth.

Legend:

X-axes: timeline, starting the carbon uptake at year zero.

Y-axes: accumulative carbon uptake in the system

Yellow star: year where carbon has been stored for minimum 100 years, and reflecting on the Y-axes the amount of carbon to be accounted for as credit (named X kg)

Situation 2. After the uptake in the forest system, the carbon storage continues in the final product.

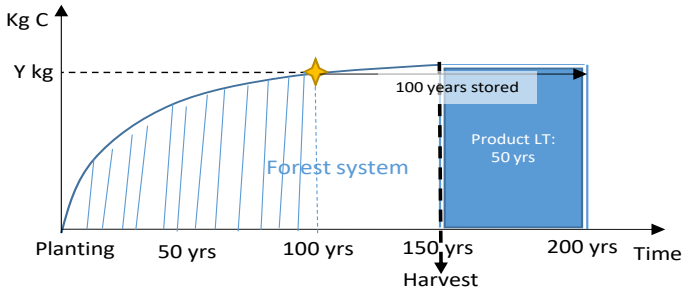
When the product lifetime (LT) is > 100 years: All carbon in the product is stored longer than 100 years: All product carbon gets a -1 credit

When the product LT is < 100 years: No carbon in the product is stored longer than 100 years: The carbon storage time is co-determined by the storage time in the forest system (see situation 3)

Situation 3. Carbon is stored in the forest system and the final product: carbon storage time in forest and carbon storage time in product determines if a carbon credit can be accounted for.

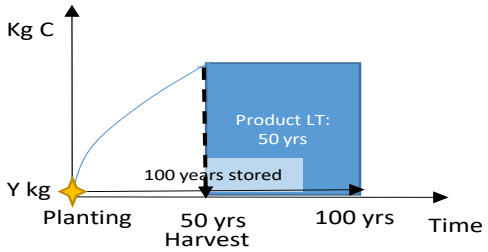
Figure 11: Two examples for better understanding of carbon stored in forest system and final product.

A) A forest plantation with harvested wood products after 150 years. The product LT is 50 years.



Y kg of carbon in the product is stored over 100 years (50yrs in the forest system + 50yrs in the product).

B) A forest plantation with harvested product after 50 years. The product LT is 50 years.



Only Y kg of carbon is stored over 100 years. Y kg is the amount after one year growth.

Legend:

X-axes: timeline, starting the carbon uptake at year zero and ending when the product is degraded/incinerated/…

Y-axes: accumulative carbon uptake in the system + product

Yellow star: year where carbon has been stored for minimum 100 years, and reflecting on the Y-axes the amount of carbon to be accounted for as credit (named Y kg)

Annex I - EF-compliant dataset

A basic requirement of the PEF and OEF methods is that LCI data used shall be compliant with the entry level (EL) requirements of the International Reference Life Cycle Data System (ILCD). Going beyond the ILCD EL requirements, the EF requirements provide further specifications to ILCD EL and refer to provisions e.g. in the Product Environmental Footprint (PEF) Guide (Rec 2013/179/EU - Annex II) or the Organisation Environmental Footprint (OEF) Guide (Rec 2013/179/EU - Annex III). In those cases the more specific (and sometimes more strict) EF requirements prevail over the ILCD EL requirements. Exceptions are allowed in case EF-compliant datasets are not available (see section 7.19.5).

The requirements listed in this Annex will be used for any future call for secondary datasets launched starting from 1st January 2018 and will be the basis for determining the EF-compliance of any LCI dataset starting from 1st January 2021.

I.1 List of all technical requirements to be fulfilled by datasets to be recognised as EF compliant

I.1.1 Documentation

ILCD format shall be used. The developer kit is available at: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

Furthermore, the requirement available at: http://eplca.jrc.ec.europa.eu/uploads/QMS_H08_ENSURE_ILCD_GuidanceDocumentationLCADataSets_Version1-1Beta_2011_ISBN_clean.pdf shall be fulfilled.

The editor for datasets can be downloaded to: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

In the same page other tools and documents for the creation, editing and compliance validation of datasets are also available.

I.1.2 Nomenclature

Nomenclature shall be compliant with "ILCD Handbook – Nomenclature and other conventions" (including elementary flows see link for Elementary Flow list available at: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml).

Details to fulfil this aspect are available at http://eplca.jrc.ec.europa.eu/uploads/MANPROJ-PR-ILCD-Handbook-Nomenclature-and-other-conventions-first-edition-ISBN-fin-v1.0-E.pdf

EF requirements allow some grouped flows (see the reference flow list available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml).

As grouped flows like "AOX" or "heavy metals" are not preferable in the impact assessment phase, the EF tries to avoid the use of such grouped flows and urges for further specification and the break-down of grouped flows into their single components.

I.1.3 Review

The review report shall include at least:

- File name and administrative information
  - Data set name
  - UUID (Universal Unique IDentifier)
  - Data set provider
  - Reviewer name(s) and affiliation(s), contact
  - Review type applied (see Table 37)
  - Date of review completion (DD/MM/YYYY)
  - EF compliance
- Review reporting items for the criterion "nomenclature"
- Review reporting items for the criterion "documentation"
- Review reporting items for the criterion "Methodological appropriateness and consistency. In particular, the reviewer shall check and report in the review report the % of impact covered for each impact category in order to fulfil the completeness criterion. This check shall be based on expert judgement and could be performed by comparing the coverage of flows existing in equivalent

datasets available in other databases, or by referring to the elementary flows that contribute most to the JRC-provided normalisation data of the respective impact category.

- Review reporting items for the criterion "Data quality". The list of items checked and the procedure used to check the data quality shall be included in the review report.
- Review for the Data Quality score, including a check of the results of the contribution analysis to determine the scoring of each parameter in the DQR formula.

Table 37: Typology of reviews

Typology and number of reviewers	Type 1	Panel of at least 3 independent reviewers, with at least one external
	Type 2	Two independent reviewers, with at least one external reviewer
	Type 3	Two independent internal reviewers
	Type 4	One independent external reviewer
	Type 5	One independent internal reviewer

I.1.4 Methodological requirements

In order to be considered EF-compliant a dataset shall fulfil all the modelling requirements described in section 7 of this Guidance.

Moreover, the following additional requirements shall also be fulfilled:

- **Completeness**: all 16 EF impact categories shall be covered in the dataset. The reviewer shall check that for each impact category the most important elementary flows are included.
- **Water use:** water use shall be modelled at country level using separate flows for water withdrawal, water release and water evaporation.
- **Cut off**: processes can be excluded up to 1.0%, based on material and energy flow and the level of environmental significance, but it has to be clearly checked, documented (i.e. the processes subject to cut-off have to be made explicit in the documentation) and confirmed by the reviewer, in particular with reference to the environmental significance of the cut-off applied. A cut-off higher than 1.0% per process and higher than 5% cumulative is not allowed and the dataset is considered as not-compliant with EF requirements.
- **Direct land use change**: Direct land use change shall be accounted for on the basis of a 20 year time period (starting from when the land use happened) and implemented in the calculation of 1) Climate Change according to the PAS2050-1:2012 method described at page 24 and 2) Land Use.
- **Carbon storage and delayed emissions**: credits associated with temporary (carbon) storage or delayed emissions up to 100 years shall not be considered.
- **Emissions off-setting:** not to be included

- **Capital goods (including infrastructures) and their End of life**: they shall be included unless they can be excluded based on the 1.0% cut-off rule. The eventual exclusion has to be clearly documented.
- **System boundaries**: system boundaries shall include all processes linked to the product supply chain (e.g. maintenance), unless they can be excluded based on the cut-off rule.
- **Time period**: emissions and removals shall be modelled as if released or removed at the beginning of the assessment period (no time discounting is allowed).
- The **biogenic carbon content** at factory gate (physical content and allocated content) shall be reported. If derived from native forest, it shall report that the corresponding carbon emissions shall be modelled with the elementary flow '(land use change)'.
- The **recycled content** (R_1) shall be reported.
- The LCIA shall be reported, specifying which version of the EF method has been used for the assessment.
- Calculation of Data Quality score.

I.2 Aggregation

An EF-compliant dataset should be available both as aggregated and disaggregated dataset (minimum at level 1). The level 1 disaggregated dataset shall include, as a minimum, the following individual elements:

- Sub-processes for energy input(s) (differentiated by energy carrier, including any potential energy conversion of fuels and thus direct emissions, as "steam from [name of fuel]", or "process heat from [name of fuel]"). For each sub-process, the exact dataset (name and uuid) used in the aggregated version of the dataset shall be indicated
- Sub-processes in case system expansion is used as allocation: the datasets used for substitution. For each sub-process, the exact dataset (name and uuid) used in the aggregated version of the dataset shall always be indicated;
- Sub-processes for each transport activity per input (material, ingredient, component, etc) entering the gate of the process modelled[106]. For each sub-process, the exact dataset (name and uuid) used in the aggregated version of the dataset shall always be indicated;
- One aggregated sub-process for all the other processes that represent the background system (blue box in Figure 12. The exact dataset (name and uuid) used in the aggregated version of the dataset shall always be indicated).
- The output product flow;
- Elementary flows of direct emissions and resource outputs of the foreground system constituting the final output product.
- Elementary flows of direct resource inputs (e.g., land use, water use) of the foreground system constituting the final output product.

[106] Some EF datasets tendered during the pilot phase might have one transport mode for all inputs summed together.

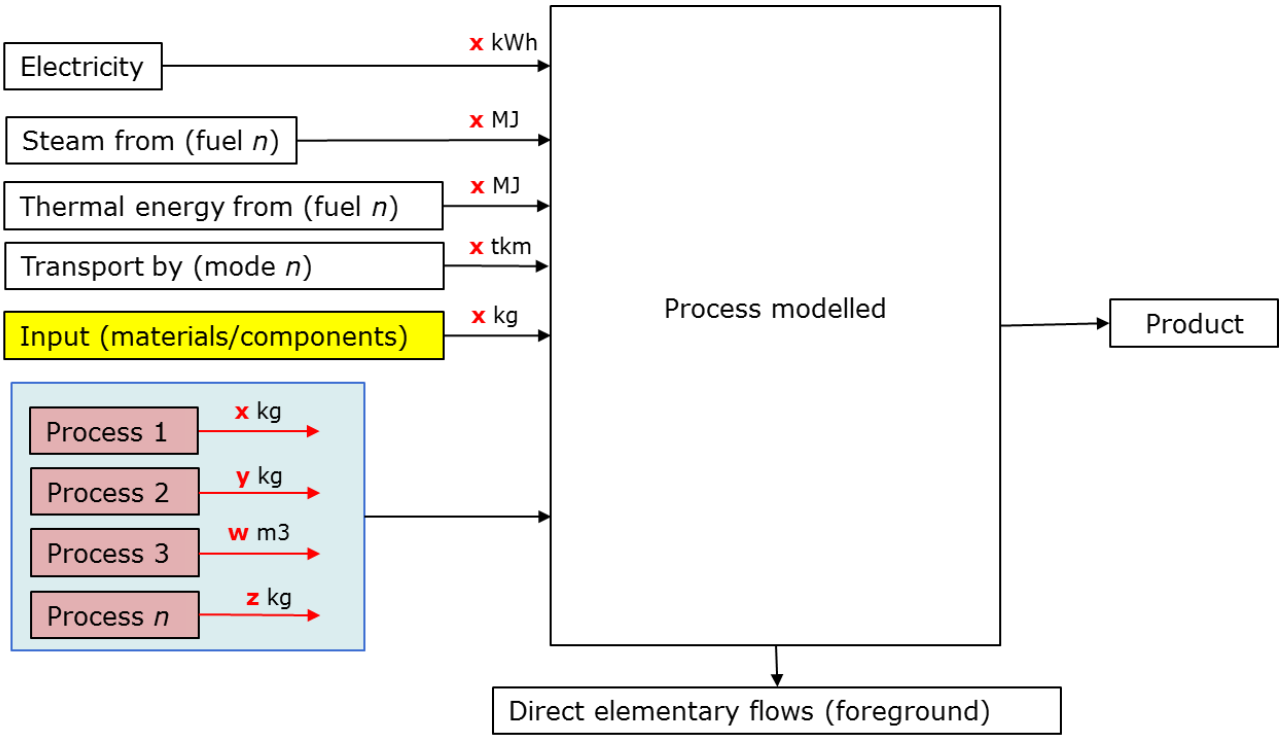


Figure 12: Minimum level of disaggregation requested for a dataset aggregated at level 1. The yellow box is optional when going beyond the minimum requirements.

I.3 Data quality criteria and scores

The DQR of a dataset shall be calculated based on the equation J.1[107]:

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\bar{P}}{4} \quad \text{[Equation I.1]}$$

Where TeR is the Technical Representativeness, G_R is the Geographical Representativeness, Ti_R is the Time Representativeness and P is the Precision. 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 DQR shall be calculated before any aggregation of sub-processes or elementary flows is performed. In particular, the procedure shall be applied before the creation of the aggregated sub-process of the level-1

[107] The EF datasets tendered during the pilot phase might apply a different approach, like expert judgement. The approach used is clarified in the respective dataset meta data information.

disaggregated dataset (the "blue box" in Figure 12). For secondary datasets (e.g., developed by database providers) the following procedure applies[108]:

1) Select the most relevant sub-processes and direct (foreground) elementary flows that account for at least 80% of the total environmental impact of the secondary 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 38.

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}. For example, evaluate 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 4 DQR criteria are calculated as follow: (i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}), while (ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary dataset used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}AD}$ and $G_{R\text{-}SD}$). As Ti_R is evaluated twice, the mathematical average of the activity data and secondary dataset 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:

1 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).
2 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 separately the Te_R, Ti_R, G_R and P for the secondary dataset as the weighted average of each criteria of the most relevant sub-processes and most relevant direct elementary flows. The weight is the relative contribution (in %) of each most relevant process and direct elementary flow calculated in step 3.

5) Calculate the total DQR of the secondary dataset using equation I.1, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \bar{P}$ are the weighted averages calculated as specified in point 4. In order to be EF-compliant, each single criteria in cannot be higher than 3.0.

[108] For datasets based on company-specific data the procedure described in section 7.19.4.37.19.4.3 applies.

5751 **Table 38: Quality rating for the data quality criteria**

Quality rating	P_{EF} and P_{AD}	Ti_{R-EF} and Ti_{R-AD}	Ti_{R-SD}	Te_{R-EF} and Te_{R-SD}	G_{R-EF} and G_{R-SD}
1	Measured/calculated and verified	The data (collection date) can be maximum 2 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset falls within the time validity of the secondary dataset	Technology aspects have been modelled exactly as described in the title and metadata, without any significant need for improvement	The processes included in the dataset are fully representative for the geography stated in the "location" indicated in the metadata
2	Measured/calculated/literature and plausibility checked by reviewer	The data (collection date) can be maximum 4 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 2 years beyond the time validity of the secondary dataset	Technology aspects are very similar to what described in the title and metadata with need for limited improvements. For example: use of generic technologies' data instead of modelling all the single plants.	The processes included in the dataset are well representative for the geography stated in the "location" indicated in the metadata
3	Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data (collection date) can be maximum 6 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 3 years beyond the time validity of the secondary dataset	Technology aspects are similar to what described in the title and metadata but merits improvements. Some of the relevant processes are not modelled with specific data but using proxies.	The processes included in the dataset are sufficiently representative for the geography stated in the ""location" indicated in the metadata. E.g. the represented country differs but has a very similar electricity grid mix profile,
4	Qualified estimate based on calculations, plausibility not checked by reviewer	The data (collection date) can be maximum 8 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 4 years beyond the time validity of the secondary dataset	Technology aspects are different from what described in the title and metadata. Requires major improvements.	The processes included in the dataset are only partly representative for the geography stated in the "location" indicated in the metadata. E.g. the represented country differs and has a substantially different electricity grid mix profile
5	Rough estimate with known deficits	The data (collection date) is older than 8 years with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is more than 4 years beyond the time validity of the secondary dataset	Technology aspects are completely different from what described in the title and metadata. Substantial improvement is necessary	The processes included in the dataset are not representative for the geography stated in the ""location" indicated in the metadata.

5752 Ti_{R-EF}: time representativeness for the elementary flow
5753 Ti_{R-AD}: time representativeness for the activity data
5754 Ti_{R-SD}: time representativeness for the secondary dataset
5755

How to report the DQR for the datasets: The dataset shall state as meta-data one numerical value for each DQR criteria (namely $\overline{Te_R}$; $\overline{G_R}$; $\overline{Ti_R}$; $\bar{P}$) and the total DQR numerical value, always referred to the dataset.