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H08 Sustainability Assessment Unit

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Product Environmental Footprint Guide

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Contents

Executive Summary

The Product Environmental Footprint is a multi-criteria measure of the environmental performance of a good or service throughout its life cycle. Product Environmental Footprint information is produced for the overarching purpose of seeking to reduce the environmental impacts of goods and services. This document provides guidance on how to calculate a Product Environmental Footprint, as well as how to create product category-specific methodological requirements for use in Product Environmental Footprint Category Rules (PFCRs).

Context

This work relates to one of the building blocks of the Flagship initiative of the Europe 2020 Strategy – “A Resource-Efficient Europe.” The European Commission's “Roadmap to a Resource Efficient Europe”[1]

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[11] E.g. claims of overall environmental superiority or equivalence of one product over another product fulfilling the same function disclosed to the public.
[1] Quantifies changes in soil organic matter associated with specific land use strategies.
[1] http://lct.jrc.ec.europa.eu/assessment/publications
[1] http://lct.jrc.ec.europa.eu/assessment/publications
[1] ILCD Handbook – General guide for Life Cycle Assessment – Detailed guidance, Chapter 5.3
[1] Attributional - refers to process-based modeling intended to provide a static representation of average conditions, excluding market-mediated effects.
[1] This means that not all data in the set must achieve a ranking of "very good quality" for the data set to achieve an overall “very good quality” rating. Rather, two may be ranked as "good". If more than two are ranked as “good”, the data set is downgraded to the next quality class.
[1] http://lct.jrc.ec.europa.eu/assessment/data
[1] http://lct.jrc.ec.europa.eu/assessment/data
[1] http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=54808
[1] Error = two standard deviations, expressed as a percent of the mean; where sufficient studies were not available for a statistical analysis a default, a value based on expert judgment (40 %, 50%, or 90%) is used as a measure of the error. NA denotes ‘Not Applicable’, for factor values that constitute reference values or nominal practices for the input or management classes. This error range does not include potential systematic error due to small sample sizes that may not be representative of the true impact for all regions of the world.
[1] Note: The climate regions, soil types, temperature and moisture regimes, as well and the land use and management adopted in all these examples is for illustrative purposes only.
[1] For no use of the land (i.e. fallow, natural forest, etc.), the land management factor and the input factor are both always = 1; these values are not given in the table that only lists factors for managed land (i.e. cropland and grassland).
[1] The numbers are given per ha (10,000 m2) and need to be converted to the e.g. kg of harvested crop.
[1] These numbers are of course to be complemented with other GHG etc. emissions from machine operation, fertiliser production, etc.
[1] Note that the Carbon bound in the biomass (i.e. trees) of the natural tropical forest is several times higher.
[1] Negative loss, i.e. an accumulation
[1] GHG protocol initiative, 2010): Product accounting and Reporting standard (draft as of Jan 2011)…..
[1] Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/main_tables
[1] Eurostat 2010 report “Environmental statistics and accounts in Europe”; ISBN 978-92-79-15701-1; available online at http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/introduction
[1] Eurostat - Environmental Data Center on Waste; http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastemanagement/recycling
[1] Eurostat - Environmental Data Center on Waste; http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastemanagement/recycling

(European Commission 2011) proposes ways to increase resource productivity and to decouple economic growth from both resource use and environmental impacts, taking a life-cycle perspective. It states specifically as one of the objectives to: "Establish a common methodological approach to enable Member States and the private sector to assess, display and benchmark the environmental performance of products, services and companies based on a comprehensive assessment of environmental impacts over the life-cycle ('environmental footprint')". The European Council also invited the Commission to develop supporting methodologies.[2] Thus, the Product and Organisation Environmental Footprint (OEF) project was initiated with the aim of developing a harmonized European methodology for environmental footprint studies that can accommodate a broader suite of relevant environmental performance criteria using a life cycle approach.

The life cycle approach takes into consideration all relevant environmental interactions associated with a good, service, activity, or entity. In other words, the life cycle approach requires attention to impacts that occur along the entire life cycle, i.e. from the level of primary resource extraction through processing, distribution, use, and eventual disposal or reuse phases. Such an approach is essential to effective management because important environmental effects may occur "upstream" or "downstream", and hence may not be immediately evident. This approach is also essential to making transparent any potential trade-offs between different types of environmental impacts associated with specific management decisions to help avoid unintended shifting of burdens.

Objectives

This document aims at providing detailed technical guidance on how to conduct a Product Environmental Footprint study. Product Environmental Footprint studies may be used for a variety of purposes, including in-house management and participation in either voluntary or mandatory programs.

Product Environmental Footprint Category Rules (PFCRs) are a necessary extension of and complement to the general guidance for Product Environmental Footprint studies. As they are developed, PFCRs will play an important role in increasing the reproducibility, consistency, and relevance of Product Environmental Footprint studies. PFCRs will facilitate focusing on the most important parameters, thus also possibly reducing time, efforts, and costs for completing a PEF study. In addition to general guidance and requirements for PEF studies, this document therefore also specifies the requirements for development of Product Environmental Footprint Category Rules.

Process and Results

Each requirement for Product Environmental Footprint studies specified in this methods guide has been chosen taking into consideration the recommendations of similar, internationally recognized product

[1] Based on the International Resource Panel: Appendix C and Appendix E of "Recycling Rates of Metals: a status report" I

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environmental accounting methods and guidance documents. Specifically, the methodology guides considered were:

- ISO 14044: Environmental management -- Life cycle assessment -- Requirements and guidelines
- ISO 14067: Carbon footprint of products
- ILCD: International Reference Life Cycle Data System
- Ecological Footprint
- Product and supply chain standards, Greenhouse Gas Protocol (WRI/ WBCSD)
- Méthodologie d'affichage environnemental (BPX 30-323)
- Specification for the assessment of the life cycle greenhouse gas emissions of goods and services (PAS 2050)

Although such documents align closely on much of the methodological guidance they provide, it is noteworthy that discrepancies and/or lack of clarity remains on a number of important decision points, which reduces the consistency and comparability of analytical outcomes. Whereas existing methods may provide several alternatives for a given methodological decision point, the intention of this Product Environmental Footprint guidance is (wherever feasible) to identify a single requirement for each decision point to support more consistent, robust and reproducible Product Environmental Footprint studies. Thus, **comparability is given priority over flexibility**.

This document is therefore intended as a detailed, stand-alone guide to implementing the requirements for Product Environmental Footprint studies across sectors. However, additional Product Environmental Footprint Category Rules (PFCRs) should be developed as a complement to this general guide in order to further increase methodological harmonization, specificity, relevance and reproducibility for a given product category.

1. General Considerations for Product Environmental Footprint Studies

The Product Environmental Footprint is a multi-criteria measure of the environmental performance of a good or service throughout its life cycle. Product Environmental Footprint information is produced for the overarching purpose of seeking to reduce the environmental impacts of goods and services. This document provides guidance on how to calculate a Product Environmental Footprint, as well as how to create product category-specific methodological requirements for use in Product Environmental Footprint Category Rules (PFCRs). Product Environmental Footprint Category Rules (PFCRs) are a necessary extension of and complement to the general guidance for Product Environmental Footprint studies. As they are developed, PFCRs will play an important role in increasing the reproducibility, consistency, and relevance of Product Environmental Footprint studies. PFCRs will facilitate focusing on the most important parameters, thus also possibly reducing time, efforts, and costs for completing a PEF study.

Based on life cycle approach, the Product Environmental Footprint guide provides a method for modeling the quantitative, physical environmental impacts of the flows of material/energy and resulting emissions and waste streams associated with a product from a supply chain perspective. The life cycle approach to environmental management, and Life Cycle Thinking (LCT) in general, takes into consideration all relevant environmental interactions associated with a good, service, activity, or entity from a supply chain perspective in contrast to focusing on site level impacts only or on single environmental impacts in order to reduce the possibility of unintended burden shifting.

Achieving a model that provides for realistic representation of these physical flows and impacts requires that modeling parameters are defined, as far as possible, based on concrete, physical terms and relationships. The Product Environmental Footprint is not a financial accounting model, hence efforts have been made to minimize the need for using financial information, which may be poorly representative of the physical relationships pertinent to the systems modeled.

REQUIREMENT: A Product Environmental Footprint study shall be based on a life cycle approach.

How to Use this Guide

The Product Environmental Footprint guide provides the information necessary to conduct a PEF study. The material in the guide is presented in a sequential manner, in order of the methodological phases necessary to calculate a PEF. Each section begins with a general description of the methodological phase, along with an overview of necessary considerations and supporting examples. “Requirements” specify the methodological norms that must be satisfied in order to achieve a PEF-compliant study. These are positioned in text boxes with single solid line borders following the general description sections. “Tips” describe non-mandatory but recommended best practices. These are positioned in shaded text boxes, also with single solid line borders. Where additional requirements for creating PFCRs are specified, these are positioned in text boxes with double solid line borders at the end of each respective section.

1.1 Principles for Product Environmental Footprint Studies

To achieve the objective of consistent, robust and reproducible Product Environmental Footprint studies requires strict adherence to a core suite of analytical principles. These principles are intended to provide overarching guidance in the application of the Product Environmental Footprint method. They should be considered with respect to each phase of Product Environmental Footprint studies, from the articulation of study goals and definition of the scope of the research, through data collection, impact assessment, reporting and verification of study outcomes.

Accordingly, users of this guide shall observe the following principles in Product Environmental Footprint studies:

(1) Relevance

All methods and data collected and used for the purpose of quantifying the Product Environmental Footprint shall be as relevance to the study as possible.

(2) Completeness

Quantification of the Product Environmental Footprint shall include attention to all environmentally significant material/energy flows and other environmental interventions as required for adherence to the defined system boundaries, the data requirements, and the impact assessment methods employed.

(3) Consistency

Strict conformity with this guide shall be observed in all steps of the Product Environmental Footprint study so as to ensure internal consistency as well as comparability with similar analyses.

(4) Accuracy

All reasonable efforts shall be taken to reduce uncertainties both in product system modeling and reporting of results.

(5) Transparency

Product Environmental Footprint information shall be disclosed in such a way so as to provide intended users with the necessary basis for decision making, and for stakeholders to assess its robustness and reliability.

Principles for Product Environmental Footprint Category Rules:

1. Relationship with the Product Environmental Footprint (PEF) guide

The methodological requirements set out in PFCR shall apply to Product Environmental Footprint studies in addition to the requirements of this PEF guide. Where the PFCR provides more specific requirements than the PEF guide, such specific requirements shall take precedence.

2. Modularity

LCA-based data for materials, energy carriers, and other inputs that are used in the manufacture or assembly of products may be used to calculate the PEF for those products. In such circumstances, the LCA-based data for the inputs shall be referred to as information modules and may represent the whole or a portion of the life cycle of the inputs. Information modules may be used to develop a PEF or may be combined to develop a PEF for a product, provided that the information modules are in compliance with the PEF general guide and also with the PFCR for the product category (adapted from ISO 14025).

3. Involvement of selected interested parties

The process of developing Product Environmental Footprint Category Rules (PFCRs) shall be open and transparent and shall include a consultation with relevant stakeholders parties. Reasonable efforts should be made to achieve a consensus throughout the process (adapted from ISO 14020:2000, 4.9.1, Principle 8).

4. Striving for comparability

The results of PEF studies that have been conducted in line with this PEF guide and the relevant PFCR document may be used to support the comparison of the environmental performance of products on a life cycle basis. Therefore, comparability of the results is critical. The information provided for this comparison shall be transparent in order to allow the user to understand the limitations of comparability inherent in the calculation result (adapted from ISO 14025).

2. Role of Product Environmental Footprint Category Rules

2.1 General

Product Environmental Footprint Category Rules (PFCRs) can complement general methodological guidance for Product Environmental Footprint studies by providing further specification at the product level. PFCRs can thus make important contributions to increased reproducibility and consistency in Product Environmental Footprint studies.

PFCRs should, to the extent possible, be in conformity with existing international Product Category Rule (PCR) guidance documents. As defined in ISO 14025(2006), PCRs include sets of specific rules, guidelines and requirements that are aimed at developing “Type III environmental declarations” for any product category (i.e. goods and/or services providing equivalent functions). “Type III environmental declarations” are quantitative, LCA-based claims of the environmental aspects of a certain good or service, e.g. quantitative information regarding potential environmental impacts.

2.2 Role of PFCRs

Product Environmental Footprint Category Rules (PFCRs) aim at providing detailed technical guidance on how to conduct a Product Environmental Footprint (PEF) study for a specific product category. PFCRs provide a robust, life cycle based framework that complements the PEF methodological guide for the assessment of the environmental footprint of products. PFCRs shall provide further specification at the process and/or product level and thus have an important role in increasing the reproducibility, consistency, and relevance of product environmental footprint studies. PFCRs facilitate focusing on the most important parameters, thus also possibly reducing time and efforts for completing a PEF study.

In particular, PFCRs should provide further specification and guidance in e.g.:

- Defining the goal and scope
- Defining relevant/irrelevant impact categories
- Identifying appropriate system boundaries for the analysis
- identifying environmentally significant versus insignificant processes
- identifying key parameters and life cycle stages
- providing guidance as to possible data sources in line with the hierarchy specified in the Product Environmental Footprint guide
- completing the Resource Use and Emissions Profile phase
- Providing further specification on how to solve multi-functionality problems

2.3 Relation between PFCRs and Product Category Rules (PCRs)

For development and review of Product Category Rules (PCRs) ISO 14025(2006) describes the procedure and establishes requirements for comparability of different so called “Type III environmental declarations”.

The minimum content of a PCR document has been used as basis for the guidelines on how to develop PFCRs. Following ISO 14025 for PCRs this includes, but is not limited to:

- Identification of the product category for which a PCR is to be developed, including a description of e.g., the product's function(s), technical performance and utilization(s)
- Definition of goal and scope for the LCA of the product, according to the requirement of the ISO 14040 series in terms of e.g. functional unit, system boundary, data quality requirements, cut-off rules
- Description of the Life Cycle Inventory (LCI) analysis, with special focus on the data collection phase, calculation procedures, and allocation rules
- Choice of the environmental impact category indicators to be included in the LCA
- Description on any eventual predetermined parameter for reporting of LCA data, e.g. certain predetermined inventory data categories and/or impact category indicators
- If not all life cycle stages are included in the LCA, information/justification on which stages are not covered is to be provided
- Time span of validity of the PCR being developed

If there is/are other PCRs available from other schemes, these PCRs shall be checked for compliance with the PEF guide. If the PCR is not compliant with the PEF guide it can be used as a starting point for development of a PFCR.

2.4 The CPA-based PFCR structure

The PFCR document describes the type of information to be given about a product from a life cycle perspective as well as how this information shall be generated. Classification of Products by Activity (CPA) scheme shall be used for coding and defining the information modules used to represent the product life cycle. CPA product categories are related to activities as defined using NACE codes (i.e. by the Statistical classification of economic activities in the European Community). Each CPA product is assigned to one single NACE activity, hence the CPA structure is parallel to that of NACE at all levels.

An example of such an approach for a PFCR document is given below for "Milk and milk-based products." Here, the two-digit code (divisions) defines an industry specific product group (e.g. division 10. Food products) which has a number of individual products coded under it (e.g. group 10.51.11 Processed liquid milk and cream). Thus, the two-digit code, and sometimes the one digit code, may be used to define industry specific information modules which, when combined, build up specific product life-cycles in a horizontal dimension. Each of these also provides an embedded vertical structure going from a general product group to more specific individual products.

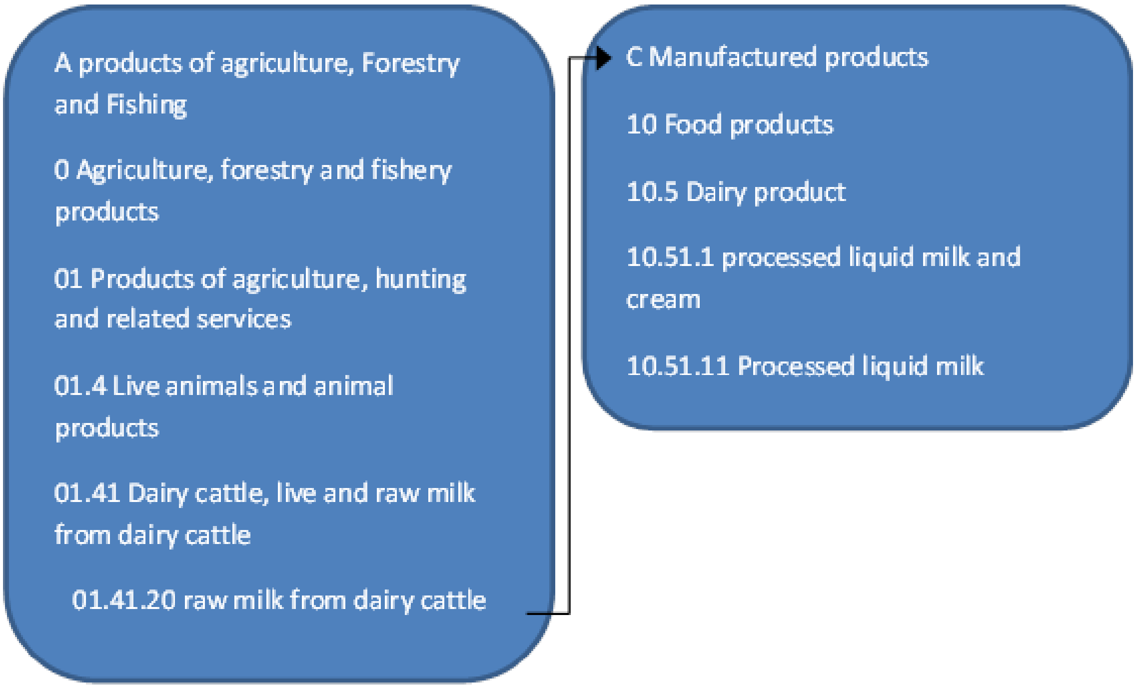

Figure 1: Outline of the principles of the CPA classification scheme

Product Environmental Footprint Category Rules shall be based on two-digit code divisions of CPA.

3. Summary of Product Environmental Footprint Requirements and Requirements for Developing Product Footprint Category Rules

Table 1: Summary of Product Environmental Footprint requirements and additional requirements for developing PFCRs

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
	General Approach	PEF studies shall be based on a life cycle approach	- Specify general Information about the context in which the Product Environmental Footprint Category Rules are developed, e.g. a program (if any) • General Introduction to the program (if any) • The role of PFCR (scope)
	Principles	Users of this guide shall observe the following principles in conducting a Product Environmental Footprint study: • Relevance • Completeness • Consistency • Accuracy • Transparency	- Relationship with the Product Environmental Footprint (PEF) guide: The methodological requirements set out for PFCRs shall apply to Product Environmental Footprint studies in addition to the requirements of the PEF guide. These more specific requirements take precedence over the more general requirements described in the PEF guide. - Modularity LCA-based data for materials, energy carriers, and other inputs that are used in the manufacture or assembly of products may be used to calculate the PEF for those products. In such circumstances, the LCA-based data for the inputs shall be referred to as information modules and may represent the whole or a portion of the life cycle of the inputs. Information modules may be used to develop a PEF or may be combined to develop a PEF for a product, provided that the information modules are in compliance with the PEF general guide and also with the PFCR for the

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
			product category (adapted from ISO 14025). - Involvement of selected interested parties The process of developing Product Environmental Footprint Category Rules (PFCRs) shall be open and transparent and shall include a consultation with relevant stakeholders parties. Reasonable efforts should be made to achieve a consensus throughout the process (adapted from ISO 14020:2000, 4.9.1, Principle 8). - Striving for comparability The results of PEFs that have been conducted in line with the PEF general guide and the relevant PFCR document may be used to support the comparison of the environmental performance of products on a life cycle basis. Therefore, comparability of the results is critical. The information provided for this comparison shall be transparent in order to allow the user to understand the limitations of comparability inherent in the calculation result (adapted from ISO 14025).
	Defining the product category subject to the PFCR		- Define the product group that is subject to the PFCR - Include as wide a range of product groups as possible based on functions, purposes, regulations, and industry categories. - If a specific product group must be selected, the reason shall be provided.
	Range of products (OPTIONAL)		- Define the range of products that are subject to calculations. - Consider the main functions and sales units of the products.

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
	Product Specifications		- The product specifications are to be provided in proper form.
	Goal definition	Goal definition for a Product Environmental Footprint study shall include: • Intended application(s) • Reasons for carrying out the study and decision context • Target audience • Whether for the purpose of comparative assertions[3] to be disclosed to the public • Commissioner of the study • Review procedure (if applicable)	- specify the review requirements for PFCR studies.
	Scope definition	Scope definition for a Product Environmental Footprint study shall include: • Unit of analysis (functional unit) and reference flow • System boundaries • Cut-off criteria • Environmental footprint impact categories • Limitations due to assumptions, data, and impact coverage	
	Unit of analysis and reference flow	The functional unit for a Product Environmental Footprint study shall be defined according to the following aspects: • The function(s)/service(s) provided: "what"	The PFCR shall specify the functional unit(s) or provide further guidance as to how these shall be defined for product category PEF studies

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Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		• The magnitude of the function or service: "how much" • The duration of the service provided or service life time: "how long" • The expected level of quality: "how well" An appropriate reference flow shall be determined in relation to the functional unit. The quantitative input and output data collected in support of the analysis shall be calculated in relation to this flow	
	System boundaries (Product life cycle stages)	The system boundaries shall include all relevant processes in the product supply chain. To establish whether or not a certain process is environmentally relevant, cut-off rules shall be established and applied.	- specify the system boundaries for product category PEF studies, including specification of relevant processes
	Offsets	Offsets shall not be included in the Product Environmental Footprint. However, they may be reported separately as "additional environmental information.	
	Environmental Footprint impact categories and additional environmental in formation	Default Categories: • Climate change • Ozone depletion • Human toxicity, cancer effects • Human toxicity, non-cancer effects • Particulate matter/Respiratory inorganics • Ionising radiation, (human health) • Photochemical ozone formation • Acidification • Eutrophication, terrestrial	- specify: • the mandatory environmental footprint impact categories that must be considered for the product category in question, as well as those that may be excluded • additional environmental information that is to be included in the PEF study. Additional environmental information may include: ○ Other relevant environmental impacts for the product category

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		• Eutrophication, aquatic • Ecotoxicity (aquatic, freshwater) • Land Transformation[4] • Resource depletion, water • Resource depletion, mineral, fossil and Renewable The specified impact assessment models shall be implemented. For a Product Environmental Footprint study, all of the specified default environmental footprint impact categories and associated specified impact assessment models shall be applied. Any exclusion shall be explicitly justified and their influence on the final results discussed. Such exclusions are subject to review. Justification shall be supported by documents derived from: • International consensus process • Independent external review • Multi-stakeholder process Additional relevant environmental indicators can be included as appropriate as "additional	○ Environmental indicators or Product responsibility indicators (as per the Global Reporting Initiative (GRI)) ○ Total energy consumption by primary energy source, separately accounting for "renewable" energy use ○ Direct energy consumption by primary energy source, separately accounting for "renewable" energy use for facility gate ○ For gate-to–gate phases, Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk ○ Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas. ○ Total weight of waste by type and disposal method. ○ Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally • justifications for inclusions/exclusions

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Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		environmental information", with all supporting methods clearly referenced/documented.	
	Cut off criteria	If cut-offs are applied, they should be based on contributions to each environmental impact category. The threshold shall be 90% inclusiveness. Any cut-offs must be justified and their potential influence on final results assessed.	- specify more stringent cut-off rules for the PFCR, if appropriate for the product category considered and identify processes to be included/excluded. These may include: • gate-to-gate activities/processes • upstream or downstream phases • environmentally significant processes • key supply chain activities for the product category • key environmental footprint impact categories for the product category
	Resource Use and Emissions Profile	All relevant resource use and emissions associated with the life cycle stages included in the defined system boundaries shall be included in the Resource Use and Emissions Profile	The PFCR should provide one or more templates for compiling the Resource Use and Emissions Profile, including specifications with respect to: • substance lists for included activities/processes • units • nomenclature for elementary flows These may apply to one or more supply chain stages, processes, or activities, for the purpose of ensuring standardized data collection and reporting. The PFCR may specify more stringent data requirements for key upstream, gate-to-gate or downstream phases than those defined in the PEF general guide. For modelling processes/activities within the core module (i.e. gate-to-gate phase), the PFCR shall also specify: • Included processes/activities

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
			• Specifications for compiling data for key processes, including averaging data across facilities • Any site-specific data required for reporting as "additional environmental information" • Data quality requirements The PFCR shall also specify: • The use phase and end-of-life scenarios to be included in the study • Transport scenarios to be included in the study
	Temporary Storage, Delayed Emissions, and Delayed Credits	Credits associated with temporary storage and delayed emissions shall not be considered in the Product Environmental Footprint calculation.	
	Screening phase to identify environmentally significant processes	The organisation shall use a screening step to identify relevant processes. At least "fair quality" data shall be used to identify relevant processes.	In place of the screening phase, the PFCR shall specify the environmentally significant processes that must be taken into account. The PFCR shall also specify for which processes specific data is required, and for which the use of generic data is either permissible or required.
	Nomenclature	All relevant resource use and emissions associated with the life cycle stages included in the defined system boundaries shall be documented using ILCD Nomenclature. If nomenclature and properties for a given flow are not available in the ILCD, the practitioner must create an appropriate nomenclature and document the flow properties	
	Data Quality requirements	For the most environmentally significant processes or activities, accounting for at least 70% of	

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		contributions to each impact category, both directly collected (specific) and generic data shall achieve at least an overall "good quality" level. A semi-quantitative assessment of data quality shall be performed and reported for these processes. For environmentally significant processes accounting for the subsequent 20% (i.e. from 70% to 90%) of contributions to environmental impacts, at least "fair quality" data shall be used, as assessed via qualitative expert judgment. Remaining data (used for approximation and filling identified gaps (beyond 90% contribution to environmental impacts)) shall be based on best available information.	
	Specific data collection	Specific data (including average data representing multiple sites whether internally or provided by a supplier) must be obtained for all significant/relevant foreground processes and for significant background processes where possible.	1. Specify for which processes specific data has to be collected. 2. Specify the requirements for directly collected data for each environmentally significant process. 3. Define the data collection range for the conditions listed below for each site: - Target stage(s) and the data collection coverage, - Location of data collection (domestically, internationally, representative factories, and so on), - Term of data collection (year, season, month, and so on),

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
			- When the location or term of data collection must be limited to a certain range, provide a reason and show that the collected data will serve as sufficient samples. - Note: The basic rule is that the location of data collection is all target areas and the term of data collection is a year or more.
	Generic data collection	Generic data shall be used only if data for a specific process are unavailable, not environmentally significant. Generic data shall, as far as possible, fulfill the data quality requirements specified in this guidance document. Subject to data quality requirements, generic data should be preferentially sourced from the identified priority data sources.	- Specify where the use of generic data is permitted as an approximation for a substance for which specific data is not available) - Specify the level of required similarities between the actual substance and the generic substance - Specify the combination of more than one generic data sets, if necessary
	Data Gaps for Specific Data	Data gaps for specific data - Any data gaps for environmentally significant processes shall be filled using generic or extrapolated data that achieves at least a “fair” data quality level rating. Such processes (including generic data gaps) shall not account for more than 10% of the overall contribution to each impact category considered based on the initial screening phase.	- The PFCR shall specify potential data gaps and provide detailed guidance for filling data gaps
	Data Gaps for Generic Data	Data gaps for generic data - Any data gaps for environmentally significant processes shall be filled using extrapolated data or other data that achieves	- The PFCR shall specify potential data gaps and provide detailed guidance for filling data gaps

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		at least a "fair" data quality level rating. Such processes (including specific data gaps) shall not account for more than 10% of the overall contribution to each impact category considered based on the initial screening phase.	
	Handling Multi functionality	The Product Environmental Footprint multi-functionality decision hierarchy shall be applied for resolving all multi-functionality problems at both process and facility-level. All choices made in this context shall be reported and justified with respect to the overarching goal of ensuring physically representative, environmentally relevant results. For substitution in recycling situations the equation described in Annex III shall be applied. Default recycling rates and prices are given. Companies can use more relevant values if available and justifiable. Specific multi-functionality solution shall be provided in PFCRs, where available.	The PFCR shall further specify multi-functionality solutions for application within the defined system boundaries and, where appropriate, for upstream and downstream phases. If feasible/appropriate, then PFCR may further provide specific factors to be used in the case of allocation solutions. All such multi-functionality solutions specified in the PFCR must be clearly justified with reference to the PEF multi-functionality solution hierarchy, using the template provided. Where sub-division is to be applied, the PFCR shall specify which processes are to be sub-divided and according to what principles. Where substitution is to be applied, the PFCR shall specify the substitution scenarios, including the specific or market-mix substitutes that are required. Where allocation by physical relationship is to be applied, the PFCR shall specify the relevant underlying physical relationships to be considered, and establish the relevant allocation factors.

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
			Where allocation by some other relationship is to be applied, the PFCR shall specify the relationship and establish the relevant allocation factors. For example, in the case of economic allocation, the PFCR shall specify the rules for determining the economic values of co-products.
	Environmental Footprint Impact Assessment	Environmental footprint impact assessment shall include: • Classification • Characterisation	
	Classification	All inputs/outputs tabulated during the compilation of the Resource Use and Emissions Profile shall be assigned to the environmental footprint impact categories to which they contribute ("classification") using the provided classification data.	
	Characterisation	All classified inputs/outputs in each environmental footprint impact category shall be assigned characterisation factors representing the contribution per unit input/output to the category, using the specified characterisation factors. Environmental footprint impact assessment results shall subsequently be calculated for each category by multiplying the amount of each input/output by its characterisation factor and summing contributions of all inputs/outputs within each category to a single measure expressed in terms of an appropriate reference unit.	
	Normalisation (if	Normalization is not a required step for	

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
	applied)	Organisation Environmental Footprint studies. If normalization is applied, the normalized environmental footprint results shall be calculated using the provided normalization factors. Other normalization factors can be used in addition to those provided and the results reported under “additional environmental information”. Normalized results shall not be aggregated as this implicitly applies a weighting factor (i.e. one)	
	Weighting (if applied)	If weighting is applied, the environmental footprint results shall be multiplied by the weighting factors provided. Other weighting factors can be used in addition to those provided. Weighted results shall be reported as “additional environmental information, with all methods and assumption documented. Results of the environmental footprint impact assessment prior to weighting have to be reported alongside weighted results.	
	Interpretation	Interpretation of the Product Environmental Footprint study shall include: • Identification of significant issues • Identification of uncertainties • Conclusions, recommendations including	

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		improvement potentials, and limitations	
	Identification of Significant Issues	Significant methodological issues shall be evaluated using a combination of completeness and consistency checks as appropriate. Product Environmental Footprint results shall subsequently be evaluated to assess supply chain hotspots/weak points on input/output, process, and supply chain stage bases and to assess improvement potentials.	
	Identification of Uncertainties	A qualitative description of uncertainties shall be provided.	
	Conclusions, Recommendations, and Limitations	Conclusions, recommendations and limitations shall be described in accordance with the defined goals and scope of the Product Environmental Footprint. Product Environmental Footprint studies intended to support comparative assertions (i.e. claims about the environmental superiority or equivalence of product compared to other product) cannot be made on the basis of studies using only the PEF guide but rather shall be based both on PEF guide and related Product Footprint Category Rules (PFCRs).	
	Report	The study report shall include, at a minimum, an executive summary, technical summary,	If necessary, specify requirements for a report template that are appropriate beyond those provided in the PEF general guide

Chapter	Criteria	Requirements for PEF	Additional Requirements for Developing PFCRs
		environmental footprint impact assessment, and any necessary supporting information.	
	Review	If intended for external use, the study shall be reviewed by an independent and qualified external reviewer (or review team).	
	Reviewer Qualifications	A review of the Product Environmental Footprint study shall be conducted as per the requirements of the intended application. Unless otherwise specified, the minimum necessary score to qualify as a reviewer is 6 points, including at least one point for each of the three mandatory criteria (i.e. verification and audit practice, LCA methodology and practice, and technologies or other activities relevant to the Product Environmental Footprint study). Reviewers or panels of reviewers must provide a self-declaration of their qualifications, stating how many points they achieved for each criterion.	

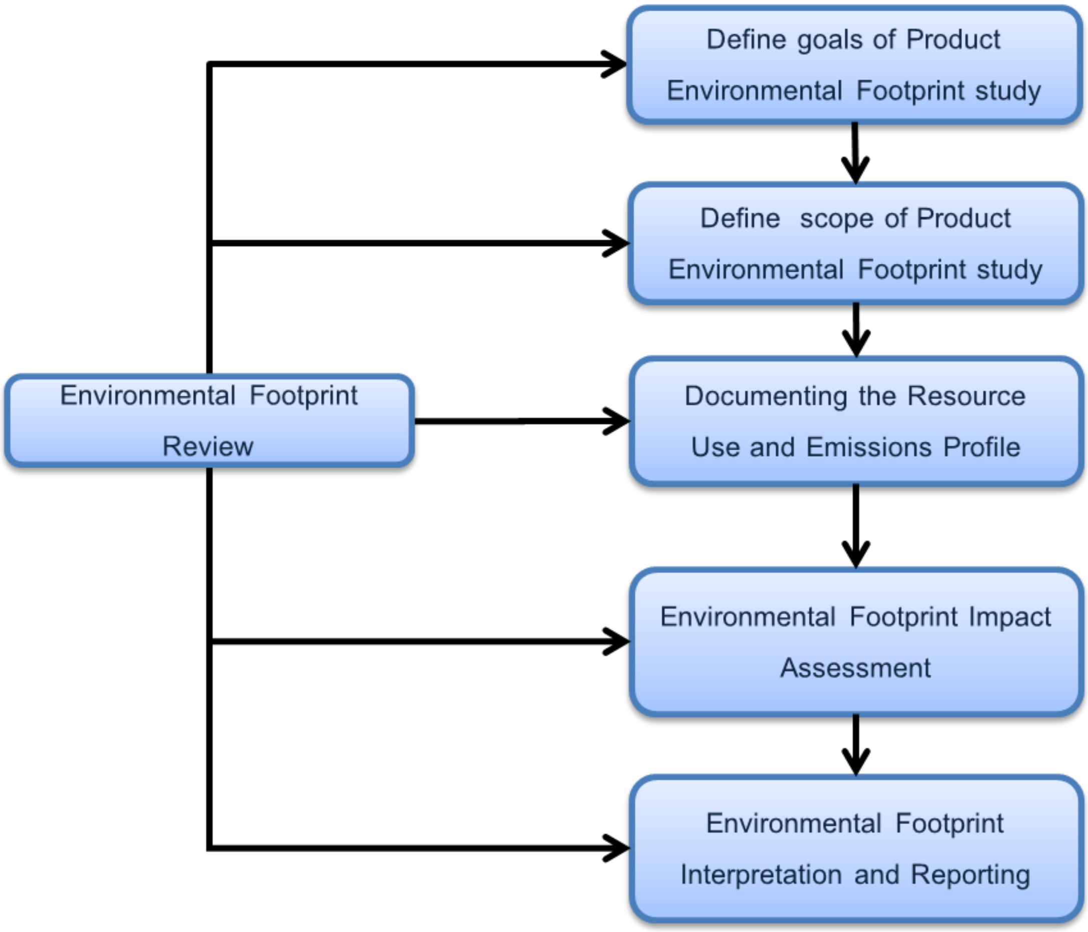

Figure 2: simplified diagram for Product Environmental Footprint studies

4. Defining the Goal(s) of the Product Environmental Footprint Study

4.1 General

Goal definition is the first step of a Product Environmental Footprint study, and sets the overall context for the study. The purpose of clearly articulating goals is to ensure that the analytical aims, methods, results and intended applications are optimally aligned, and that a shared vision is in place to guide participants in the study. The choice to use the Product Environmental Footprint guidance implies that some aspects of goal definition will be, a priori, decided. Nonetheless, taking the time to carefully consider and articulate goals will be an important step towards the success of the Product Environmental Footprint.

An important element of the goal definition phase is to identify the intended applications of the study, and the associated necessary degree of analytical depth and rigor. In turn, this should be reflected in the defined study limitations (Scope definition phase). For analyses geared towards least-environmental cost sourcing, product design, benchmarking or reporting, fully quantitative studies in conformance with the analytical requirements specified in this general guide will be necessary. Combined approaches where only certain parts of the supply chain are subject to quantitative analysis and others to qualitative descriptions of potential environmental hotspots are also possible (for example, a quantitative cradle-to-gate analysis combined with qualitative descriptions of gate-to-grave environmental considerations or with quantitative analyses of the use and end of life stages for selected representative product/service types).

REQUIREMENT: Goal definition for the Product Environmental Footprint study shall include:

- Intended application(s)
- Reasons for carrying out the study and decision context
- Target audience
- Commissioner of the study
- Review Procedure

Table 2: Example - Environmental Footprint of T-shirt

Aspects	Detail
Intended application(s):	Provide product information to customer
Reasons for carrying out the study:	Respond to a request from a customer
Assumptions	Use phase and end-of-life management data are based on a final user survey
Comparisons intended to be disclosed to the public:	No

Target audience	External, technical audience, business-to-business.
Review	Independent external reviewer, Mr. Y
Commissioner of the study:	G company limited

The PFCR shall the review requirements.

5. Defining the Scope of the Product Environmental Footprint Study

5.1 General

Defining the scope of the Product Environmental Footprint study refers to describing in detail the system to be evaluated along with the associated analytical specifications. Scope definition must be in alignment with the defined study goals and the requirements of the Product Environmental Footprint guidance. The unit of analysis (functional unit), reference flow, system boundaries, cut-off rules and environmental footprint impact categories for Product Environmental Footprint shall be identified and clearly described, along with any important assumption/limitations.

REQUIREMENT: Scope definition shall include:

- Unit of analysis (functional unit) and reference flow
- System boundaries
- Cut-off criteria
- Environmental footprint impact categories
- Assumptions/Limitations

5.2 Unit of analysis (functional unit) and reference flow

Users of the Product Environmental Footprint guidance are required to define the unit of analysis and reference flow for the Product Environmental Footprint study. The unit of analysis, also called the "functional unit", describes qualitatively and quantitatively the function(s) or the service(s) provided by the product, as well as their duration. In practice, the definition of the functional unit answers the questions "what", "how much", "how well", and "for how long".

REQUIREMENT:

The functional unit shall be defined according to the following aspects:

- They function(s)/service(s) provided: “what”
- The magnitude of the function or service: “how much”
- The duration of the service provided or service life time: “how long”
- The expected level of quality: “how well”

The PFCR shall specify the functional unit(s) or provide further guidance as to how these shall be defined for product category PEF studies

Example:

> Guide/Requirement: Define functional unit
>
> Names and quantifies the qualitative and quantitative aspects of the function(s) of product along the questions "what", "how much", "how well", and "for how long".

> Example define functional unit,
> Function unit of T shirt:
> (WHAT) T shirt (average for size S, M, L) made from polyester,
> (HOW MUCH) One T shirt,
> (HOW WELL) Wear One time per week and use washing machine at 30 degree for cleaning
> (HOW LONG) for 5 years.

Note:

Some interim products may have more than one function. It may be necessary to identify and choose among these functions.

The reference flow is the amount of product necessary to provide the defined function. It constitutes the flow(s) to which all other input and output flows in the analysis quantitatively relate. The reference flow can be expressed in direct relation to the functional unit or in a more product-oriented way.

> REQUIREMENT: An appropriate reference flow shall be determined in relation to the functional unit. The quantitative input and output data collected in support of the analysis shall be calculated in relation to this flow.

Example:

> Reference flow: 160 gram of T-shirt

5.3 System boundaries for Product Environmental Footprint Studies

The system boundaries define which parts of the product life cycle and which associated processes belong to the analysed system (i.e. are required for providing its function as defined by the functional unit). Therefore, the system boundary must be clearly defined for the product system to be evaluated.

The system boundary should be defined following general supply-chain logic, including all phases from raw material extraction through processing, distribution, the use phase and end-of-life treatment of the product, as appropriate to the intended application of the study. If a Product Footprint Category Rules (PFCR) is developed, the relevant processes will be further specified in the sector or product specific requirements, including temporal, geographical, and technological specifications.

Off-set emissions (e.g. due to carbon off-setting by the Clean Development Mechanism, carbon credits, and other system-external off-sets) **are not to be included** in the system boundaries and the related (reduced) emissions are not to be integrated into the inventory.

System boundary diagram

A system boundary diagram is a schematic representation of the analyzed system. It details which parts of the product life cycle are included or excluded from the analysis. A system boundary diagram can be a useful tool in defining the system boundary and organizing subsequent data collection activities.

REQUIREMENT: The system boundaries shall include all relevant processes in the product supply chain. To establish whether or not a certain process is environmentally relevant, cut-off rules shall be established and applied.

The PFCR shall specify the system boundaries for product category PEF studies, including specification of relevant processes

Offsets

The term "offset" is frequently used with reference to third-party greenhouse gas mitigation activities. Offsets are discrete GHG reductions used to compensate for (i.e., offset) GHG emissions elsewhere, for example to meet a voluntary or mandatory GHG target or cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project that generates the offsets. To avoid double counting, the reduction giving rise to the offset must occur at sources or sinks not included in the target or cap for which it is used.

REQUIREMENT: Offsets shall not be included in the Organisation Environmental Footprint study. However, they may be reported separately as "additional environmental information."

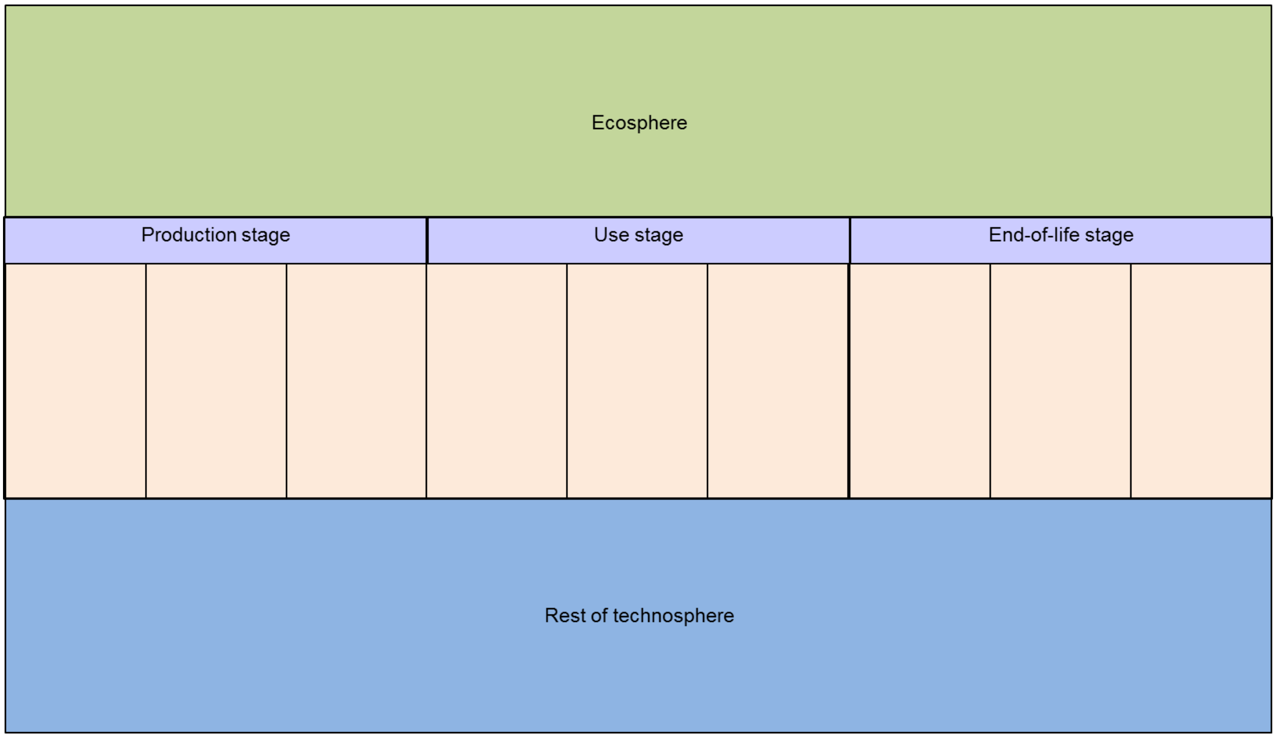

Figure 3: system boundary diagram of environmental footprint of T-shirt (example) from Cradle to Grave

5.4 Selecting Environmental Footprint Impact Categories and Assessment Methods

Environmental footprint impact categories refer to specific categories of environmental impacts considered in a Product Environmental Footprint study. These are generally related to resource use (for example fossil fuels and mineral ores) or emissions of environmentally problematic substances, such as greenhouse gases or toxic chemicals. Environmental footprint impact assessment methods use models for quantifying the causal relationships between the material/energy inputs and emissions associated with the product life cycle (tabulated in the Resource Use and Emissions Profile) and each environmental footprint impact category considered. Each impact category hence has an associated, stand-alone environmental footprint impact assessment method.

The purpose of environmental footprint impact assessment is to group and aggregate the collected inventory data (Resource Use and Emissions Profile) according to the respective contributions to impact category. This subsequently provides the necessary basis for interpretation of the footprint results relative to the goals of the footprint study (for example, identification of supply spots" and option s for improvement). The selection of environmental footprint impact categories therefore be comprehensive in the sense that they cover all relevant environmental issues related to product supply chain of interest.

Table 3 provides a default list of environmental impact categories and related assessment methods to be used.

Table 3: Default environmental footprint impact categories and impact assessment models for Product Environmental Footprint studies.

Environmental Footprint Impact Category	Impact Assessment Model	Source
Climate Change	Bern model - Global Warming Potentials (GWP) over a 100 year time horizon.	Intergovernmental Panel on Climate Change, 2007
Ozone Depletion (OD)	EDIP model based on the ODPs of the World Meteorological Organisation (WMO)	WMO 1999
Ecotoxicity – aquatic, freshwater	USEtox model	Rosenbaum et al, 2008
Human Toxicity - cancer effects	USEtox model	Rosenbaum et al, 2008
Human Toxicity – non-cancer effects	USEtox model	Rosenbaum et al, 2008
Particulate Matter/Respiratory Inorganics	RiskPoll model	Rabl and Spadaro, 2004
Ionising Radiation – human health effects	Human Health effect model	Dreicer et al. 1995
Photochemical Ozone Formation	LOTOS-EUROS model	Van Zelm et al, 2008 as applied in ReCiPe
Acidification	Accumulated Exceedance model	Seppälä et al.,2006, Posch et al, 2008
Eutrophication – terrestrial	Accumulated Exceedance model	Seppälä et al.,2006, Posch et al, 2008
Eutrophication – aquatic	EUTREND model	Struijs et al, 2009 as implemented in ReCiPe
Resource Depletion – water	Swiss Ecoscarcity model	Frischknecht et al, 2008
Resource Depletion – mineral, fossil	CML2002 model	Van Oers et al 2002
Land Transformation	Soil Organic Matter (SOM) model	Milà i Canals et al, 2007

To implement these methods, users of this guidance document shall apply the provided classification and characterization data (WEBLINK TO BE PROVIDED) (see section 7.1). For further information on specific impact assessment categories and methods, please refer to the ILCD Handbook: - Recommendations based on existing environmental impact assessment models and factors for Life Cycle Assessment in the European context[5].

Depending on the product system and intended application, users of this methodology guide may elect to narrow the suite of environmental impacts considered in the study. However, exclusion of any of the default impact categories must be sufficiently justified. Such justification may be supported by documents derived from the following processes:

:

- International consensus process
- Independent external review
- Multi stakeholder process

Example supporting documents meeting these criteria may come from:

- Previous, detailed OEF and PEF studies of similar systems
- Existing Ecolabel type I criteria for similar products
- Product Categories Rule from other initiatives/ schemes
- Criteria employed in EMAS for the product of concern
- Life cycle based macro level monitoring indicators on resources, products and wastes for the EU-27
- Environmental Key Performance Indicators for sectors, as reported by DEFRA (http://archive.defra.gov.uk/environment/business/reporting/pdf/envkpi-guidelines.pdf)
- Environmental Impact of Products (EIPRO) and Environmental Improvement of Products (IMPRO) studies
- normalization of Product Environmental Footprint results (see section 7.2.1),

Any exclusion of default impact categories must be explicitly documented and justified in the Product Environmental Footprint report.

All relevant information sources should be considered. The resource directory (http://lct.jrc.ec.europa.eu) facilitated by the European Commission Joint Research Centre (JRC), Institute for Environmental and Sustainability (IES) may be useful for this purpose.

The selection of environmental footprint impact categories should be guided by the following considerations:

- For which of the default environmental impact categories are the highest impact? (e.g. top five of the whole list);
- Where are the largest potentials for reducing environmental impacts?
- Where are the win/win opportunities for simultaneously reducing costs and impacts?
- What are the key stakeholder concerns related to environmental impacts?
- What are the existing environmental reporting requirements?

To identify relevant/irrelevant impact categories and/or methods, the form in Annex VII shall be used to ensure a thorough and systematic approach, as well as transparency of the process. Inclusion of additional environmental information (other environmental indicators, other impact categories and/or methods) should be similarly justified.

REQUIREMENT: For a Product Environmental Footprint study, all of the specified default environmental footprint impact categories and associated specified impact assessment models shall be applied. Any exclusion shall be explicitly justified and their influence on the final results discussed. Such exclusions are subject to review.

Justification shall be supported by documents derived from:

- International consensus process
- Independent external review
- Multi-stakeholder process

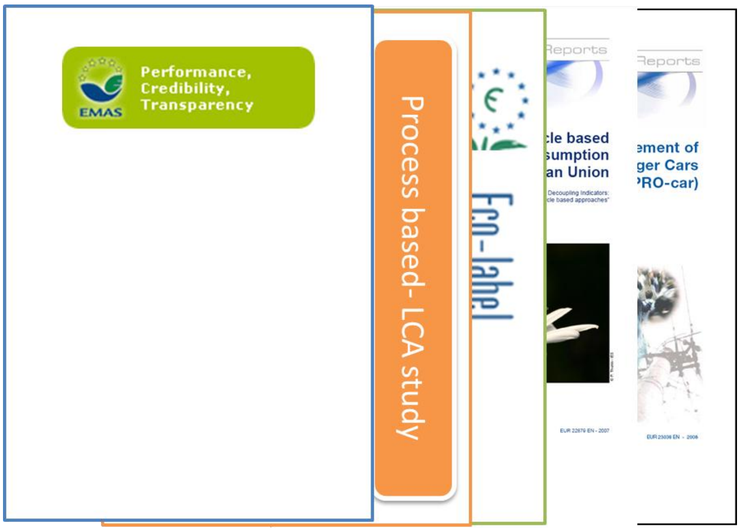

Figure 4: Potential sources of information for selection of relevant environmental footprint impact categories

Table 4: Example of selection of relevant environmental footprint impact categories for T-shirt study

Impact Categories Coverage	Life Cycle Impact Assessment Methods
Climate change,	Bern model - Global Warming Potentials (GWP) over a 100 year time horizon.
Acidification,	Accumulated Exceedance model
Eutrophication, aquatic	EUTREND model
Human toxicity,-cancer effects	USEtox model
Ecotoxicity	USEtox model

It is useful to further distinguish between "mid-point" and "end-point" environmental footprint impact assessment methods. The basis for the calculation of impact indicators using mid-point assessment methods is earlier in the cause-effect chain (for example, global warming potential reflect relative contributions to cumulative radiative forcing), whereas end-point assessment methods are based on impacts (for example, biodiversity loss due to e.g. climate change).

Both mid-point and end-point impact assessment methods are available for a variety of environmental impacts. Mid-point methods are generally better established (see ILCD …). They are hence preferred for Organisation Environmental Footprint studies. For example, impacts on biodiversity (end-point) are not calculated as such for Organisation Environmental Footprint studies, but are represented by indicators at mid-points for impact categories that negatively affect biodiversity, predominantly eco-toxicity, eutrophication, acidification, land use, climate change, and ozone depletion. Many pressures on biodiversity are hence well represented in the environmental footprint, even though a direct measure of biodiversity loss is not explicitly accommodated.

5.5 Selecting additional environmental information to be included in the PEF

Even where widely accepted life cycle-based environmental impact assessment methods do not exist, however, it is important to consider as many relevant environmental impacts as is feasible – for example, biodiversity impacts that may occur in association with a specific site or activity. This may require the application of additional environmental impact assessment methods beyond the default list provided in this guidance document, or even additional qualitative descriptions where impacts cannot be linked to the product supply chain in a quantitative manner. Such additional methods should be viewed as complementary to the default suite of product environmental footprint impact categories.

The PFCR shall specify additional environmental information that must be presented, or that is recommended to be presented as relevant to the product category of concern. Such additional information shall be reported separately from the life-cycle based PEF results, with all methods and assumptions clearly documented. Additional environmental information may be quantitative and/or qualitative.

Additional environmental information shall be:

- Based on information that is substantiated and has been reviewed or verified, in accordance with the requirements of ISO 14020 and Clause 5 of ISO 14021:1999, and
- Specific, accurate and not misleading, and
- Relevant to the particular product category

Additional environmental information may include, for example:

(a) Bill-of-materials data;
(b) Disassemblability, recyclability, recoverability, and reusability information;
(c) Information on the use of hazardous substances;
(d) Information on disposal of hazardous/non-hazardous waste;
(e) Information on energy consumption;
(f) Information on local/site specific impacts, e.g. on biodiversity;
(g) Other relevant environmental information on the activities and/or sites involved, as well as on the product output.

Note: Additional environmental information shall only be related to environmental issues. Information and instructions, e.g. product safety sheets that are unrelated to the environmental performance of the product shall not be part of a PEF.

Annex VII provides the template that shall be used for justifying the inclusion of additional environmental information.

The PFCR shall specify:

- the mandatory environmental footprint impact categories that must be considered for the product category in question, as well as those that may be excluded
- additional environmental information that is to be included in the PEF study. Additional environmental information may include:
  - Other relevant environmental impacts for the product category
  - Environmental indicators or Product responsibility indicators (as per the Global Reporting Initiative (GRI))
  - Total energy consumption by primary energy source, separately accounting for “renewable” energy use
  - Direct energy consumption by primary energy source, separately accounting for “renewable” energy use for facility gate
  - For gate-to–gate phases, Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk
  - Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas.
  - Total weight of waste by type and disposal method.
  - Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally
- justifications for inclusions/exclusions

5.6 Cut-off Criteria

In principle, all processes and flows that are attributable to the analyzed system within the defined system boundaries are to be considered in the Product Environmental Footprint study. However, not all these processes and flows may be environmentally significant. Cut-off criteria serve to establish thresholds for inclusion of environmentally significant processes and flows, in the interest of balancing returns on effort and analytical robustness.

Neither the Product nor the Organisation Environmental Footprint methods provide for systematically excluding specific classes of activities – for example, employee commuting, business travel, or capital goods. Rather, all activities should be assessed for environmental significance in order to support inclusion or exclusion from the analysis. The cut-off criterion to be applied in Product Environmental Footprint studies is that modeled flows must account for at least 90% of the overall contributions to each of the environmental impact categories considered.

REQUIREMENT: If cut-offs are applied, they should be based on contributions to each environmental impact category. The threshold shall be 90% inclusiveness. Any cut-offs must be justified and their potential influence on final results assessed.

TIP: identify the 90 % cut-off level by using generic data to estimate the overall environmental impact of the product system for each impact category during the screening phase.

PFCRs may specify more stringent cut-off rules, if appropriate for the product category considered, and identify processes to be included/excluded. These may include:

- gate-to-gate activities/processes
- upstream or downstream phases
- environmentally significant processes
- key supply chain activities for the product category
- key environmental footprint impact categories for the product category

6. Compiling and Recording the Resource Use and Emissions Profile

6.1 General

An inventory (profile) of all environmentally significant material/energy resource inputs/outputs and emissions into air, water and soil for the product supply chain shall be compiled as a basis for modeling the Product Environmental Footprint. This is called the Resource Use and Emissions Profile.

Ideally, the model of the product supply chain would be constructed using facility or product/service specific data (i.e. modeling the exact life cycle depicting the supply-chain, use, and end-of-life phases as appropriate). In practice, and as a general rule, for directly collected, facility-specific inventory data should be used wherever possible. For processes where the company does not have direct access to specific data, generic data will typically be used. However, it is good practice to attempt to access directly collected data from suppliers when possible, in particular for environmentally significant processes. Generic data is data sourced from third-party life cycle inventory databases, government or industry association reports, statistical databases, peer-reviewed literature, or other sources. All such data shall satisfy the quality requirements specified in the Organisation Environmental Footprint guidance document.

Documenting the data collection process is useful for improving the data quality over time, preparing for assurance, and revising future product inventories to reflect changes in production practices. To ensure that all of the relevant information is documented, it may be helpful to establish a data management plan early in the inventory process (see Annex II).

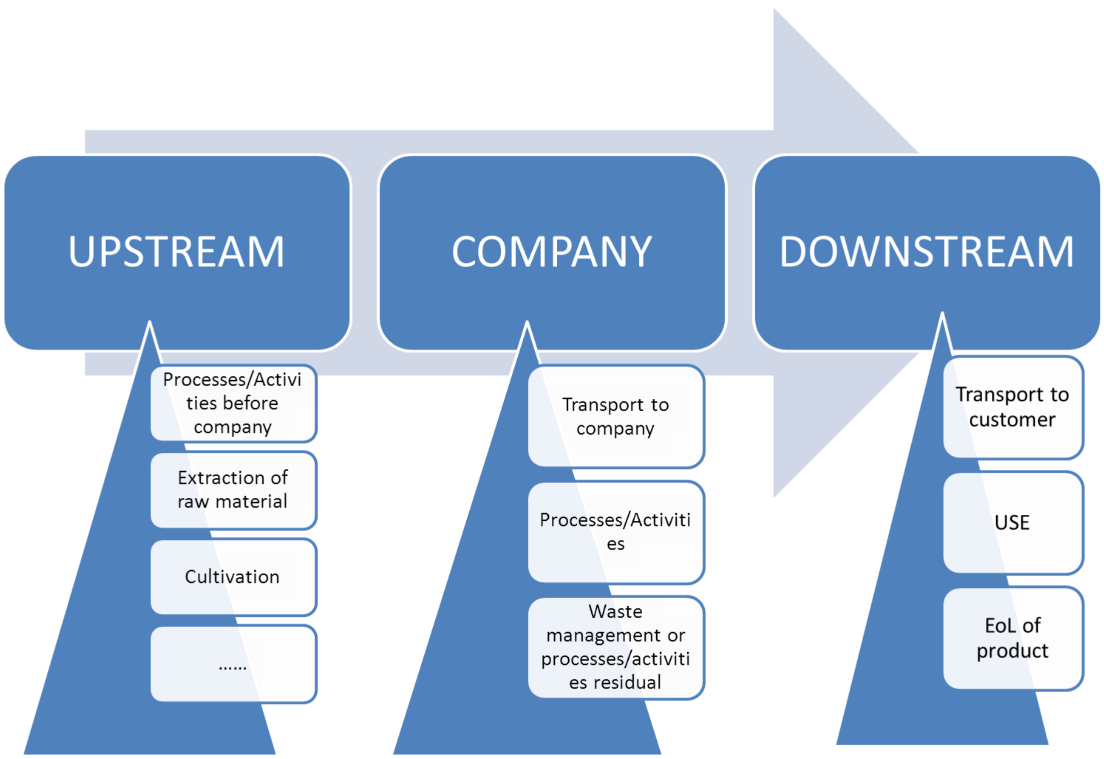

Figure 5: Examples of upstream and downstream processes

Documenting the data collection process is useful for improving the data quality over time, preparing for assurance, and revising future product inventories to reflect changes in the product's life cycle. To ensure that all of the relevant information is documented, it may be helpful to establish a data management plan early in the inventory process (see Annex II).

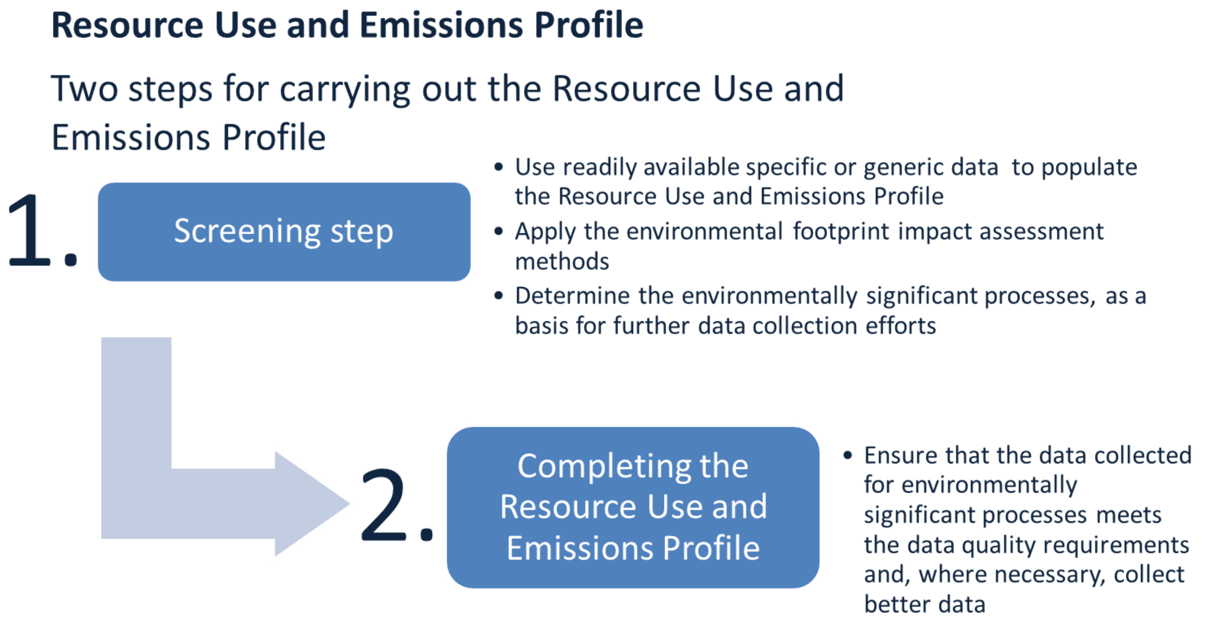

Figure 6: Two-step procedure to build a resource use and emissions profile

6.2 Screening phase to identify environmentally significant processes within the product system boundary

An initial "screening-level" Resource Use and Emissions Profile shall be constructed using generic data, and environmental footprint impact assessment methods applied, in order to identify the most environmentally significant processes or activities accounting for at least 70% of contributions to each environmental footprint impact category. At least "fair quality" data is to be used to identify the environmentally significant processes, as assessed via expert judgment. The data selection process must further be documented and is subject to review. The results of the screening exercise subsequently inform the data quality requirements for completing the Resource Use and Emissions Profile (i.e for which processes "good" quality data is required). In turn, this screening study can help focus data collection activities and data quality priorities for the actual Resource Use and Emissions Profile.

REQUIREMENT: The organisation shall use a screening step to identify relevant processes. At least "fair quality" data shall be used to identify relevant processes.

In place of the screening exercise, the PFCR shall specify the most environmentally significant processes, as well as associated data quality and review requirements, which may exceed those of the general guide. It shall also specify for which processes specific data is required, for which the use of generic data is either permissible or required.

6.3 Data management plan

A data management plan may be a valuable tool for managing data and for tracking the process of compiling the product Resource Use and Emissions Profile.

The data management plan can include:

- A description of data collection procedures
    - Upstream and downstream system – specific, average, or generic data?
- Data sources
- Calculation methodologies
- Data transmission, storage and backup procedures
- Quality control and review procedures for data collection, input and handling activities, data documentation and emissions calculations.

For additional guidance on possible approaches to formulating a data management plan, see Annex II.

6.4 Sources of Resource Use and Emissions Profile Data

Raw Material Acquisition and Pre-processing (Cradle-to-Facility Gate)
The raw material acquisition and pre-processing stage starts when resources are extracted from nature and ends when the product components enter the gate of the studied product's production facility. Processes that may occur in this stage include e.g.:

- Mining and extraction of resources
- Pre-processing of all material inputs to the studied product, such as:
    - Forming metals into ingots
    - Cleaning coal
- Conversion of recycled material
- Photosynthesis for biogenic materials
- Cultivation and harvesting of trees or crops
- Transportation within and between extraction and pre-processing facilities, and to the production facility

Capital goods (if environmentally significant)
Examples of capital goods to be included in Product Environmental Footprint studies include:

- Machinery used in production processes
- Buildings

- Office equipment
- Transport vehicles
- Transportation infrastructure

Production

The production stage begins when the product components enter the production site for the studied product and ends when the finished product of interest leaves the production facility gate. Examples of production-related activities include:

- Chemical processing
- Manufacturing
- Transport of semi-finished products between manufacturing processes
- Assembly of material components
- Packaging
- Treatment of waste
- employee commuting (if material/relevant)
- business travel (if material/relevant)

Product Distribution and Storage

Products must be distributed to users and may be stored at various points along the supply chain. Examples of processes related to distribution and storage that should be included in the Product Environmental Footprint study include:

- Energy inputs for warehouse lighting and heating
- Use of refrigerants in warehouses and transport vehicles
- Fuel use in vehicles

Use

The use stage begins when the consumer or end user takes possession of the product and ends when the used product is discarded for transport to a recycling or waste treatment facility. Examples of use phase processes to be included in the Product Environmental Footprint study include:

- Use/consumption patterns), location, time (day/night, summer/winter, week/weekend), and assumed service life for the use stage of products
- Transportation to the location of use
- Refrigeration at the location of use
- Preparation for use (e.g., microwaving)
- Resource consumption during the use stage (for example, detergent, energy and water for washing machine use)
- Repair and maintenance of the product during the use phase

The use scenario also needs to reflect whether or not the use of the analysed products might lead to changes in the systems that they are used in, e.g. energy using products might affect the energy needed for heating/cooling in a building or the weight of a car battery might affect the fuel consumption of the car. If such interdependencies exist, they need to be checked for relevance (change of environmental profile), and if relevant be explicitly included. The following sources related to technical information on the use scenario should be taken into account (non-exhaustive list):

- Product Footprint Category Rules (PFCR)

- Published international standards that specify guidance and requirements for development of scenarios and service life for the use stage for the product being assessed;
- Published national guidelines that specify guidance for development of scenarios and service life for the use stage for the product being assessed;
- Published industry guidelines that specify guidance for development of scenarios and service life for the use stage for the product being assessed;
- Market surveys or other market data;

All relevant assumptions for the use stage shall be documented.

Where no method for determining the use stage of products has been established in accordance with the previously specified techniques, the approach taken in determining the use stage of products shall be established by the organization carrying out the study. Documentation of methods and assumptions shall be provided.

NOTE: The manufacturer's recommended method to be applied in the use phase (e.g. cooking in an oven at a specified temperature for a specified time) might provide a basis for determining the use stage of a product. The actual usage pattern may, however, differ from those recommended and should be used if known.

Modelling logistics for the analysed product

Important parameters that should be taken into account when modelling transport include:

Transport type: The type of transport e.g. (by land (truck, rail, pipe), by water (boat, ferry, barge), or air (airplane)) should be taken into account.

Vehicle type & fuel consumption: The type of vehicle should be taken into account by transport type, as well as the fuel consumption when fully loaded and empty. An adjustment has to be applied to the consumption of a fully-loaded vehicle according to loading rate (example see below).

Loading rate: Environmental impacts are directly linked to the actual loading rate, therefore the loading rate should be considered if possible.

Number of empty returns: It is essential to take into account the number of empty returns, i.e. the ratio of the distance travelled to collect the next load after unloading the considered product to the distance travelled to transport the product. The kilometres travelled by the empty vehicle should also be allocated to the considered product. Specific values must be developed by country and by type of transported product.

Transport distance: Transport distances must be documented. For the core module, average transport distances should be applied.

Allocation of impacts from transport: A fraction of transportation phase impacts should be allocated to the functional unit (to the considered product) based on the load-limiting factor. The following requirements apply:

- Goods transport: time or distance AND mass or volume (or in specific cases: pieces/pallets) of the transported good

a) If mass is the load-limiting factor (this is the case when transporting products with a high density: the maximum authorised weight is reached before the vehicle has reached its maximum physical load: at 100% of its volume), then allocation should be based on the mass of transported products
b) If the truck is transporting goods with a low density (in this case, the truck is loaded at 100% of the volume but it does not reach the authorised maximum weight), then allocation should be based on the volume of transported products.
c) The allocation may be based on number of pallets, when all transported products are stored on pallets.

- Personal transport: time or distance

- Staff business travel: time or distance or economic

Fuel production: Fuel production should be taken into account. Default values for fuel production can be found e.g. in the European Reference Life Cycle Database (ELCD).

Infrastructure: the transport infrastructure especially for road, rail and boat should be taken into account, if the transport steps play a relevant role (more than 10% contribution to at least one of the impact categories according to the screening).

End-of-Life

The end-of-life stage begins when the used product is discarded by the user and ends when the product is returned to nature as a waste or enters another product's life cycle (i.e. as a recycled input). Examples of end-of-life processes to include in the Product Environmental Footprint study are:

- Collection and transport of end-of-life products and packages
- Dismantling of components from end-of-life products
- Shredding and sorting
- Incineration and disposal of bottom ash
- Landfilling and landfill operation and maintenance
- Conversion into recycled material
- Composting or other organic waste treatment methods

Accounting for Electricity Use

For electricity from the grid consumed upstream or within the defined organisational boundary, country-specific consumption mix data shall be used. For electricity consumed during the use phase of products/services, the energy mix shall reflect ratios of sales between countries. Where such data is not available, the average EU consumption mix shall be used (ELCD Database).

Accounting for Renewable Electricity Generation

Some organisations may produce electricity from renewable sources in excess of the amount consumed. If excess renewable energy produced within the defined organisational boundary is sold, it may only be credited to the organisation if the credit has not been taken in other related schemes. Documentation is required to explain whether or not the credit is considered in the calculation. Credits shall be calculated with respect to the average, country-level consumption mix.

Accounting for temporary (carbon) storage and delayed emissions

Credits associated with temporary (carbon) storage or delayed emissions shall not be considered in the calculation of the Organisation Environmental Footprint for the default impact categories. However, this may be reported as “additional environmental information.” For more information, please see in the International Reference Life Cycle Data System Handbook: General Guide [6].

Additional considerations for documenting greenhouse gas emissions and removals

Fossil and biogenic emissions: removals and emissions shall be reported separately for both fossil and biogenic sources.

Land Use Change (impact for climate change): greenhouse gas emissions from land use change shall be allocated to products/services for 20 years after the land use change occurs using the IPCC default values table. For details, see Annex I.

Indirect Land Use Change: shall not be included for the time being, as no accepted methodology is currently available.

REQUIREMENT: All relevant resource use and emissions associated with the life cycle stages included in the defined system boundaries shall be included in the Resource Use and Emissions Profile.

REQUIREMENT: Credits associated with temporary storage, delayed emissions, and substitution shall not be considered in the Product Environmental Footprint calculation.

The PFCR should provide one or more templates for compiling the Resource Use and Emissions Profile, including specifications with respect to:

- substance lists for included activities/processes
- units
- nomenclature for elementary flows

These may apply to one or more supply chain stages, processes, or activities, for the purpose of ensuring standardized data collection and reporting. The PFSR may specify more stringent data requirements for key upstream, gate-to-gate or downstream phases than those defined in the PEF general guide.
For modelling processes/activities within the core module (i.e. gate-to-gate phase), the PFCR shall also specify:

- Included processes/activities
- Specifications for compiling data for key processes, including averaging data across facilities
- Any site-specific data required for reporting as “additional environmental information”
- Data quality requirements

The PFCR shall also specify:

- The use phase and end-of-life scenarios to be included in the study
- Transport scenarios to be included in the study

6.5 Nomenclature

Check the documented nomenclature and properties for a given flow in the Resource Use and Emissions Profile against the ILCD nomenclature and properties (Annex III Ensure correspondence with the ILCD nomenclature rules and properties. For a detailed treatment of nomenclature rules and supporting examples, see Annex III.

REQUIREMENT: All relevant resource use and emissions associated with the life cycle stages included in the defined system boundaries shall be documented using ILCD Nomenclature. If nomenclature and properties for a given flow are not available in the ILCD, the practitioner must create an appropriate nomenclature and document the flow properties.

6.6 Data quality requirements

Data quality indicators address how well the data fits the given process in the product inventory. When identifying collected (primary or secondary) data for use in a Product Environmental Footprint study, data quality indicators shall be applied. Five data quality criteria are adopted for Product Environmental Footprint studies.

Table 5: Data compliance criteria

Data quality	• Technological representativeness • Geographical representativeness • Time-related representativeness • Completeness; • Precision/uncertainty; • Methodological Appropriateness and Consistency • Semi-quantitative assessment of data quality
Method	• Completion of Resource Use and Emissions Profile according to this general guide
Documentation	• Compliance with ILCD format
Nomenclature	• Compliance with ILCD nomenclature document (e.g. use of ILCD reference elementary flows for IT compatible inventories)

Review	• Review by "Qualified reviewer" (see chapter 8):
	  • knowledge of relevant sector
	  • knowledge of represented process or product
	  • LCA methods expertise and experience
	• separate review report

Semi-quantitative assessment of data quality

The following tables and corresponding equation describe the criteria to be used for a semi-quantitative assessment of data quality.

Table 6: Criteria for semi-quantitative assessment of overall data quality of the Life Cycle Inventory data sets used in the EF study.

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged with respect to the contribution to each environmental impact category and in comparison to a hypothetical ideal data quality **(in case figures are available the figures can be used to assess the quality according to the provided scheme)**	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any."	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology** representativeness "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical** representativeness "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty** (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement) Comment: The uncertainty assessment is related to the resource use and emission

				Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook[7].				data only, not covering the impact assessment.
Very good	1	Meets the criterion to a very high degree, without need for improvement.	Very good completeness (≥ 90 %)	Full compliance with all requirements of the EF guide				**Very low uncertainty (≤ 7 %)**
Good	2	Meets the criterion to a high degree, with little significant need for	Good completeness ([80 % to 90 %)	Attributional[8] Process based approach AND: Following three method				**Low uncertainty (7 % to 10 %]**

9

7

		improvement.		requirements of the EF guide met: • Dealing with multi-functionality • End of life modelling • System boundary				
Fair	3	Meets the criterion to an acceptable degree, but merits improvement.	Fair completeness ([70 % to 80 %)	Attributional Process based approach AND: Two of the following three method requirements of the EF guide met: • Dealing with multi-functionality • End of life modelling • System boundary				**Fair uncertainty (10 % to 15 %]**

Poor	4	Does not meet the criterion to a sufficient degree, but rather requires improvement.	Poor completeness ([50 % to 70 %)	Attributional Process based approach AND: One of the following three method requirements of the EF guide met: • Dealing with multi-functionality • End of life modelling • System boundary				**High uncertainty (15 % to 25 %]**
Very poor	5	Does not meet the criterion. Substantial improvement is necessary OR: This criterion was not judged / reviewed or	Very poor or unknown completeness (< 50 %)	Attributional Process based approach BUT: None of the following three method requirements of the EF guide met: • Dealing with				**Very high uncertainty (> 25 %)**

		its quality could not be verified / is unknown.		multi-functionality • End of life modelling • System boundary				

The overall data quality shall be calculated by summing up the achieved quality rating for each of the quality components. The rating of the weakest quality level is counted 5-fold. The sum is divided by the number of applicable quality components plus 4. The Data Quality Rating result is used to identify the corresponding quality level in Table 6. Formula 1 provides the calculation provision:

Formula 1 $$DQR = \frac{TeR + GR + TiR + C + P + M + X_w * 4}{i + 4}$$

- *DQR* : Data Quality Rating of the data set; see Table 5
- *TeR: Technological Representativeness*
- *GR: Geographical Representativeness*
- *TiR: Time-related Representativeness*
- *C: Completeness;*
- *P: Precision/uncertainty;*
- *M*: Methodological Appropriateness and Consistency
- *Xw* : weakest quality level obtained (i.e. highest numeric value) among the data quality indicators
- *i* : number of applicable (i.e. not equal "0") data quality indicators

1 **Table 7: Example of semi-quantitative assessment of data quality required for key Life Cycle Inventory data sets. Process: dyeing process.**

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
Very good	1	Meets the criterion to a very high degree, without need for improvement.	Very good completeness (≥ 90 %)	Full compliance with all requirements of the EF guide	2009-2012	Discontinuous with airflow dyeing machines	Central Europe mix	Very low uncertainty (≤ 7 %)

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
Good	2	Meets the criterion to a high degree, with little significant need for improvement.	Good completeness ([80 % to 90 %)	Attributional Process based approach AND: Following three method requirements of the EF guide met: • Dealing with multi-functionality	2006-2008	e.g. "Consumption mix in EU: 30% Semi-continuous, 50% exhaust dyeing and 20% Continuous dyeing"	EU 27 mix; UK, DE; IT; FR	Low uncertainty (7 % to 10 %]

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
				• End of life modelling • System boundary				
Fair	3	Meets the criterion to an acceptable	Fair completeness	Attributional Process based approach AND:	1999-2005	e.g. "Production mix in EU: 35% Semi-continuous,	Scandinavian Europe; other	Fair uncertainty (10 % to 15

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
		degree, but merits improvement.	([70 % to 80 %)	The following two method requirements of the EF guide met: • Dealing with multi-functionality • End of life modelling		40% exhaust dyeing and 25% Continuous dyeing"	EU27 countries	%]

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
				However, the following one method requirement of the EF guide is not met: • System boundary				

Quality level	Quality rating	Definition	Completeness To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	Methodological compliance and consistency "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	Time representativeness "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	Technology representativeness "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	Geographical representativeness "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement) Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
Poor	4	Does not meet the criterion to a sufficient degree, but rather requires improvement.	Poor completeness ([50 % to 70 %)	Attributional Process based approach AND: The following one method requirement of the EF guide met: • Dealing with multi-functionality	1990-1999	e.g. "Exhaust dyeing"	Middle east; US; JP	High uncertainty (15 % to 25 %]

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
				• However, the following two method requirements of the EF guide are not met: End of life modelling • System				

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
				boundary				
Very poor	5	Does not meet the criterion. Substantial improvement is necessary OR:	Very poor or unknown completeness (< 50 %)	Attributional Process based approach BUT: None of the following three method requirements of the	<1990; Unknown	Continuous dyeing; other; unknown	Other; Unknown	Very high uncertainty (> 25 %)

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment
		This criterion was not judged / reviewed or its quality could not be verified / is unknown.		EF guide met: • Dealing with multi-functionality • End of life modelling • System boundary				

Quality level	**Quality rating**	**Definition**	**Completeness** To be judged in comparison to a hypothetical ideal data quality (in case figures, e.g. from third party data sources, are available the figures can be used to assess the quality according to the provided scheme)	**Methodological compliance and consistency** "The applied LCI methods and methodological choices (e.g. allocation, substitution, etc.) are in line with the goal and scope of the data set, especially its intended applications and decision support context. The methods also have been consistently applied across all data including for included processes, if any." Comment: i.e. correct and consistent application of the recommended LCI modelling framework and LCI method approaches for the given Situation A, according to the ILCD Handbook.	**Time representativeness** "Degree to which the data set reflects the true population of interest regarding time / age of the data, including for included background data sets, if any." Comment: i.e. of the given year (and - if applicable – of intra-annual or intra-daily differences).	**Technology representativeness** "Degree to which the data set reflects the true population of interest regarding technology, including for included background data sets, if any." Comment: i.e. of the technological characteristics including operating conditions.	**Geographical representativeness** "Degree to which the data set reflects the true population of interest regarding geography, including for included background data sets, if any." Comment: i.e. of the given location / site, region, country, market, continent, etc.	**Precision / uncertainty (relative standard deviation in % if a Monte Carlo simulation is used, otherwise qualitative expert judgement)** Comment: The uncertainty assessment is related to the resource use and emission data only, not covering the impact assessment

Table 8 shall be used to identify the overall data quality level according to the achieved data quality rating.

Table 8: overall data quality level according to the achieved data quality rating

Overall data quality rating (DQR)	Overall data quality level
≤ 1.6[9]	**“Excellent quality”**
>1.6 to≤ 2.0	**"Very good quality"**
>2.0 to ≤3.0	**“Good quality”**
>3 to ≤4.0	**"Fair quality"**
>4	**“Poor quality”**

REQUIREMENT: For the most environmentally significant processes or activities, accounting for at least 70% of contributions to each impact category, both directly collected (specific) and generic data shall achieve at least an overall “good quality” level.

A semi-quantitative assessment of data quality shall be performed and reported for these processes. For environmentally significant processes accounting for the subsequent 20% (i.e. from 70% to 90%) of contributions to environmental impacts, at least “fair quality” data shall be used, as assessed via qualitative expert judgment.

Remaining data (used for approximation and filling identified gaps (beyond 90% contribution to environmental impacts)) shall be based on best available information.

Table 9: Overview of requirements for data quality and the assessment of data quality

8

	Type of required data quality assessment	Minimum data quality required
Data covering at least 70% of contributions to each impact category	Semi-quantitative based on tables 3 and 5	Overall “Good” data quality (DQR $\leq$ 3.0)
Data accounting for the subsequent 20% (i.e. from 70% to 90%) of contributions to each impact category	Qualitative expert judgment (table 3 can be used to support the expert judgment)	Overall “Fair” data quality
Data used for approximation and filling identified gaps (beyond 90% contribution to each impact category	Qualitative expert judgment (table 3 can be used to support the expert judgment)	

Example

Example for determining the data quality rating.

Component	Achieved quality level	Corresponding quality rating
Technological representativeness (TeR)	good	2
Geographical representativeness (GR)	good	2
Time-related representativeness (TiR)	fair	3
Completeness (C)	good	2
Precision / uncertainty (P)	good	2
Methodological appropriateness and consistency (M)	Good	2

DQR = (TeR+GR+TiR[1]+C+P+M+3*4) / (6[2]+4) = (2+2+3+2+2+2+3*4) / 10 = 2.5

[1] The second occurrence of the lowest level "fair". [2] six indicators / components are counted.

6.7 Specific data collection

Specific data (including average data representing multiple sites whether internally or provided by a supplier) must be obtained for all environmentally significant foreground processes and for environmentally significant background processes where possible. The data should include all relevant inputs and outputs for the processes. Inputs are (for example) use of energy, water, materials, etc. Outputs are the products, co-products, and emissions. Emissions can be divided into four categories: emissions to air, to water, to soil, and emissions as solid waste. Specific data can be collected, measured or calculated.

Data collection - measurements and tailored questionnaires

The most representative sources of data for specific processes are measurements directly performed on the process, or obtained from operators via interviews or questionnaires. The data may need scaling, aggregation or other forms of mathematical treatment to bring them in relation to the process' functional unit and reference flow.

Typical specific data sources are:

- Process or plant level consumption data
- Bills and stock/inventory-changes of consumables
- Emission measurements (concentrations plus corresponding off-gas and wastewater amounts)
- Composition of waste and products
- Procurement and sale department(s)/unit(s)

REQUIREMENT: Specific data (including average data representing multiple sites whether internally or provided by a supplier) must be obtained for all significant/relevant foreground processes and for significant background processes where possible.

Example calculation using primary data

Activity data x emission factor = emission per unit of analysis

	Electricity consumption	Life cycle emission factor	Emission	unit
CO2	0.056	0.623	0.0353	CO2 kg
CH4	0.056	0.001	0.000056	CH4 kg
NOx	..	..	..	
SOx	..	..	..	
…	…	…	…	

1. Specify for which processes specific data has to be collected.
2. Specify the requirements for directly collected data for each environmentally significant process.

3. Define the data collection range for the conditions listed below for each site:
- Target stage(s) and the data collection coverage,
- Location of data collection (domestically, internationally, representative factories, and so on),
- Term of data collection (year, season, month, and so on),
- When the location or term of data collection must be limited to a certain range, provide a reason and show that the collected data will serve as sufficient samples.

Note: The basic rule is that the location of data collection is all target areas and the term of data collection is a year or more.

6.8 Generic data collection

Generic data refers to data that are not based on direct measurements or calculation for the respective process(es) in the system. Generic data shall be used only if data for a specific process are unavailable, not environmentally significant, or refer to a process in the background system. Sources of generic data must be documented. Examples of generic data include:

- Data from literature or scientific papers.
- Industry-average life cycle data from life cycle inventory databases, industry association reports, government statistics, etc.

Sourcing generic data

All generic data shall fulfill the data quality requirements specified in this guidance document. Generic data shall be sourced in the following hierarchy (i.e. order of priority):

- Data developed in line with the requirements for Product Environmental Footprint studies;
- Data developed in line with the requirements for Organisation Environmental Footprint studies;
- International Reference Life Cycle Data System (ILCD) Data Network (giving preference to “ILCD-compliance” over “ILCD Data Network – entry level” data sets)[10];
- European Reference Life Cycle Database (ELCD)[11];
- Databases provided by international governmental organisations (for example FAO, UNEP);
- Country-specific national governmental LCI database projects (for data specific to the database host country);
- National governmental LCI database projects
- Other third-party LCI databases;
- Peer-reviewed literature

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If the necessary data cannot be found in the above listed sources, other sources may be used. These shall be clearly documented.

REQUIREMENT: Generic data shall be used only if data for a specific process are unavailable, not environmentally significant, or refer to a process outside of the defined system boundary. Generic data shall, as far as possible, fulfill the data quality requirements specified in this guidance document. Subject to data quality requirements, generic data should be preferentially sourced according to the specified hierarchy.

Example:
Source of generic data: ELCD and ILCD Data network, for following data sets.

European Reference Life Cycle Database (ELCD)

Germany electric grid mix
Ethylene production
Natural gas production
Distillation
Desalting
Hydro treating
Methanol production
Acetic acid production

International Reference Life Cycle Data System (ILCD) Data network

Detergent production	Database AA
Dye production	Database CC
Other data sets for Petro chemical industry	US Chemical Association

TIP: Proceeding through the hierarchy of priority data sources, once a data set has been identified that fulfills at least the minimum data quality requirements it is not required to search further for higher quality data. However, it is good practice to use the best available data in all cases, hence it is recommended to also check subsequent sources as per the hierarchy for higher quality data. A data set from a source listed lower in the provided hierarchy of data sources can only be used in place of a data set from a source listed higher in the hierarchy if it achieves a higher data quality rating.

The PFCR shall specify:

- (where the use of generic data is permitted as an approximation for a substance for which specific data is not available) the level of required similarities between the actual substance and the generic substance
-

example: High impact polystyrene (HIPS) = Polystyrene (PS) resin generic data or

- the combination of more than one generic data set, if necessary
-

example: material generic data + polymerization processing generic data = PS resin or Generic data correction factors

6.9 Dealing with remaining unit process data gaps / missing data

6.9.1 General

Data gaps exist when there is no available specific or generic data that is sufficiently representative of the given process in the product's life cycle. For most processes where data may be missing it should be possible to obtain sufficient information to provide a reasonable estimate of the missing data. Therefore, there should be few, if any, data gaps in the final Resource Use and Emissions Profile. Missing information can be of different types and have different characteristics, each requiring separate approaches to resolve.

Data gaps may exist when:

- Data does not exist for a specific input/product, or
- Data exists for a similar process but:
  - The data has been generated in a different region
  - The data has been generated using a different technology
  - The data has been generated in a different time period

6.9.2 How to deal with remaining missing inventory data / information

Data gaps exist when there is no available specific or generic data that is sufficiently representative of the given process in question. For most processes where data may be missing, it should be possible to obtain sufficient information to provide a reasonable estimate of the missing data. Therefore, there should be few, if any, data gaps in the final Resource Use and Emissions Profile. Missing information can be of different types and have different characteristics, each requiring separate approaches to resolve.

Data gaps may exist when:

- Data does not exist for a specific input/output, or
- Data exists for a similar process but:

- The data has been generated in a different region
- The data has been generated using a different technology
- The data has been generated in a different time period

REQUIREMENT: Data gaps for specific data - Any data gaps for environmentally significant processes shall be filled using generic or extrapolated data that achieves at least a "fair" data quality level rating. Such processes (including generic data gaps) shall not account for more than 10% of the overall contribution to each impact category considered based on the initial screening phase.

REQUIREMENT: Data gaps for generic data - Any data gaps for environmentally significant processes shall be filled using extrapolated data or other data that achieves at least a "fair" data quality level rating. Such processes (including specific data gaps) shall not account for more than 10% of the overall contribution to each impact category considered based on the initial screening phase.

The PFCR shall specify potential data gaps and provide detailed guidance for filling data gaps

6.10 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 must be partitioned between the product of interest and the other co-products in a principled manner. Similarly, where a jointly owned and/or operated facility produces multiple products, it may be necessary to partition related inputs and emissions among the products within the defined Goods/Services Portfolios of different organizations. Organisations undertaking an Product Environmental Footprint may therefore have to address multi-functionality problems both at the product and facility level.

Systems involving multi-functionality of processes shall be modeled in accordance with the following decision hierarchy, with additional guidance at the sectorial level provided by Product Environmental Footprint Category Rules (PFCRs) if available. All choices concerning multi-functionality problems shall be reported and justified with respect to the overarching goal of ensuring physically representative, environmentally relevant analytical outcomes. Fig 5 provides a decision tree for handling multi-functional processes.

Decision hierarchy

I) Subdivision

Subdivision refers to disaggregating multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output. First investigate whether the analyzed process can be subdivided. Where subdivision is possible, inventory data should be collected only for those unit processes directly attributable to the products/services of concern.

II) Substitution

Substitution refers here to identification and modeling of mono-functional processes which yield functions equivalent to those of the outputs of the multi-functional process of concern. The inventory for each mono-functional process (e.g. each independently produced equivalent of the co-products/services), is subtracted from the inventory of the original multi-functional process in order to isolate the remaining inventory attributable to the process output of concern. In order of preference, substitution shall be based on (a) specific, equivalent alternatives or, (b) a representative market mix of equivalent alternatives. Substitution shall only be applied where a realistic, physically representative substitution scenario can be identified. Such scenarios shall be clearly documented and justified, and their implications for the final results discussed

III.a) Allocation Based on a Relevant Underlying Physical Relationship

Allocation based on a relevant underlying physical relationship refers to allocating the input and outflows of a multi-functional process 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).

III.b) 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, II and III.a) are not possible. In any case, a clear justification must be provided, with reference to ensuring the physical representativeness of the Organisation Environmental Footprint results.

The decision hierarchy also applies for product recycling (EoL). In cases of substitution, the equation described in Annex III shall be applied.

REQUIREMENT: The Product Environmental Footprint multi-functionality decision hierarchy shall be applied for resolving all multi-functionality problems at both process and facility-level. All choices made in this context shall be reported and justified with respect to the overarching goal of ensuring physically representative, environmentally relevant results. For substitution in recycling situations the equation described in Annex III shall be applied. Default recycling rates and prices are given. Companies can use more relevant values if available and justifiable. Specific multi-functionality solution shall be provided in PFCRs, where available.

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

Where sub-division is to be applied, the PFCR shall specify which processes are to be sub-divided and according to what principles.

Where substitution is to be applied, the PFCR shall specify the substitution scenarios, including the specific or market-mix substitutes that are required.

Where allocation by physical relationship is to be applied, the PFCR shall specify the relevant underlying physical relationships to be considered, and establish the relevant allocation factors.

Where allocation by some other relationship is to be applied, the PFCR shall specify the relationship and establish the relevant allocation factors. For example, in the case of economic allocation, the PFCR shall specify the rules for determining the economic values of co-products.

In the event that information is sourced from documents derived from PEF of PFCR studies, the multi-functionality solutions used in such studies shall be retained for the data sets of interest.

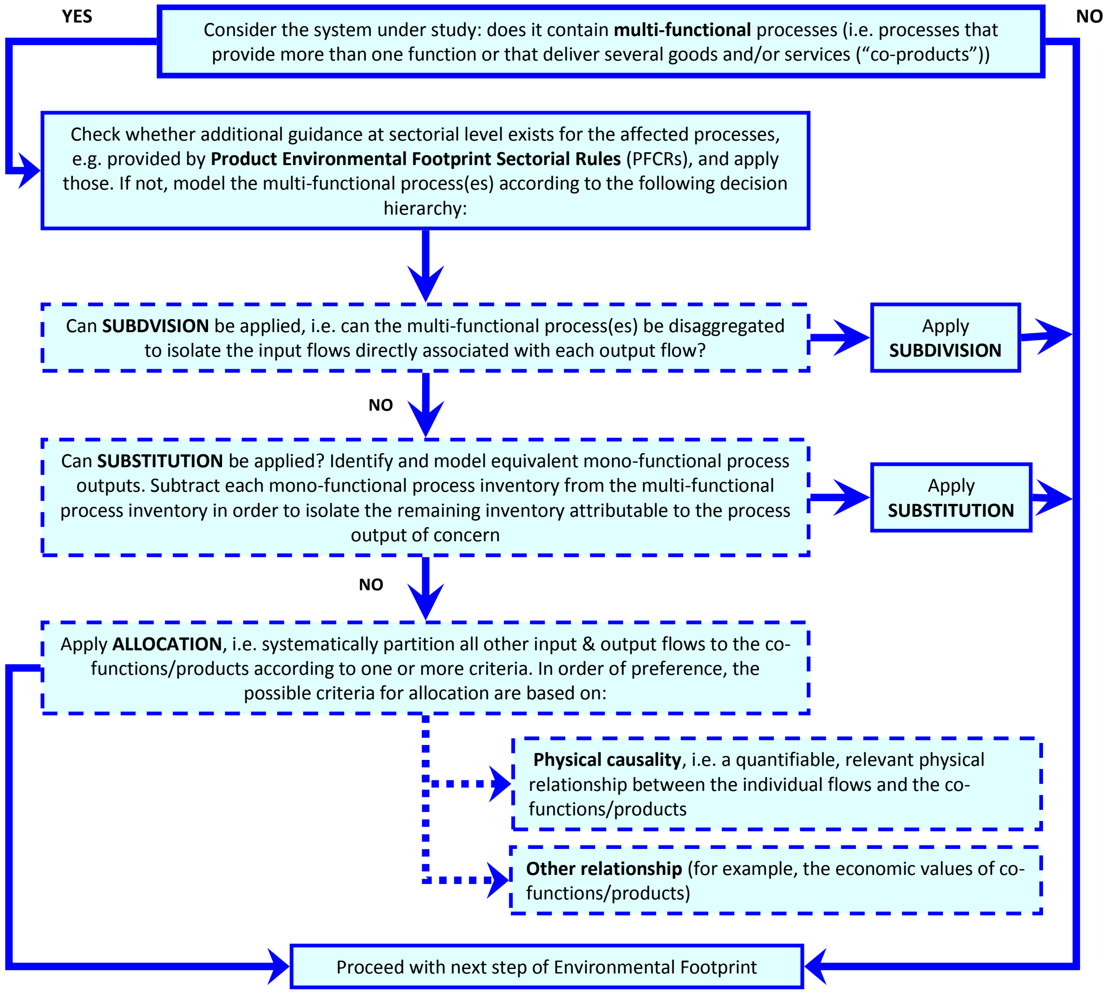


Figure 7: Decision tree for handling multi-functional processes

6.11 Data collection template

A data collection template is useful for organizing data collection activities and results while compiling the Resource Use and Emissions Profile. A data collection template may include the following aspects:

- Introduction to the Product Environmental Footprint study, including an overview of the objectives of data collection and the template/questionnaire employed
- Information on the entity(ies) or person(s) responsible for measurement and data collection procedures
- Description of the site where data is to be collected (for example, maximum and normal operation capacity, annual productive output, location, number of employees, etc.)
- Date/year of data collection
- Description of the product (and functional unit)
- Product system description
- Overall technical flow diagram
- Individual process diagram
- Input and output per reference flow per unit

Example: Data collection template

Technical overview

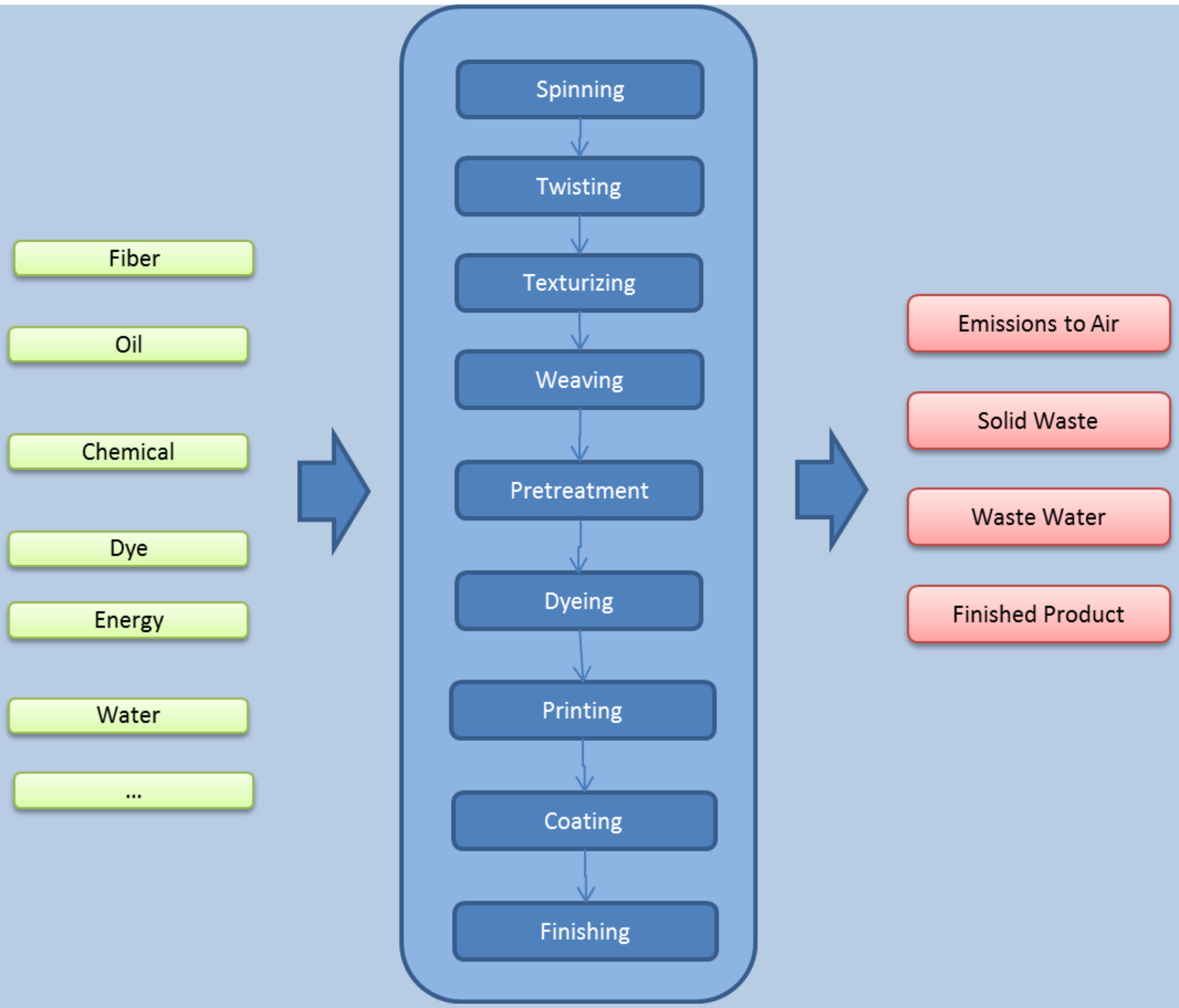


Fig 8: Process overview diagram for the production stage at a T-shirt company

List of processes within the system boundaries:

- Fibre Production
- Spinning
- Twisting
- Texturizing
- Weaving
- Pre-treatment
- Dyeing
- Coating
- Finishing

Collection of unit process Resource Use and Emissions Profile data

Process name: Finishing process

Process diagram: finishing refers to processes performed on yarn or fabric after weaving or knitting to improve the look, performance, of the finished textile product

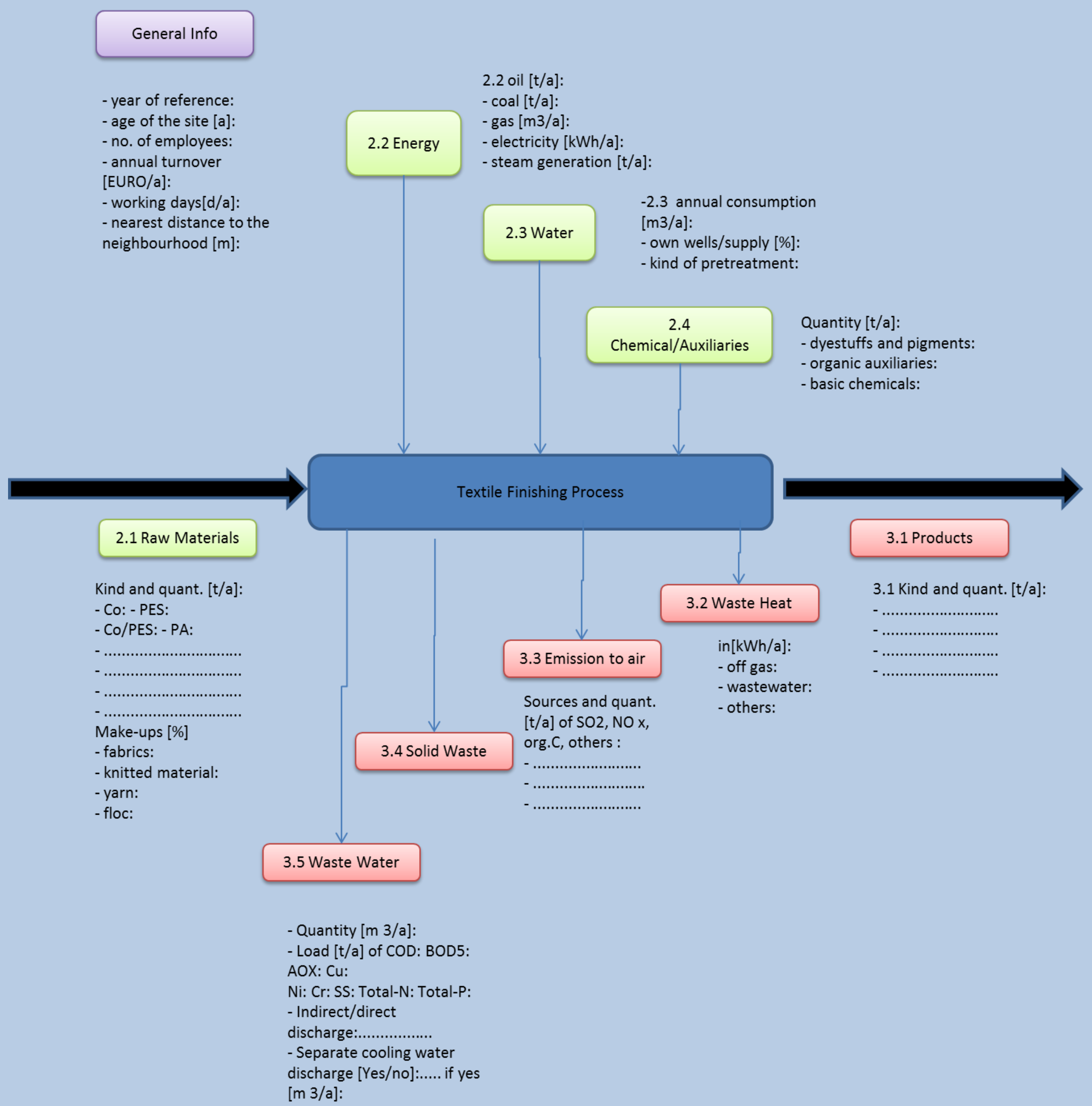


Figure 8: Technical process diagram- finishing process

Input

Code	Name	Amount	Unit

Output (Per reference flow)

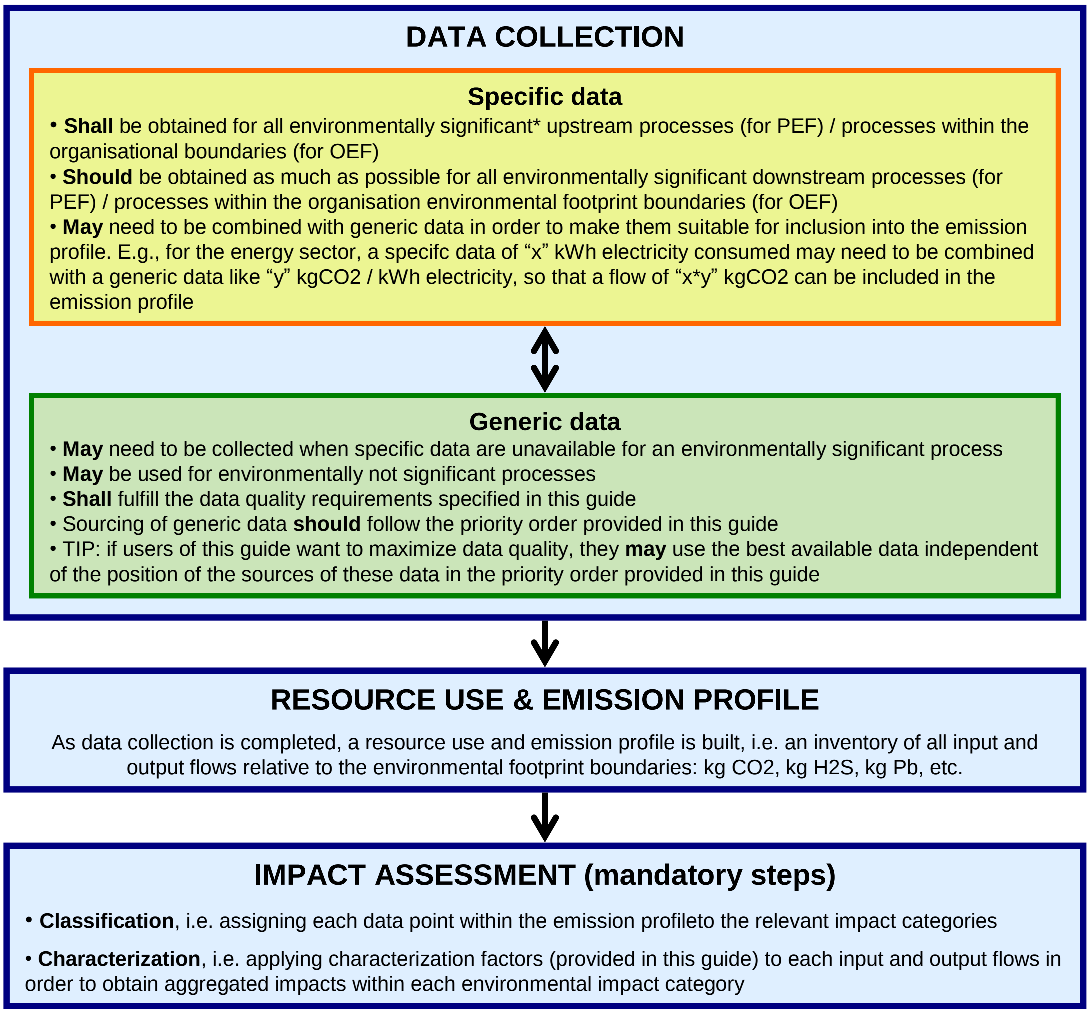
Code	Name	Amount	Unit

Table 10: Example of Resource Use and Emissions Profile data inventory (selected substances)

Parameter	Unit/kg	
Energy consumption	MJ	115.5
Electricity	MJ	34.6
Fossil Fuel	MJ	76
Others	MJ	4.9
Non-renewable resources	Kg	2.7
Natural gas	Kg	0.59
Natural gas, feedstock	Kg	0.16
Crude oil	Kg	0.57
Crude oil, feedstock	Kg	0.48
Coal	Kg	0.66
Coal, feedstock	Kg	0.21
LPG	Kg	0.02
Hydro power (MJel)	MJ	5.2
Water	Kg	12400
Emissions to air		
CO2	g	5,132
CH4	g	8.2
SO2	g	3.9
Nox	g	26.8
CH	g	25.8
CO	g	28
Emission to water		

COD Mn	g	13.3
BOD	g	5.7
Tot-P	g	0.052
Tot-N	g	0.002

The following figure provides an overview of some steps to be taken when developing a PEF study: the main focuses is here on data collection, development of the resource use and emission profile and subsequent impact assessment



* **"Environmentally significant process"** are here defined as any process or activity to be included in the Environmental Footprint calculation (i.e. does not qualify for exclusion based on the cut-off criterion on 90% inclusiveness for each environmental footprint impact category)

Figure 9: Relationship between data collection, resource and emission profile and impact assessment in PEF studies

7. Environmental Footprint Impact Assessment

Once the Resource Use and Emissions Profile has been compiled, the environmental footprint impact assessment phase is undertaken to calculate the environmental performance of the product being assessed, with respect to the key identified areas of concern. Environmental footprint impact assessment includes two mandatory and two optional steps.

7.1 Mandatory Steps: Classification and Characterization

Environmental footprint impact assessment involves two mandatory steps:

1. The first step, which is called "classification", requires assigning each value that has been compiled in the Resource Use and Emissions Profile to the relevant environmental footprint impact categories (chosen during the scope definition phase). Classification for substances for Organisation Environmental Footprint studies can be accessed at WEBLINK TO BE PROVIDED IN FINAL VERSION.

2. The second step, which is called "characterisation", requires multiplying the value compiled in the Resource Use and Emissions Profile by the relevant characterisation factor for each impact category. This allows aggregation of impact indicators within categories. Characterisation factors for Organisation Environmental Footprint studies can be accessed at WEBLINK TO BE PROVIDED IN FINAL VERSION.

7.1.1 Classification of Environmental Footprint Data

Classification requires assigning the material/energy inputs and outputs tabulated in the Resource Use and Emissions Profile to the appropriate environmental footprint impact category. For example, during the classification phase, all inputs/outputs that result in greenhouse gas emissions are assigned to the Climate Change category, whereas those that result in emissions of ozone depleting substances are classified accordingly. In some cases, an input/output may contribute to more than one environmental footprint impact category (for example, chlorofluorocarbons (CFCs) contribute to both Climate Change and Ozone Depletion).

In principle, as part of the classification of the Resource Use and Emissions profile, data should be expressed in terms of constituent substances for which characterisation factors are available. For example, data for a composite NPK fertilizer should be disaggregated and classified according to its N, P, and K fractions, since each constituent element will contribute to different environmental footprint impact categories. In practice, much of the inventory data used to model the product supply chain of interest may be drawn from existing public or commercial life cycle inventory databases, where classification has already been implemented. In such cases, it must be assured that the classification and linked environmental footprint impact assessment pathways correspond to the requirements specified in this guidance document.

REQUIREMENT: All inputs/outputs tabulated during the compilation of the Resource Use and Emissions Profile shall be assigned to the environmental footprint impact categories to which they contribute ("classification").

Example: Classification of data in the climate change impact category for a T-shirt study

CO2 g	Yes
CH4 g	Yes
SO2 g	No
NOx g	No

7.1.2 Characterisation of Environmental Footprint Results

Characterisation refers to calculating the magnitude of the contribution of each classified input/output to their respective environmental footprint impact categories, and aggregation of contributions within each category. The characterisation factors are substance/resource-specific. They represent the impact intensity of a substance relative to a common reference substance for an environmental footprint impact category. For example, in the case of calculating climate change impacts, all greenhouse gas emissions tabulated in the Resource Use and Emissions Profile are weighted in terms of their impact intensity relative to carbon dioxide, which is the reference substance for this category. This allows for the aggregation of impact potentials and expression in terms of a single equivalent substance (in this case, CO2-equivalent emissions) for each environmental footprint impact category.

The characterisation models must be scientifically and technically valid, and based upon distinct, identifiable environmental mechanisms or reproducible empirical observations. Moreover, the entirety of characterization factors should have no relevant gaps in coverage for the impact categories to which they relate.

REQUIREMENT: All classified inputs/outputs in each environmental footprint impact category shall be assigned characterization factors representing the contribution per unit input/output to the category. Environmental footprint impact assessment results shall subsequently be calculated for each category by multiplying the amount of each input/output by its characterization factor and summing contributions of all inputs/outputs within each category to a single measure expressed in the appropriate reference unit.

Example

Calculate Environmental footprint impact assessment

Global warming

			CF	
CO2 g	5,132	x	1	=5.132 kg CO_{2eq}
CH4 g	8.2	x	25	=0.205 kg CO_{2eq}
SO2 g	3.9	x	0	=0 kg CO_{2eq}
NOx g	26.8	x	0	=0 kg CO_{2eq}
		Total=		5.337 kg CO_{2eq}

Acidification

			CF	
CO2 g	5,132	x	0	=0 kg SO_2eq
CH4 g	8.2	x	0	=0 kg SO_2eq
SO2 g	3.9	x	1.31	=0.005 kg SO_2eq
NOx g	26.8	x	0.74	=0.019 kg SO_2eq
		Total=		0.024kg SO_2eq

Eutrophication

..

Eco Toxicity

…

7.2 Optional Steps: Normalization and Weighting

Following the two mandatory steps of classification and characterisation, the environmental footprint impact assessment may be complemented with two optional steps (as appropriate to or required for the intended application): these are referred to as normalization and weighting.

7.2.1 Normalization of Environmental Footprint Impact Assessment Results

Normalization is an optional step in which the environmental footprint impact assessment results are multiplied with normalization factors in order to calculate and compare the magnitude of their contributions to the environmental footprint impact categories of concern relative to a reference unit (typically a whole country or an average citizen). As a result, dimensionless, normalized environmental footprint results are obtained. This allows comparisons of the relevance of the contributions made by organisational activities to the environmental impact categories considered.

Normalized environmental footprint results do not, however, indicate the severity/relevance of the respective impacts, nor can they be summed across impact categories, which would assume an implicit one-to-one weighting).

REQUIREMENT: Normalization is not a required step for Organisation Environmental Footprint studies. If normalization is applied, the normalized environmental footprint results shall be calculated using the provided normalization factors. Other normalization factors can be used in addition to those provided and the results be reported under “additional environmental information”.

Normalized results shall not be aggregated as this implicitly applies a weighting factor (i.e. one).

7.2.2 Weighting of Environmental Footprint Impact Assessment Results

Weighting is an additional, but not required step that may support the interpretation and communication of the results of the analysis. In this step, normalized environmental footprint results are multiplied by a set of weighting factors which reflect the perceived relative importance of the impact categories considered. Weighted environmental footprint results can then compared to assess their importance. They can also be summed across impact categories to obtain a single-value overall impact indicator. In contrast to the preceding, natural sciences-based phases (classification, characterisation and normalization), weighting requires value judgements as to the respective importance of the environmental impact categories considered. These judgments may be based on expert opion, cultural/political view points, or economic considerations.

Application of normalization and weighting steps in Product Environmental Footprint studies must be consistent with the defined goals and scope of the study, including the intended applications. It should be noted that ISO 14040 and 14044 do not permit the use of weighting in support of comparative assertions[12].

REQUIREMENT: If weighting is applied, the environmental footprint results shall be multiplied by the weighting factors provided. Other weighting factors can be used in addition to those provided. Weighted results shall be reported as "additional environmental information, with all methods and assumption documented. Results of the environmental footprint impact assessment prior to weighting have to be reported alongside weighted results.

2

8. Interpretation of Product Environmental Footprint results

8.1 General

Interpretation of the results of the Product Environmental Footprint study serves two purposes:

- The first is to ensure that the way in which the environmental footprint model corresponds to the goals and quality requirements of the study. In this sense, interpretation may inform iterative improvements of the environmental footprint model until all goals and requirements are met;
- The second purpose is to derive robust conclusions and recommendations from the analysis, e.g. in support of environmental improvements.

To meet these objectives, the interpretation phase may be broken down into two key steps: “Identification of significant issues” and “Conclusions, limitations and recommendations”.

8.2 Identification of Significant Issues

Identification of significant issues refers to:

- Identifying the methodological considerations and choices that may significantly influence the accuracy of the calculated Product Environmental Footprint results; and
- Identifying the main contributing elements to the calculated results in support of answering the study questions and assessing improvement potentials.

Identifying key methodological considerations requires assessing the extent to which methodological choices such as system boundaries, cut-off criteria, data sources, and allocation choices influence the analytical outcomes. It must be ensured that these correspond to the requirements specified in this guidance document, and that they are appropriate to the context.

Tools that should be used to assess the robustness of the Product Environmental Footprint model include:

- Completeness checks: assess the inventory data to ensure that it is complete relative to the defined goals, scope, system boundaries, cut-off criteria and quality criteria. This includes completeness of process coverage (i.e. all relevant processes at each supply chain stage considered have been included) and input/output coverage (i.e. all relevant material or energy inputs and emissions associated with each process have been included).

- Sensitivity checks: assess the extent to which the results are determined by specific methodological choices, and the impact of implementing alternative, defensible choices where these are identifiable. It is useful to structure sensitivity checks for each phase of the Product Environmental Footprint study, including goal and scope definition, the Resource Use and Emissions Profile, and environmental footprint impact assessment.

- Consistency checks: assess the extent to which assumptions, methods, and data quality considerations have been applied consistently throughout the Product Environmental Footprint study.

Any issues flagged in this evaluation should inform iterative improvements to the model.

Once it has been ensured that the Product Environmental Footprint model is robust and conforms with all aspects defined in the goal and scope definition phases, the next step is to identify the main contributing elements to the Product Environmental Footprint results. This step may also be referred to as “hot spot” or “weak point” analysis. Contributing elements may be specific life cycle stages, processes, or individual material/energy inputs/outputs associated with a given stage or process in the product supply chain. These are identified by systematically reviewing the Product Environmental Footprint study results. Graphical tools may be particularly useful in this context. Such analyses provide the necessary basis to identify improvement potentials associated with specific management interventions.

REQUIREMENT: Significant methodological issues shall be evaluated using a combination of completeness, sensitivity and consistency checks as appropriate. Product Environmental Footprint results shall subsequently be evaluated to assess supply chain hotspots/weak points on input/output, process, and supply chain stage bases and to assess improvement potentials.

8.3 Estimating Uncertainty

Estimating uncertainties supports iterative improvement of Product Environmental Footprint studies. It also helps the target audience of the Product Environmental Footprint study results to assess their robustness and applicability.

There are two key sources of uncertainty in Product Environmental Footprint studies. Each type of uncertainty must be accommodated separately.

(1) Stochastic uncertainties for inventory data or characterisation factors

Stochastic uncertainties (both parameter and model) refer to statistical descriptions of variance around a mean. For normally distributed data, this variance is typically described in terms of an average and standard deviation. Product Environmental Footprint results that are calculated using average data (i.e. the mean of multiple data points for a given process) or using characterisation factors with known associated variance do not reflect the uncertainty associated with such variance. However, uncertainty may be estimated and communicated using appropriate statistical tools.

In practice, it may be difficult to access estimates of uncertainty for all data used in a Product Environmental Footprint study. At a minimum, efforts to accurately characterize stochastic uncertainty and its impact on modeling outcomes should focus on those processes identified as environmentally significant in the environmental footprint impact assessment and interpretation phases.

(2) Choice-related uncertainties

Choices-related uncertainties arise from methodological choices including modeling principles, system boundaries and cut-off criteria, choice of environmental footprint impact assessment methods, and other assumptions related to time, technology, geography, etc. These are not amenable to statistical description, but rather can only be characterized via scenario model assessments (e.g., modeling worst and best-case scenarios for significant processes) and sensitivity analyses.

REQUIREMENT: A qualitative description of uncertainties shall be provided.

TIP: Quantitative uncertainty assessments can be calculated for variance associated with significant processes and characterization factors using Monte Carlo simulations. The influence of choice-related uncertainties should be estimated at the upper and lower bounds using scenario model assessments. These shall be clearly documented and reported. Where quantitative assessments are not possible, qualitative descriptions of any remaining uncertainties shall be provided.

8.4 Conclusions, Recommendations and Limitations

The final aspect of the interpretation phase is to draw conclusions based on the analytical results, answer the questions posed at the outset of the Product Environmental Footprint study, and advance recommendations appropriate to the intended audience and context whilst explicitly taking into account any limitations to the robustness and applicability of the results.

As required under ISO 14044:2006, if the results of the Product Environmental Footprint study are intended to support comparative assertions (i.e. claims about the relative merits of products based on environmental footprint results), then it is essential to carefully consider whether any differences in data quality and methodological choices used to model the compared products may influence the comparability of the outcomes. Any inconsistencies in functional units, system boundaries, inventory data quality, or environmental footprint impact assessment must be considered and communicated.

Conclusions derived from the Product Environmental Footprint study should include a summary of identified supply chain “hotspots” and the improvement potentials associated with possible management interventions. The improvement potentials may be linked to, for example, cleaner technology techniques, EMAS or ISO 14001, or other systematic approaches.

REQUIREMENT: Conclusions, recommendations and limitations shall be described in accordance with the defined goals and scope of the Product Environmental Footprint study. Product Environmental Footprint studies intended to support comparative assertions (i.e. claims about the environmental superiority or equivalence of organisations compared to other organisations) cannot be made on the basis of studies using only the PEF general guide but rather shall be based both on this PEF guidance and related Product Footprint Category Rules (PFCRs).

Example of interpretation of Product Environmental Footprint results for a T-shirt

Taken together, resin and fiber production account for less than 30% of T shirt manufacturing-related solid waste. Fabric production and apparel manufacture creates the largest portion of the waste from the T shirt manufacturing operations. Because product waste, such as fabric scraps, are collected and recycled, most of this waste is related to operating processes, including waste water treatment sludges from the dyeing process and wastes produced during energy generation. Most of the solid waste produced during apparel manufacturing is created from packaging used in transporting the finished blouses. (packaging discarded from operations prior to apparel production is classified as industrial, rather than postconsumer, waste). Again, cuttings and fabric scraps are generally collected for recycling and not considered as waste. The largest air emissions, by weight, were found to be: particulates, nitrogen oxides, hydrocarbons, sulphur-oxides, carbon monoxide and carbon dioxide. Most of these emissions were related to the generation of energy, in particular, electricity for the laundering process. Over half of the emissions for each of these five categories is related to the fuels consumed in the laundry operation. Similar patterns of environmental releases can be found in examining the waterborne effluents. The six largest effluents on a weight basis are: dissolved solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), acid, iron, and suspended solids. Wastewater from the laundry operation accounted for large quantities of BOD, COD, suspended solids, and dissolved solids. Acid and iron releases came mostly from the burning of fossil fuels associated with the generation of energy.

9. Product Environmental Footprint Reports

9.1 General

A Product Environmental Footprint report provides a relevant, complete, consistent, accurate, and transparent account of the study and of the calculated environmental impacts associated with the product life cycle of concern. It reflects the best possible information in such a way as to maximize its usefulness to intended users, whilst honestly and transparently communicating limitations.

Effective Product Environmental Footprint reporting requires the satisfaction of several criteria, both procedural (report quality) and substantive (report content). The reported information must also provide a robust basis for assessing, tracking, and seeking to improve the environmental performance of the product over time. Towards this end, a combination of performance metrics will be useful.

For the purposes of tracking and seeking to improve performance, it is helpful to distinguish between (related) absolute and intensity-based metrics. Absolute metrics convey the total contribution of production of the product to the environmental impact categories of concern. An example of an absolute metric would be the total greenhouse gas emissions associated with producing the product over a specified interval. Absolute metrics support management decisions associated with overall environmental performance objectives. In contrast, intensity-based metrics refer to environmental impacts per unit good/service. These are most useful from a resource and waste efficiency perspective, and for tracking relative environmental performance improvements at the product level.

9.2 Reporting elements

A high quality Product Environmental Footprint report begins with a clear description of the methodologies, data sources, assumptions, results and limitations. Moreover, the reported information must be presented using internationally accepted formats and nomenclature.

The Product Environmental Footprint report consists of at least four elements: the Main Report, which is additionally condensed into a Technical Summary and an Executive Summary, and an Annex that documents e.g. assumptions and data (which can also be referenced). Confidential and proprietary information can be documented in a fifth element, a complementary confidential report. Review reports are either annexed as well or referenced.

9.2.1 First element: Executive Summary

The executive summary shall be able to stand alone without compromising the results and conclusions/recommendations (if included).

The executive summary shall, at a minimum, include key elements of the goal and scope of the study. The main results from the inventory and impact assessment components shall be presented in a manner so as to ensure the proper use of the information, and relevant statements about data quality, assumptions and value judgments should be included.

Finally, the executive summary report should state any recommendations made and conclusions drawn, and shall specify any limitations that may apply.

9.2.2 Second element: Technical Summary

This technical summary shall be able to stand alone without compromising the results of the environmental footprint study. The technical summary shall therefore also fulfill the same criteria about transparency, consistency, etc. as the detailed report.

The technical summary shall, at a minimum, include the goal, the scope, with relevant limitations and assumptions, an overall flow diagram of the system studied, and shall clearly indicate what has been achieved by the study. The main results from the inventory and impact assessment components shall be presented in a manner to ensure the proper use of the information, and statements about data quality and value judgments shall be included.

Finally, the technical summary shall specify any recommendations made and conclusions drawn.

9.2.3 Third element: Main Report

The Main Report shall include the following components:

- Goal of the study: The report shall include clear and concise statements with respect to the following aspects:
    - Intended application(s)
    - Methodological or impact category limitations
    - Reasons for carrying out the study
    - Target audience
    - Comparative assertions to be disclosed to the public
    - Commissioner of the study

- Scope of the study

The Scope chapter shall identify the analyzed system in detail and address the overall approach used to establish the system boundaries. The scope chapter should also address data quality requirements. Finally, the scope chapter should include a description of the methods applied for assessing potential environmental impacts and which impact categories, methods, normalization and weighting sets are included. Mandatory reporting elements are:

- Function, functional unit, and reference flow
- System boundaries and cut-off criteria (completeness);
- The reasons for and potential significance of any exclusions should be provided;
- All assumptions and value judgments, along with justficiations for the assumptions made;
- Data representativeness, appropriateness of data, andtypes/ sources of required data and information
- Impact assessment methods and factors, normalization basis and weighting set (if used)

- Compiling and recording the Resource Use and Emissions Profile

Mandatory reporting elements are:

- Flow diagram (should clearly describe the foreground system and links to the background system, and all major inputs and outputs)
- Description and documentation of all unit process data collected for the foreground system;

- Calculating Product Environmental Footprint impact assessment results

  - Documentation of environmental footprint impact assessment methods and characterization factors
  - If included, normalization and weighting factors and results

- Interpretation

  - Significant issues
  - Completeness check
  - Sensitivity check (of achieved accuracy and precision)
  - Consistency check
  - Conclusions
  - Recommendations and improvement potentials

9.2.4 Fourth element: Annex

The annex serves to document elements that would inappropriately interrupt the reading flow of the main report, and which are of a more technical nature. It shall include:

- Questionnaire / data collection template and raw data
- Descriptions of all assumptions
- Review report (if conducted) / answers to the review report (if any)

This shall include those assumptions that have been shown to be irrelevant. The important ones are to be considered quantitatively in the sensitivity analysis and quantitatively and qualitatively in the interpretation.

- Full Resource Use and Emissions Profile (optional if considered sensitive and communicated separately in the Confidential Report)

9.2.5 Fifth element: Confidential report

The confidential report shall contain all those data and information that are confidential or proprietary and cannot be made externally available. It shall be made available to the critical reviewers under confidentiality.

REQUIREMENT: The study report shall include, at a minimum, an Executive Summary, a Technical Summary, the Main Report, Annexes, and any other necessary supporting information.

For an example Product Environmental Footprint report template, see Annex V.

10. Product Environmental Footprint Review

10.1 General

Critical review is important to ensuring the reliability of the Product Environmental Footprint results. This not only increases the credibility and acceptance of the Product Environmental Footprint study, but also helps improve its quality. Close interaction between the company and the reviewer is therefore vital for an efficient and effective review process.

The critical review shall serve to assure that:

- The methods used to carry out the Product Environmental Footprint study are consistent with this guidance document,
- The methods used to carry out the Product Environmental Footprint study are scientifically and technically valid,
- The data used are appropriate, reasonable and meet the defined data quality requirements,
- The interpretation of results reflects the limitations identified, and
- The study report is transparent, accurate and consistent.

10.2 Review Type

The most suitable review type that provides the required minimum guarantee of quality assurance is an independent external review. The type of review conducted should be informed by the goals and intended applications of the Product Environmental Footprint study.

REQUIREMENT: The study shall be reviewed by an independent and qualified external reviewer (or review team.) A study intended to support a comparative assertion shall be reviewed by an independent external reviewer together with a stakeholder panel.

10.3 Reviewer Qualification

The assessment of reviewer qualification is based on a scoring system taking into account review and audit practice, LCA methodology and practice, and knowledge of relevant technologies, processes or other activities represented by the studied product(s). Table 6 presents the scoring system for each relevant competence and experience topic. Unless otherwise specified in the context of the intended application, reviewer self-declaration based on the scoring system constitutes the minimum requirement. The minimum qualification to act as a reviewer of an environmental footprint study is satisfied by achieving a total score of SIX or more points, including at least ONE point for each of the three mandatory elements (i.e. verification and audit practice, LCA methodology and practice, and technologies or other activities relevant to the Product Environmental Footprint study). If one reviewer alone does not fulfill the requirements for reviewers specified below, the review framework allows for having more than one reviewer to jointly fulfill the requirements, forming a "review team".

Table 11: Scoring system for eligible reviewers/review teams and for qualification as a potential member of a review team.

	Topic	Criteria	Score (points)				
			0	1	2	3	4
Manda-tory criteria	Verification and audit practice						
		Years of experience[1]	0-<3	3 – <4	5 – <9	9 – 14	> 14
		Number of reviews[2]	0-<3	3 – <6	6 – <16	16 – 30	> 30
	LCA methodology and practice	**Years of experience[3]**	0-<3	3 – <5	5 – <9	9 – 14	> 14
		"Experiences" of participation in LCA work	0-<5	5 – <9	9 – <16	16 – 30	> 30
	Technologies or other activities relevant to the Product Environmental Footprint study	**Years of experience[4]*in private sector**	0-<3 (within the last 10 years)	3 – <6 (within the last 10 years)	6 – <11 (within the last 20 years)	11 – 20	> 20
		Years of experience[5]*in public sector	0-<3 (within the last 10 years)	3 – <6 (within the last 10 years)	6 – <11 (within the last 20 years)	11 – 20	> 20
Other[6]	Verification and audit practice	Optional scores relating to audit	▪ 2 points: Accreditation as third party reviewer for at least one EPD Scheme, ISO 14001, or other EMS. ▪ 1 point: Attended courses on environmental audits (at least 40 hours). ▪ 1 point: Chair of at least one review panel (for LCA studies or other environmental applications). ▪ 1 point: Qualified trainer in environnemental audit course.				

Notes:

1) Years of experience in the field of environmental review and auditing.

2) Number of reviews for ISO 14040/14044 compliance, ISO 14025 compliance (Environmental Product Declarations (EPD)), or LCI data sets.

3) Years of experience in the field of LCA work, starting from University degree (Masters or equivalent) or Bachelor degree if Masters thesis predominantly includes LCA work.

4) Years of experience in a sector related to the studied product (s. 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 can also be used. Experience gained with technologies or processes in any sub-sector are considered valid for the whole sector.

5) Years of experience in the public sector, e.g. research centre, university, government relating to the studied product (s)

* Candidate needs to calculate years of experience based on employment contracts. For example, Prof A works in University B part-time from Jan 2005 until Dec 2010 and part-time at a refinery company. Prof A can count years of experience in private sector as 3 years and 3 years for public sector (university).

6) The additional scores are complementary.

REQUIREMENT: A review of the Product Environmental Footprint study shall be conducted as per the requirements of the intended application. Unless otherwise specified, the minimum necessary score to qualify as a reviewer is 6 points, including at least one point for each of the three mandatory criteria (i.e. verification and audit practice, LCA methodology and practice, and technologies or other activities relevant to the Product Environmental Footprint study). Reviewers or panels of reviewers must provide a self-declaration of their qualifications, stating how many points they achieved for each criterion.

11. Acronyms and Abbreviations

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
B2B	Business to Business
B2C	Business to Consumer
BSI	British Standards Institution
ELCD	European Reference Life Cycle Database
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
PAS	Publicly Available Specification
PFCR	Product Footprint Category Rules
WRI	World Resources Institute
WBCSD	World Business Council for Sustainable Development

12. Glossary

Additional Environmental Information – Environmental impact categories and other environmental indicators that are calculated and communicated alongside Organisation Environmental Footprint results.

Acidification - Impact category that addresses impacts due to acidifying substances in the environment. Emissions of NO_x, NH_3 and SO_x lead to releases of hydrogen ions (H^+) when the gases are mineralized. The protons contribute to acidification of soils and water when they are released in areas where the buffering capacity is low, resulting in forest decline and acidified lakes.

Allocation – An approach to solving multi-functionality problems. Refers to partitioning the input flows of a process or facility between the multiple outputs.

Attributional - refers to process-based modeling intended to provide a static representation of average conditions, excluding market-mediated effects.

Average Data – Refers to a production-weighted average of specific data. Example: A pharmaceutical organisation compiles production-weighted average data for twenty of their factories producing acetylsalicylic acid.

Background System – Refers to those stages of the organisations supply chain for which no direct information access is possible. For example, most of the upstream supply-chain processes and generally all processes further downstream will be considered part of the background system.

Best environmental management practice: means the most effective way to implement the environmental management system by organisations in a relevant sector and that can result in best environmental performance under given economic and technical conditions. [EMAS regulation]

Characterization - Calculating the magnitude of the contribution of each classified input/output to their respective environmental footprint impact categories, and aggregation of contributions within each category. This requires a linear multiplication of the inventory data with *characterization factors* for each substance and environmental footprint impact category of concern. For example, with respect to the environmental footprint impact category "climate change", CO_2 is chosen as reference substance and the reference unit is kg CO_2-equivalents.

Classification - Assigning the material/energy inputs and outputs tabulated in the Resource and Emissions Profile to environmental footprint impact categories according to each substances potential to contribute to each of the environmental impact categories considered.

Comparative Assertions – A statement of overall superiority or equivalence of organisations concerning the relative environmental performance, based on the results of an Organisation Environmental Footprint study.

Cradle to Gate - An assessment of a partial Organisation supply chain, from the extraction of raw materials (cradle) up to the manufacturer's "gate". The distribution, use stage and stage phase of the supply chain are omitted.

Cradle to Grave - An assessment, including raw material extraction, processing, distribution, storage, use, and disposal or recycling phases. All relevant inputs and outputs are considered for all of the stages of the life cycle.

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

Cut-off Criterion - Specification of the amount of material or energy flow or the level of environmental significance associated with processes to be excluded from an Organisation Environmental Footprint study.

Data Quality - Characteristics of data that relate to their ability to satisfy predefined quality requirements. Data quality covers various aspects, such as technological, geographical and time-related representativeness, as well as completeness and precision of the inventory data.

Directly attributable – refers to a process, activity or impact occurring with the defined Organisational Boundary

Downstream – occurring along the supply chains of sold goods/services after exiting the Organisational Boundary

Ecotoxicity: Impact category that addresses toxic impacts on an ecosystem, damaging individual species and changing the structure and function of the ecosystem. Ecotoxicity is a result of a variety of different toxicological mechanisms caused by release of all substances with a direct effect on the health of the ecosystem.

Environmental aspect: an element of an organisation's activities, products or services that has or can have an impact on the environment. [EMAS regulation]

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

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

Environmental impact - any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services. [EMAS regulation]

Environmental performance - the measurable results of an organisation's management of its environmental aspects. [EMAS regulation]

Environmentally significant – any process or activity to be included in the Environmental Footprint calculation (i.e. does not qualify for exclusion based on the cut-off criterion of 90% inclusiveness for each environmental footprint impact category)

Eutrophication - Nutrients (mainly nitrogen and phosphorus) from sewage outfalls and fertilized farmland accelerate the growth of algae and other vegetation in water. The degradation of organic material consumes oxygen resulting in oxygen deficiency and, in some cases, fish death. Eutrophication translates the quantity of emission of substances into a common measure expressed as the oxygen required for the degradation of dead biomass.

Extrapolated Data – Refers to data from a given process that is used to represent a similar process for which data is not available, on the assumption that it is reasonably representative

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

Functional Unit - The functional unit defines the qualitative and quantitative aspects of the function(s) and/or service(s) that the organisation being evaluated provides; the functional unit definition answers the questions "what?", "how much?", "how well?", and "for how long?"

Gate to Gate - A partial assessment looking only at the processes within a specific organisation or site.

Generic Data – Refers to data that is not directly collected, measured, or estimated, but rather sourced from a third-party life cycle inventory database or other source that complies with the data quality requirements of the Organisation Environmental Footprint method. Synonymous with "secondary data." Example: An organisation operating a facility that purchases acetylsalicylic acid from a number of regional firms on a least-cost basis as an input to their production process sources generic data from a life cycle inventory database to represent average acetylsalicylic acid production conditions in the region of interest.

Global Warming Potential – Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO_2-equivalent units) and specified time horizon **(**e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years)**.** Relates to capacity to influence changes in the global, average surface-air temperature and subsequent change of various climate parameters and their effects such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.

Human Toxicity –cancer – impact category that accounts for the adverse health effects on human beings caused by intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin as far as they are related to cancer

Human Toxicity- non cancer - Impact category that accounts for the adverse health effects on human beings caused by intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin as far as they are related to non-cancer effects that are not caused by particulate matter/respiratory inorganics or ionizing radiation.

Indirectly attributable – refers to a process, activity or impact occurring outside of the defined Organisational boundary but within the defined Organisation Environmental Footprint boundary (i.e. upstream or downstream)

Ionising Radiation, human health – Impact categories that accounts for the adverse health effects on human health caused by radioactive releases.

Land Use - Impact category related to use (occupation) and conversion (transformation) of land area by activities such as agriculture, roads, housing, mining, etc. Land occupation considers the effects of the land use, the amount of area involved and the duration of its occupation (quality-changes multiplied with area and duration). Land transformation considers the extent of changes in land properties and the area affected (quality changes multiplied with the area).

Life Cycle Approach - Refers to taking into consideration the spectrum of resource flows and environmental interventions associated with a product, service, or organisation from a supply chain perspective, including all phases from raw material acquisition through processing, distribution, use, and end-of-life processes, and all relevant related environmental impacts (in place of focusing on a single issue)

Life Cycle Impact Assessment (LCIA) - Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a system throughout the life cycle [ISO 14044:2006]. The employed LCIA methods provide impact characterization factors for elementary flows to aggregate the impact to a limited number of midpoint and/or damage indicators.

Life Cycle Inventory - Phase of life cycle assessment involving the compilation and quantification of inputs and outputs (mass and energy basis) for a given system throughout its life cycle.

Loading rate:- Ratio or capacity e.g. mass or volume that vehicle carry per trip

Normalization – After the characterization step, normalization is an optional step in which the LCIA results are multiplied with normalization factors that represent the overall inventory of a reference unit (e.g., a whole country or an average citizen). Normalized LCIA results express the relative shares of the impacts of the analyzed system in terms of the total contributions to each impact category per reference unit. When displaying the normalised LCIA results of the different impact topics next to each other, it becomes evident which impact categories the analyzed system affects most, and least. Normalized LCIA results reflect only the contribution of the analyzed system to the total impact potential, not the severity/relevance of the respective total impact. Normalized results are dimensionless, but not additive.

Organisation Environmental Footprint Sector Rules (OFSRs)– are sector-specific, life cycle based rules that complement general methodological guidance for Organisation Environmental Footprint studies by providing further specification at the sectorial level. CFCRs can help shifting the focus of the Organisation Environmental Footprint study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency.

Ozone Depletion Impact category that accounts for the degradation of stratospheric ozone due to emissions of ozone depleting substances, for example long-lived chlorine and bromine containing gases (e.g. CFCs, HCFCs, Halons).

Particulate Matter/Respiratory Inorganics – Impact categories that accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NO_x, SO_x, NH_3)

Photochemical Ozone Formation – Impact category that accounts for the formation of ozone at the ground level of the troposphere caused by photochemical oxidation of Volatile Organic Compounds (VOCs) and carbon monoxide (CO) in the presence of nitrogen oxides (NO_x and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts and manmade materials through reaction with organic materials.

Resource Depletion - Impact category that addresses use of natural resources, either renewable or non-renewable, and either biotic or abiotic.

Reference Flow – measure of the outputs from processes in a given system required to fulfill the function expressed by the functional unit

Resource Use and Emissions Profile – Refers to the inventory of data collected to represent the inputs and outputs associated with each stage of the Organisation supply chain of concern. The Resource Use and Emissions Profile includes three types of data: specific data, average data, and generic data.

Significant Environmental Aspect: an environmental aspect that has or can have a significant environmental impact. [EMAS regulation]

Soil Organic Matter (SOM) – is the measure of the content of organic material in soil. This derives from plants and animals and comprises all of the organic matter in the soil exclusive of the material that has not decayed.

Specific Data – Refers to directly measured or collected data representative of activities at a specific facility or set of facilities. Synonymous with "primary data."
Example: A pharmaceutical organisation compiles data from internal inventory records to represent the material and energy inputs and emissions from a factory producing acetylsalicylic acid.

System Boundary – Definition of aspects included or excluded from the study. For example, for a "cradle-to-grave" environmental footprint analysis, this should include all activities from extraction of raw materials through processing, manufacturing, use, repair and maintenance processes as well as transport, waste treatment and other purchased services such as e.g. cleaning and legal services, marketing, production and decommissioning of capital goods, operation of premises such as retail, storage, administration offices, staff commuting, business travel, and end-of-life processes.

Upstream – occurring along the supply chain of purchased goods/services prior to entering the Organisational Boundary

Weighting - Weighting is an additional, but not required, step that may support the interpretation and communication of the results of the analysis. Normalized Organisation Environmental Footprint results are multiplied by a set of weighting factors, which reflect the perceived relative importance of the impact categories considered. Weighted environmental footprint results can be directly compared across impact categories, and also summed across impact categories to obtain a single-value overall impact indicator. In contrast to the preceding, natural sciences-based phases (classification, characterisation), weighting requires value judgements as to the respective importance of the environmental footprint impact categories considered. These judgments may be based on expert opinion, social science methods, cultural/political view points, or economic considerations.

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Annex I: Calculation of CO2 emissions from land transformation

(Source: IPCC 2007; as adapted in EC 2010: ILCD Handbook; General guide for Life Cycle Assessment – Detailed guidance, Annex B)

Many aspects influence emissions from land transformations. Their combinations result in the native soil carbon stock, varied by four further influence factors:

- Native soil carbon stock factors (climate region and soil type (Table 12),
- land use factor (land use type, temperature regime, and moisture regime (Table 13)), and
- management factor (specific land management for cropland and for grassland (Table 14 and Table 15), and the related
- input level factor (in variation of the above named land management types, in the same tables).

These aspects and resulting factors are derived from the most recent available related IPCC reports and are included in the tables below. CO_2 emissions from any land transformation can be easily calculated by calculating the difference of the steady-state soil carbon content between the land use before and after transformation. This number is then to be multiplied by 44/12 to convert C-losses stoichiometrically to CO_2 emissions. The steady-state carbon stock of each land use is calculated by simple multiplication of its basic soil carbon stock with the loss factors.

Formula 2 and Formula 3 serve to calculate the soil organic carbon stock of the initial and final land use. Formula 6 provides the final prescription.

Formula 2 $$SOCi = SOCn * LUF_1 * LMF_1 * IL_1$$

with

- *SOCi* = Initial soil organic carbon stock of initial land use "1", given in [t/ha]
- *SOCn* = Native soil organic carbon stock (climate region, soil type); Table 10, given in [t/ha]
- *LUF* = Land use factor; Table 13, dimensionless
- *LMF* = Land management factor; Table 14 and Table 15, dimensionless
- *IL* = Input level factor; also Table 14 and Table 15, dimensionless

Formula 3 $$SOCf = SOCn * LUF_2 * LMF_2 * IL_2$$

with

- *SOCf* = Final soil organic carbon stock of land use "2", i.e. after transformation, given in [t/ha]

Formula 4 $$CO2 = (SOCi - SOCf) * \frac{44}{12}$$

with

- CO2 = resulting CO_2 emissions from soil (given in [t/ha]) as the difference in soil carbon stocks multiplied by the atomic weight of CO_2 and divided by the atomic weight of C.

Note that this is the total amount of CO_2 that has to be allocated to the individual crops and/or crop years after conversion, as detailed in the ILCD general handbook chapter 7.4.4.1.

At the end of the tables some example calculations are given.

Table 12: Native soil carbon stocks under native vegetation (tonnes C ha-1 in upper 30 cm of soil) (IPCC 2006)

Climate Region	High activity clay soils	Low activity clay soils	Sandy soils	Spodic soils	Volcanic soils	Wetland soils
Boreal	68	NA	10	117	20	146
Cold temperate, dry	50	33	34	NA	20	97
Cold temperate, moist	95	85	71	115	130	
Warm temperate, dry	38	24	19	NA	70	88
Warm temperate, moist	88	63	34	NA	80	
Tropical, dry	38	35	31	NA	50	86
Tropical, moist	65	47	39	NA	70	
Tropical, wet	44	60	66	NA	130	
Tropical montane	88	63	34	NA	80	

Table 13: Land use factors (IPCC 2006)

Land-use	Temperature regime	Moisture regime	Land use factors (IPCC default)	Error (±)[13]
Long-term cultivated	**Temperate/Boreal**	**Dry**	0.80	9 %
		Moist	0.69	12 %
	Tropical	**Dry**	0.58	61 %

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		Moist/Wet	0.48	46 %
	Tropical montane	**n/a**	0.64	50 %
Permanent grassland	**All**		1.00	
Paddy rice	**All**	**Dry and Moist/Wet**	1.10	50 %
Perennial/Tree Crop	**All**		1.00	50 %
Set-aside (< 20 yrs)	**Temperate/Boreal and Tropical**	**Dry**	0.93	11 %
		Moist/Wet	0.82	17 %
	Tropical montane	**n/a**	0.88	9

Table 14: Land management and input level factors for cropland (IPCC 2006)

Land management (for cultivated land only)				
Land-use management	**Temperature regime**	**Moisture regime**	**Land management and input level factors (IPCC defaults)**	**Error (±)**[225]
Full tillage	**All**	**Dry and Moist/Wet**	1.00	NA
Reduced tillage	**Temperate/Boreal**	**Dry**	1.02	6 %
		Moist	1.08	5 %
	Tropical	**Dry**	1.09	9 %
		Moist/Wet	1.15	8 %
	Tropical montane	**n/a**	1.09	50 %
No tillage	**Temperate/Boreal**	**Dry**	1.10	5 %
		Moist	1.15	4 %
	Tropical	**Dry**	1.17	8 %
		Moist/Wet	1.22	7 %
	Tropical montane	**n/a**	1.16	50 %
Input level (for cultivated land only)				
Low input	**Temperate/Boreal**	**Dry**	0.95	13 %

		Moist	0.92	14 %
	Tropical	**Dry**	0.95	13 %
		Moist/Wet	0.92	14 %
	Tropical montane	**n/a**	0.94	50 %
Medium input	**All**	**Dry and Moist/Wet**	1.00	NA
High input without manure	**Temperate/Boreal and Tropical**	**Dry**	1.04	13 %
		Moist/Wet	1.11	10 %
	Tropical montane	**n/a**	1.08	50 %
High input with manure	**Temperate/Boreal and Tropical**	**Dry**	1.37	12 %
		Moist/Wet	1.44	13 %
	Tropical montane	**n/a**	1.41	

Table 15: Land management and input level factors for grassland (IPCC 2006)

Land management (for grassland only)			
Land-use management	**Temperature regime**	**Land management and input level factors (IPCC defaults)**	**Error (±)[225]**
Nominally managed (non-degraded)	**All**	1.00	NA
Moderately degraded	**Temperate/Boreal**	0.95	13 %
	Tropical	0.97	11 %
	Tropical Montane	0.96	40 %
Severely degraded	**All**	0.70	40 %
Improved grassland	**Temperate/Boreal**	1.14	11 %
	Tropical	1.17	9 %
	Tropical Montane	1.16	40 %
Input level (for improved grass land only)			
Medium	**All**	1.00	NA

High	**All**	1.11	7 %

In order to calculate the annual changes in carbon stocks due to land-use change, please refer to the following three illustrative examples[14]:

Example 1: Transformation of "set-aside land" in the UK for "annual crop production"

Aspects:

- Climate Region of UK: Cold temperature
- Moisture Regime of UK: Moist
- Soil type (typical, average, or specific, e.g. this might be): High activity clay soils

--> *SOCn* = 95 t/ha (Table 12)

- Land use 1 (before transformation): Set-aside land (< 20 yrs)

--> *LUF1* = 0.82 (Table 13)

- Land use 2 (after transformation): Long-term cultivated crop land

--> *LUF2* = 0.69 (Table 13)

- Land management of land use 1: none (as land use is "set-aside land")

--> *LMF1* = 1[15]

- Input factor land use 1: none (as land use is "set-aside land")

--> *IF1* = 1

- Land management of land use 2: Full tillage

--> *LUF2* = 1.00 (Table 14)

- Input factor land use 2: High input without manure

--> *IF2* = 1.11 (Table 14)

Factors from the tables and calculations:

- Original carbon stock of land use 1= 95 * 0.82 * 1 * 1 = 77.9 tonnes of Carbon per ha
- Final carbon stock of land use 2= 95 * 0.69 * 1.00 * 1.11 = 72.8 tonnes of Carbon per ha
- Loss in carbon stock = 5.1 tonnes of Carbon per ha

Resulting annual CO_2 emissions to be attributed to that "annual crop" over the applicable entire time period of use (20 years) = 5.1 * 44 / 12 = 18.7 tonnes of CO_2 emissions per ha[16,17].

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Example 2: Transformation of forest in Indonesia for annual crop production

- Climate Region of Indonesia: Tropical
- Moisture Regime of Indonesia: wet
- Soil type: Volcanic
- Land use 1: Native
- Land use 2: Long-term cultivated
- Land management and input level of land use 1: none
- Land management and input level of land use 2: Reduced tillage, low input

- Original carbon stock of land use 1= 130 * 1.00 * 1 * 1 = 130 tonnes of Carbon per ha
- Final carbon stock of land use 2 = 130 * 0.48 * 1.15 * 0.92 = 66.0 tonnes of Carbon per ha
- Loss in carbon stock = 64.0 tonnes of Carbon per ha[18]

Resulting annual CO_2 emissions to be attributed to that "annual crop" over the applicable entire time period of use (20 years) = 64 * 44 / 12 = 234.67 tonnes of CO_2 emissions per ha.

Example 3: Transformation of grassland in Canada for annual crop production

- Climate Region of Canada: Cold temperate
- Moisture Regime of Canada: dry
- Soil type: Sandy soils
- Land use 1: Permanent grassland
- Land use 2: Long-term cultivated
- Land management and input level of land use 1: Nominally managed (non-degraded), medium input
- Land management and input level of land use 2: Full tillage, high input with manure

- Original carbon stock of land use 1 = 34 * 1.00 * 1.00 * 1.00= 34 tonnes of Carbon per ha
- Final carbon stock of land use 2 = 34 * 0.80 * 1.00 * 1.37 = 37.3 tonnes of Carbon per ha
- Loss in carbon stock = -3.3[19] tonnes of Carbon per ha

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Resulting annual CO_2 emissions to be attributed to that "annual crop" over the applicable entire time period of use (20 years) = -3.3 * 44 / 12 = -12.1 tonnes of CO_2 emissions per ha, i.e. 12.1 tonnes of CO_2 accumulation / binding as soil organic carbon.

This last example illustrates a land transformation that results in net carbon storage in the soil. Please note that, even though this crop is credited for sequestering carbon dioxide from the atmosphere to the soil, the temporary nature of this storage may need to be considered in the results interpretation.

Annex II: Data Management Plan (adapted from GHG protocol initiative[20])

If a data management plan is developed, the following steps should be undertaken and documented.

1. ***Establish an Organisation accounting quality person/team.*** This person/team should be responsible for implementing and maintaining the data management plan, continually improving the quality of Organisation inventories, and coordinating internal data exchanges and any external interactions (such as with relevant Organisation accounting programs and reviewers).

2. ***Develop Data Management Plan and Checklist***. Development of the data management plan should begin before any data is collected to ensure all relevant information about the inventory is documented as it proceeds. The plan should evolve over time as data collection and processes are refined. In the plan, the quality criteria and any evaluation/scoring systems are to be defined. The data management plan checklist outlines what components should be included in a data management plan and can be used as a guide for creating a plan or for pulling together existing documents to constitute the plan.

3. ***Identify relevant processes.*** Generic data shall be used to identify relevant processes. Checks should be performed on all processes in the system within the selected system boundaries.

4. ***Perform data quality checks.*** Checks should be applied to all aspects of the inventory process, focusing on data quality, data handling, documentation, and calculation procedures. The defined quality criteria and scoring systems form the basis for the data quality checks.

5. ***Review final of Organisation inventory and reports.*** Selected independent external reviewers should review the study – ideally from the beginning.

6. ***Establish formal feedback loops to improve data collection, handling and documentation processes.*** Feedback loops are needed to improve the quality of the Organisation inventory over time and to correct any errors or inconsistencies identified in the review process.

7. ***Establish reporting, documentation and archiving procedures.*** Establish record-keeping processes for what data should be stored and how they should be stored; what information should be reported as part of internal and external inventory reports; and what should be documented to support data collection and calculation methodologies. The process may also involve aligning or developing relevant database systems for record keeping.

The data management plan is likely to be an evolving document that is updated as data sources change, data handling procedures are refined, calculation methodologies improve, Organisation inventory responsibilities change within an organisation, or the business objectives of the Organisation inventory change.

Data collection template

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A data collection template is useful for organizing data collection activities and results while compiling the Resource Use and Emissions Profile. A data collection template may include the following aspects:

- Introduction to the Organisation Environmental Footprint study, including an overview of the objectives of data collection and the template/questionnaire employed;
- Information on the entity(ies) or person(s) responsible for measurement and data collection procedures;
- Description of the site where data is to be collected (for example, maximum and normal operation capacity, annual productive output, location, number of employees, etc.);
- Date/year of data collection;
- Description of the Organisation;
- Product/Service Portfolio description;
- Overall technical flow diagrams for owned/operated facilities within defined organisational boundaries;
- Input and outputs per facility;

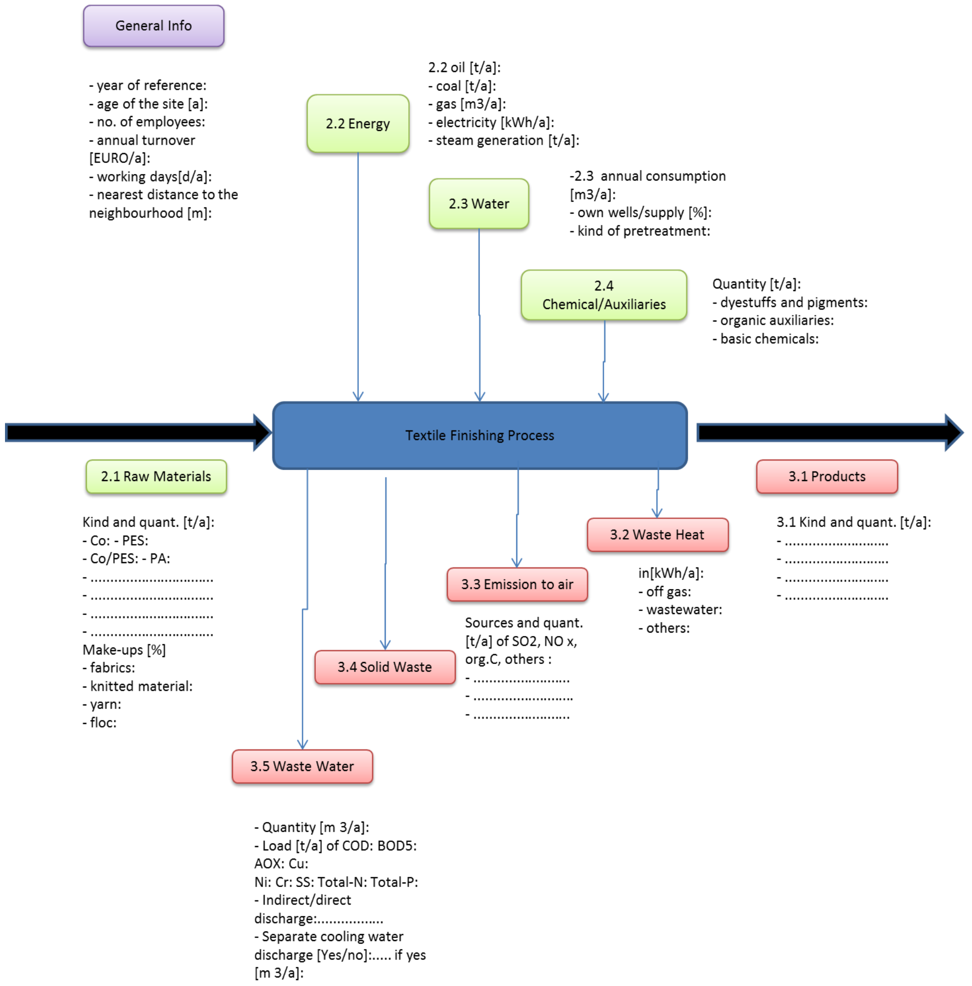

Figure 10: Technical flow diagram for a facility within the defined organisational boundary

Total Inputs to Facility

Code	Name	Amount	Unit

Total Outputs from Facility

Code	Name	Amount	Unit

Example of Resource Use and Emissions Profile data inventory for a facility (selected substances)

Parameter	Unit	
Energy consumption	GJ	115.5
Electricity	GJ	34.6
Fossil Fuel	GJ	76
Natural gas	Mg	0.59
Natural gas, feedstock	Mg	0.16
Crude oil	Mg	0.57
Crude oil, feedstock	Mg	0.48
Coal	Mg	0.66
Coal, feedstock	Mg	0.21
LPG	Mg	0.02
Hydro power	GJ	5.2
Water	Mg	12400
Emissions to air		
CO2	Mg	5,132
CH4	Mg	8.2
SO2	Mg	3.9
Nox	Mg	26.8
CH	Mg	25.8
CO	Mg	28
Emissions to water		
COD Mn	Mg	13.3
BOD	Mg	5.7
Tot-P	Mg	0.052
Tot-N	Mg	0.002
Product Outputs		

Pants	#	20,000
T-Shirts	#	15,000

Annex III: Dealing with Multi-functionality in Recycling Situations

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 “Recycling rate method” is to be used for this purpose for the calculation of PEF. This method is also referred to as the "end-of-life recycling" approach, or the "recyclability substitution” approach. The overall resulting emissions (per unit of analysis) including the entire waste management of the product to be recycled can be estimated using material recycling. Likewise, the overall resulting emissions (per unit of analysis) including the entire waste management in case energy recovery is involved can be estimated using the formula for energy recovery.

For multi-functionality issues involving only material recycling

$$\textbf{Overall emissions (per kg of material)} = \overbrace{EP*Cp}^{\text{Primary Production}} + \overbrace{ED*(1-Rm)_{*}}^{\text{Disposal}} + \overbrace{(ER*Rm)}^{\text{Recycling}} - \overbrace{(Rm-Cr)*(EP*(Qs/Qp))}^{\text{Credits or Debits}}$$

Where:

Assuming that the material from the recycling process has the same inherent properties (although it may have a different quality level) as the primary material.

- EP = emissions (per kg of material) arising from primary production
- Cp = “content, primary” is the proportion of primary material that is used in the initial production
- ER = emissions (per kg of recycled output) arising from the recycling processing
- Cr = “content, recycled” is the proportion of recycled material that is used in the initial production (Cr = 1 – Cp)
- ED = emissions (per kg of waste) arising from disposal of waste material
- Rm = “recycling rate of material” is the proportion of material in the product that will be recycled in a subsequent system. Rm must take into account the inefficiencies in the collection and recycling processes (i.e. Rm=<1)
- Qs = quality of the secondary material

- Qp = quality of the primary material

This formula can be divided into four blocks which are interpreted as follows:

- Primary production = EP*Cp represents the emissions from primary production
- Disposal = ED*(1-Rm) represents the emissions from disposal of waste, taking into account the proportion of the material in the product that is not recycled at end-of-life (1-Rm)

  Note* if the amount material input to the recycling process (Rin) is known, replace Rm with Rin
- Recycling = ER*Rm represents the emissions from the recycling process including all related activities (e.g. transport and waste treatment processes), which is proportional to the share of material that is recycled into secondary material at end-of-life (Rm)
- Credits or Debits = (Rm-Cr)*(EP*(Qs/Qp) represents the credits (i.e. avoided emissions) for the replaced material, taking into account the quality correction ratio. This ratio is taken as an approximation for any differences in quality between the secondary material and the primary material. Following the environmental footprint multi-functionality hierarchy, it shall first be considered whether a relevant, underlying physical relationship can be identified as a basis for the quality correction ratio. If this is not possible some other relationship shall be used - for example, economic value. Here, prices of primary versus secondary materials are assumed to provide a proxy for quality. In this case, Qs/Qp would be the ratio between the market price of the secondary material (Qs) and the market price of the primary material (Qp).

For multi-functionality issues involving only energy recovery

$$\textbf{Overall emissions (per kg)} = \overbrace{EP*Cp}^{\text{Primary Production}} + \overbrace{ED*(1-Re)}^{\text{Disposal}} + \overbrace{EER*Re}^{\text{Energy recovery}} - \overbrace{Re*LCV*NEE*Ee-(Cr*EP*(Qs/Qp))}^{\text{Credits or Debits}}$$

Where:

- EP = emissions (per unit of analysis) arising from primary production
- Cp = “content, primary” is the proportion of primary material that is used in the initial production
- ER = emissions (per unit of analysis) arising from the processing of recycled material output for use in a subsequent product system
- ED = emissions (per kg of waste material) arising from disposal of waste material by means other than for energy recovery

- Re = “rate for energy recovery” is the proportion of material in the product that is assumed to be used for energy recovery at end-of-life. Re must take into account the inefficiencies in the collection processes (i.e. Re=<1)
- EER = emissions (per kg incinerated material) arising from the energy recovery process
- Ee = emissions (per MJ) arising from the (assumed) substituted form of energy production
- Cr = “content, recycled” is the proportion of recycled material that is used in the initial production
- LCV = lower calorific value
- NEE = Energy efficiency of the recovery processes
- Qs = quality of the secondary material

  Qp = quality of the primary material

This formula can be divided into four blocks which are interpreted as follows:

- Primary production = EP*Cp represents the emissions from primary production and from the processing of recycled material, taking into account the recycled content on the input side
- Disposal = ED*(1-Re) represents the emissions from disposal of waste, thus taking into account the proportion of the material in the product that is not used for energy recovery at end-of-life (1-Re)
- Energy recovery = EER*Re represents the emissions from the energy recovery process, proportional to the share of material that is used for energy recovery at end-of-life (Re)

Credits or Debits = Re*(calorific Value)*NEE*Ee-(Cr*EP*(Qs/Qp)) represents the credits (avoided emissions) from the energy production that is assumed to be substituted by the recovered energy (including emissions related to the primary material used to produce the substituted energy). The ratio Qs/Qp is taken as an approximation for any differences in quality between the secondary material and the primary material. Following the environmental footprint multi-functionality hierarchy, it shall first be considered whether a relevant, underlying physical relationship can be identified as a basis for the quality correction ratio. If this is not possible some other relationship shall be used - for example, economic value. Here, prices of primary versus secondary materials are assumed to provide a proxy for quality. In this case, Qs/Qp would be the ratio between the market price of the secondary material (Qs) and the market price of the primary material (Qp).

To use the above formula for material, the (end-of-life) recycling rate (Rm) should be known. The following table (Table 16), based on statistics from Eurostat[21,22,23], provides default recycling rate values for a number

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of selected streams of packaging waste (reference year: 2008). These shall be intended as purely indicative values, which may be used as default only if specific, high quality data are not available. Figure 11provides recycling rates for packaging waste (i.e. all packaging waste streams included) in the EU-27 Member States (reference year: 2007) [24]. Table 17 provides suggested default recycling rates for metals[25]. Comprehensive statistics on waste recycling rates can be found in the above referenced sources from Eurostat. Table 18 and Table 19 provide examples of primary and secondary materials' prices, respectively.

Table 16: Suggested default recycling rates for selected streams of packaging waste (Eurostat, 2008)

Country	Overall packaging waste	Plastic packaging	Paper & Cardboard packaging	Metal packaging	Wooden packaging	Glass packaging
Belgium	78.9	39.5	89.4	94.0	57.9	100
Bulgaria	50.3	15.6	84.9	65.1	40.6	47
Czeck Republic	67.1	50.2	93.8	42.9	29.3	69.9
Denmark	59.7	25.4	61.0	81.9	41.0	120.9
Germany	70.5	47.3	87.7	91.7	28.8	82.2
Estonia	43.5	22.0	65.1	25.6	56.7	45.8
Ireland	61.7	28.9	78.2	62.0	76.7	73.9
Greece	43.8	11.9	73.6	43.8	30.8	15
Spain	59.1	24.4	73.4	67.8	58.2	60
France	55.2	22.5	86.9	60.2	18.9	62.7
Italy	59.6	31.1	73.8	68.4	53.1	65
Cyprus	34	14.8	59.9	94.9	14.9	17.7
Latvia	46.8	17.6	66.1	68.1	28.3	53
Lithuania	51.7	32.6	73.0	62.1	43.4	49.9
Luxemburg	63.6	29.7	77.6	79.4	19.2	92.2
Hungary	50.8	25.1	90.6	66.9	22.6	27.8
Netherlands	72.4	36.4	96.4	86.3	36.1	87
Austria	67.9	34.9	85.4	63.9	21.9	84.3
Poland	42.9	23.9	67.1	37.5	26.3	43.8
Portugal	61.0	19.1	87.8	64.8	64.5	51.8
Romania	33.5	15.5	61.6	51.0	8.3	34.7
Slovenia	52.4	55.6	66.4	21.4	7.2	79.8
Slovakia	47.7	43.7	53.6	55.8	16.1	47.6
Finland	56.7	22.7	93.1	75.4	21.3	79.8
Sweden	58.5	37.0	74.1	71.3	16.7	93.5
United Kingdom	61.5	23.7	79.7	56.9	76.5	61.3

Figure 11: Packaging waste recycling rates in EU-27 Member States (year 2007)

Table 17: suggested default recycling rates for metals

Metal	Recycling Rate (R)	Metal	Recycling Rate (R)
Cr	90%	Mg	39%
Mn	53%	Al	57%
Fe	72%	Ti	91%
Ni	59%	Co	68%
Nb	53%	Cu	48%
Mo	30%	Zn	40%
V	1%	Sn	75%
Ru	10%	Pb	72%
Rh	55%	Pt	71%
Pd	65%	Au	51%
Ag	65%	Os	1%

Table 18: Primary material price

World Bank Commodity Price Data (Pink Sheet)

Annual Prices in Nominal and Real 2000 US dollars, 1960 to Present

(Annual series are available in nominal and real 2000 dollars; see column "BU" for real price series)

Updated as of: December 6, 2010

	Nominal US dollars Petroleum crude ($/bbl)	Coal Australian ($/mt)	Natural gas US ($/mmbtu)	Natural gas Europe ($/mmbtu)	Natural gas Japan ($/mmbtu)	Cocoa (cents/kg)	Aluminum ($/mt)	Copper ($/mt)	Lead (cents/kg)	Tin (cents/kg)	Nickel ($/mt)	Zinc (cents/kg)	Gold ($/toz)	Silver (cents/toz)	Iron ore ($/mt fe)	Steel Index Japan (2000=100	Steel cold rolled coilsheet ($/mt)	Nominal US dollars Steel hot rolled coilsheet ($/mt)	Steel rebar ($/mt)	Steel wire rod ($/mt)
1980	36.87	40.14	1.55	4.22	5.70	260.35	1456.00	2182.00	90.60	1677.49	6518.70	76.10	607.90	2063.60	28.09	108.74	386.08	323.33	330.83	350.83
1981	35.48	53.62	1.93	4.60	6.03	207.96	1263.00	1741.90	72.70	1415.91	5953.10	84.60	459.75	1051.80	28.09	111.43	399.67	328.83	313.33	387.50
1982	32.65	54.77	2.40	4.45	6.05	173.56	992.00	1480.40	54.60	1282.58	4837.50	74.50	375.80	794.70	32.50	95.27	367.92	281.67	242.50	353.33
1983	29.66	38.19	2.53	4.05	5.55	211.99	1439.00	1591.90	42.50	1298.80	4672.80	76.40	422.53	1144.10	29.00	89.02	360.42	270.00	222.50	312.50
1984	28.56	30.96	2.59	3.80	5.24	239.60	1251.00	1377.30	44.30	1223.35	4752.30	92.20	360.47	814.10	26.15	93.70	376.67	283.83	233.33	308.75
1985	27.18	33.75	2.45	3.70	5.23	225.45	1041.00	1417.40	39.10	1153.90	4899.10	78.30	317.91	614.20	26.56	80.96	326.25	245.83	225.42	272.92
1986	14.35	31.13	1.89	2.90	4.10	206.97	1150.00	1373.80	40.60	616.14	3881.20	75.40	364.17	547.00	26.26	82.49	325.42	269.58	219.58	239.58
1987	18.15	27.50	1.62	2.15	3.35	199.42	1565.00	1782.50	59.70	666.48	4872.20	79.90	446.47	701.00	25.30	95.86	385.42	323.33	202.92	248.33
1988	14.72	34.88	1.64	2.00	3.34	158.46	2551.00	2601.70	65.60	705.16	13778.30	124.10	437.05	654.00	24.30	125.30	501.25	395.83	262.50	313.75
1989	17.84	38.00	1.70	2.10	3.28	124.10	1951.00	2848.40	67.30	853.44	13308.20	165.90	381.43	550.00	27.83	140.08	550.42	441.92	341.67	350.83
1990	22.88	39.67	1.70	2.55	3.64	126.67	1639.00	2661.50	81.10	608.54	8864.10	151.30	383.47	488.83	32.50	134.43	511.25	411.25	364.17	362.92
1991	19.37	39.67	1.49	3.11	3.99	119.51	1302.20	2338.80	55.80	559.50	8155.60	111.70	362.18	404.14	34.76	131.86	504.17	408.33	367.08	383.33
1992	19.02	38.56	1.77	2.56	3.60	109.96	1254.30	2281.15	54.10	610.10	7001.23	124.00	343.73	393.60	33.10	116.48	469.17	369.17	306.67	372.50
1993	16.84	31.33	2.12	2.67	3.51	111.69	1139.05	1913.08	40.64	516.11	5293.42	96.20	359.77	429.84	29.09	122.67	470.00	375.83	348.75	395.83
1994	15.89	32.30	1.92	2.44	3.18	139.60	1476.78	2307.42	54.78	546.38	6339.82	99.77	384.01	528.42	26.47	122.59	511.67	402.92	322.50	371.67
1995	17.18	39.37	1.72	2.73	3.45	143.24	1805.65	2935.61	63.10	621.38	8228.04	103.11	384.16	519.18	28.38	141.87	554.17	440.83	381.67	420.83
1996	20.42	38.07	2.73	2.84	3.67	145.56	1505.66	2294.86	77.43	616.51	7500.82	102.51	387.70	518.34	30.00	128.42	483.92	365.58	360.17	438.50
1997	19.17	35.10	2.48	2.74	3.91	161.87	1599.33	2276.77	62.42	564.68	6927.39	131.61	331.10	489.22	30.15	117.94	448.17	337.25	325.17	382.67
1998	13.07	29.23	2.09	2.42	3.02	167.64	1357.47	1654.06	52.86	554.03	4629.52	102.45	294.16	553.43	31.00	98.44	370.83	279.17	257.50	332.08
1999	18.07	25.89	2.27	2.13	3.14	113.53	1361.09	1572.86	50.26	540.36	6011.23	107.63	278.77	524.95	27.59	89.09	340.42	243.33	234.17	290.00
2000	28.23	26.25	4.31	3.86	4.71	90.58	1549.14	1813.47	45.39	543.57	8637.74	112.81	279.03	499.92	28.79	100.00	385.83	295.83	244.17	291.67
2001	24.35	32.31	3.96	4.06	4.63	106.87	1443.63	1578.29	47.62	448.44	5944.73	88.58	270.99	438.61	30.03	86.93	299.15	216.52	221.46	302.29
2002	24.93	25.31	3.36	3.05	4.28	177.79	1349.92	1559.48	45.27	406.05	6771.75	77.88	309.97	462.52	29.31	88.21	328.33	246.67	204.17	300.00
2003	28.90	26.09	5.49	3.91	4.73	175.09	1431.29	1779.14	51.50	489.49	9629.47	82.77	363.51	491.07	31.95	103.31	444.58	320.21	265.83	300.00
2004	37.73	52.95	5.90	4.28	5.13	154.99	1715.54	2865.88	88.65	851.27	13823.24	104.78	409.21	669.05	37.90	168.19	607.08	502.50	428.75	487.50
2005	53.39	47.62	8.92	6.33	5.99	153.81	1898.31	3678.88	97.64	737.98	14743.96	138.13	444.84	733.81	65.00	186.80	733.33	633.33	423.13	579.17
2006	64.29	49.09	6.72	8.47	7.08	159.19	2569.90	6722.13	128.97	878.08	24254.41	327.53	604.34	1156.91	77.35	181.62	693.75	600.00	443.75	581.25
2007	71.12	65.73	6.98	8.56	7.68	195.23	2638.18	7118.23	258.00	1453.68	37229.81	324.24	696.72	1341.25	84.70	181.97	650.00	550.00	521.50	533.33
2008	96.99	127.10	8.86	13.41	12.55	257.71	2572.79	6955.88	209.07	1851.01	21110.64	187.47	871.71	1499.90	140.60	289.33	965.63	883.33	760.17	1009.75
2009	61.76	71.84	3.95	8.71	8.94	288.92	1664.83	5149.74	171.93	1357.39	14654.63	165.51	972.97	1469.41	100.95	227.05	783.33	683.33	486.04	969.42

Table 19: Secondary material price

Material	Secondary material price per kg
Al	1.45
Cu	1.67
Zn	2.32
Au	9653.23
Ag	166.55
Ni	7.84
Steel	0.29
Sn	-
PET	1.15
Paper	0.14
Glass	-
HDPE	0.93
PP	
Stainless steel	

Ref: (Analysis of National Solid Waste Recycling Programs, 1999; Financial Times, 2000; American Metal Market, 1999; US Geological Survey, 1997–2000)

Annex IV: Identifying Appropriate Nomenclature and Properties for Specific Flows

Table 20: Required rules for each flow type.

Items	Rule from the ILCD- Nomenclature
Raw material, Input	2, 4, 5
Emission, output	2,4,9
Product flow	10,11,13,14,15,16,17

Table 21: ILCD Nomenclature Rules.

Rule #	Rule Category	Rule/ Required Nomenclature
1	Requirement status of the individual rules	For ILCD-compliant LCI data sets, LCA studies and other ILCD-compliant deliverables the "mandatory" rules shall always be met, while the “recommended” ones are only recommended.
CLASSIFICATION/CATEGORIZATION OF FLOWS		
CLASSIFICATION/CHARACTERIZATION OF ELEMENTARY FLOWS		
Classification / categorisation according to (sub)compartment of receiving / providing environment		
2	"elementary flow categories" by receiving / providing environmental compartment	Resources - Resources from ground Resources - Resources from water Resources - Resources from air Resources – Resources from biosphere Land use – Land transformation Land use – Land occupation Emissions – Emissions to air - Emissions to air, unspecified Emissions – Emissions to air - Emissions to air, unspecified (long-term)

Rule #	Rule Category	Rule/ Required Nomenclature
		Emissions – Emissions to air - Emissions to urban air close to ground Emissions – Emissions to air - Emissions to non-urban air or from high stacks Emissions – Emissions to air - Emissions to lower stratosphere and upper troposphere Emissions – Emissions to water - Emissions to water, unspecified Emissions – Emissions to water - Emissions to water, unspecified (long-term) Emissions – Emissions to water - Emissions to fresh water Emissions – Emissions to water - Emissions to sea water Emissions – Emissions to soil - Emissions to soil, unspecified Emissions – Emissions to soil - Emissions to agricultural soil Emissions – Emissions to soil - Emissions to non-agricultural soil Emissions – Emissions to soil - Emissions to soil, unspecified (long-term) Other elementary flows
3	Splitting emissions to brackish water	If an emission into brackish water appears, the amount of emissions should be split into a 50% share of emission to seawater and 50% to freshwater.
Discussion of a possible further differentiation of receiving / providing environment		
4	Further differentiation of providing/receiving environmental compartments	Further differentiated receiving / providing environmental compartments below the compartments defined more above shall presently not be used.
Classification according to substance-type of elementary flow		

Rule #	Rule Category	Rule/ Required Nomenclature
Substance-type based classification for resources		
5	Additional, non-identifying classification for "Resources from ground" elementary flows	“Non-renewable material resources from ground” (e.g. "Sand", "Anhydrite; 100%", etc.) “Non-renewable element resources from ground ” (e.g. "Gold", "Copper", etc.) “Non-renewable energy resources from ground ” (e.g. "Hard coal; 32.7 MJ/kg net calorific value", "Uranium; natural isotope mix; 451000 MJ/kg", etc.) “Renewable element resources from ground ” (e.g. "Radon", etc.) “Renewable energy resources from ground” (e.g. "Wind energy", "Water energy; running", etc.) "Renewable material resources from ground" “Renewable resources from ground, unspecified” (for renewable resource elementary flows from ground that do not fit into any of the other categories) “Non-renewable resources from ground, unspecified” (for non-renewable resource elementary flows from ground that do not fit into any of the other categories)
6	Additional, non-identifying classification of "Resources from water" elementary flows	“Non-renewable element resources from water” (e.g. Magnesium, Bromium, Hydrogen etc.) “Non-renewable material resources from water” “Non-renewable energy resources from water” “Renewable element resources from water” “Renewable material resources from water ” (e.g. "Groundwater, etc) “Renewable energy resources from water” (e.g. "Hydro energy; running", “Tidal energy”, etc.) “Renewable resources from water, unspecified” (for renewable resource elementary flows from water that do not

Rule #	Rule Category	Rule/ Required Nomenclature
		fit into any of the other categories) “Non-renewable resources from water, unspecified” (for non-renewable resource elementary flows from water that do not fit into any of the other categories)
7	Additional, non-identifying classification of "Resources from air" elementary flows	“Non-renewable material resources from air” “Non-renewable element resources from air” “Non-renewable energy resources from air” “Renewable element resources from air” (e.g. "Oxygen", "Argon", etc.) “Renewable energy resources from air” (e.g. Wind energy, solar energy, etc.) "Renewable material resources from air" “Renewable resources from air, unspecified” (for renewable resource elementary flows from air that do not fit into any of the other categories) “Non-renewable resources from air, unspecified” (for non-renewable resource elementary flows from air that do not fit into any of the other categories)
8	Additional, non-identifying classification of resource elementary flows (for use as sub-classification for the "Resources from biosphere" top class	"Renewable genetic resources from biosphere" (for extraction/hunting of wild species e.g. “Mahagony wood (Tectona grandis), without bark; standing; primary forest”) "Renewable material resources from biosphere" (e.g. “Round soft wood; 50% H2O”) “Renewable energy resources from biosphere" (e.g. "Wood biomass; 50% H2O, 7.2 MJ/kg”) “Renewable element resources from biosphere” “Renewable resources from biosphere, unspecified” (for renewable resource elementary flows from biosphere that do not fit into any of the other categories)
Substance-type based classification for emissions		

Rule #	Rule Category	Rule/ Required Nomenclature
9	Recommended for both technical and non-technical target audience: additional, non-identifying classification for emissions	"Metal and semimetal elements and ions" (e.g., "Arsenic", "Cadmium", "Chromium, III", etc.) "Non-metallic or -semimetallic ions" (e.g. "Ammonium", "Phosphate", etc.) "Inorganic covalent compounds" (e.g. "Carbon dioxide, fossil", "Carbon monoxide", "Sulphur dioxide", "Ammonia", etc.) "Cyclic organics" (e.g. "Hexachloro-benzene", "Cyclopentane", "Naphthalene", etc.) "Acyclic organics" (e.g. "Ethene", "3-methyl-1-butene", "1,2-chloro-pentane" etc.) "Pesticides" (e.g. "Chlorfenvinphos", "Tributyl-tin" etc.) "Radioactives" (e.g. "Cesium-137", "Radon-220", etc.) "Particles" (e.g. "PM <2.5µm", "PM 2.5-10µm", etc.) "Other substance type"
HIERARCHICAL CLASSIFICATION OF PRODUCT FLOWS, WASTE FLOWS, AND PROCESSES		
10	Top-level classification for Product flows, Waste flows, and Processes	"Energy carriers and technologies" "Materials production" "Systems" "End-of-life treatment" "Transport services" "Use and consumption" "Other services"
11	Second level classifications for Product flows, Waste flows, and Processes (for preceding top-level classification)	"Energy carriers and technologies" "Energetic raw materials" (Note: this refers to the extracted products and related technologies, not the resources

Rule #	Rule Category	Rule/ Required Nomenclature
		e.g. in the ground) "Electricity” "Heat and steam” "Mechanical energy" "Hard coal based fuels" "Lignite based fuels" "Crude oil based fuels" “Natural gas based fuels” "Nuclear fuels" "Other non-renewable fuels" "Renewable fuels" “Materials production” “Non-energetic raw materials” (Note: this refers to the extracted products and related technologies, not the resources e.g. in the ground) "Metals and semimetals" "Organic chemicals" "Inorganic chemicals" "Glass and ceramics" "Other mineral materials" "Plastics" "Paper and cardboards" "Water"

Rule #	Rule Category	Rule/ Required Nomenclature
		"Agricultural production means" “Food and renewable raw materials" "Wood" "Other materials" “Systems" "Packaging" "Electrics and electronics" "Vehicles" "Other machines" "Construction" "White goods" "Textiles, furniture and other interiors" "Unspecific parts" "Paints and chemical preparations" "Other systems" "End-of-life treatment" "Reuse or further use" "Material recycling" "Raw material recycling" “Energy recycling"

Rule #	Rule Category	Rule/ Required Nomenclature
		"Landfilling" "Waste collection" "Waste water treatment" "Raw gas treatment" "Other end-of-life services" "Transport services" Road" Rail" Water" Air" Other transport" “Use and consumption" "Consumption of products" "Use of energy-using products" "Other use and consumption" "Other Services" "Cleaning" "Storage"

Rule #	Rule Category	Rule/ Required Nomenclature
		"Health, social services, beauty and wellness" "Repair and maintenance" "Sale and wholesale" "Communication and information services" "Financial, legal, and insurance" "Administration and government" "Defence" "Lodging and gastronomy" "Education" "Research and development" "Entertainment" "Renting" "Engineering and consulting" "Other services"
NOMENCLATURE FOR FLOWS AND PROCESSES		
STRUCTURING FLOW NAMES		
12	General flow and process naming rules	the entries within the same name component field should be listed separated by the character ",". Within the entries of the various name component fields the character ";" should be avoided abbreviations should be avoided in the base name field, unless these are very widely in use and complement the long name in the name field (e.g. do not use "PP" for "Polypropylene", but it can be added as "Polypropylene, PP") or chemical element symbols (e.g. do not use "Fe" for "Iron"). Chemical symbols can be used in the "Quantitative flow properties" field to indicate concentrations (e.g. "45% Fe" for

Rule #	Rule Category	Rule/ Required Nomenclature
		an iron ore can be used). brackets within the field entries should be avoided
13	“Base name” field	Definition: "General descriptive name of the flow. Technical language should be used." Additional recommendations: The technical name should be given as it is used in the respective industry or towards their customers. For emissions the "base name" is the only one to be used; for certain resource flows also the last name component "quantitative flow properties" (see more below) is required, e.g. for energetic raw materials such as "Hard coal; 32.7 MJ/kg net calorific value". Recommendations for land use flows will depend on further developments in the LCIA area.
14	“Treatment, standards, routes” name field	Definition: "Qualitative information on the (product or waste) flow in technical term(s): treatment received, standard fulfilled, product quality, use information, production route name, educt name, primary / secondary etc. separated by commata." Additional recommendations and examples: Examples for types of terms that should be used preferably are: o For "treatment received": e.g. "polished", "cleaned", "chromium plated", "sterilised", etc. o For "standard fulfilled": technical standards such as for material grades/purity, fulfilled emission limits, etc. o For "product quality": other qualitative information such as e.g. "glossy", "UV-resistant", "flame-retardant", "antibacterial finishing", etc.

Rule #	Rule Category	Rule/ Required Nomenclature
		o For "use information": e.g. "indoor use", "bottle grade", "for wafer production", etc. o For "production route name": process or production route used for producing this product, such as "suspension polymerisation", "spray dried", "Fischer-Tropsch", etc. o For "educt name": main in-going products ("educts") in case different routes exist may be needed, such as "from ore roasting" for sulphuric acid, "pine wood" for timber, etc. (note that in practice often the educt is part of the commonly used base name, e.g. "Pine wood table"). o For "primary / secondary": "primary", "secondary"; for mixes with a fixed share of primary/secondary it should be enough to quantify the shares in the next name field on "Quantitative flow properties".
15	“Mix type and location type” name field	Definition: "Specifying information on the (product or waste) flow whether being a production mixture or consumption mix, location type of availability (such as e.g. "to consumer" or "at plant"), separated by commata." Additional recommendations and examples: o "Production mix" refers to the weighted average mix of production-routes of the represented product in the given geographical area and for the named technology (if any; otherwise overall average for all technologies). o "Consumption mix" is analogous i.e. including the weighted contribution of imported and exported products from/to outside the given geographical area, with the trade partners (e.g. countries) explicitly considered. Both apply both to goods and services. Entry is not required for technology-specific product flows or waste flows that do not depend on the geographical region.

Rule #	Rule Category	Rule/ Required Nomenclature
		o For "location type of availability", the mainly required entries are: "at plant" (i.e. as/when leaving the production site), "at wholesale" (i.e. as/when leaving the wholesale storage), "at point-of-sale" (i.e. as/when leaving the point of sale to user), "to consumer" (i.e. including all transport, storage, wholesale and sale efforts and losses; consumer can be both private and business consumer). Further location types are possible and are to be named analogously. In case the point of entry to the wholesale / sale is to be named, the attribute "to" should be used, instead of the term "at" (e.g. "to wholesale" would include the transport efforts and losses until the good reaches the wholesale). Confusion with the intended use of a product/waste should be avoided, i.e. "at waste incineration plant", not "for waste incineration"; the latter would be a qualitative specifying property (as the waste may have received a dedicated pre-treatment etc.) and be put into the respective name field "Treatment, standards, routes".
16	"Quantitative flow properties" name field	Definition: "Further, quantitative specifying information on the (product or waste) flow, in technical term(s): qualifying constituent(s)-content and / or energy-content per unit, as appropriate. Separated by commata. (Note: non-qualifying flow properties, CAS No, Synonyms, Chemical formulas etc. are documented exclusively in the respective fields.)" Additional recommendations and examples: Examples for which kind of terms should be used preferably are: o For "qualifying constituent(s)-content and / or energy-content per unit": quantitative element-, substance-, or energy-content, expressed in units per unit of a relevant other flow property. Examples: "24% Fe", "9.6 MJ/kg net calorific value", "90.5% methane by volume". Note that often the units are not required explicitly; e.g. "24% Fe" refers per default to "mass/mass". If another relation is meant, this one has to be given explicitly, of course, e.g. "24% Fe molar" for chemical interim products or e.g. "13.5% ethanol by volume" for wine.

Rule #	Rule Category	Rule/ Required Nomenclature
		Any ambiguity should be avoided, of course.
17	Naming pattern of flows and processes	<“Base name”; “Treatment, standards, routes”; “Mix type and location type”; “Quantitative flow properties”>.
NAMING OF ELEMENTARY FLOWS		
18	Naming of elementary flows	Substances and materials should be given a lower case first letter. Brand names should be given a upper case first letter (E.g. "benzene", "1,2,3-trichloro-benzene", "Alachlor"). Isotopes of elements (e.g. used for radioactive substances) are given the IUPAC name plus the isotope number added at the end with a hyphen (e.g. "radon-220"). Particles are to be inventoried via the widely used and understood abbreviation "PM", with further specification of the particle size class (e.g. "PM <2.5µm" or "PM unspecified".) Salts of O-containing acids are to be named according to the commonly used trivial names as also supported by IUPAC (e.g. “calcium carbonate” better than the name derived from applying the SETAC WG rule, which results in “carbonic acid, calcium salt”). Other simple chemicals are to be named according to the commonly used trivial names, if widely used (e.g. "methane", "sulphuric acid", "acetone", etc.). Pesticides should be named by their commonly used trivial or even brand names when commonly used as trivial names across industry (e.g. "Alachlor" better than "2-chloro-n-(2,6-diethylphenyl)-n-(methoxymethyl)-acetamide"). Artificial splitting of fixed technical terms with change of order of the name fragments is to be avoided (e.g. "hard coal" better than “coal, hard”; the complete flow name should comprise quantitative flow properties information, e.g. "hard coal; 32.7 MJ/kg net calorific value", of course). The attributes of flows "to" for emissions and "in" for resources as foreseen in the SETAC WG document are redundant, as this information is already given by the class the flow belongs to (e.g. "Emissions to air"), as this is part of the

Rule #	Rule Category	Rule/ Required Nomenclature
		elementary flow identifying information. For the sake of shortening the flow names this info is not be doubled in the flow name. The “…, ion” variants of metal emissions are to be joined with the elemental flow, with the exception of chromium (e.g. the flow “iron” to water should represent all variants, i.e. Fe III, Fe II, organically bound or ionic or complexed iron and metallic Fe to water; note that NO "ion" information is inn the name.). The only exception are the commonly used flows “chromium III” and “chromium VI” ions, while a joint flow “chromium, unspecified” is required, too, that one joining also metallic chromium. (To be revised in view of further developed LCIA methods.) Substituted organics are to be named applying the former IUPAC recommendation, that was in place until the late 1990ies and is still widely preferred in industry practice (e.g. “1,2,3-trichloro-benzene“ better than the new IUPAC pattern that was recommended by the SETAC WG “benzene, 1,2,3-trichloro-“). CFCs and HCFCs are to be named using their trivial name. The full chemical name is to be given in the “Synonyms” field only (e.g. “HFC-227” as flow name with the chemical name "1,1,1,2,3,3,3-heptafluoro-propane" only in the "Synonyms" field). Carbon dioxide and methane are to be separately inventoried whether from biogenic or fossil sources, both as emission and resource (the latter e.g. from uptake into biomass); the source is added at the end of the base name separated by a comma. (E.g. "carbon dioxide, fossil", "methane, biogenic"). A clearer specification is required for certain flows, e.g. “Wood” from primary forests, as it is unclear whether it refers to the wood only or the whole tree; extracted is however often the tree as a whole (e.g. better “Mahagony wood (Tectona grandis), without bark; standing; primary forest” instead of “wood, Mahagony, standing”. In case the bark would be extracted as well as often done in primary forests, an additional

Rule #	Rule Category	Rule/ Required Nomenclature
		flow of “other wood biomass” would be inventoried). Last but not least: Naming is always to be unambiguous (e.g. better “ferrous chloride” or “iron II chloride” instead of the formerly SETAC recommended “iron chloride”, while in this case it is recommended to inventory this emission as the two elementary flows “iron” and “chloride” anyway; this will be addressed in the LCI method chapter of the LCA handbook.) Taking this baseline the above recommendation for nomenclature is applied to derive the names for the "ILCD reference elementary flows”.
NAMING OF PRODUCT FLOWS AND WASTE FLOWS		
19	Naming of product and waste flows	Product and waste flows are to be named using technical names, being as precise as possible, with the different types of information being documented into the four names fields as defined and illustrated for the ILCD reference format. See chapter 3.2. Other information such as represented country/region or year should not be part of the flow name but be documented in separate documentation fields. (Examples: Product flows "Aluminium extrusion profile; primary production; Production mix, at plant", "Stainless steel hot rolled coil; annealed and pickled, grade 304, austenitic, electric arc furnace route; production mix, at plant; 18% chromium, 10% nickel", "Diesel; consumption mix, at refinery; 200 ppm sulphur", "Electricity AC; consumption mix, to consumer; 220V", "Corrugated board boxes; consumption mix; 16.6% primary fibre, 83.4% recycled fibre", "Polyethylene terephthalate (PET) granulate; bottle grade; production mix, at plant", "Lorry, 22t; interurban, one-way; load factor 80%, EURO 3", "Lorry, unspecified", "Incineration of polyethylene (PE); waste incinerator with dry flue gas cleaning technology; production mix", “Loaded cargo” and “Cargo at destination”. Waste flows "Household waste; production mix; 9.5 MJ/kg net calorific value", "Overburden; 0.20% lead, 0.13% zinc, 0.5%

Rule #	Rule Category	Rule/ Required Nomenclature
		sulphur", "Waste tyres, unspecified"
NAMING OF PROCESSES		
20	Naming of processes	The name of process data sets with exactly one "reference flow" should be identical to the name of that reference flow. Geographical and data set age information is documented not as part of the flow or process name, but in a separate documentation field. The name of multi-functional process data sets with more than one "reference flow" should combine the name of the technology / plant represented and include information on all reference flows. The name of process data sets with quantitative references other than "reference flow" (e.g. “functional unit”, “production period”, "other flow", etc.) should be named according to their quantitative reference. If required for clarity, this name should be combined with the technology or plant name.
CLASSIFICATION, NOMENCLATURE, AND ASSIGNMENT OF FLOW PROPERTIES, UNIT GROUPS, AND UNITS		
CLASSIFICATION OF FLOW PROPERTIES AND UNIT GROUPS		
21	Classification for flow properties	“Technical flow properties" (e.g. "Net calorific value", "Mass" etc.) "Chemical composition of flows" (e.g. "Iron content", "Methane content" etc.) "Economic flow properties” (e.g. "Market value US 1997, bulk prices", "Market value EU-27 2008, private consumer prices", etc.) “Other flow properties”
22	Classification of unit groups	“Technical unit groups" (e.g. "Units of energy", "Units of mass", etc.) "Economic unit groups" (e.g. "Units of currency 1997", "Units of

Rule #	Rule Category	Rule/ Required Nomenclature
		currency 1998", etc.) "Other unit groups" Note that no "Chemical composition unit groups" class is required, as the related flow properties / LCIA factors will always use technical Unit groups and units (e.g. mass, volume, etc.). E.g. it will be "kg" Iron content (per given reference unit of an enriched ore flow, i.e. kg Fe per kg iron ore).
NAMES OF FLOW PROPERTIES, UNIT GROUPS AND UNITS; THEIR ASSIGNMENT TO FLOWS		
23	Reference flow properties and reference units for types of flows, first criterion	All flows that possess a mass, are measured in the flow property "Mass", as long as none of the below rules would require to use a different flow property. The unit group for mass is "Units of mass" with the reference unit "kg".
24	Reference flow properties and reference units for types of flows, second criterion	Elementary flows, for which the energy content is the most relevant unit, are measured in the flow property "Net calorific value". The unit group for the net calorific value is "Units of energy" with the reference unit "MJ". Product and waste flows such as fuels, in contrast, can be measured as is general usage, e.g. in mass (e.g. diesel, hard coal, etc.), normal volume (e.g. natural gas), "Net calorific value" with the unit "MJ", or other. Note that for Uranium ore, for which a net calorific value per se can not be given, the usable fission energy content is expressed nevertheless as "Net calorific value" to ease aggregation with other fossil energy resources to primary energy consumption figures.
25	Reference flow properties and reference units for types of flows, further criteria:	Product and waste flows that are typically dealt with in standard volume and for which none of the other units named in this chapter is in use in practice, are measured in the flow property "Standard volume" (e.g. for the product flows "Compressed air; 10 bar", "Oxygen; from refill gas cylinder of 40 l; 150 bar", etc.). Not applicable to elementary flows. The unit group is "Units of volume" with the reference unit

Rule #	Rule Category	Rule/ Required Nomenclature
		"m3". Elementary flows for which the substance's radioactivity is in focus, are measured in the flow property "Radioactivity" (e.g. elementary flow "thallium-201"). The unit group is "Units of radioactivity" with the reference unit "kBq", i.e. Kilo-Becquerel. Flows that are typically dealt with in number of items are measured in the flow property "Number" (e.g. product flows "Spare tyre passenger car; generic average", "Milk cow; Holstein, alive, start of lactation" etc.). The unit group is "Units of items" with the reference unit "Item(s)". Product and waste flows that are typically dealt with in length or distance are measured in the flow property "Length" (e.g. product flows "Welding seam; MIG/MAG, steel on steel" and "Water pipe; copper; max 5 bar, 15mm diameter", etc.). Not applicable to elementary flows. The unit group is "Units of length" with the reference unit "m". Product and waste flows that are typically dealt with in duration are measured in the flow property "Time" (e.g. product flow / functional unit "Storage in warehouse; unheated"). Not applicable to elementary flows. The unit group is "Units of time" with the reference unit "d", i.e. days. Product and waste flows that are typically dealt with in weight multiplied with distance are measured in the flow property

Rule #	Rule Category	Rule/ Required Nomenclature
		"Mass*length" (e.g. product flow / functional unit "Road transport; bulk goods, generic mix; long distance"). Not applicable to elementary flows. The unit group is "Units of mass*length" with the reference unit "t*km". Product and waste flows that are typically dealt with in volume multiplied with distance are measured in the flow property "Volume*length" (e.g. product flow / functional unit "Road transport; voluminous goods, generic mix; long distance"). Not applicable to elementary flows. The unit group is "Units of volume*length" with the reference unit "m3*km". Person transport product flows / functional units are given in the flow property "Person*distance". Not applicable to elementary flows. The unit group is "Units of items*length" with the reference unit "Items*km". Flows that are typically dealt with in surface area are measured in the flow property "Area" (e.g. elementary flow "Land conversion; XY specification", product flow / functional unit "Surface cleaning; heavily soiled, plastic; 1 m2"). The unit group is "Units of area" with the reference unit "m2". Flows that are typically dealt with in surface area multiplied with time are measured in the flow property "Area*time" (e.g. elementary flow "Land occupation; XY specification", product flow / functional unit "Façade weather protection; exposed, white; 70% reflection"). The unit group is "Units of area*time" with the reference unit

Rule #	Rule Category	Rule/ Required Nomenclature
		“m2*a”. (1 year approximated as 365 days) Product and waste flows that are typically dealt with in volume multiplied with time are measured in the flow property “Volume*time” (e.g. product flow / functional unit "Landfill occupation"). Not applicable to elementary flows. The unit group is “Units of volume*time” with the reference unit “m3*a”. (1 year approximated as 365 days) For products where the content of specific elements or of well defined chemical compounds is of interest, the respective information should be given as secondary flow property for conversion, display or modelling purposes. This is done using flow properties of the type “Substance/element X content”, e.g. “Cadmium content”, “Ammonia content”, “Water content”, “Methane content” etc. (Nomenclature for the element or substance name should be identical to the one for these elements or substances as given elsewhere in this document). Depending on the specific interest, the information can be given in mass or volume units: E.g. “Iron content” in the product flow “Iron ore, enriched; floating …” as mass information or “Methane content” in the product flow “Natural gas; …” volumetric. The required “Unit group data set” is then the same as already defined “Units of mass” and “Units of volume”, i.e. there is no necessity to define new Unit group data sets. For product and waste flows where the economic value should be given (typically as secondary flow property for allocation purposes or cost calculation in Life Cycle Costing) this is done using the flow property “Market value”, which is further specified as required, typically referring to the country or region, time period, and wholesale/retail etc. situation, by adding the respective information: E.g. "Market value US 1997, bulk prices", "Market value EU 2000, private consumer prices".

Rule #	Rule Category	Rule/ Required Nomenclature
		(Can be used for e.g. product / waste / elementary flows "Gold", "Waste tyres", "Carbon dioxide", etc.). The unit group name is formed by the combination of the string "Units of currency" and an addition that characterises the time period to which it refers, e.g. "1997", "1990-1999", "May 1995" etc., e.g. “Units of currency 1997” with the reference unit “EUR”, i.e. Euro. (Note: The reference to a time period is required to allow giving correct average conversion numbers for other currencies for that time period).
NOMENCLATURE FOR NEW FLOW PROPERTIES, UNIT GROUPS, AND UNITS		
26	Creation and naming of flow properties, unit groups and units	The creation/use of new flow properties, unit groups and units should be avoided, if possible, and any of the existing ones as provided in the upcoming more complete list of the ILCD system should be used. If the creation of new flow properties and unit groups is unavoidable (as to be expected e.g. for economic flow properties), they should be named following the same pattern as the ones above, i.e. flow properties carry the name of the physical or other property, units carry the unit short as name (with the option to provide a long name and further info in the comment field foreseen in the data format). Unit groups are named by a combination of the string “Units of” and the name of the flow property they refer to. Please note, that in some cases it is useful to have common unit groups for more than one flow property were all are measured in the same units. In such cases the naming can be referred to a more general flow property (e.g. “Energy” “Units of energy”) and not only to one specific one (e.g. NOT “Units of net calorific value” or “Units of exergy” etc.).
CLASSIFICATION OF CONTACTS		
27	Classification of contact data sets	"Group of organisations, project" "Organisations" "Private companies"

Rule #	Rule Category	Rule/ Required Nomenclature
		"Governmental organisations" "Non-governmental organisations" "Other organisations" "Working groups within organisations" "Persons" "Other"
CLASSIFICATION OF SOURCES		
28	Classification of source data sets	"Images" "Data set formats" "Databases" "Compliance systems" "Statistical classifications" "Publications and communications" "Other source types"

Example of Identifying Appropriate Nomenclature and Properties for Specific Flows

Raw material, Input: Crude oil (Rules 2,4,5)

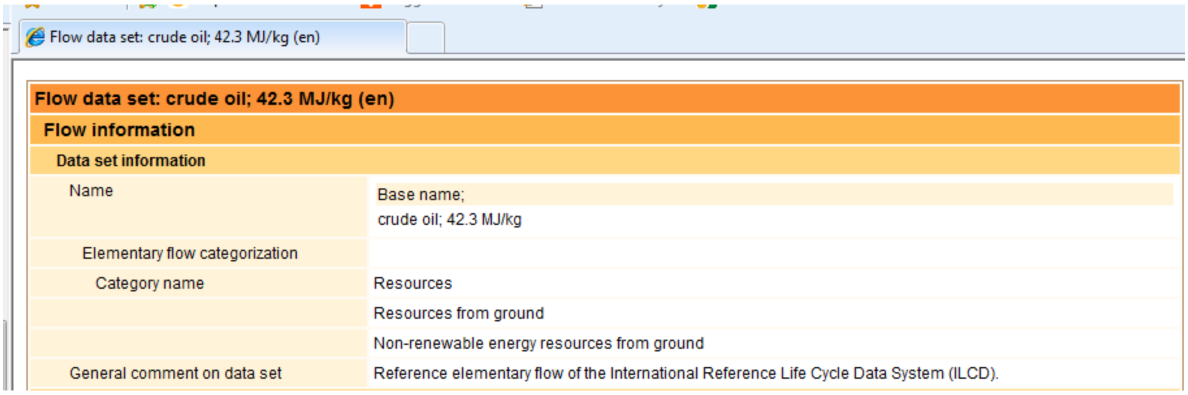
(1)Specify "elementary flow category" by receiving / providing environmental compartment:
Example: Resources - Resources from ground

(2) Further differentiation of providing/receiving environmental compartments
Example: Non-renewable energy resources from ground

(3)additional, non-identifying classification for "Resources from ground" elementary flows
Example:

Example: Non-renewable energy resources from ground ” (e.g. "Crude oil; 42.3 MJ/kg net calorific value")

Flow data set: Crude oil: 42.3 MJ/kg net calorific value



Flow data set: crude oil; 42.3 MJ/kg (en)

Flow data set: crude oil; 42.3 MJ/kg (en)	
Flow information	
Data set information	
Name	Base name; crude oil; 42.3 MJ/kg
Elementary flow categorization	
Category name	Resources
	Resources from ground
	Non-renewable energy resources from ground
General comment on data set	Reference elementary flow of the International Reference Life Cycle Data System (ILCD).

Ref: http://lct.jrc.ec.europa.eu/

Emission, output: Example: Carbon Dioxide (Rules 2,4,9)

:(1) Specify "elementary flow categories" by receiving / providing environmental compartment:

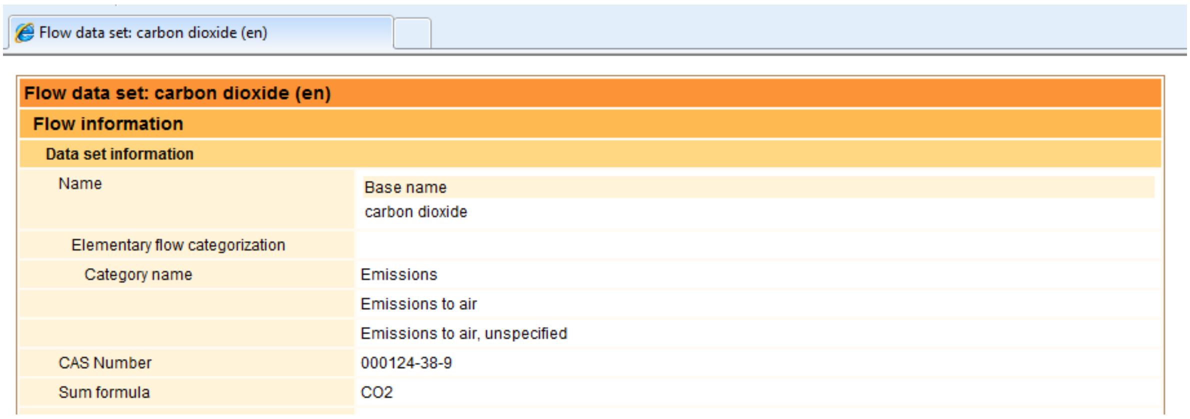
Example: Emissions – Emissions to air - Emissions to air, unspecified

(2) Further differentiation of providing/receiving environmental compartments

Example: “Emission to air, DE”

(3) additional, non-identifying classification for emissions

Example: Inorganic covalent compounds” (e.g. "Carbon dioxide, fossil", "Carbon monoxide", "Sulphur dioxide", "Ammonia", etc.)



Flow data set: carbon dioxide (en)

Flow data set: carbon dioxide (en)	
Flow information	
Data set information	
Name	Base name carbon dioxide
Elementary flow categorization	
Category name	Emissions
	Emissions to air
	Emissions to air, unspecified
CAS Number	000124-38-9
Sum formula	CO2

Ref: http://lct.jrc.ec.europa.eu/

Product flow: Example: T-shirt (Rules 10-17)

(1) top-level classification for Product flows, Waste flows, and Processes:

Example: “System”

(2) second level classifications for Product flows, Waste flows, and Processes (for preceding top-level classification):

Example: “Textiles, furniture and other interiors”

(3) “Base name” field:

Example: “Base Name: White polyester Tshirt”

(4) “Treatment, standards, routes” name field:

Example: “ ”

(5) “Mix type and location type” name field:

“Production mix, at point of sale”

(6) “Quantitative flow properties” name field:

Example: “160 grams polyester”

(7) naming pattern of flows and processes.

<“Base name”; “Treatment, standards, routes”; “Mix type and location type”; “Quantitative flow properties”>.

Example: “White polyester Tshirt; product mix at point of sale; 160 grams polyester”

(INFORMATIVE)

Annex V: Example of Documentation Template

General Information	
Items	Description
Company name and contact information (Producer description)	
Product Name (Product related information)	
Product function	
Product system description	
Product picture (optional)	
Reviewer	

Goal of Product Environmental Assessment	
Items	Description
Intended application (s)	
Reasons for carrying out the study	
Limitations	

Assumptions	
Target audience(s)	
Comparative assertion intended to be disclosed to public (yes/No)	

Scope of Product Environmental Footprint			
Items	Description		
Unit of Analysis (functional unit)			
Reference flow			
Reference time of the study (year/month)			
Country/Region of production of product			
Country/Region of consumption of product			
System boundary	Cradle to grave	Cradle to gate	Gate to gate
	Description of system boundary		
System boundary diagram			
Cut-off criteria			
Impact assessment categories covered	Impact assessment method use		

Data quality requirements	
Generic data sources	

Life Cycle Stages		
Items	description	
	Included	Excluded
Raw material acquisition and preprocessing		
Capital goods		
Production		
Distribution & Storage		
Use		
End of life		
*Processes that exclude in the study (specify)		

Emission and resource use (Life Cycle Inventory)	
Items	description
Data collection procedure	

Technical process flow diagram	
Unit process description	
Calculation procedure	
Allocation procedure for environmental footprint	
Life Cycle Inventory result (optional)	

Life Cycle Environmental Impact Assessment		
Impact category/method	Result	Unit
Climate Change		
Toxicity		
…		

Climate change per life cycle stage (optional)		
Impact category/method	Result	Unit
Raw material acquisition and preprocessing		
Capital goods		
Production		

Distribution & Storage		
Use		
End of life		
Total		

Acidification per life cycle stage (optional)		
Impact category/method	Result	Unit
Raw material acquisition and preprocessing		
Capital goods		
Production		
Distribution & Storage		
Use		
End of life		
Total		

Interpretation	
Items	description
Conclusions	

Quantitative assessment (optional for pilot study)	
Limitations	
Improvement potential (optional)	

Annex VI: Justification for Selection of Environmental Footprint Impact Categories and Additional Environmental Information

To identify relevant/irrelevant environmental footprint impact categories and/or methods, including additional environmental information, the following form shall be used.

Source of information	*Source I:* *Ecolabel of …*	*Source II:* *LCA of.. .*	*Source III:* *…*
Environmental indicators, impact categories and methods covered in this source of information (please provide a comprehensive list)			
Climate Change			
Ozone Depletion			
Ecotoxicity – aquatic, fresh water			
Human Toxicity - cancer effects			
Human Toxicity – non-cancer effects			
Particulate Matter/Respiratory Inorganics			
Ionising Radiation – human health effects			
Photochemical Ozone Formation			
Acidification			
Eutrophication – terrestrial			
Eutrophication – aquatic			
Resource Depletion – water			
Resource Depletion – mineral, fossil and renewable			
Land transformation			
…..			
Additional indicators, impact categories and methods beyond the OEF guide (for each source)			
Exclusion/ Deviations to the default list of impact categories provided in the OEF general guide	**Justification for change to the default**		
1			
2			
…			
Additional environmental indicator(s),	**Justification for additional environmental indicator**		

impact categories or methods	
1	
2	
…	
Selected Environmental indicators, impact categories and methods for OEF according to this OFSR	1. 2. 3. 4.
Analysed by (Name, and date)	