GUIDELINES FOR ADAPTATION OF LCA METHODOLOGY TO ESTIMATE ENVIRONMENTAL IMPACT (DT2.2.1)

Subtitle

Version 1

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1. Introduction

The CIRCE2020 project is aimed at introducing innovative solutions for the industrial waste management in order to reduce dependencies from primary natural resources within industrial processing. In fact, traditional waste management is based on a linear approach, in which all the residues and industrial flows generated in a manufacturing process are sent to disposal, without taking into account their potential of valorisation within the production system or into another one (industrial symbiosis). In this sense, CIRCE2020 represents an important step to move to a closed loop system based on innovative reusing, remanufacturing and recycling products, thanks to the testing and implementation of innovative solutions (hereafter referred to as Circular Economy cases) in 5 pilot areas.

In the project framework, in order to test the environmental sustainability of the pre-selected Circular Economy (CE) cases in the pilot areas, a life cycle assessment will be performed based on the latest Product Environmental Footprint (PEF) methodological requirements. For a consistent application of the PEF methodology across the different case studies in the 5 pilot areas, guidelines are necessary, with a two-fold purpose:

- Tailor the PEF methodology to the project specific application (waste management or, in more general terms, the optimisation of use of virgin resources) and simplify some specific methodological requirements, which are still under definition ;
- Define a set of specific rules to calculate the relevant environmental impacts of the CE cases and their potential improvements with respect to current management of the analysed waste streams with the aim of enabling comparisons of the CE cases analysed within the pilot areas.

In the present document, the general guidelines to be used as supporting document for the development of PEF-based studies within the project are illustrated, developed by Ecoinnovazione, ETRA's external technical support.

It must be underlined that the guidelines are not aimed to be PEF fully compliant, but they can be used as supporting document for developing studies aligned with the PEF methodology.

These guidelines are structured in six sections. Section 2 provides an overview on the PEF methodology, and of the background policy context which led to the development of the initiative. Section 3 entails the main requirements outlined by the PEF for the definition of the goal and scope of the study including also the presentation of a theoretical example, based on one of the most promising CE solutions identified by ETRA, for a better understanding of the methodological requirements here described. Provisions on how to perform the data collection and handling modelling choices are provided afterwards in section 4. The mandatory impact assessment method is reported in section 5, whereas how to perform the interpretation of results is shown in section 6. Lastly, in the annexes a further guidance for the identification and the selection of the LCI databases to be used is provided, together with the template for the reporting of the study and the glossary.

2. PEF methodology

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

In recent years, the environmental considerations are increasingly part of the operations and marketing strategies for a large number of companies, and for their investors. Such companies are increasingly using Life Cycle Assessment (LCA) as a tool to assess their own, or their suppliers' green credentials and to measure (and improve) the environmental performance of their products.

The number of footprint methods (e.g. carbon footprint, water footprint) is rapidly increasing, in parallel with a proliferation of national and private sector initiatives.

This fact can generate significant costs for businesses, especially in case they need to use different methods or if they have to comply with labelling and verification requirements for different countries and retailers.

In addition to the extra costs, the proliferation of methods may also reduce the opportunity for producers of green products to trade them, even within the EU.

Companies may want to trade across national borders, but find that the requirements related to the environmental information for the products they intend to sell change across those borders.

On the other hand, the proliferation of national standard and labelling schemes generates on consumers a lack of trust on the environmental information provided by producers and retailers. Moreover, often the environmental performance of products is not communicated in a way that is comparable, thus limiting the ability to make informed choices.

In order to tackle these criticalities, the European Commission in the COM(2013) 196 final “Building the Single Market for Green Products. Facilitating better information on the environmental performance of products and organisations” defined two LCA-based methods for assessing the environmental performances of products and organisations: the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF).

The guidelines of the two methods were published as an Annex to the Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. The two methods are tightly interlinked and have many elements in common.

They introduce several important improvements compared to other existing methods, among others:

- a clear identification of the potential environmental impact categories to be looked at in order to perform a comprehensive LCA;
- the requirement to quantify data quality;
- setting minimum data quality requirements;
- clearer technical instructions for addressing some critical aspects of a LCA study (such as allocation, recycling).

With the purpose of testing the effectiveness of the method proposed, the PEF Guidance developed by DG ENV was tested between 2013-2018 using a limited number of pilot studies, selected by a call for volunteers, representative of a wide variety of goods and services..

As for PEF, the testing included: agriculture, construction, chemicals, ICT, food, manufacturing (footwear, televisions, paper, leather, t-shirt). In each pilot the relevant stakeholders of the analysed sectors were involved, namely material suppliers, manufacturers, trade associations, purchasers, users, consumers, government representatives, non-governmental organizations (NGOs), public agencies and, when relevant, independent parties and certification bodies.

Besides testing the effectiveness of the method proposed, the pilots had to develop specific guidance and rules - Product Environmental Footprint Category Rules (PEFCRs) - for calculating and reporting products' life cycle environmental impacts.

Based on the results of the testing, the European Commission is now discussing on how to use the Product and Organisation Environmental Footprint methods in policies.

In the period between the end of the Environmental Footprint pilot phase and the possible adoption of policies implementing the PEF and OEF methodologies, a transition phase is established (2018-2021).

The main aims of the transition phase are to provide a framework for

- monitoring the implementation of existing PEFCRs and Organisation Environmental Footprint Sector Rules (OEFSRs);
- developing new PEFCRs/ OEFSRs;
- address new methodological developments.

The development of new PEFCRs / OEFSRs will be subject to a call for volunteers belonging to the following clusters:

- Apparel and footwear;
- Beverages;
- Chemistry based final products;
- Construction products;
- Electrical and electronics;
- Food products (including products not for human consumption);
- Materials and intermediate products;
- To be defined based on which products or sectors will engage in the development of PEFCRs/OEFSRs.

3. Goal and scope of the study

3.1 Goal of the study

The main goals of the PEF-based studies can be summarized as follows:

- quantify the potential environmental benefits of the identified CE solution compared to the current waste management practice;
- Identify the hotspots of the CE solution to be used as indication for a further improvement of the technology solution and its implementation at pilot scale.

Besides, what is extremely important to outline in this phase is the identification of the intended audience of the study as well as **the perspective from which the CE solution is analysed**, as the latter may involve more than one stakeholder (waste donor, waste recipient, other entities). Indeed, **those elements will affected the definition of the functional unit and the delimitation of the system boundaries, and consequently the may lead to different results**.

The following guiding questions could be used in this phase for setting the intended audience and the study perspective:

- "for which problem (s) was/were the CE solution identified?" For instance, possible options are the following: i) to minimize a specific waste generated by a manufacturing process; ii) to exploit the opportunity of an industrial symbiosis between two or more firms (i.e., the use by one company or sector of by-products, including energy, water, logistics and materials, from another), iii) to optimize a current waste management practice performed by a waste collector;
- "who were the stakeholders involved in CE solution identification and expected to take advantages of this technological improvement (waste donor, waste recipient or both of them)?"

Other additional goals are possible and can be integrated in the PEF background report.

In the below-reported box, the main information about the theoretical case study, which is used as a reference for this section, is briefly described.

CASE STUDY: VALORISATION OF LANDFILL LEACHATE THROUGH THE PRODUCTION OF FERTILISER	
Current waste management (business as usual - BaU situation also referred as scenario 0 in this document)	CE solution identified
Management of the leachate produced by a closed-down landfill, which had treated urban and urban like waste. The leachate is sent to an external wastewater treatment (WWT) for a traditional treatment nitrification, denitrification, biodegradation, settling). The biogas naturally generated by the landfill is internally used in the landfill for power generation (electricity) but the heat is not recovered. The output of the product system is the leachate which needs a further treatment in an external WWT.	A plant for the production of ammonium sulphate from leachate will be built next to the landfill. After an alkalization process, the liquid fraction of the leachate will be separated by settling and then heated and passed through a stripping process for the extraction of ammonia by means of sulfuric acid. Lastly, the ammonia stream will be dried in order to reach the solid form as ammonium sulphate $(NH_4)_2SO_4$. The biogas will be internally recovered for power generation (electricity) as well as for the production of the heat used in the technological system.

	The expected outputs generated by the product system (landfill + new technological plant) are the followings. - Solid sludge to be treated in an external landfill - Purified leachate from stripping sent to sewage (after a pH neutralisation) - Ammonium sulphate sold as fertilizer

3.2 Definition of the functional unit

The functional unit (FU) is the quantified performance of a product system, to be used as a reference unit (e.g., the FU of paint could be described as providing protection of 1m2 of substrate for 50 years with a minimum 98% opacity). Meaningful comparisons shall only be made when products fulfil the same function. Therefore, the FU shall describe qualitatively and quantitatively the function(s) and duration of the product, according to the four aspects reported in Table 1:

Table 1: Four aspects of the FU to be taken into account

Elements of the FU
1. The function(s)/service(s) provided: "**what**"
2. The extent of the function or service: "**how much**"
3. The expected level of quality: "**how well**"
4. The duration/life time of the product: "**how long**"

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

Based on the four aspects reported in Table 1 and considering the theoretical case study of the valorisation of the landfill leachate through the production of fertiliser, the function unit can be defined from the **waste donor perspective** as follow:

Table 2: Example of a possible definition of the FU from the waste donor perspective

What?	Management of leachate generated from a municipal landfill
How much?	1 m^3 of landfill leachate
How well?	Treated to reach the limits of pollutants concentration defined by the national regulation for the intake in the municipal sewage
How long?	The duration is the one necessary for its treatment

In this case, the primary function of the system remains the management of the landfill leachate and the ammonium sulphate is considered as a by-product of the product system. The expected level of quality is defined according to the national regulation, which defines the thresholds of organic and inorganic pollutants for the direct intake of the leachate in the municipal sewage system. The duration of the product in this application can be seen as the time necessary for the treatment of the leachate (in the external waste water treatment (WWT) or in the foreseen technological solution identified) to reach the required level of quality. The above-reported interpretation can be used for similar waste treatment applications.

On the other hand, the system function from the **waste recipient perspective** is the fertiliser production, therefore the functional unit is defined as follows:

Table 3: Example of a possible definition of the FU from the waste recipient perspective

What?	Production of ammonium sulphate
How much?	1 kg
How well?	20% ammoniacal nitrogen content
How long?	The duration is related to the release time of nitrogen in the soil

As can be seen from the example above, the perspective affects directly the definition of the F.U. Therefore, whenever possible, **it is highly recommended to consider both the waste**

donor and the recipient ones, as this will contribute to have a more holistic overview of the potential impacts and benefits related to the CE solution.

3.3 System boundaries

In this section, the list of all the product life-cycle stages and processes that are part of the product system shall be included together with a system diagram of the system boundaries.

In the latter, the following information shall be clearly indicated:

- Processes that are included and those excluded,
- Level of influence of the companies on the analysed processes (situation 1, 2, and 3 of the Data Need Matrix) (see **Table 4**);
- Life-cycle stages or processes where primary activity data / primary life cycle inventory data is used.

As general rule the system boundaries shall be from cradle to grave, but considering that the main application of this guidance is the waste management, a narrower delimitation of the product system is allowed.

Due to the wide range of possible applications of this guidance (from waste management prevention to optimisation of the existing waste streams), a univocal definition of the life-cycle stages is not provided in the present document. However, the LCA commonly used definition of life cycle stages, such as transport of raw materials, manufacturing phase, etc., can be adopted. It is important to stress that a further aggregation of the life cycle stages in upstream, core and downstream processes does not support a proper interpretation of the results and thus it shall be avoided.

The definition of the system boundaries is of extreme importance for enabling a fair comparison of the two scenarios that will be analysed in the PEF-based studies (CE solution vs current waste management practice). They have to be clearly outlined in order to take also into account other expected additional functions of the CE solution (see the theoretical example below in the coloured box).

In Figures 1 and 2 the example of ammonium sulphate production is further elaborated for the definition of the system boundaries for the two scenarios considering the **waste donor perspective**.

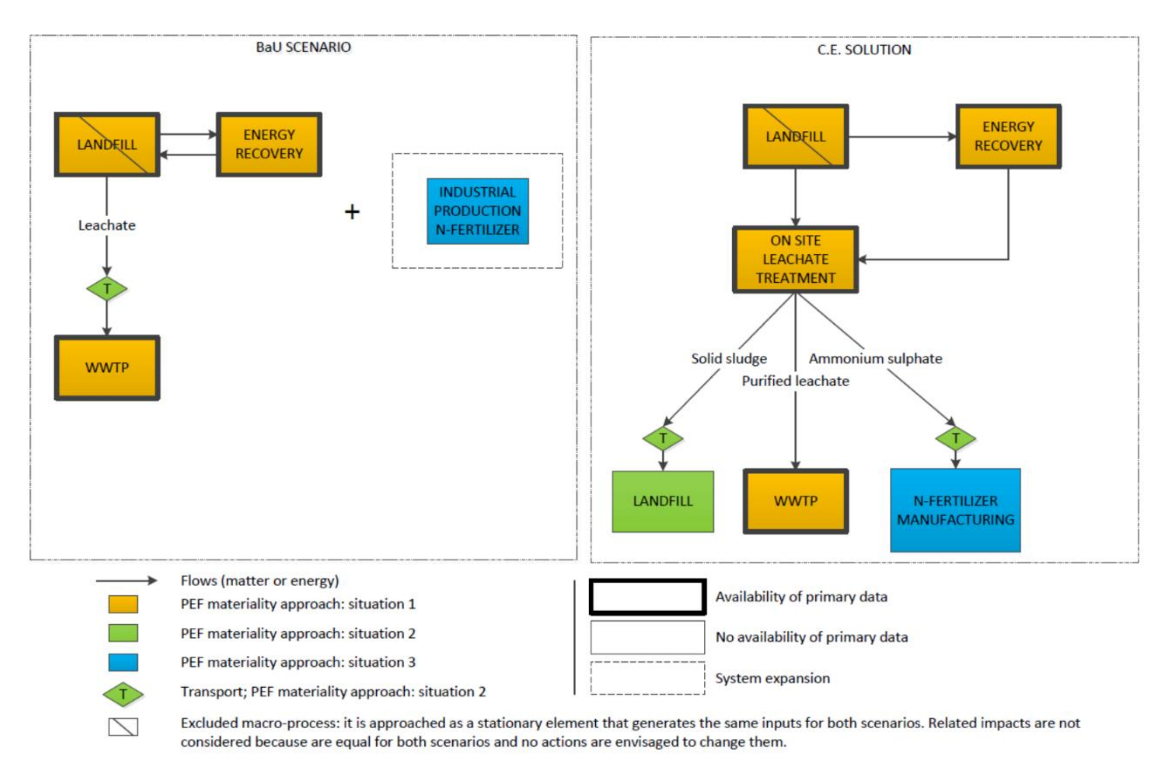


Figure 1: System diagram for the ammonium sulphate production from landfill leachate considering the waste donor perspective

Looking at the drawing of the system boundaries, the BaU scenario have been expanded to include the production of chemical fertiliser (with the same nutrient content), which represents an additional function provided by the CE solution, to make a consistent comparison of the environmental burdens of the two scenarios. The delimitation of the technosphere entails the leachate production and its possible on-site treatment, the transport of the different co-products generated by the landfill/on-site leachate treatment before the waste flows enter in the ecosphere. As for the production of the chemical fertiliser the processes accounted for in the technosphere are from the extraction/processing of the raw materials up to its final formulation and packaging.

In this case, it has been decided to exclude the landfill process since it is identical in both scenarios. Moreover, it has been assumed that the ammonium sulphate generated by the on-site treatment can directly substitute the production of an inorganic N fertiliser. In case a similar situation will occur in the PEF-based studies, the direct substitution of a secondary material with a virgin one shall be verified and documented in the PEF background report.

The definition of the system boundaries considering the **<u>waste recipient perspective</u>** can be drawn as depicted in Figure 2. In the theoretical example, the waste donor is the fertiliser manufacturer who uses the ammonium sulphate in the production process for preparing the fertiliser formulation to be put on the market, in addition with other additional materials.

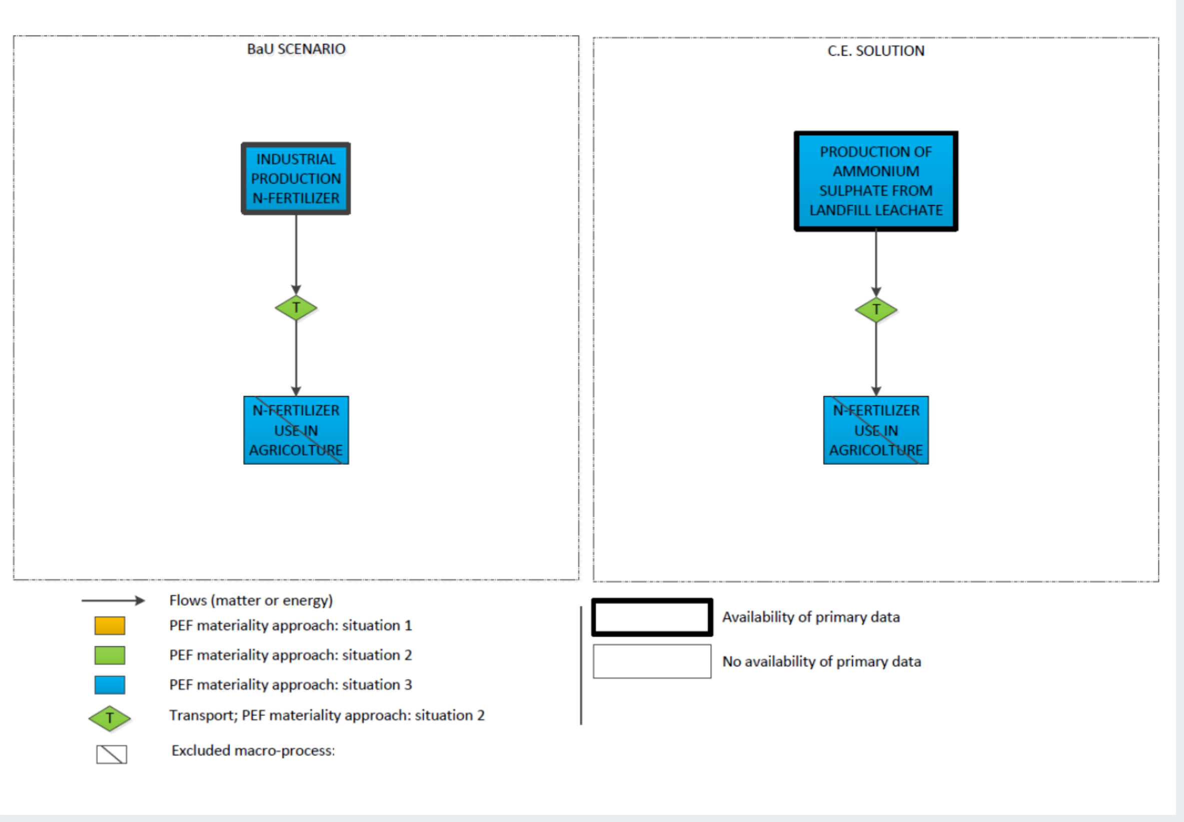


Figure 2: System diagram for the ammonium sulphate production from landfill leachate considering the waste recipient perspective

From the waste recipient's point of view, the BaU scenario entails the current production process of the N-fertiliser from "virgin" resources and the transport to the final consumers. On the other hand, the CE scenario includes the production of ammonium sulphate from leachate, its transport to a possible manufacturer for reaching the final formulation and packaging and the final transport to the end-users. In this example, it has been assumed that the "traditional" fertiliser and the one generated by the leachate has the same application, therefore the use in the crop is neglected.

4. Life cycle inventory

4.1 Data collection

During the data collection phase, two types of data have to be gathered:

1. Specific data (primary data), which are data directly measured or collected representative of activities at a specific facility or set of facilities. The data should include all known inputs and outputs for the processes. Inputs are (for example) use of energy, water, materials, etc. Outputs are the products, co-products, and emissions to environment.
2. Generic data (secondary data) refers to data that are not based on direct measurements or calculation of the respective processes in the system. Generic data can be either sector-specific, i.e. specific to the sector being considered for the PEF-based study, or multi- sector.

The choice between using primary and secondary data is dealt with the PEF methodology in a different way than with the “traditional” LCA approach. One of the main features of the PEF methodology is the attempt to operationalise the "materiality" approach, i.e. focusing where it really matters. In the PEF context the materiality approach is developed around two main areas:

1. Impact categories, life cycle stages, processes. These should be the contributions where companies or other relevant stakeholders should focus more;
2. Data requirements: as the most relevant contributions are those driving the environmental profile of a product, these shall be assessed by using data with higher quality compared to the less relevant contributions, independently from where these processes happen in the supply chain.

In this perspective what becomes relevant are two elements:

1. Which are the processes that are driving the environmental profile of the product (most relevant processes)?
2. What is the level of influence that the company performing the study has on them?

a) Is the process run by the company performing the study?

b) If not, does the company have the possibility to have access to more specific data?

Based on the relevance of the processes for each impact category and the level of influence a company performing the study will have to use for each process data according to one of the options described in Table 4. Whenever applicable, option 1 represents the preferred one.

It should be noted that since the analysis performed in the project framework considers likely scenarios, it may be not always feasible applying the materiality approach. However, it is recommended to apply it whenever possible.

Table 4: PEF “materiality” approach

		Most relevant process	Other process
Situation 1: process run by the company applying the PEFCR	**Option 1**	Provide company-specific data	
	Option 2	Provide company-specific data	Use default secondary dataset in aggregated form
Situation 2: process not run by the company applying the PEFCR but with access to company-specific information	**Option 1**	Provide company-specific data	
	Option 2	Use company-specific activity data for transport (distance), and use the specific supply-chain electricity mix and means of transport (available at http://lcdn.thinkstep.com/Node/)	
Situation 3: process not run by the company applying the PEFCR and without access to company-specific information		Use default secondary data set in aggregated form	

4.2 How to deal with data gaps

Data gaps exist when there is no specific or generic data available 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 Life Cycle Inventory. Missing information can be of different types and have different characteristics, each requiring separate resolution approaches.

Data gaps may exist when:

- Data does not exist for a specific input/product, or
- Data exists for a similar process (proxy) 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.

Data gaps stemming during the data collection will be treated according to the hierarchy reported below:

- Proxy data as much as possible representative of the reference sector will be selected from specific literature sources. The update of the data and the adjustment of the geographical context will be performed with the support of high skilled experts with a deep knowledge of the product system under study.
- Generic data will be selected among LCA databases based on expert judgment. If those data during the life cycle assessment would be identified as the most relevant processes, they will be treated with a sensitivity analysis.

4.3 Cut-offs

The cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly described.

In case processes are excluded from the model this shall be done based on a 1% cut-off for all impact categories based on environmental significance. To calculate a 1% cut-off order the processes starting from the less relevant to the most relevant one. The processes that in total account less than 1% of the environmental impact for each impact category may be excluded from PEF-based studies (starting from the less relevant).

4.4 Handling multifunctional processes

If a process or facility provides more than one function, i.e. it delivers several goods and/or services ("co-products"), it is "multifunctional". In these situations, all inputs and emissions linked to the process shall be partitioned between the product of interest and the other co-products in a principled manner. Systems involving multi-functionality of processes shall be modelled in accordance with the following decision hierarchy.

4.4.1 Decision hierarchy

I) Subdivision or system expansion

Wherever possible, subdivision or system expansion should be used to avoid allocation. Subdivision refers to disaggregating multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output (i.e. in the theoretical case the subdivision implies the disaggregation of the on-site landfill leachate in sub-processes which can be directly associated to the leachate treatment and to the ammonium sulphate production). System expansion refers to expanding the system by including additional functions related to the co-products. It shall be investigated first whether the analysed process can be subdivided or expanded. Where subdivision is possible, inventory data should be collected only for those unit processes directly attributable to the goods/services of concern. Or if the system can be expanded, the additional functions shall be included in the analysis with results communicated for the expanded system as a whole rather than on an individual co-product level (see the definition of the system boundaries in the theoretical case from the waste donor perspective).

II) Allocation based on a relevant underlying physical relationship

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

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

III) Allocation Based on Some Other Relationship

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

Dealing with multi-functionality of products is particularly challenging when recycling or energy recovery of one (or more) of these products is involved as the systems tend to get rather complex. The Circular Footprint Formula (see section 4.4.5) provides an approach that shall be used to estimate the overall emissions associated to a certain process involving recycling and/or energy recovery. These moreover also relate to waste flows generated within the system boundaries.

4.4.2 Climate change modelling

The PEF guide indicates that credits from 'temporary carbon storage' are excluded. This means that emissions emitted within a limited amount of time after their uptake shall be counted for as emitted "now" and there is no discounting of emissions within that given time frame (also in line with ISO/TS14067). The term ‘limited amount of time’ is here defined as 100 years, in line with other guiding documents such as in ILCD handbook (JRC 2016) and PAS2050:2011. Therefore, biogenic carbon emitted later than 100 years after its uptake is considered as permanent carbon storage.

4.4.2.1 Climate change fossil

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

Modelling requirements: The flows falling under this definition should be modelled consistently with the most updated ILCD list of elementary flows[1]. The names ending with '(fossil)' (e.g., 'carbon dioxide (fossil)" and 'methane (fossil)') shall be used if available.

4.4.2.2 Climate change biogenic

This sub-category covers carbon emissions to air (CO2, CO and CH4) originating from the oxidation and/or reduction of aboveground biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or above ground plant residues such as litter and dead wood.

Modelling requirements: the flows falling under this definition shall be modelled consistently with the most updated ILCD list of elementary flows and using the flow names ending with '(biogenic)', modelling all emissions and removals separately. In this case, the corresponding characterisation factors for biogenic CO2 uptakes and emissions are set to zero.

4.4.2.3 Climate change – land use and land transformation

This sub-category accounts for carbon uptakes and emissions (CO2, CO and CH4) originating from carbon stock changes caused by land use change and land use. Considering the specific application of this guidance and the lack of scientific consensus on a uniform approach for dealing land use, it was decided that this sub-category do not need to be calculated.

For carbon modelling the list of characterisation factors in Table 5 shall be applied:

Table 5: CFs (in CO2-equivalents, with carbon feedbacks).

Substance	Compartment	GWP_{100}
Carbon dioxide (fossil)	Air emission	1
Methane (fossil)	Air emission	36.75
Carbon monoxide (fossil)	Air emission	1.57 [2]
Carbon dioxide (biogenic)	Resources from air	0
Carbon dioxide (biogenic-100yr)	Resources from air	-1
Carbon dioxide (biogenic)	Air emission	0
Methane (biogenic)	Air emission	34
Carbon monoxide (biogenic)	Air emission	0

[1] http://eplca.jrc.ec.europa.eu/ELCD3/elementaryFlowList.xhtml;jsessionid=2F73DCD64E29860321DF038227916F2A?stock=default

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

4.4.3 Electricity modelling

In PEF-based studies the EU-28 electricity mix (available at http://lcdn.thinkstep.com/Node/) shall be used. Whenever electricity represents a relevant process (see section 6.3) or the identified CE solution is energy-intensive, different and more specific energy mixes (available at http://lcdn.thinkstep.com/Node/) shall evaluated through sensitivity analyses.

4.4.4 Modelling transport

4.4.4.1 Truck transport

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

- If the load is mass limited: a default utilisation ratio of 64% shall be used. This utilisation ratio includes empty return trips. Therefore, empty returns shall not be modelled separately.
- If the load is volume limited and the full volume is used: the company-specific utilisation ratio calculated as the kg real load/kg payload of the dataset shall be used (also including empty return).
- Bulk transport (e.g., gravel transport from mining pit to concrete plant) shall be modelled with a default utilisation ratio of 50% (100% loaded outbound and 0% loaded inbound).

4.4.4.2 From supplier to factory

In case the primary data for transport are not available, the default data provided below shall be used.

i. For suppliers located within Europe:

the following scenario shall be used:

- 130 km by truck (>32 t, EURO 4; UUID[3] 938d5ba6-17e4-4f0d-bef0-481608681f57), using as default an utilisation ratio of 64%; and
- 240 km by train (average freight train; UUID 02e87631-6d70-48ce-affd-1975dc36f5be); and
- 270 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

ii. For all suppliers located outside Europe

the following scenario shall be used:

- 1000 km by truck (>32 t, EURO 4; UUID 938d5ba6-17e4-4f0d-bef0-481608681f57), for the sum of distances from harbour/airport to factory outside and inside Europe. using as default an utilisation ratio of 64%; and
- 18000 km by ship (transoceanic container; UUID 6ca61112-1d5b-473c-abfa-4accc66a8a63) or 10'000 km by plane (cargo; UUID 1cc5d465-a12a-43da-aa86-a9c6383c78ac).
- If producers country (origin) is known: the adequate distance for ship and airplane should be determined using http://www.searates.com/services/routes-explorer or https://co2.myclimate.org/en/flight_calculators/new

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

4.4.4.3 From EoL collection to EoL treatment

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

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

4.4.5 End of life modelling

A particular case of multifunctional system can arise in the end of life (EoL) phase, when reuse, recycling or energy recovery of one (or more) of the products is involved as the systems tend to get rather complex.

According to the PEF methodology, in such cases the Circular footprint formula (CFF) shall be applied (Equation 1):

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

[3] Universally Unique Identifier

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

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

Equation 1 - The Circular Footprint Formula (CFF)

- **A**: allocation factor of burdens and credits between supplier and user of recycled materials.
- **B:** allocation factor of energy recovery processes: it applies both to burdens and credits.
- **Q_{sin}**: quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.
- **Q_{sout}**: quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.
- **Q_p**: quality of the primary material, i.e. quality of the virgin material.
- **R1**: it is the proportion of material in the input to the production that has been recycled from a previous system.
- **R2**: it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.
- **R3**: it is the proportion of the material in the product that is used for energy recovery at EoL.
- **Erecycled (Erec)**: specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.
  - **ErecyclingEoL (ErecEoL)**: specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.
  - **Ev**: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.
  - **E*v**: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.
  - **EER**: specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …).
  - **ESE,heat** and **ESE,elec**: specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.
  - **ED**: specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.

- **XER,heat** and **XER,elec**: the efficiency of the energy recovery process for both heat and electricity.
- **LHV**: Lower Heating Value of the material in the product that is used for energy recovery.

The Circular footprint formula represents the methodological basis for handling the multifunctionality at the EoL stage in the CIRCE2020 framework and for quantifying the material production. A further simplification of the formula, when more information on the CE solutions identified by project partners will be provided, whenever possible.

Going back to the example of the production of ammonium sulphate, from the **waste donor perspective** in both of the analysed scenarios the leachate has only one type of treatment when leaves the landfill, namely the wastewater treatment in the BaU scenario or in the CE solution the sewage and external landfill for the liquid and solid fraction of leachate respectively. Moreover, the recycled/reused content of material (R_1) is not applicable in this specific case, thus the Circular footprint formula is simplified and results in accounting only the disposal part which becomes equal to E_D (all the other parameters are zero).

4.4.6 Data quality requirements

The data quality is addressed by applying the requirements set in the ISO 14044 standard, and not according to the PEFCR Guidance, due to the lack of its full applicability in the context of the project. More in detail, the LCA applicant is requested to document in the study the following criteria:

- **time-related coverage**: age of data and the minimum length of time over which data should be collected;
- **geographical coverage**: geographical area from which data for unit processes should be collected to satisfy the goal of the study;
- **technology coverage**: specific technology or technology mix;
- **precision**: measure of the variability of the data values for each data expressed (e.g. variance);
- **completeness**: percentage of flow that is measured or estimated;
- **representativeness**: qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);
- **consistency**: qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;
- **reproducibility**: qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study;
- **sources of the data**;
- **uncertainty of the information** (e.g. data, models and assumptions).

5 Life cycle impact assessment

5.1 Characterisation

The list of the 16 impact categories to be used to calculate the PEF profile is reported in Table 6.

The list of updated characterisation factors is not currently available in the LCA software, but it is expected to be implemented in the next months. In the meanwhile, the reference source to be checked the updated characterisation factors is the following: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml;jsessionid=2FD82E9C10200B5B45B38239B598AA8C.

If, for any technical reason, the updated characterisation factors will not be available in the LCA software for completing the PEF-based studies according to the project timetable, the last version of the PEF-ILCD method include in the LCA software shall be used.

Table 6: List of recommended models at midpoint, together with their indicator, unit and source.

Recommendation at midpoint					
Impact category	**Indicator**	**Unit**	**Recommended default LCIA method**	**Source of CFs**	**Robustness[4]**
Climate change[5]	Radiative forcing as Global Warming Potential (GWP100)	kg $CO_{2\ eq}$	Baseline model of 100 years of the IPCC (based on IPCC 2013)	EC-JRC, 2017[6]	I
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	Steady-state ODPs as in (WMO 1999)	EC-JRC, 2017	I
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Human toxicity, non-cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Particulate matter	Impact on human health	disease incidence	PM method recomended by UNEP (UNEP 2016)	EC-JRC, 2017	I
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq $U^{235}{}_{eq}$	Human health effect model as developed by Dreicer et al. 1995	EC-JRC, 2017	II

[4] The recommended characterisation models and associated characterisation factors in ILCD are classified according to their quality into three levels: "Level I" (recommended and satisfactory), "Level II" (recommended but in need of some improvements) or "Level III" (recommended, but to be applied with caution). For more details: http://eplca.jrc.ec.europa.eu/uploads/LCIA-characterization-factors-of-the-ILCD.pdf

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

			(Frischknecht et al, 2000)		
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008	EC-JRC, 2017	II
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Ecotoxicity, freshwater*	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	USEtox model, (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Land use	• Soil quality index[7] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production • kg soil • m^3 water • m^3 groundwater	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	EC-JRC, 2017	III
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq}$	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	EC-JRC, 2017	III
Resource use[8], minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.		III
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[9]	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	EC-JRC, 2017	III

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

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

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

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

5.2 Normalisation

The global normalisation factors to be used are listed in Table 7.

The list of updated normalisation factors is not currently available in the LCA software, but it is expected to be implemented in the next months. In the meanwhile, the reference source to be checked the updated characterisation factors is the following: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml;jsessionid=2FD82E9C10200B5B45B38239B598AA8C.

If for any technical reason, the updated normalisation factors will not be available in the LCA software for completing the PEF-based studies according to the project timetable, the last version of the PEF-ILC method include in the LCA software shall be used, aligned with the corresponding characterisation method.

Table 7: List of PEF normalisation factors to be used

Impact category	Unit	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Climate change	kg CO_2 eq	7.76E+03	I	II	I	
Ozone depletion	kg CFC-11 eq	2.34E-02	I	III	II	
Human toxicity, cancer	CTUh	3.85E-05	II/III	III	III	
Human toxicity, non-cancer	CTUh	4.75E-04	II/III	III	III	
Particulate matter	disease incidence	6.37E-04	I	I/II	I /II	NF calculation takes into account the emission height both in the emission inventory and in the impact assessment.
Ionising radiation, human health	kBq U^{235} eq	4.22E+03	II	II	III	

Photochemical ozone formation, human health	kg NMVOC $_{eq}$	4.06E+01	II	III	I/II	
Acidification	mol H+ $_{eq}$	5.55E+01	II	II	I/II	
Eutrophication, terrestrial	mol N $_{eq}$	1.77E+02	II	II	I/II	
Eutrophication, freshwater	kg P $_{eq}$	2.55E+00	II	II	III	
Eutrophication, marine	kg N $_{eq}$	2.83E+01	II	II	II/III	
Land use	pt	1.33E+06	III	II	I I	The NF is built by means of regionalised CFs.
Ecotoxicity, freshwater	CTUe	1.18E+04	II/III	III	III	
Water use	m^3 world $_{eq}$	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
Resource use, fossils	MJ	6.53E+04	III	I	II	
Resource use, minerals and metals	kg Sb $_{eq}$	5.79E-02	III			

5.3 Weighting

Table 8: List of the PEF weighting factors to be used

	Final weighting factors
WITHOUT TOX CATEGORIES	
Climate change	**22.19**
Ozone depletion	**6.75**
Particulate matter	**9.54**
Ionizing radiation, human health	**5.37**
Photochemical ozone formation, human health	**5.1**
Acidification	**6.64**
Eutrophication, terrestrial	**3.91**
Eutrophication, freshwater	**2.95**
Eutrophication, marine	**3.12**
Land use	**8.42**
Water use	**9.03**

Resource use, minerals and metals	**8.08**
Resource use, fossils	**8.92**

The above-reported weighting factors shall be applied only if the updated characterisation and normalisation factors reported in Table 6 and Table 7 are used.

6 Interpretation of the results

6.1 Procedure to identify the most relevant impact categories

The identification of the most relevant impact categories shall be based on the normalised and weighted results. At last three relevant impact categories shall be considered. The most relevant impact categories shall be identified as all impact categories that cumulatively contribute to at least 80% of the total environmental impact (excluding toxicity related impact categories). This should start from the largest to the smallest contributions.

6.2 Procedure to identify the most relevant life cycle stages

The most relevant life cycle stages are the life cycle stages, which together contribute to at least 80% of any of the most relevant impact categories identified. This should start from the largest to the smallest contributions.

6.3 Procedure to identify the most relevant processes

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

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

In Table 9 the requirements to define most relevant contributions are summarized.

Table 9 Summary of requirements to define most relevant contributions.

Item	At what level does relevance need to be identified?	Threshold	Additional notes
MOST RELEVANT IMPACT CATEGORIES	Normalised and weighted results	Impact categories cumulatively contributing at least **80%** of the total environmental impact (excluding toxicity related impact categories)	

MOST RELEVANT LIFE CYCLE STAGES	For each most relevant impact category	All life cycle stages contributing cumulatively more than **80%** to that impact category	
MOST RELEVANT PROCESSES	For each most relevant impact category	All processes contributing cumulatively more than **80%** to that impact category	The identification of the most relevant processes shall be done at whole life cycle level

7 References

European Commission, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL. Building the Single Market for Green Products Facilitating better information on the environmental performance of products and organisations, COM(2013) 196 final.

European Commission, COMMISSION RECOMMENDATION of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. OJ L 124/4.

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

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

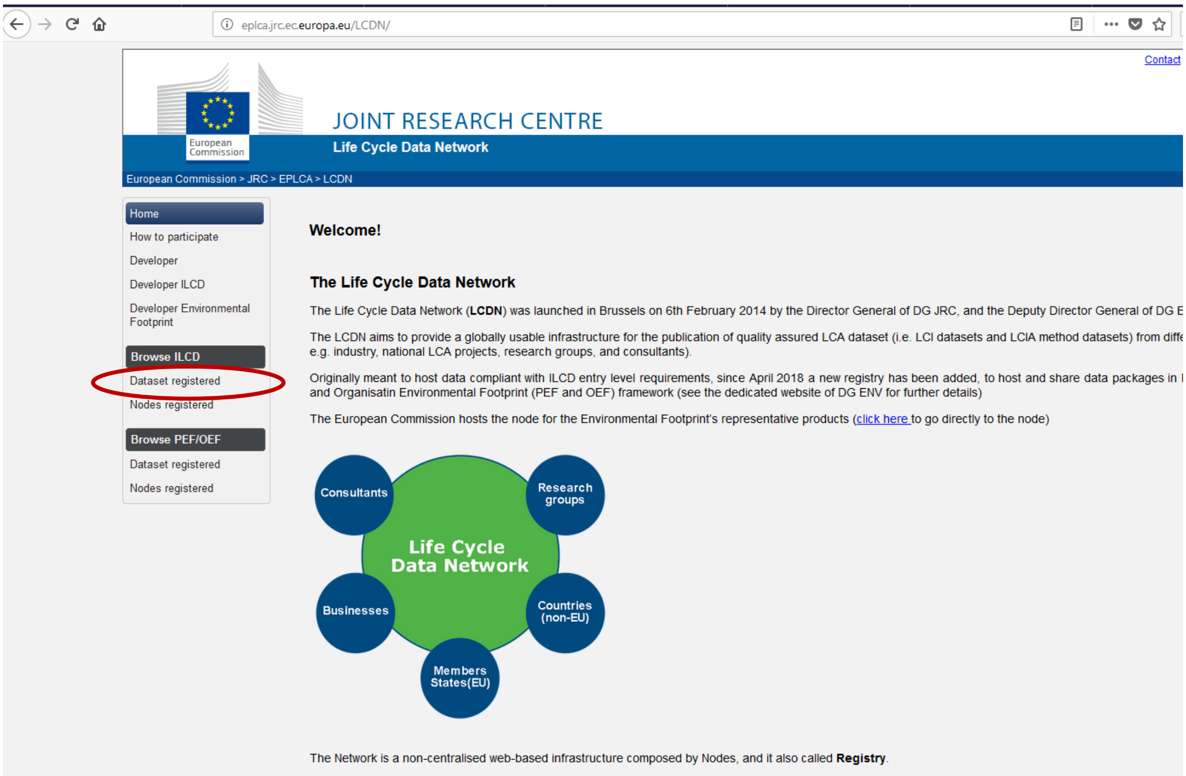
UNI EN ISO 14044:2006 - Environmental management Life cycle assessment. Requirements and guidelines

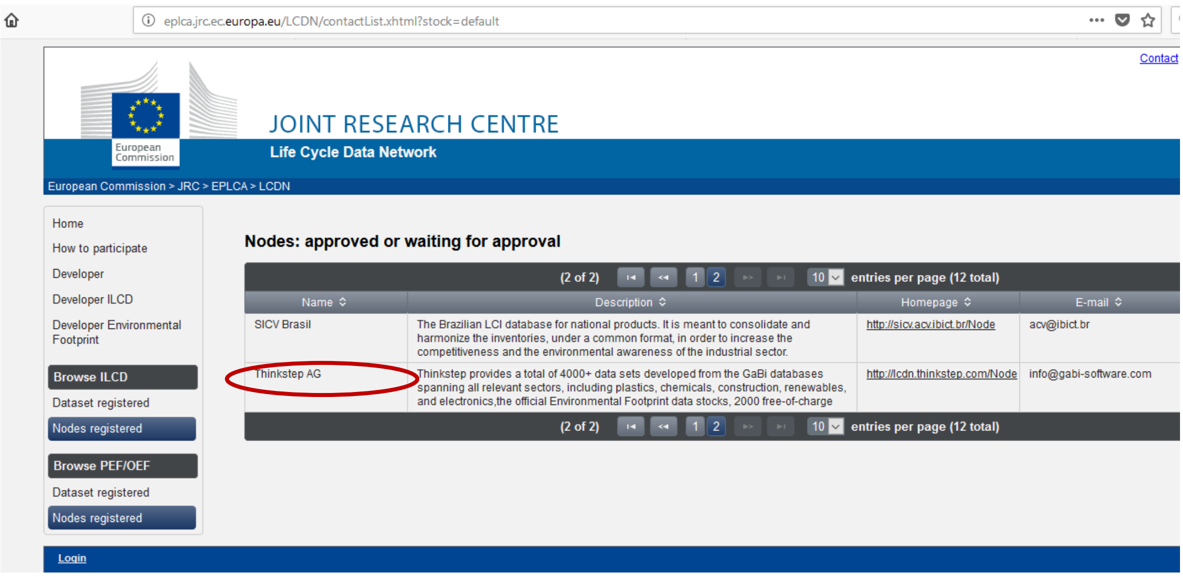
A. ANNEX I Hierarchy for the selection of the LCI database

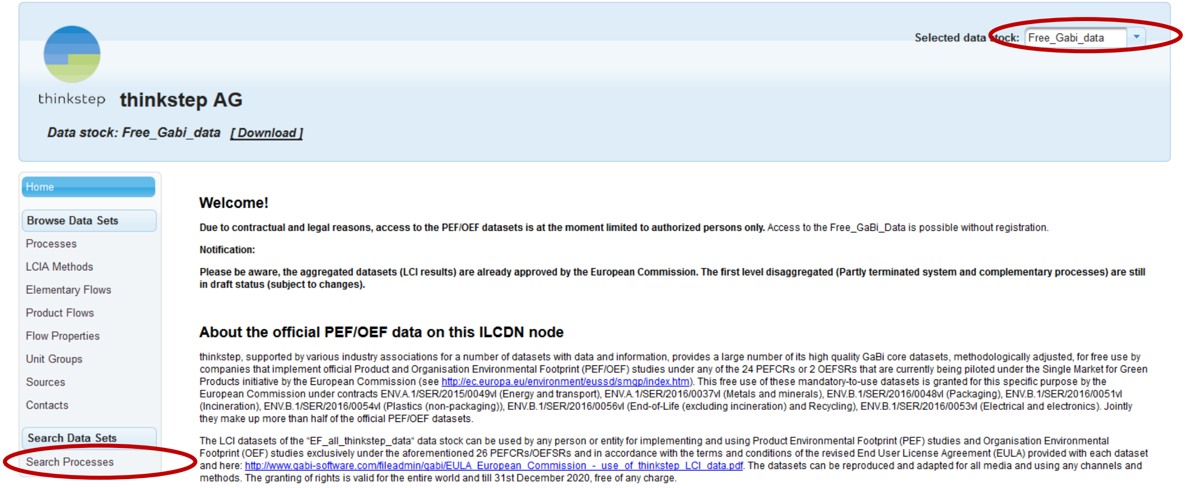
The selection of the LCI dataset to be used in the PEF-based study shall be done according to the hierarchy reported below:

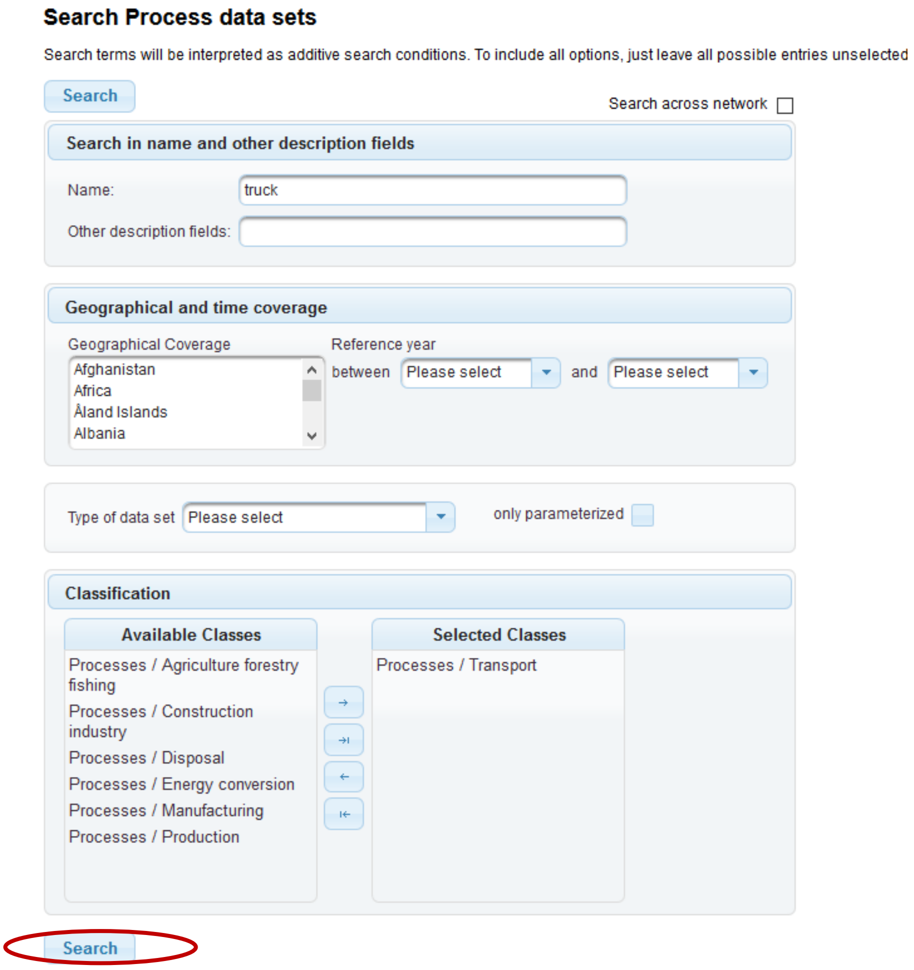
1. For the processes included in the Life Cycle Data Network (http://eplca.jrc.ec.europa.eu/LCDN/), this database represents the preferred source to be used.

   The following figures illustrate how to search a process and check the UUID






Selected data stock: Free_Gabi_data
thinkstep
thinkstep AG
Data stock: Free_Gabi_data [Download]
Home
Browse Data Sets
Processes
LCIA Methods
Elementary Flows
Product Flows
Flow Properties
Unit Groups
Sources
Contacts
Search Data Sets
Search Processes
Welcome!
Due to contractual and legal reasons, access to the PEF/OEF datasets is at the moment limited to authorized persons only. Access to the Free_GaBi_Data is possible without registration.
Notification:
Please be aware, the aggregated datasets (LCI results) are already approved by the European Commission. The first level disaggregated (Partly terminated system and complementary processes) are still in draft status (subject to changes).
About the official PEF/OEF data on this ILCDN node
thinkstep, supported by various industry associations for a number of datasets with data and information, provides a large number of its high quality GaBi core datasets, methodologically adjusted, for free use by companies that implement official Product and Organisation Environmental Footprint (PEF/OEF) studies under any of the 24 PEFCRs or 2 OEFSRs that are currently being piloted under the Single Market for Green Products initiative by the European Commission (see http://ec.europa.eu/environment/eussd/smgp/index.htm). This free use of these mandatory-to-use datasets is granted for this specific purpose by the European Commission under contracts ENV.A.1/SER/2015/0049vl (Energy and transport), ENV.A.1/SER/2016/0037vl (Metals and minerals), ENV.B.1/SER/2016/0048vl (Packaging), ENV.B.1/SER/2016/0051vl (Incineration), ENV.B.1/SER/2016/0054vl (Plastics (non-packaging)), ENV.B.1/SER/2016/0056vl (End-of-Life (excluding incineration) and Recycling), ENV.B.1/SER/2016/0053vl (Electrical and electronics). Jointly they make up more than half of the official PEF/OEF datasets.
The LCI datasets of the "EF_all_thinkstep_data" data stock can be used by any person or entity for implementing and using Product Environmental Footprint (PEF) studies and Organisation Environmental Footprint (OEF) studies exclusively under the aforementioned 26 PEFCRs/OEFSRs and in accordance with the terms and conditions of the revised End User License Agreement (EULA) provided with each dataset and here: http://www.gabi-software.com/fileadmin/gabi/EULA_European_Commission_-_use_of_thinkstep_LCI_data.pdf. The datasets can be reproduced and adapted for all media and using any channels and methods. The granting of rights is valid for the entire world and till 31st December 2020, free of any charge.


Search Process data sets
Search terms will be interpreted as additive search conditions. To include all options, just leave all possible entries unselected
Search
Search across network
Search in name and other description fields
Name: truck
Other description fields:
Geographical and time coverage
Geographical Coverage
Afghanistan
Africa
Åland Islands
Albania
Reference year
between Please select and Please select
Type of data set Please select
only parameterized
Classification
Available Classes
Processes / Agriculture forestry fishing
Processes / Construction industry
Processes / Disposal
Processes / Energy conversion
Processes / Manufacturing
Processes / Production
Selected Classes
Processes / Transport
Search

Search Results

Back to search form

(2 of 8) 1 2 3 4 5 6 7 8 10 entries per page (80 total)

Name	Type	Location	Classification	Reference year	Valid until
Truck-trailer; diesel driven, Euro 3, cargo; consumption mix; 28 - 34t gross weight / 22t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 3, cargo; consumption mix; 34 - 40t gross weight / 27t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 3, cargo; consumption mix; up to 28t gross weight / 12,4t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 4, cargo; consumption mix; 28 - 34t gross weight / 22t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 4, cargo; consumption mix; 34 - 40t gross weight / 27t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2012	2016
Truck-trailer; diesel driven, Euro 4, cargo; consumption mix; up to 28t gross weight / 12,4t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 5, cargo; consumption mix; 28 - 34t gross weight / 22t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 5, cargo; consumption mix; 34 - 40 t gross weight / 27t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 5, cargo; consumption mix; up to 28t gross weight / 12,4t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016
Truck-trailer; diesel driven, Euro 6, cargo; technology mix; 28 - 34t gross weight / 22t payload capacity	(Parameterized) Unit process, single operation	GLO	Processes / Transport / Road / Truck	2013	2016

(2 of 8) 1 2 3 4 5 6 7 8 10 entries per page (80 total)

Process data set overview page

Data set: Truck-trailer (09.00.000)

View entire data set | Download data set as XML file

Full name	Location	Reference year	Valid until
Truck-trailer; diesel driven, Euro 4, cargo; consumption mix; 34 - 40t gross weight / 27t payload capacity	GLO	2012	2016

Reference flow(s)	Type	Parameterized?	LCIA results included?
Cargo - 1.0 kg (Mass)	Unit process, single operation	yes	no

Category	Synonyms
Processes / Transport / Road / Truck	articulated lorry

Use advice for data set	Data set use approval
The data set should be used for LCI/LCA studies where bulk or packaged goods have to be transported via road (motorway) over a longer distance. The data set allows individual settings of the variable parameters. The following parameters are variable: payload, utilisation ratio, distance, sulphur content of fuel and driving share urban/interurban/motorway. Default values of the variable parameters have to be checked and adjusted for individual use. The data set does not include the fuel supply route. Therefore the fuel supply data set has to be linked with this data set.	No official approval by producer or operator

General comment
- average emission values Euro 4 - source emissions/driving share: HBEFA 3.1, status January 2010 - input parameter: distance [km], payload [t], utilisation [-], sulphr content diesel [ppm], driving share motorway/rural/urban - average sulphur content: EU = 10 ppm

LCI Method Principle	LCI Method Approaches	Completeness of product model
Attributional	Not applicable	All relevant flows quantified

Reviews

Independent external review by
- GaBi user community
- GaBi bug forum
- GaBi user forum

Dependent internal review by
- PE INTERNATIONAL
- LBP-GaBi
- IBP-GaBi

Data quality indicators
- Overall quality: Good
- Methodological appropriateness and consistency: Good
- Precision: Good
- Completeness: Good
- Geographical representativeness: Very good
- Time representativeness: Very good
- Technological representativeness: Very good

Administrative information

Commissioner and goal	
Commissioner of data set	PE INTERNATIONAL
Intended applications	The data set represents a cradle to gate inventory. It can be used to characterise the supply chain situation of the respective commodity in a representative manner. Combination with individual unit processes using this commodity enables the generation of user-specific (product) LCAs. The data set does not necessarily fit for any possible specific supply situation - especially if significantly different technology routes exist - but is representative for a common supply chain situation.
Data generator	
Data set generator / modeller	LBP-GaBi
Data entry by	
Time stamp (last saved)	2014-12-01T00:00:00+01:00
Data set format(s)	ILCD format 1.1
Data entry by	PE INTERNATIONAL
Official approval of data set by producer/operator	No official approval by producer or operator
Publication and ownership	
UUID	05[illegible]68254-9d64-473a-8dc5-16cb5bf3c45f
Date of last revision	2014-12-01T00:00:00+01:00
Data set version	09.00.000
Workflow and publication status	Data set finalised; entirely published
Unchanged re-publication of	GaBi databases
Owner of data set	PE INTERNATIONAL
Copyright	Yes
License type	Other
Access and use restrictions	GaBi (source code, database including extension modules and single data sets, documentation) remains property of PE INTERNATIONAL AG. PE INTERNATIONAL AG delivers GaBi licenses comprising data storage medium and manual as ordered by the customer. The license guarantees the right of use for one installation of GaBi. Further installations using the same license are not permitted. Additional licenses are only valid if the licensee holds at least one main license. Licenses are not transferable and must only be used within the licensee's organisation. Data sets may be copied for internal use. The number of copies is restricted to the number of licenses of the software system GaBi the licensee owns. The right of use is exclusively valid for the licensee. All rights reserved. thinkstep has put this specific dataset into The Life Cycle Data Network (LCDN) (http://46.163.107.157:8080/Node/index.xhtml) under the following Creative Commons license http://creativecommons.org/licenses/by-nc-nd/4.0/

2. LCI datasets developed by Industrial European Associations shall be used for modelling the raw materials production, such as PlasticsEurope, European Aluminum Association, Worldsteel Association.
3. LCI processes available in LCA databases as much as possible representative of the reference sector.
4. Generic processes to be used as proxy available in the LCA database.

B. ANNEX II Template for PEF-based report

1. Summary

The summary includes the following elements:

- The goal and scope of the study;
- Relevant statements about data quality, assumptions, value judgments and limitations;
- The main results from the impact assessment of the two scenarios (scenario = and CE solution);
- Recommendations made and conclusions drawn.

To the extent possible the Summary should be written with a non-technical audience in mind and should not be longer than 3-4 pages.

2. General

In this section, the information below should be reported:

- *General description of the CIRCE2020 project;*
- *Overview of the specific CIRCE2020 pilot area;*
- *Illustration of the scenario 0 and the CE solution identified for the waste stream under analysis.*

3. Goal of the study

The goals listed in section 3.1 shall be included, clearly indicating which is the analysed perspective and the intended audience. Any other additional intended application shall be also reported here.

4. Scope of the study

4.1 Functional/declared unit and reference flow

Provide the functional unit and reference flow, as described in this guidance.

4.2 System boundaries

This section shall include as a minimum:

- *List all attributable life-cycle stages and processes that are part of the product system. The co-products, by-products and waste streams of at least the foreground system shall be clearly identified.*
- *Provide a system diagram clearly indicating the system boundaries, the processes that are included and those excluded, highlight those activities which falls respectively under situation 1, 2, and 3 of the Data Need Matrix, and highlight where primary activity data / primary life cycle inventory data is used. The system diagram shall clearly indicate which are the processes in the company foreground system (where they have operational control) and which are those in the company background system]*

4.3 Supplementary analysis

Describe any supplementary analysis made, e.g.:

- *Scenario sensitivity and uncertainty analysis*
- *The use of impact assessment methods, end of life formulas or datasets other than those recommended in this guidance*

5. Life Cycle Inventory analysis

5.1 Data collection and quality assessment (CONFIDENTIAL IF RELEVANT)

This section shall include as a minimum:

- *Description and documentation of all primary data collected*
  - *per life cycle stage,*
  - *list of activity data used*
- *Detailed Bill of Materials/ingredients, including substance names, units and quantities, including information on grades/purities and other technically and/or environmentally relevant characterisation of these*
- *List of primary and secondary datasets used*
- *modelling parameters derived from primary data or additional to those described in this guidance (e.g. transportation distance, etc)*
- *Primary data collection/estimation/calculation procedures*
- *Sources of published literature*
- *Validation of data, including documentation*
- *Justification of allocation procedures used*

5.2 Data gaps

Specify data gaps and the way in which these gaps were filled.

5.3 Supplementary analysis

This section shall describe more in detail the supplementary analysis made.

- *Calculation procedure, assumptions, data sources used, etc.*

6. Impact assessment results (CONFIDENTIAL IF RELEVANT)

6.1 PEF results

This section shall include as a minimum:

- *List of the most relevant life cycle stages, processes based on the approach explained in section 5 of this guidelines (using normalization and weighting).*
- *Characterised results per life cycle stage and impact category (all 15 PEF impact categories shall be calculated)*
- *Normalised and weighted results*
- *Limitation of the EF results relative to the defined goal and scope of the PEF-based study*

In case alternative impact assessment methods and/or normalisation factors and/or weighting systems are used, the results shall be calculated separately for the baseline PEF approach and for each of the alternative options included.

6.1.1 Supplementary analysis

This section shall include as a minimum:

- *Results or conclusions of any supplementary analysis made*

7. Interpreting PEF results

7.1 PEF results

This section shall include as a minimum:

- *Comparison of CE solution results against those of scenario 0*
- *Average data quality evaluation of the PEF-based-study;*
- *Uncertainty (at least a qualitative description).*

Annex I

The Annex serves to document supporting elements to the main report which are of a more technical nature. It could include:

- *Bibliographic references;*
- *Additional results that have been shown to be not relevant;*
- *Life Cycle Inventory analysis (optional if considered sensitive and communicated separately in the Confidential annex, see below)*

Annex II: Confidential

The Confidential annex is an optional chapter that shall contain all those data (including raw data) and information that are confidential or proprietary and cannot be made externally available.

C. ANNEX III Glossary

Activity data - This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF Guide it is also called "non-elementary flows". Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. In the context of PEF the amounts of ingredients from the bill of material (BOM) shall always be considered as activity data (PEF Guidance).

Aggregated dataset - This term is defined as a life cycle inventory of multiple unit processes (e.g. material or energy production) or life cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level (PEF Guidance).

Allocation -Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems (ISO 14040:2006).

Characterization factor - Factor derived from a characterization model which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator (ISO 14040:2006).

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

Co-product - any of two or more products coming from the same unit process or product system (ISO 14040:2006).

Cut-off criteria - Specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product system to be excluded from a study (ISO 14040:2006).

Functional unit -Quantified performance of a product system for use as a reference unit (ISO 14040:2006).

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

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

Impact category - Class representing environmental issues of concern to which life cycle inventory analysis results may be assigned (ISO 14040:2006).

LCA - Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14040:2006).

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

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

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

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

Product Environmental Footprint Category Rules (PEFCRs) – Product category-specific, life-cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF guide (PEF Guidance).

Product system - Collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product (ISO 14040:2006).

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

Sensitivity analysis - Systematic procedures for estimating the effects of the choices made regarding methods and data on the outcome of a study (ISO 14040:2006).

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

System boundary - Set of criteria specifying which unit processes are part of a product system (ISO 14040:2006).

Supply-chain – It refers to all of the upstream and downstream activities associated with the operations of the company performing the PEF study, including the use of sold products by consumers and the end-of-life treatment of sold products after consumer use (PEF Guidance).