Final DRAFT

Product Environmental Footprint Category Rules for vegetable oil and proteinmeal industry products

Version 1.0

April 2022

Date of expiration: 30 April 2025

This PEFCR is based on the PEFCR template of ANNEX B of the document *Suggestions for updating the Product Environmental Footprint (PEF) method* (Zampori and Pant, 2019). However, at this point it is not possible for FEDIOL to be fully compliant with the PEF method, and the process of developing a PEFCR has not been followed. This document is thus no official PEFCR. We aim to be as much PEF compliant as possible, indicate where there are deviations from the PEF method and justify why. Because of the PEFCR not being fully compliant with PEF, studies performed according to this PEFCR are not compliant either.

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1. INTRODUCTION

The Product Environmental Footprint (PEF) method provides detailed and comprehensive technical rules on how to conduct PEF studies that are more reproducible, consistent, robust, verifiable and comparable. Results of PEF studies are the basis for the provision of EF information and they may be used in a diverse number of potential fields of applications, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this PEFCR the user of the PEFCR shall refer to the documents this PEFCR is in conformance with (see section 2.6).

This PEFCR is largely based on the document *Suggestions for updating the Product Environmental Footprint (PEF) method* (Zampori and Pant, 2019), but is not fully compliant. The official process of developing a PEFCR has not been followed. Studies performed according to this PEFCR are therefore not fully compliant with PEF. The sector believes that in Europe PEF will be the preferred LCA approach and it is expected that main customers (e.g. compound feed industry) will adhere to PEF as well.

16 December 2021 the European Commission has published the Recommendation on the use of Environmental Footprint methods. The method was released after the main part of this study was done, but is largely based on the method published in 2019 by Zampori and Pant which has been followed in this study.

Terminology: shall, should and may

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

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

A list with acronyms and definitions is available in Annex 1.

2. GENERAL INFORMATION ABOUT THE PEFCR

2.1. COMMISSIONER

This PEFCR has been commissioned by the European vegetable oil and proteinmeal industry association, FEDIOL. FEDIOL represents the European Vegetable Oil and Proteinmeal Industry. FEDIOL members purchase, store and transport oilseeds and vegetable oils, process oilseeds into meals and crude oils, refine and transform crude vegetable oils and sell oils in bulk and in bottles to the food, feed and energy markets and meals to the feed market.

The PEFCR has been developed by the Flemish institute for technological research (VITO) and is based on a participatory process which included consultation with the members of FEDIOL. FEDIOL members represent more than 85% of EU vegetable oil and proteinmeal production. In this study, thirteen FEDIOL member companies were involved, who participated in meetings and provided feedback on the draft documents. Ten member companies provided data for the life cycle assessment of the sector

average products and representative product. The provided data are applicable to 33% of the EU vegetable oil sector.

In 2013 FEDIOL commissioned TU Berlin to conduct an ISO compatible life cycle assessment (LCA) of EU rapeseed and soybean crushing and rapeseed oil, soybean oil and palm oil refining. The goal of this study was to establish a robust and up to date Life Cycle Inventory dataset to assess the key potential environmental impacts of these activities. A PCR on respectively crude oil refining and oilseed processing was developed for publication under the EPD system. This however was not maintained and is outdated by now. In the meantime, the EU has developed the product environment footprint (PEF). Furthermore, the EU Green Deal tells us that that method should sooner or later be used to help consumers making informed decision on the environmental impact of the products they purchase. This is already translating on the market in new customer requests; FEDIOL member companies are being pressed for environmental impact data of their products. This has triggered the desire to extend the 2013 study to one covering the full life cycle of the main products of EU oilseed processing and refining. This work should help set the LCA/PEF standards for the vegetable oil and protein meal industry that is as compliant as possible with PEF.

2.2. REVIEWER AND REVIEW REQUIREMENTS OF THE PEFCR

This PEFCR has been reviewed by prof. Dr. Matthias Finkbeiner, Chair of Sustainable Engineering, Technische Universität Berlin. The reviewer acts and was contracted as an independent expert, not as a representative of his affiliated organization.

The reviewer has reviewed that the following requirements are fulfilled:

- *The PEFCR has been developed in accordance with the requirements provided in the PEF method and Annex A of the PEF method;*
- *The PEFCR scope and the representative products are adequately defined;*
- *The functional unit, allocation and calculation rules are adequate for the product category under consideration;*
- *The selected additional environmental and technical information are appropriate for the product category under consideration and the selection is done in accordance with the requirements stated in the PEF method.*

2.3. REVIEW STATEMENT

See Annex 5.

2.4. GEOGRAPHIC VALIDITY

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

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

2.5. LANGUAGE

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

2.6. CONFORMANCE TO OTHER DOCUMENTS

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

- *Product Environmental Footprint (PEF) method*

3. PEFCR SCOPE

3.1. PRODUCT CLASSIFICATION

The scope of this PEFCR are products of the vegetable oil and proteinmeal industry. The following products with their CPA codes are included in this PEFCR:

The scope of this PEFCR are products of the vegetable oil and proteinmeal industry. The following products with their CPA codes are included in this PEFCR:

- Flours and meals of oil seeds or oleaginous fruits, except those of mustard (CPA 10.41.42).
- Crude vegetable oils (CPA 10.41.2) except groundnut oil (CPA 10.41.22), olive oil (CPA 10.41.23), cotton seed oil (CPA 10.41.25), mustard oil (CPA 10.41.26), other vegetable oils (CPA 10.41.29).
- Refined oils(CPA 10.41.5) including byproducts of the refining of the oil except groundnut oil (CPA 10.41.52), except olive oil (CPA 10.41.53), except cotton-seed oil (CPA 10.41.55), except mustard oil (as part of CPA 10.41.56)

Additionally, some products that fall under other CPA codes are included:

- Maize oil (CPA 10.62.14)

The underlying PEF-study referred to in this PEFCR includes all products from the vegetable oil and protein meal industry listed in Table 1.

Table 1: Overview of products included in the scope of this PEFCR

Raw material		Rapeseeds	Soybeans	Sunflower seeds	Maize germs	Palm	Palm kernel	Coconut
Status raw material at reception		uncleaned	uncleaned	uncleaned, including husk	uncleaned	crude oil	crude oil	crude oil
Products	Crushing	Crude oil Meal Lecithin	Crude oil Meal Lecithin Hulls	Crude oil Meal Lecithin Husks	Crude oil Meal			
	Oil processing	Refined oil Soap stock Acid oil/deodistillates/fatty acid distillates	Refined oil Soap stock Acid oil/deodistillates/fatty acid distillates	Refined oil Acid oil/deodistillates/fatty acid distillates	Refined oil Acid oil/deodistillates	Refined oil Acid oil/deodistillates/fatty acid distillates	Refined oil Fatty acid distillates	Refined oil Acid oil/deodistillates/fatty acid distillates
Technology	Main refining technology	Chemical refining and physical refining	Physical and chemical refining	Physical and chemical refining	Chemical refining	Physical and chemical refining	Physical refining	Physical and chemical refining

The vegetable oil and protein meal industry products are used in a wide range of applications, including food (ingredient in a vast number of products from food dressings to dairy and confectionary products), animal feed and other industries (e.g. cosmetics, detergents, paints, plastics, candles, pharmaceuticals, biofuels). The performance depends on the specific product and application.

3.2. REPRESENTATIVE PRODUCT

The representative product may be a virtual (non-existing) product or a real product. The virtual product should be calculated based on average European market sales-weighted characteristics of all existing technologies/materials covered by the product category or sub-category. Other weighting sets may be used, if justified, for example weighted average based on mass (ton of material) or weighted average based on product units (pieces).

A **virtual product** is composed of all products covered by this PEFCR. The composition is based on:

- weighted average quantities (production volumes, market shares or consumption data) of European sales

The representative product is included to use as a reference for the development of the PEFCR. It is used to derive the most representative live cycle stages, impact categories, processes and elementary flows and to identify processes subject to cut-off. As the products under investigation concern intermediate products, benchmarking is not allowed and life cycle impact assessment results for the representative product shall therefore not be used to compare with.

The representative product is a virtual vegetable oil and protein meal industry product, composed of all products covered by this PEF study (Table 2). Its composition is based on weighted average quantities (mass) of European sales to end user industries. Statistics reported by FEDIOL on its website and shares of co-products estimated for the share of output products as reported by the participating member companies were used to establish the representative product. The FEDIOL statistics used are:

for rapeseed, sunflower, soybean and maize germs:

- 'EU-27* + UK 2020 PRODUCTION OF CRUDE VEGETABLE OILS AND FATS', and,
- 'EU-27* + UK 2020 PRODUCTION OF MEALS'

for palm, palm kernel and coconut:

- 'EU-27* + UK 2020 IMPORTS OF VEGETABLE OILS AND FATS'

An average value of the years 2016, 2017 and 2018 has been used. The share of the different products is calculated as the share of the mass of the product within the total mass of all sold products.

Table 2: Composition of the representative product (weighted average shares)

	Raw material	Rapeseed		Soybean		Sunflower		Coconut		Maize germs		Palm		Palm kernel	
Products	Crushing	Crude oil	**8,44%**	Crude oil	**4,47%**	Crude oil	0,49%			Crude oil	0,10%				
		Meal	**22,11 %**	Meal	**23,01 %**	Meal	**6,28%**			Meal	0,59%				
		Lecithin	0,02%	Lecithin	0,09%	Lecithin	0,02%								
				Hulls		Husks	0,52%								
	Oil processing	Refined oil	**9,34%**	Refined oil	**1,86%**	Refined oil	**6,63%**	Refined oil	0,95%	Refined oil	0,43%	Refined oil	**11,89 %**	Refined oil	**1,19%**
		Soap stock	0,22%	Soap stock	0,05%	Acid oil/deodistillates/Fatty acid distillates	0,14%	Acid oil/deodistillates/Fatty acid distillates	0,03%	Acid oil/deodistillates	0,02%	Acid oil/deodistillates/Fatty acid distillates	0,95%	Fatty acid distillates	0,02%
		Acid oil/deodistillates/Fatty acid distillates	0,14%	Acid oil/ Deodistillates/Fatty acid distillates	0,01%										
				Other	0,01%										

3.3. FUNCTIONAL UNIT AND REFERENCE FLOW

The products of the vegetable oil and proteinmeal industry fulfil multiple functions (Table 1) and their whole life cycle is unknown. It is not feasible to include a description of the function, as a vast number of functions exist (e.g. add nutrients, cooking at high temperature, frying, enhance flavour, give texture). Even for one specific product, different applications exist. Therefore, the functional unit should be considered as a declared unit (identical to the reference flow[1]) and does not aim to quantify the performance of a product. *All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.*

The functional unit[2] (FU) is "the production of 1 tonne of vegetable oil and proteinmeal industry product at the user's entry gate".

3.4. SYSTEM BOUNDARY

The system boundaries are split up in various figures due to the large number of products and processes included. The system boundaries for the production of vegetable oil and co-products are presented in Figure 1 for products from rapeseed, Figure 2 for products from soybean, in Figure 3 for products from sunflower, in Figure 4 for products from maize, in Figure 5 for products from palm, in Figure 6 for products from palm kernel and in Figure 7 for products from coconut.

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

[2] This is a declared unit rather than a functional unit, but the term "functional unit" is kept for consistency reasons.

In all system boundary diagrams, grey life cycle steps (further processing by other industries, distribution of the final products, use and end of life) are excluded from the system boundaries.

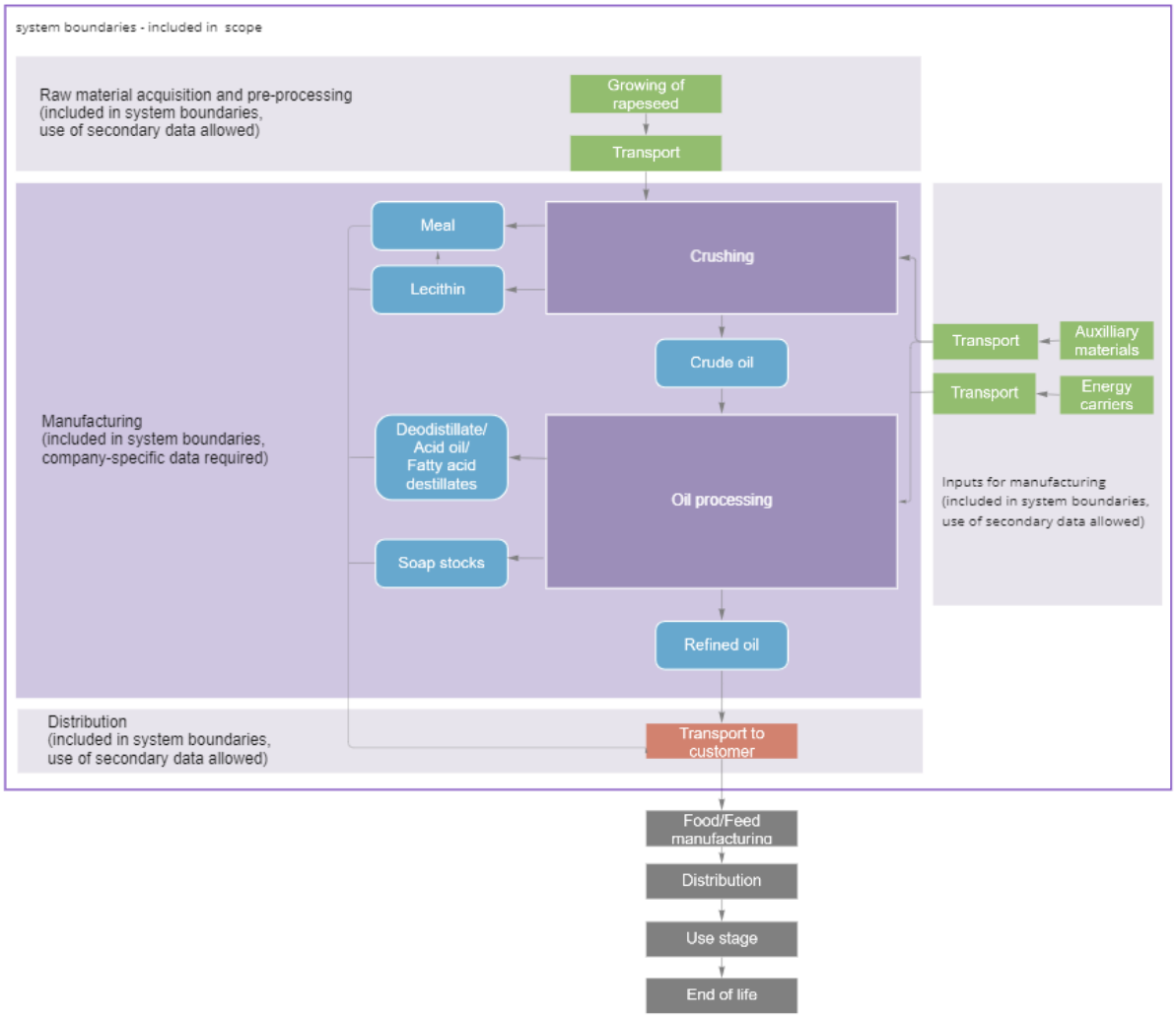

Figure 1: System boundary diagram for vegetable oil and co-products from rapeseed

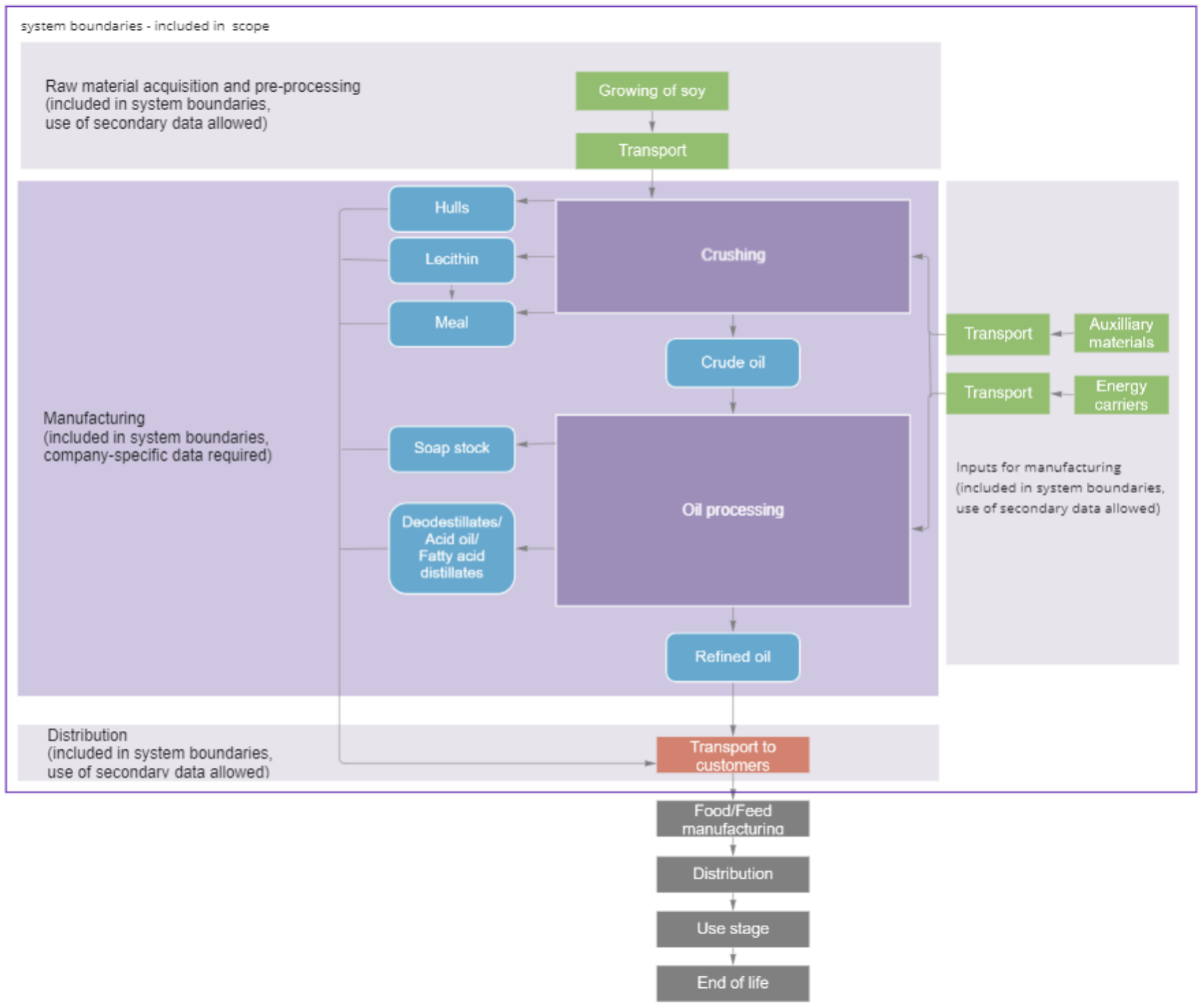

Figure 2: System boundary diagram for vegetable oil and co-products from soybean

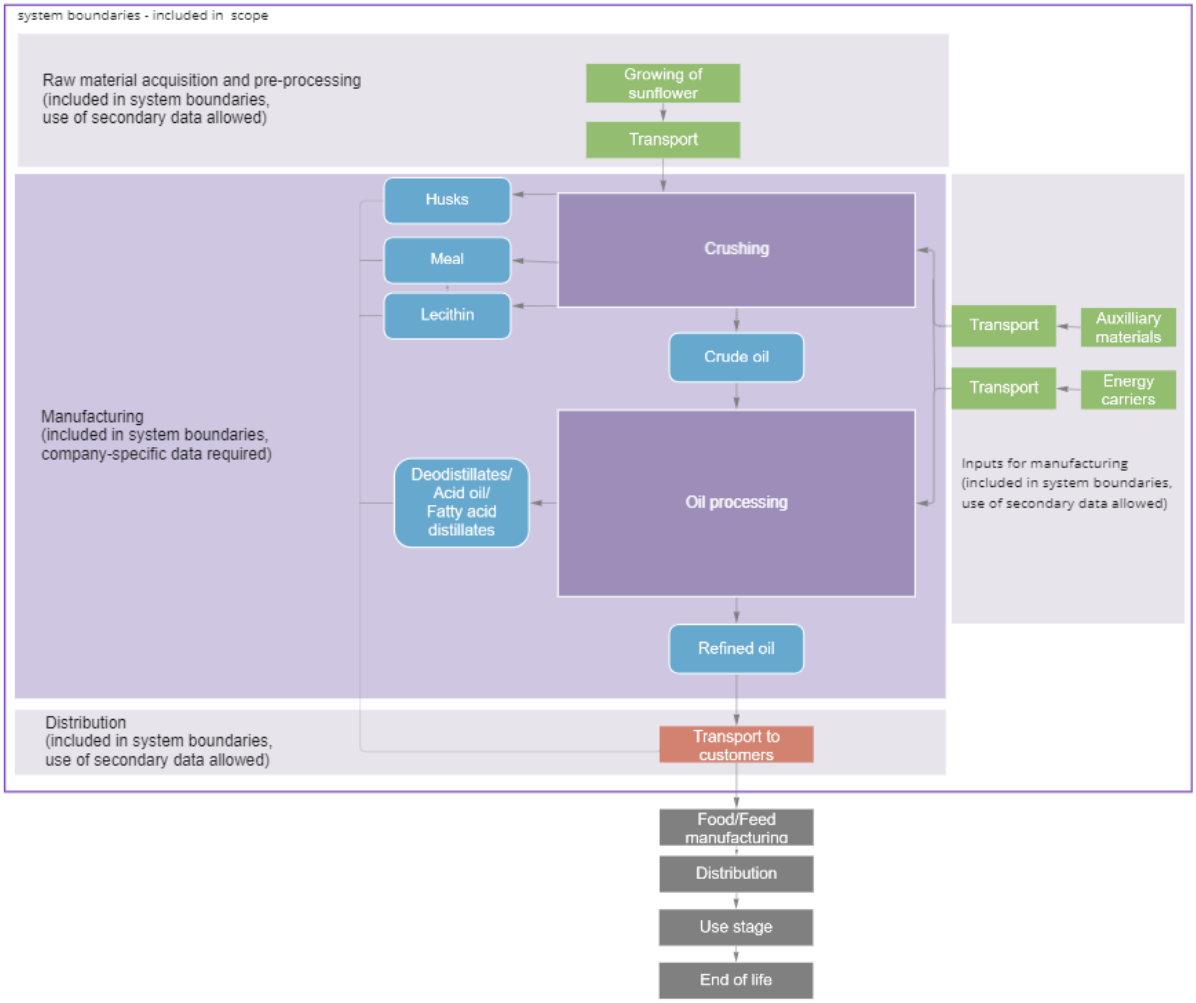

Figure 3: System boundary diagram for vegetable oil and co-products from sunflower seeds

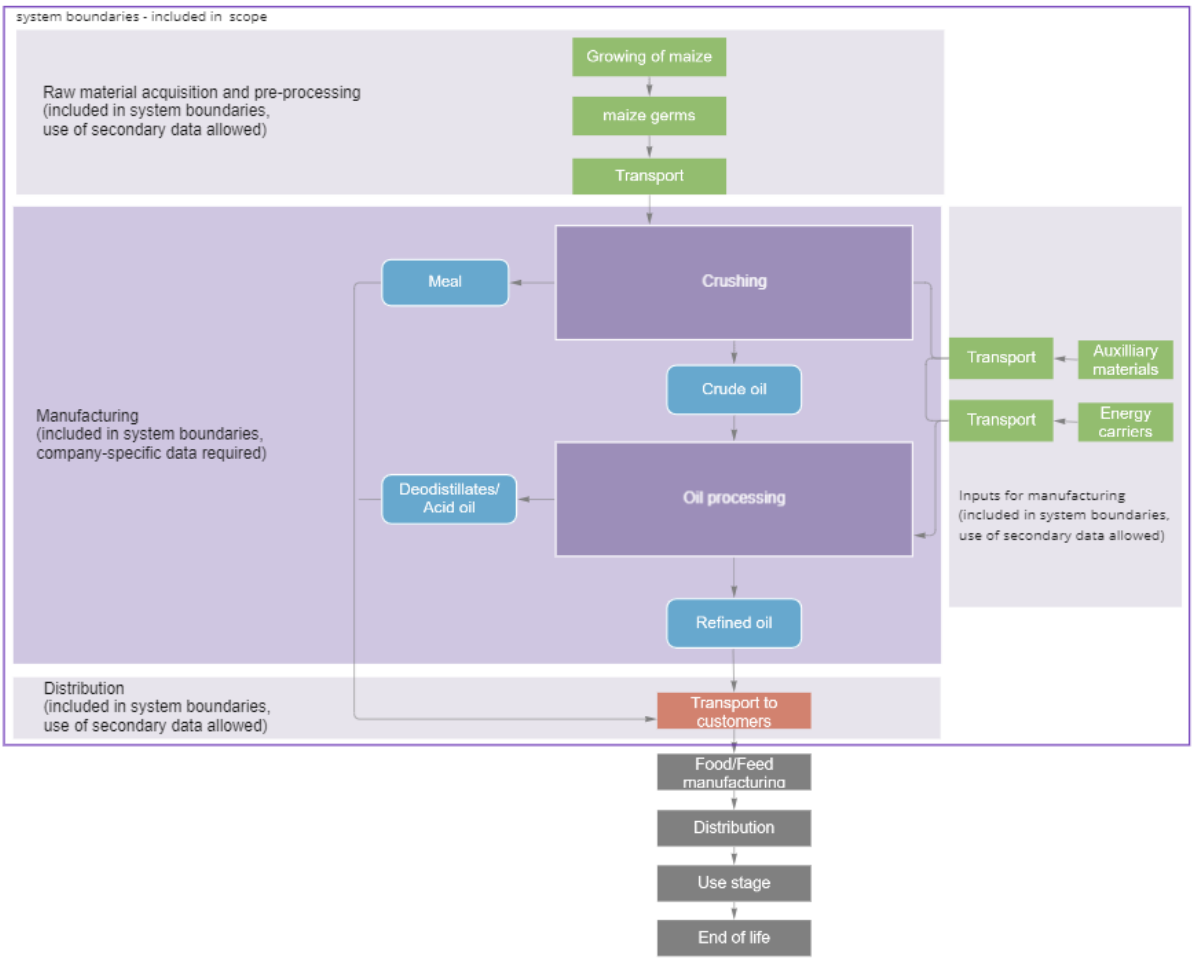

Figure 4: System boundary diagram for vegetable oil and co-products from maize germs

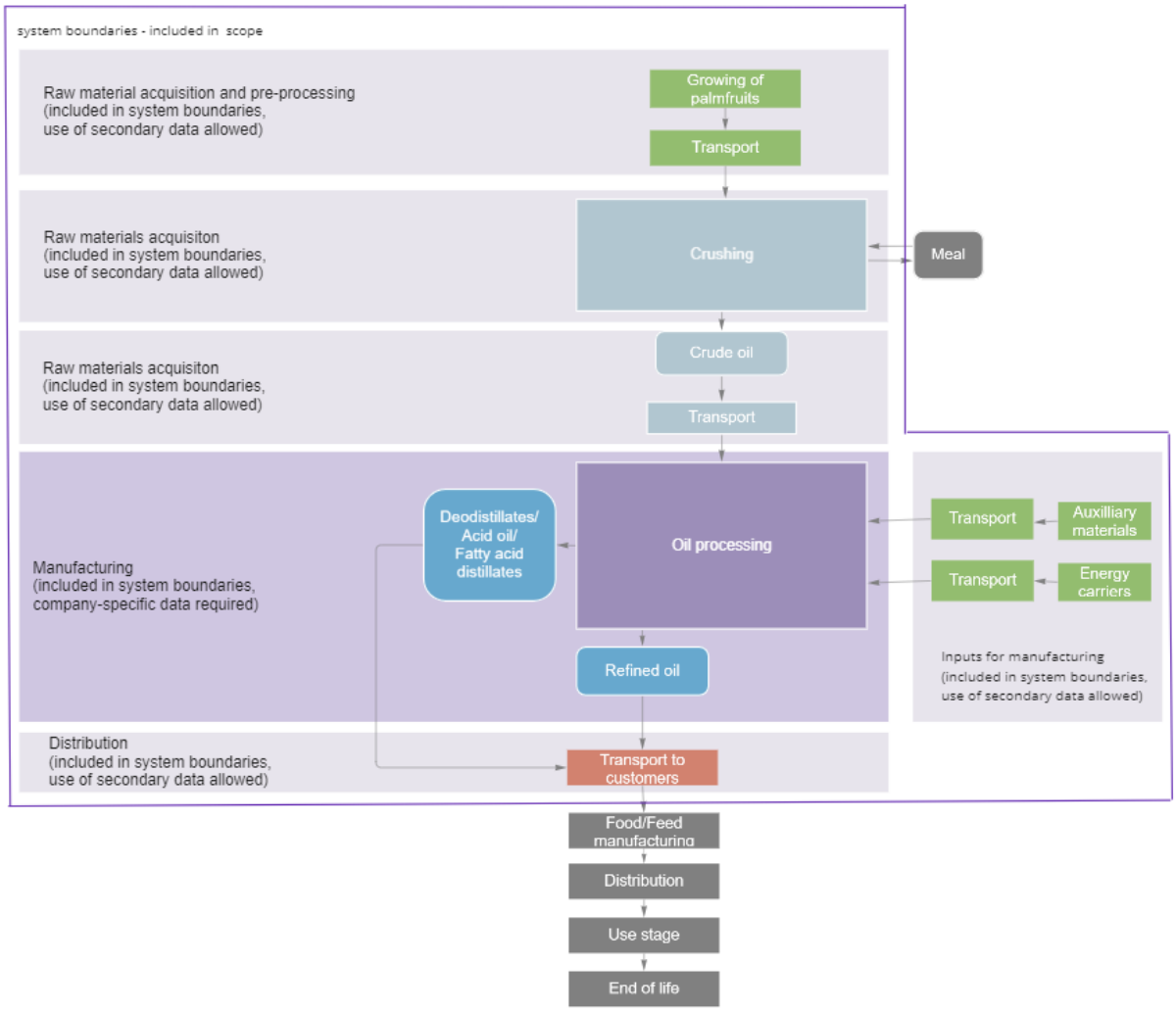

Figure 5: System boundary diagram for vegetable oil and co-products from palm

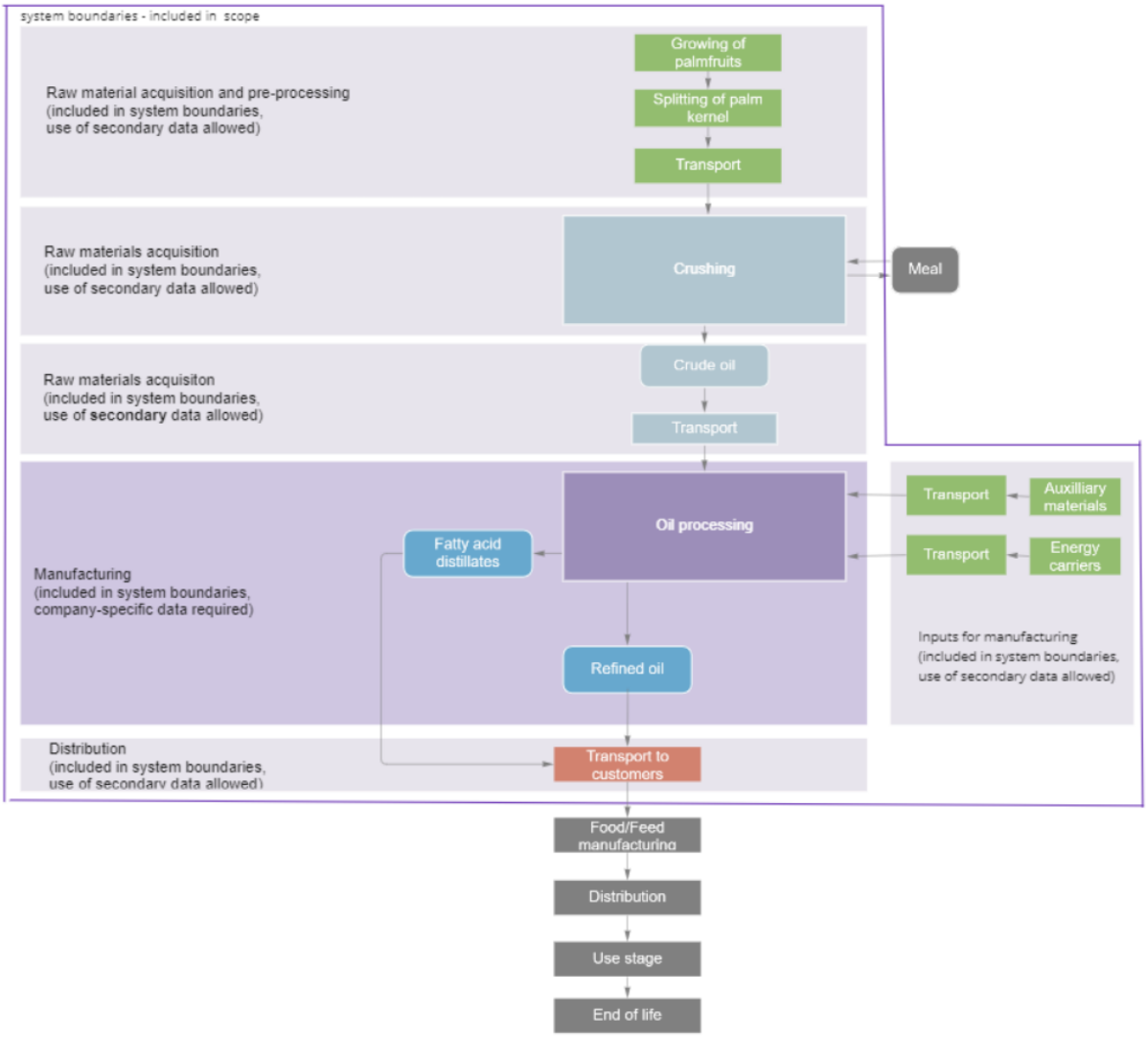

Figure 6: System boundary diagram for vegetable oil and co-products from palm kernel

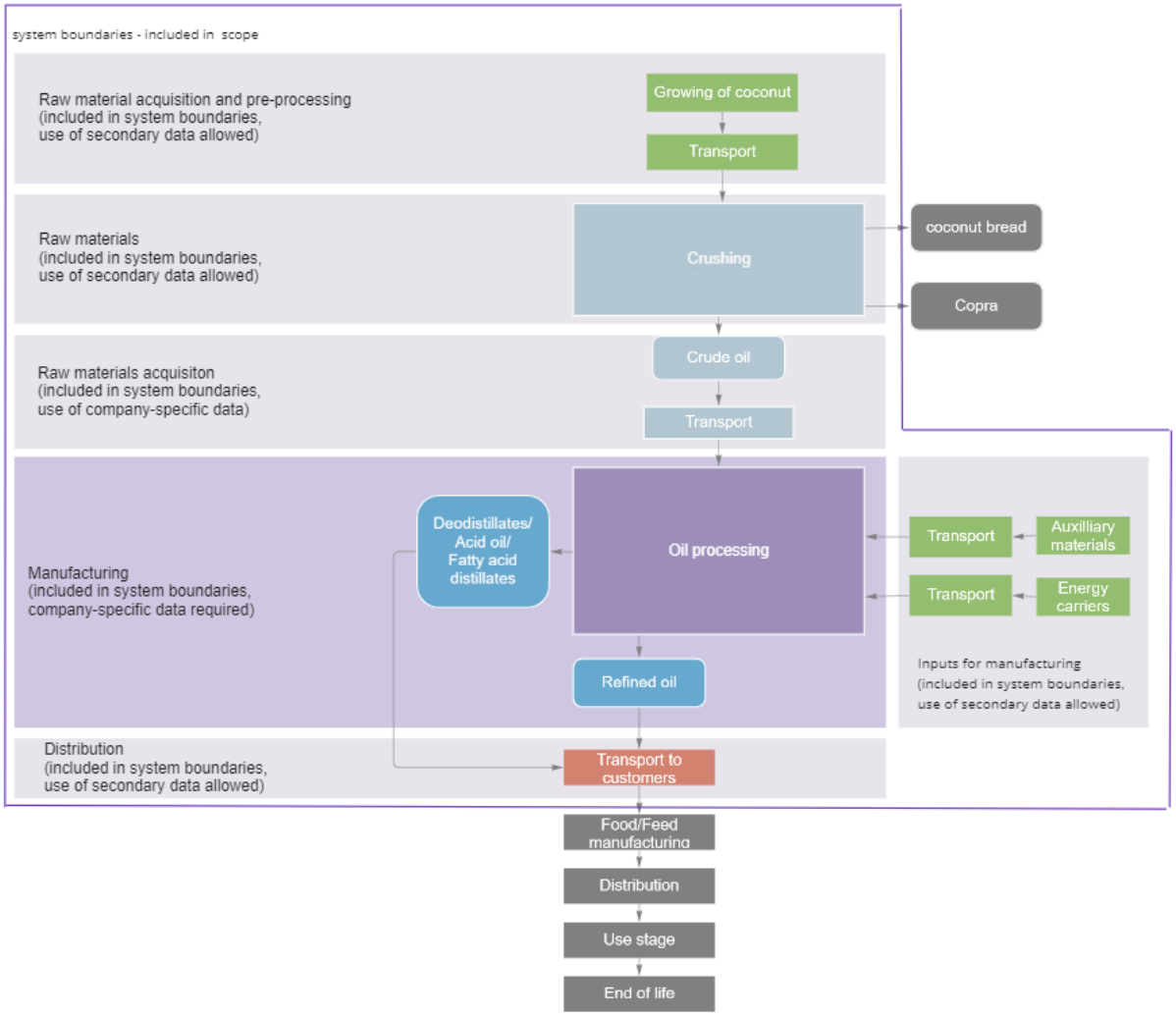

Figure 7: System boundary diagram for vegetable oil and co-products from coconut

The following life cycle stages and processes shall be included in the system boundary:

Table 3: Life cycle stages products from rapeseed, soybeans, sunflower seeds and maize germs

Life cycle stage	Short description of the processes included
Raw material acquisition and pre-processing: agriculture	The agricultural processes include soil cultivation, sowing, weed control, fertilisation, pest and pathogen control, harvest and drying (if relevant). Growing rapeseed, soybeans, sunflower and maize requires energy, water and materials such as fertilisers, pesticides and seeds. It may also result in land transformation. Inputs of chemicals lead to emissions to air, water and soil. Land use change emissions shall be included, following the methodology described in the PEF method (Zampori and Pant, 2019).
Raw material acquisition and pre-processing: transportation	Transport of raw materials from the field to the crushing plant. Crushing can either take place at FEDIOL member company sites or elsewhere. This life cycle stage takes into account the transportation to either the FEDIOL member companies or the external company doing the crushing.
Manufacturing: crushing	All relevant processes, starting with the reception and storage of the raw materials need to be included. Relevant processes are reception and unloading, storage, cleaning, conditioning, flaking, pressing, solvent extraction, oil distillation, meal desolventising and toasting, meal cooling and drying, meal storage and loading (vessel, truck, train). This life cycle stage includes the production of energy, steam, water and solvent (or other chemicals) needed for crushing. The process may produce waste and emissions to air and water.
Manufacturing: oil processing	All relevant processes, starting with the reception of crushed seeds/fruits/beans need to be included. Relevant processes are reception and unloading, storage, chemical or physical refining, bleaching, desodorisation, special processes like interesterification, winterization, hardening, soapstock splitting (chemical refinery only), storage and loading of vessels, trucks, trains. These processes require energy, and often also water and chemicals (caustic soda, hydrochloric acid etc.) and may produce waste and emissions to air and water. Optional modification steps such as interesterification, fractionation and hardening.
Distribution	Transportation from the vegetable oil and protein meal production facility to the customers.

Table 4: Life cycle stages products from palm, palm kernel and coconut

Life cycle stage	Short description of the processes included
Raw material acquisition and pre-processing: crude oil production	This life cycle stages concerns the production of crude oil. It includes agricultural processes, transport of the crops to the crushing plant and the crushing process. The agricultural processes include soil cultivation, sowing, weed control, fertilisation, pest and pathogen control, harvest and drying (if relevant). Growing palm and coconut requires energy, water and materials such as fertilisers, pesticides and seeds. It may also result in land transformation. Inputs of chemicals lead to emissions to air, water and soil. Land use change emissions shall be included following the methodology described in the PEF method (Zampori and Pant, 2019).
Raw material acquisition and pre-processing: transportation	Transport of raw materials from the crushing plant to the refining plants.

Manufacturing: oil processing	All relevant processes, starting with the reception of crude oil need to be included. These processes require energy, and often also water and chemicals (caustic soda, hydrochloric acid etc.) and may produce waste and emissions to air and water. Optional modification steps such as interesterification, fractionation and hardening
Distribution	Transportation from the oil processing facility to the customers.

According to this PEFCR, the following processes shall be excluded based on the cut-off rule (max 3% cumulative on each of the impact categories):

- capital goods for the manufacturing processes of the vegetable oil and protein meal industry;
- packaging of incoming auxiliary materials;
- storage of refining products;
- resources and tools for logistic operations at the vegetable oil and protein meal plants;
- process waste (excluding waste water).

No additional cut-off is allowed.

Each PEF study done in accordance with this PEFCR shall provide in the PEF study a diagram indicating the activities falling in situation 1, 2 or 3 of the data needs matrix (see section 5.5).

3.5. LIST OF EF IMPACT CATEGORIES

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

Table 5: List of the impact categories to be used to calculate the environmental profile

EF impact category	Impact Category indicator	Unit	Characterization model
Climate change	*Radiative forcing as Global Warming Potential (GWP100)*	*kg $CO_{2\ eq}$*	*Baseline model of 100 years of the IPCC (based on IPCC 2013)*
- Climate change - biogenic			
- Climate change - land use and land use change			
Ozone depletion	*Ozone Depletion Potential (ODP)*	*kg CFC-11 $_{eq}$*	*Steady-state ODPs as in (WMO 2014 + integrations)*
Human toxicity, cancer	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model 2.1 (Fankte et al, 2017)*
Human toxicity, non-cancer	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model 2.1 (Fankte et al, 2017)*
Particulate matter	*Impact on human health*	*disease incidence*	*PM method recommended by UNEP (UNEP 2016)*
Ionising radiation, human health	*Human exposure efficiency relative to U^{235}*	*kBq U^{235} $_{eq}$*	*Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)*
Photochemical ozone formation, human health	*Tropospheric ozone concentration increase*	*kg NMVOC $_{eq}$*	*LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008*

EF impact category	Impact Category indicator	Unit	Characterization model
Acidification	*Accumulated Exceedance (AE)*	*mol H+ $_{eq}$*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, terrestrial	*Accumulated Exceedance (AE)*	*mol N $_{eq}$*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, freshwater	*Fraction of nutrients reaching freshwater end compartment (P)*	*kg P $_{eq}$*	*EUTREND model (Struijs et al, 2009) as implemented in ReCiPe*
Eutrophication, marine	*Fraction of nutrients reaching marine end compartment (N)*	*kg N $_{eq}$*	*EUTREND model (Struijs et al, 2009) as implemented in ReCiPe*
Ecotoxicity, freshwater	*Comparative Toxic Unit for ecosystems (CTU_e)*	*CTUe*	*USEtox model 2.1 (Fankte et al, 2017)*
Land use	• *Soil quality index*[3] • *Biotic production* • *Erosion resistance* • *Mechanical filtration* • *Groundwater replenishment*	• *Dimensionless (pt)* • *Kg biotic production* • *kg soil* • *m3 water* • *m3 groundwater*	*Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)*
Water use	*User deprivation potential (deprivation- weighted water consumption)*	*m^3 world $_{eq}$*	*Available WAter REmaining (AWARE) as recommended by UNEP, 2016*
Resource use[4]*, minerals and metals*	*Abiotic resource depletion (ADP ultimate reserves)*	*kg Sb $_{eq}$*	*CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.*
Resource use, fossils	*Abiotic resource depletion – fossil fuels (ADP-fossil)*	*MJ*	*CML 2002 (Guinée et al., 2002) and van Oers et al. 2002*

The full list of normalization factors and weighting factors are available in Annex 2 - List of EF normalisation factors and weighting factors.

The full list of characterization factors is available at this link: *http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.* EF reference package 3.0 shall be used.

3.6. ADDITIONAL TECHNICAL INFORMATION

*The **biogenic carbon content** at factory gate (physical content) shall be reported.*

*The **recycled content (R1)** shall be reported.* $\mathbf{R_1}$ is the proportion of material in the input to the production that has been recycled from a previous system.

It is a requirement from PEF to report the recycled content for the different products. For the products under consideration, the recycled content will be zero.

3.7. ADDITIONAL ENVIRONMENTAL INFORMATION

Biodiversity is considered relevant for the product group. Impacts on biodiversity shall be calculated with ReCiPe 2016 Endpoint (H) (RVIM, 2017) and the result (species.yr) shall be reported as additional

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

[4] The results of this impact category shall be interpreted with caution, because the results of ADP after normalization may be overestimated. The European Commission intends to develop a new method moving from depletion to dissipation model to better quantify the potential for conservation of resources.

information. Users of this PEFCR are also allowed to report the biodiversity impact by means of the sector average product value as reported in the PEF study (De Smet et al., 2022).

The PEF method (Zampori and Pant, 2019) does not include any impact category named “biodiversity”, as currently there is no international consensus on a life cycle impact assessment method capturing that impact. However, the PEF method includes at least eight impact categories that have an effect on biodiversity (i.e., climate change, eutrophication aquatic freshwater, eutrophication aquatic marine, eutrophication terrestrial, acidification, water use, land use, ecotoxicity freshwater).

Considering the high relevance of biodiversity for many product groups, however, the PEF method asks users to address biodiversity separately (in addition to the EF impact categories). The use of certification as a means to address biodiversity has been discussed during the development of this PEFCR. However, this option was not retained because it is not available for all products that have to comply with this PEFCR. The ReCiPe Endpoint method gives an indication of the potential loss of species and can be easily applied, as it is available in common LCA software. For vegetable oil and protein meal industry products, biodiversity impact will be driven by the agricultural life cycle phase. Users of this PEFCR are allowed to use secondary data for this life cycle stage. The result on biodiversity will thus highly depend on the completeness of the inventory data in the background database. However, given the fact that biodiversity is considered relevant for the product group users of this PEFCR shall thus report impacts on biodiversity calculated with ReCiPe 2016 Endpoint (H) and report the result (species.yr) as additional information.

3.8. LIMITATIONS

Even if carried out in accordance with this PEFCR, a PEF study will have some limitations. These are described in the following paragraphs.

3.8.1. COMPARISONS AND COMPARATIVE ASSERTIONS

This PEFCR is for intermediate products and is thus not meant for comparative assertions, which should always be made considering the function of the product. PEF studies based on this PEFCR could be used by customers of the vegetable oil and proteinmeal industry to calculate environmental footprints of their final products, and to make comparisons of final products that fulfil the same function. When used for this purpose it needs to be verified that there are no methodological inconsistencies between the PEF studies that are combined.

3.8.2. DATABASE

The EF database consists of nodes operated by different data providers. Although in principle all data providers should have followed the same approach to establish the datasets, there may be differences in, for example, the wastewater treatment model applied. Some limitations are especially relevant for agricultural products. For example quantification of water use and land use in fact requires regionalized inventory data. Data on water use are regionalized in both Agri-footprint and EF database, while land use data are not.

3.8.3. DATA GAPS AND PROXIES

Data gaps on company-specific data

The following data gaps on the company-specific data to be collected are most frequently encountered by companies.

- Capital goods: Often companies lack data on the capital goods. They can however be excluded from the life cycle inventory as their estimated impact on each of the impact categories is below 3% cut-off (see section 3.4).

- Packaging non-bulk chemicals: Often companies lack data on the packaging of chemicals. They can however be excluded from the life cycle inventory as their estimated impact on each of the impact categories is below 3% cut-off (see section).

List of processes excluded from the PEFCR
The following processes are excluded from the PEFCR due to missing dataset and shall not be filled in by the user of the PEFCR:

- None

List of processes for which the user may apply ILCD-EL compliant proxies:

- Agricultural processes and crude oil production from palm, palm kernel and coconut are to be modelled with the datasets from Agri-footprint® 5.0 database (Paassen et al., 2019)[5]. If a new version of Agri-footprint becomes available within the period of validity of the PEFCR or if it becomes possible to use the EF database for agricultural production in the future, these databases can also be used. It is also allowed to collect primary data for the agricultural life cycle stage and for crude oil production from palm, palm kernel and coconut.

3.8.4. ALLOCATION METHOD

The implications of the choice for energy allocation may not be captured properly when only one allocation method is used. The operator of the PEF study is therefore encouraged to include a sensitivity assessment in the PEF study by testing alternatives for allocation in addition to the allocation method recommended in this PEFCR.

4. MOST RELEVANT IMPACT CATEGORIES, LIFE CYCLE STAGES, PROCESSES AND ELEMENTARY FLOWS

The most relevant impact categories, life cycle stages, processes and elementary flows are calculated using the representative product.

4.1. MOST RELEVANT EF IMPACT CATEGORIES

The most relevant impact categories for the product category in scope of this PEFCR are the following:

1. *Climate change*
2. *Ecotoxicity, freshwater*
3. *Eutrophication, marine*
4. *Land use*
5. *Particulate Matter*
6. *Eutrophication freshwater*
7. *Acidification*

[5] *The EF node containing agricultural production cannot be used outside the official 'PEF' track. Agri-footprint 5.0 appears to comply to all modelling guidelines of the PEF method (see section 6.2) and is therefore recommended as a database for agricultural production.*

4.2. MOST RELEVANT LIFE CYCLE STAGES

The most relevant life cycle stages for the product category in scope of this PEFCR are the following:

- *Raw material acquisition and pre-processing: agriculture and transport to manufacturing (R)*
- *Manufacturing (M)*

4.3. MOST RELEVANT PROCESSES

The most relevant processes for the product category in scope of this PEFCR are the following:

Table 6: List of the most relevant processes, with (R): raw material acquisition and pre-processing; (M): manufacturing

Impact category	***Processes***
Climate change	Soybeans, at farm/BR Energy (R)
	Crude palm oil, at processing/ID Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/FR Energy (R)
	Process steam from natural gas {EU-28+3} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 90% efficiency | LCI result (M)
	Soybean, production mix, at farm/US Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/DE Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
Ecotoxicity, freshwater	Rapeseed, dried, at farm/{confidential} Energy (R)
	Soybeans, at farm/BR Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Rapeseed, dried, at farm/DE Energy (R)
	Rapeseed, dried, at farm/UA Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Sunflower seed, at farm/FR Energy (R)
	Rapeseed, dried, at farm/FR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
Eutrophication, marine	Waste water treatment (M)
	Rapeseed, dried, at farm/DE Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Soybean, production mix, at farm/US Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Soybeans, at farm/BR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/FR Energy (R)
	Rapeseed, dried, at farm/UA Energy (R)
	Sunflower seed, at farm/RO Energy (R)
	Crude palm oil, at processing/ID Energy (R)
Land use	Soybean, production mix, at farm/US Energy (R)
	Soybeans, at farm/BR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Sunflower seed, at farm/FR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/FR Energy (R)

Impact category	*Processes*
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/UA Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/RO Energy (R)
	Crude palm oil, at processing/ID Energy (R)
	Crude coconut oil, at processing/PH Energy (R)
Particulate Matter	Barge {EU-28+3} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result (R (transport), D)
	Rapeseed, dried, at farm/DE Energy (R)
	Soybean, production mix, at farm/US Energy (R)
	Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000- 200.000 dwt payload capacity, ocean going | LCI result (R (transport))
	Rapeseed, dried, at farm/FR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Soybeans, at farm/BR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Crude palm oil, at processing/ID Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/FR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
Acidification	Rapeseed, dried, at farm/DE Energy (R)
	Soybean, production mix, at farm/US Energy (R)
	Rapeseed, dried, at farm/FR Energy (R)
	Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000- 200.000 dwt payload capacity, ocean going | LCI result (R (transport))
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Crude palm oil, at processing/MY Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Crude palm oil, at processing/ID Energy (R)
	Sunflower seed, at farm/HU Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Soybeans, at farm/BR Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Rapeseed, dried, at farm/{confidential} Energy (R)
	Sunflower seed, at farm/FR Energy (R)
	Barge {EU-28+3} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result (R (transport), D)
Eutrophication, freshwater	waste water treatment (M)
	Soybeans, at farm/BR Energy System (R)
	Crude palm oil, at processing/MY Energy System (R)
	Soybean, production mix, at farm/US Energy System (R)
	Crude palm oil, at processing/ID Energy System (R)
	Rapeseed, dried, at farm/DE Energy System (R)

4.4. MOST RELEVANT DIRECT ELEMENTARY FLOWS

The most relevant direct elementary flows for the product category in scope of this PEFCR are the following:

Table 7: List of the most relevant elementary flows, with (R): raw material acquisition and pre-processing; (M): manufacturing

Impact category	***Processes***	***Most relevant elementary flows[6]***
Climate change	Soybeans, at farm/BR Energy (R)	Carbon dioxide, land transformation (air)
	Crude palm oil, at processing/ID Energy (R)	Carbon dioxide, fossil (air), carbon dioxide, land transformation (air), methane, biogenic (air)
	Crude palm oil, at processing/MY Energy (R)	Carbon dioxide, fossil (air), methane, biogenic (air), methane (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Carbon dioxide, land transformation (air), carbon dioxide, fossil (air)
	Rapeseed, dried, at farm/FR Energy (R)	Carbon dioxide, land transformation (air), dinitrogen monoxide (air), carbon dioxide, fossil (air)
	Process steam from natural gas {EU-28+3} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 90% efficiency | LCI result (M)	Carbon dioxide, fossil (air)
	Soybean, production mix, at farm/US Energy (R)	Carbon dioxide, fossil (air), dinitrogen monoxide (air), carbon dioxide (air)
	Sunflower seed, at farm/HU Energy (R)	Dinitrogen monoxide (air), carbon dioxide, fossil (air), carbon dioxide, land transformation (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Carbon dioxide, land transformation (air), dinitrogen monoxide (air), carbon dioxide, fossil (air)
	Rapeseed, dried, at farm/DE Energy (R)	Dinitrogen monoxide (air), carbon dioxide, fossil (air), carbon dioxide (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Dinitrogen monoxide (air), carbon dioxide, fossil (air), carbon dioxide (air)
Ecotoxicity, freshwater	Rapeseed, dried, at farm/{confidential} Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water)
	Soybeans, at farm/BR Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Crude palm oil, at processing/MY Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Rapeseed, dried, at farm/DE Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Rapeseed, dried, at farm/UA Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water)
	Sunflower seed, at farm/HU Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Sunflower seed, at farm/FR Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air); mancozeb (water), mancozeb (air), chlorpyrifos (soil)

[6] According to Zampori and Pant (2019), this should be the most relevant direct elementary flows only. However, as the EF database contains aggregated datasets, it is not possible to distinguish between direct and indirect elementary flows.

Impact category	*Processes*	*Most relevant elementary flows*[6]
	Rapeseed, dried, at farm/FR Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air); mancozeb (water), chlorpyrifos (soil), copper (soil)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air); mancozeb (water), chlorpyrifos (soil), copper (soil)
	Sunflower seed, at farm/{confidential} Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Lambda-cyhalonthrin (water), Chlorpyrifos (water), Bifenthrin (water), lambda-cyhalothrin (air)
Eutrophication, marine	Wate water treatment (M)	Nitrogen (water)
	Rapeseed, dried, at farm/DE Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Soybean, production mix, at farm/US Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Sunflower seed, at farm/HU Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Crude palm oil, at processing/MY Energy (R)	Nitrate (water), ammonia (water)
	Soybeans, at farm/BR Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Nitrate (water)
	Sunflower seed, at farm/FR Energy (R)	Nitrate (water)
	Rapeseed, dried, at farm/UA Energy (R)	Nitrate (water)
	Sunflower seed, at farm/RO Energy (R)	Nitrate (water)
	Crude palm oil, at processing/ID Energy (R)	Nitrate (water)
Land use	Soybean, production mix, at farm/US Energy (R)	Occupation, agriculture (raw)
	Soybeans, at farm/BR Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Occupation, annual crop (raw)
	Sunflower seed, at farm/HU Energy (R)	Occupation, annual crop (raw)
	Crude palm oil, at processing/MY Energy (R)	Occupation, permanent crop (raw)
	Sunflower seed, at farm/FR Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/FR Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/UA Energy (R)	Occupation, annual crop (raw)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Occupation, annual crop (raw)
	Sunflower seed, at farm/RO Energy (R)	Occupation, annual crop (raw)
	Crude palm oil, at processing/ID Energy (R)	Occupation, permanent crop (raw)
	Crude coconut oil, at processing/PH Energy (R)	Occupation, permanent crop (raw)
Particulate Matter	Barge {EU-28+3} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result (R (transport), D)	Particulates, > 2.5µm (air)
	Rapeseed, dried, at farm/DE Energy (R)	Ammonia (air)
	Soybean, production mix, at farm/US Energy (R)	Ammonia (air), Particulates, > 2.5µm (air)
	Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000- 200.000 dwt payload capacity, ocean going | LCI result (R (transport))	Particulates, > 2.5µm (air), sulfur dioxide (air)
	Rapeseed, dried, at farm/FR Energy (R)	Ammonia (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Crude palm oil, at processing/MY Energy (R)	Ammonia (air), Particulates, > 2.5µm (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)

Impact category	*Processes*	*Most relevant elementary flows[6]*
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Sunflower seed, at farm/HU Energy (R)	Ammonia (air), Particulates, > 2.5µm (air)
	Soybeans, at farm/BR Energy (R)	Ammonia (air), Particulates, > 2.5µm (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Crude palm oil, at processing/ID Energy (R)	Ammonia (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Sunflower seed, at farm/FR Energy (R)	Ammonia (air), Particulates, > 2.5µm (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
Acidification	Rapeseed, dried, at farm/DE Energy (R)	Ammonia (air)
	Soybean, production mix, at farm/US Energy (R)	Ammonia (air), nitrogen oxides (air)
	Rapeseed, dried, at farm/FR Energy (R)	Ammonia (air)
	Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000- 200.000 dwt payload capacity, ocean going | LCI result (R (transport))	Sulfur dioxide (air), nitrogen dioxide (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Crude palm oil, at processing/MY Energy (R)	Ammonia (air), sulfur dioxide (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Crude palm oil, at processing/ID Energy (R)	Ammonia (air)
	Sunflower seed, at farm/HU Energy (R)	Ammonia (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Soybeans, at farm/BR Energy (R)	Ammonia (air), nitrogen oxides (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Rapeseed, dried, at farm/{confidential} Energy (R)	Ammonia (air)
	Sunflower seed, at farm/FR Energy (R)	Ammonia (air)
	Barge {EU-28+3} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result (R (transport), D)	Nitrogen dioxide (air)
Eutrophication, freshwater	waste water treatment (M)	Phosphorus (water)
	Soybeans, at farm/BR Energy System (R)	Phosphorus (water)
	Crude palm oil, at processing/MY Energy System (R)	Phosphorus (water), phosphate (water)
	Soybean, production mix, at farm/US Energy System (R)	Phosphorus (water)
	Crude palm oil, at processing/ID Energy System (R)	Phosphorus (water), phosphate (water)
	Rapeseed, dried, at farm/DE Energy System (R)	Phosphorus (water)

5. LIFE CYCLE INVENTORY

Sampling is allowed for the collection of primary data. The sampling procedure is described in Annex 5. *In case sampling is needed, it shall be conducted as specified in this PEFCR. However, sampling is not mandatory and any user of this PEFCR may decide to collect the data from all the plants or farms, without performing any sampling.*

5.1. WHICH DATASETS TO USE?

This PEFCR lists for which processes it is mandatory to use company-specific datasets. *This PEFCR also lists the secondary datasets to be applied by the user of the PEFCR.*

The secondary datasets shall be taken from the most recent version of the EF database. EF compliant datasets are available in nodes and can be obtained from the Life Cycle Data Network http://eplca.jrc.ec.europa.eu/LCDN/. Except for agricultural production, where the most recent version of the Agri-footprint database may be used. At the time of publication of this PEFCR, it is not possible to obtain permission for the use of the node on Feed (the part of the EF database, which contains agricultural production) outside the official PEF track. Therefore, the Agri-footprint database has been used for the development of the PEFCR. If it becomes possible to use the EF database for agricultural production in the future, these databases can also be used. It is also allowed to collect

primary data for the agricultural life cycle stage and for crude oil production from palm, palm kernel and coconut.

Whenever a dataset needed to calculate the PEF profile is not among those listed in this PEFCR, then the user shall choose between the following options (in hierarchical order):

- *Use an EF compliant dataset available on one of the nodes of the Life Cycle Data Network http://eplca.jrc.ec.europa.eu/LCDN/;*
- *Use an EF compliant dataset available in a free or commercial source;*
- *Use another EF compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitations" section of the PEF report.*
- *Use an ILCD entry level (EL) compliant dataset. These datasets shall be included in the "limitations" section of the PEF report. A maximum of 10% of the total environmental impact may be derived from ILCD-EL compliant datasets (calculated cumulatively from lowest to largest contribution to the total EF profile).*
- *If no EF compliant or ILCD-EL compliant proxy is available, it shall be excluded from the PEF study. This shall be clearly stated in the PEF report as a data gap and validated by the PEF study and PEF report verifiers.*

5.2. LIST OF MANDATORY COMPANY-SPECIFIC DATA

It is mandatory to use company-specific data for:

- The type, quantities and origin of agricultural products or crude oil;
- The transportation of agricultural products/crude oil to vegetable oil and protein meal industry plants;
- The manufacturing processes (crushing, refining) of the vegetable oil and protein meal industry.
- Packaging of FEDIOL industry products if relevant in 1 litre bottles, including manufacturing of 1 litre bottles

Raw material acquisition and pre-processing: agriculture or crude oil

Company-specific quantities and geographic origins shall be used for the agricultural products or crude oils in case crude oils are purchased. The Excel file *"PEFCR vegetable oil products - Life cycle inventory"* contains a list of company specific activity data to be collected. It also contains the default amounts used to model the representative product and the average vegetable oil and protein meal industry products.

Raw material acquisition and pre-processing: transportation

Transport of raw materials from the field to the vegetable oil and protein meal plants shall be modelled with company-specific transport modes and distances. Again, the Excel file *"PEFCR vegetable oil products - Life cycle inventory"* contains a list of company specific activity data to be collected.

Raw material acquisition and pre-processing: packaging, raw materials for bottles

Company-specific quantities and material types shall be collected for the production of 1 liter bottles, in case this is relevant. Again, the Excel file *"PEFCR vegetable oil products - Life cycle inventory"* contains a list of company specific activity data to be collected.

Manufacturing

Using company-specific data (i.e. activity data and direct elementary flows) is mandatory for the processes under operational control of the vegetable oil and proteinmeal industry. These processes depend on the specific industry product and include reception, cleaning, drying, preparation of the seeds/beans, dehulling, pre-heating, thermal treatment, crushing, mechanical cracking, flaking, degumming, solvent extraction, distillation, desolventing and toasting, degumming, neutralisation, winterisation, bleaching, deodorisation, interesterification, fractionation, hardening.

It is not always possible to collect data for each of these processes separately. Therefore, it is allowed to collect activity data and direct elementary flows for various processes together that are considered as a 'black box' that cannot be subdivided further (e.g. crushing, refining (incl. modifying if applicable)).

In the following paragraphs, processes are grouped as in section 3.4 (System boundary):

- vegetable oil and co-products from rapeseed;
- vegetable oil and co-products from soybean;
- vegetable oil and co-products from sunflower;
- vegetable oil and co-products from maize;
- vegetable oil and co-products from palm;
- vegetable oil and co-products from palm kernel;
- vegetable oil and co-products from coconut.

Manufacturing of vegetable oil and co-products from rapeseed

When producing crude oil, refined oil (including modified oil) from rapeseed, a number of co-products are produced as well (meal, lecithin, soap stock, deodestillate, acid oil and fatty acid distillates). Meal and lecithin come out of the crushing process step while deodestillates, acid oil, fatty acid distillates and soap stock are co-products from refining. This is presented graphically in the system boundary diagrams in section 3.4.

The tables below summarize the input and output flows that are related to the production process of crude oil (Table 8 and Table 9) and refined oil (Table 10 and Table 11) from rapeseed including the default datasets used for calculating the environmental impacts. Data for the additional process steps needed to finalize some of the co-products are presented in the accompanying Excel file *"PEFCR vegetable oil products - Life cycle inventory"*. The tables below (and the Excel file) list the inputs and outputs encountered in the PEF study of the representative product. If other inputs or outputs are encountered (e.g. different chemicals, another type of energy etc.), these also need to be included.

Table 8: Data collection requirements for crushing process of crude oil, meal and lecithin from rapeseed

Requirements for data collection purposes			**Requirements for modelling purposes**			**Remarks**
Activity data to be collected	*Specific requirements (e.g. frequency, measurement standard, etc.)*	*Unit of measure*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	
Inputs:						
Dried rapeseed mix	**transported**	**tonne**	**Dried rapeseed mix**	FEDIOL	/	
Hexane	1-year data	tonne	Pentane production {RER} | technology mix | production mix, at plant | 100% active substance | LCI result	Ecoinvent	18646e52-3f27-43de-81bb-68b82ba1538c	proxy for hexane
Other auxiliary materials	1-year data	tonne	confidential			Includes chemicals for wastewater treatment
Tap water	1-year data	tonne	Tap water {EU-28+3} | technology mix | at user | per kg water | LCI result	Quantis	212b8494-a769-4c2e-8d82-9a6ef61baad7	/
Electricity - from grid *[country]*	1-year data	kWh	Residual grid mix {*country*}| AC, technology mix| consumption mix, to consumer |1 kV- 60 kV| LCI result	Sphera	Depends on country	To be adapted depending on the country.
Electricity - from CHP *[country]*	1-year data	kWh	Electricity from natural gas {*country*} | AC, mix of direct and CHP, technology mix regarding firing and flue gas cleaning | production mix, at power plant | 1 kV - 60 kV | LCI result	Sphera	Depends on country	To be adapted depending on the country.
Electricity - from other sources *[country]*	1-year data	kWh	confidential	Sphera	Depends on country	To be adapted depending on the source of electricity and country.
Steam - from CHP, all sources	1-year data	kWh	Depends on source of energy	Sphera	Depends on source of energy	To be adapted depending on the source of the energy
Steam - from all sources	1-year data	kWh	confidential	Sphera	Depends on source of energy	To be adapted depending on the input material for steam boiler.

Transport of bulk auxiliary materials – truck	1-year data	tkm	Articulated lorry transport, Euro 4, Total weight >32 t (without fuel) {EU-28+3} | diesel driven, Euro 4, cargo | consumption mix, to consumer | more than 32t gross weight / 24,7t payload capacity | Unit process, single operation	Sphera	938d5ba6-17e4-4f0d-bef0-481608681f57	Adapted: the fuel input has been added and the load factor was set to 50%.
Transport of non-bulk auxiliary materials – truck	1-year data	tkm	Articulated lorry transport, Euro 4, Total weight >32 t (without fuel) {EU-28+3} | diesel driven, Euro 4, cargo | consumption mix, to consumer | more than 32t gross weight / 24,7t payload capacity | Unit process, single operation	Sphera	938d5ba6-17e4-4f0d-bef0-481608681f57	Adapted: the fuel input has been added and the load factor was set to 64%.
Outputs:						
Crude oil, from rapeseed		**tonne**	**Crude oil, from rapeseed**	**FEDIOL**		
Meal, from rapeseed		**tonne**	**Meal, from rapeseed**	**FEDIOL**		
Lecithin, from rapeseed		**tonne**	**Lecithin, from rapeseed**	**FEDIOL**		

Table 9: Direct elementary flow collection requirements for production of crude oil, meal and lecithin from rapeseed

Emissions/resources	**Elementary flow**	**UUID**	**Frequency of measurement**	**Default measurement method[7]**	**Remarks**
Resources:					
Ground water (country)	Water, well, (country)	Not applicable	1-year measurement	No default method	…
Surface water (country)	Water, river (country)	Not applicable	1-year measurement	No default method	
Emissions:					
Hexane (to air)	Hexane	Not applicable	company specific	Total hexane, all hexane consumed during crushing is emitted on-site	
Particulates (to air)	Particulates, < 10 µm	Not applicable	company specific	No default method	
Phosphorus (Ptot) (to water)	Phosphorus, total	Not applicable	company specific	No default method	
Nitrogen (Ntot) (to water)	Nitrogen, total	Not applicable	company specific	No default method	
Chloride (to water)	Chloride	Not applicable	company specific	No default method	
BOD (to water)	BOD, Biological Oxygen Demand	Not applicable	company specific	No default method	
COD (to water)	COD, Chemical Oxygen Demand	Not applicable	company specific	No default method	
Suspended solids (to water)	Suspended solids	Not applicable	company specific	No default method	

[7] Unless specific measurement methods are foreseen in a country-specific legislation

Table 10: Data collection requirements for the production of refined oil, deodistillate, acid oil and soap stock from crude rapeseed oil

Requirements for data collection purposes			**Requirements for modelling purposes**			**Remarks**
Activity data to be collected	*Specific requirements (e.g. frequency, measurement standard, etc.)*	*Unit of measure*	*Default dataset to be used*	*Dataset source (i.e. node)*	*UUID*	
Inputs:						
Crude oil from rapeseed	**transported**	**tonne**	**Crude oil, from rapeseed {RER} | from crushing | to customer | Alloc: energy, energy | per ton**	FEDIOL	/	
Transport crude rapeseed oil to refining - truck, bulk	1-year data	tkm	Articulated lorry transport, Euro 4, Total weight >32 t (without fuel) {EU-28+3} | diesel driven, Euro 4, cargo | consumption mix, to consumer | more than 32t gross weight / 24,7t payload capacity | Unit process, single operation	Sphera	938d5ba6-17e4-4f0d-bef0-481608681f57	/
Transport crude rapeseed oil to refining - barge	1-year data	tkm	Barge {EU-28+3} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result	Sphera	4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae	/
Transport crude rapeseed oil to refining - transoceanic	1-year data	tkm	Transoceanic ship, bulk {GLO} | heavy fuel oil driven, cargo | consumption mix, to consumer | 100.000-200.000 dwt payload capacity, ocean going | LCI result	Sphera		/
Transport crude rapeseed oil to refining - train	1-year data	tkm	Freight train, average (without fuel) {EU-28+3} | technology mix, electricity and diesel driven, cargo | consumption mix, to consumer | average train, gross tonne weight 1000t / 726t payload capacity | Unit process, single operation_with fuel	Sphera	02e87631-6d70-48ce-affd-1975dc36f5be	/
Caustic soda	1-year data	tonne	Sodium hydroxide production {RER} | technology mix | production mix, at plant | 100% active substance | LCI result	Econinvent	2ba49ead-4683-4671-bded-d52b80215e9e	100% concentration
Phosphoric acid	1-year data	tonne	Phosphoric acid production {GLO} | technology mix | production mix, at plant | 100% active substance | LCI result	Econinvent	648a9abc-c1be-4c18-8c0e-e7b8d99b407a	100% concentration
Sulfuric acid	1-year data	tonne	Sulphuric acid production {RER} | technology mix | production mix, at plant | 100% active substance | LCI result	Econinvent	eb6abe54-7e5d-4ee4-b3f1-08c1e220ef94	100% concentration

Citric acid	1-year data	tonne	Citric acid production {RER} | technology mix | production mix, at plant | 100% active substance | LCI result	Econinvent	d0becc20-49c4-4e8f-9ff8-8c392d5610ed	100% concentration
Bleaching earth	1-year data	tonne	Activated bentonite production {GLO} | technology mix | production mix, at plant | 100% active substance | LCI result	Econinvent	971bc6e6-237e-4ce0-8c04-f71955c2e6aa	proxy for bleaching earth
Other auxiliary materials	1-year data	tonne	confidential			Includes chemicals for wastewater treatment
Tap water	1-year data	tonne	Tap water {EU-28+3} | technology mix | at user | per kg water | LCI result	Sphera	212b8494-a769-4c2e-8d82-9a6ef61baad7	/
Electricity - from grid *[country]*	1-year data	kWh	Residual grid mix {*country*}| AC, technology mix| consumption mix, to consumer |1 kV- 60 kV| LCI result	Sphera	Depends on country	To be adapted depending on the country.
Electricity - from CHP, natural gas *[country]*	1-year data	kWh	Electricity from natural gas {*country*} | AC, mix of direct and CHP, technology mix regarding firing and flue gas cleaning | production mix, at power plant | 1 kV - 60 kV | LCI result	Sphera	Depends on country	To be adapted depending on the country.
Electricity - from other sources *[country]*	1-year data	kWh	confidential		Depends on country	To be adapted depending on the source of electricity and country.
Steam - from CHP, all sources	1-year data	kWh	Depends on source of energy	Sphera	Depending on source of energy	Proxy for steam from CHP
Steam - from all sources	1-year data	kWh	Depends on source of energy	Sphera	Depends on source of energy	To be adapted depending on the input material for steam boiler.
Heat from natural gas	1-year data	kWh	Thermal energy from natural gas {EU-28+3} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result	Sphera	81675341-f1af-44b0-81d3-d108caef5c28	Proxy for thermal energy from natural gas
Transport of bulk auxiliary materials – truck	1-year data	tkm	Articulated lorry transport, Euro 4, Total weight >32 t (without fuel) {EU-28+3} | diesel driven, Euro 4, cargo | consumption mix, to consumer | more than 32t gross weight / 24,7t payload capacity | Unit process, single operation	Sphera	938d5ba6-17e4-4f0d-bef0-481608681f57	Adapted: the fuel input has been added and the load factor was set to 50%.
Transport of non-bulk auxiliary materials – truck	1-year data	tkm	Articulated lorry transport, Euro 4, Total weight >32 t (without fuel) {EU-28+3} | diesel driven, Euro 4, cargo | consumption mix, to consumer | more than 32t gross	Sphera	938d5ba6-17e4-4f0d-bef0-481608681f57	Adapted: the fuel input has been added and the load

			weight / 24,7t payload capacity | Unit process, single operation			factor was set to 64%.
Outputs:						
Refined oil, from rapeseed		**tonne**	**Refined oil, from rapeseed {RER}**	**FEDIOL**		
Acid oil, deodistillates, fatty acid distillates from rapeseed		**tonne**	**Acid oil, deodistillates, fatty acid distillates from rapeseed {RER}**	**FEDIOL**		
Soap stock, from rapeseed		**tonne**	**Soap stock, from rapeseed {RER}**	**FEDIOL**		

Table 11: Direct elementary flow collection requirements for production of refined oil, deodistillate, acid oil and soap stock from crude rapeseed oil

Emissions/resources	Elementary flow	UUID	Frequency of measurement	Default measurement method[8]	Remarks
Resources:					
Ground water (country)	Water, well, (country)	Not applicable	1-year measurement	No default method	…
Surface water (country)	Water, river (country)	Not applicable	1-year measurement	No default method	
Emissions:					
Phosphorus (Ptot) (to water)	Phosphorus, total	Not applicable	company specific	No default method	
Nitrogen (Ntot) (to water)	Nitrogen, total	Not applicable	company specific	No default method	
Chloride (to water)	Chloride	Not applicable	company specific	No default method	
BOD (to water)	BOD, Biological Oxygen Demand	Not applicable	company specific	No default method	
COD (to water)	COD, Chemical Oxygen Demand	Not applicable	company specific	No default method	
Suspended solids (to water)	Suspended solids	Not applicable	company specific	No default method	
Emissions to air (e.g. particulates)		Not applicable	company specific	No default method	

Manufacturing of vegetable oil and co-products from soybean

When producing crude oil, refined oil and modified oil from soybean, a number of co-products are produced as well (meal, lecithin, hulls, soap stock, deodistillate, acid oil and fatty acid distillates). Meal, lecithin and hulls come out of the crushing process step while soap stock, deodestillate, acid oil and fatty acid destillates are co-products from refining. This is presented graphically in the system boundary diagrams in section 3.4.

The input and output flows that are related to the processing of soybeans into oil and co-products including the default datasets used for calculating the environmental impacts are provided in the Excel file *"PEFCR vegetable oil products - Life cycle inventory"*. The crushing step is needed for each of the products. For refined oil, soap stock, deodestillate , acid oil and fatty acid distillate production an additional refining step is needed. The life cycle inventory and default datasets are available in the Excel file. The allocation factors, to apply energy allocation, are provided as well.

Manufacturing of vegetable oil and co-products from sunflower

When producing crude oil, refined oil and modified oil from sunflower, a number of co-products are produced as well (meal, lecithin, husks, deodestillate, acid oil and fatty acid distillates). Meal, lecithin and husks come out of the crushing process step while deodistillates, acid oils and fatty acid distillates are co-products from refining. This is presented graphically in the system boundary diagrams in section 3.4.

[8] Unless specific measurement methods are foreseen in a country-specific legislation

The input and output flows that are related to the processing of sunflower seeds into oil and co-products including the default datasets used for calculating the environmental impacts are provided in the Excel file *"PEFCR vegetable oil products - Life cycle inventory"*. The crushing step is needed for each of the products. For refined oil, deodistillates, acid oil and fatty acid ditillates production an additional refining step is needed. The life cycle inventory and default datasets are available in the Excel file. The allocation factors, to apply energy allocation, are provided as well.

Manufacturing of vegetable oil and co-products from maize germs

When producing crude oil and refined oil from maize germs, a number of co-products are produced as well (meal, deodistillates and acid oil). Meal comes out of the crushing process step while deodistillate and acid oil are co-products from refining. This is presented graphically in the system boundary diagrams in section 3.4.

The input and output flows that are related to the *processing of maize germs into oil and co-products* including the default datasets used for calculating the environmental impacts are provided in the Excel file "PEFCR vegetable oil products - Life cycle inventory". The *crushing* step is needed for each of the products. For refined oil, deodistillates and acid oil production an additional refining step is needed. The life cycle inventory and default datasets are available in the Excel file. The allocation factors, to apply energy allocation, are provided as well.

Manufacturing of vegetable oil and co-products from palm

For the production of palm oil, primary data need to be collected for the oil processing process. For the crushing process and the production of crude palm oil, secondary data can be used. When producing refined oil from palm the co-products fatty acid distillates, acid oils and deodistillates are produced as well. This is presented graphically in the system boundary diagrams in section 3.4.

The input and output flows that are related to the *processing crude palm oil into refined oil and co-products* including the default datasets used for calculating the environmental impacts are provided in the Excel file "PEFCR vegetable oil products - Life cycle inventory". The allocation factors, to apply energy allocation, are provided as well.

Manufacturing of vegetable oil and co-products from palm kernel

For the production of palm kernel oil, primary data need to be collected for the oil processing process. For the crushing process and the production of crude palm kernel oil, secondary data can be used. When producing refined oil from palm kernel the co-product fatty acid destillates is produced as well. This is presented graphically in the system boundary diagrams in section 3.4.

The input and output flows that are related to the *processing crude palm kernel oil into refined oil and co-products* including the default datasets used for calculating the environmental impacts are provided in the Excel file "PEFCR vegetable oil products - Life cycle inventory". The allocation factors, to apply energy allocation, are provided as well.

Manufacturing of vegetable oil and co-products from coconut

For the production of coconut oil, primary data need to be collected for the oil processing process. For the crushing process and the production of crude coconut oil, secondary data can be used. When producing refined oil from coconut the co-products fatty acid destillates, deodestillates and acid oil are produced as well. This is presented graphically in the system boundary diagrams in section 3.4.

The input and output flows that are related to the *processing crude coconut oil into refined oil and co-products* including the default datasets used for calculating the environmental impacts are provided

in the Excel file "PEFCR vegetable oil products - Life cycle inventory". The allocation factors, to apply energy allocation, are provided as well.

See Excel file named "PEFCR vegetable oil products - Life cycle inventory" for the list of all company-specific data to be collected.

5.3. LIST OF PROCESSES EXPECTED TO BE RUN BY THE COMPANY[9]

The following processes are expected to be run by the user of the PEFCR:

- Distribution of vegetable oil and protein meal industry products

Distribution of bulk products, except bulk refined oil:

This life cycle stage includes the distribution of bulk products to customers. In case available primary data are available, they should be collected. Else the default transport distance of 150 km with a large truck can be assumed. Default datasets are provided in the Excel file *"PEFCR vegetable oil products - Life cycle inventory"*.

Distribution of bulk products, bulk refined oil:

This life cycle stage includes the distribution of bulk refined oil to customers. In case available primary data are available, they should be collected. Else the default transport distance as provided in the Excel file *"PEFCR vegetable oil products - Life cycle inventory"* can be used.

5.4. DATA QUALITY REQUIREMENTS

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

$$DQR = \frac{TeR+GeR+TiR+P}{4} \qquad \textit{[Equation B.1]}$$

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

The next chapters provide tables with the criteria to be used for the semi-quantitative assessment of each criterion.

5.4.1. COMPANY-SPECIFIC DATASETS

The DQR shall be calculated at the level-1 disaggregation, before any aggregation of sub- processes or elementary flows is performed. The DQR of company-specific datasets shall be calculated as following:

1. *Select the most relevant activity data and direct elementary flows: most relevant activity data are the ones linked to sub-processes (i.e. secondary datasets) that account for at least 80% of the total environmental impact of the company-specific dataset, listing them from the most contributing to the least contributing one. Most relevant direct elementary flows are defined as those direct elementary flows contributing cumulatively at least with 80% to the total impact of the direct elementary flows.*

[9] Data collection according to the data needs matrix in section 5.4. For mandatory company specific processes primary data collection is always required. For processes expected to be run by the company data collection has to be done according to the data needs matrix, meaning that in some cases secondary data can be used.

2. *Calculate the DQR criteria TeR, TiR, GeR and P for each most relevant activity data and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table 12.*

    a. *Each most relevant direct elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, the user of the PEFCR shall evaluate the 4 DQR criteria named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF}. For example, the user of the PEFCR shall evaluate the timing of the flow measured, for which technology the flow was measured and in which geographical area.*

    b. *For each most relevant activity data, the 4 DQR criteria shall be evaluated (named $Ti_{R\text{-}AD}$, P_{AD}, $G_{r\text{-}AD}$, $T_{er\text{-}AD}$) by the user of the PEFCR.*

    c. *Considering that the data for the mandatory processes shall be company- specific, the score of P cannot be higher than 3, while the score for TiR, TeR, and GR cannot be higher than 2 (The DQR score shall be ≤1.5).*

3. *Calculate the environmental contribution of each most relevant activity data (through linking to the appropriate sub-process) and direct elementary flow to the total sum of the environmental impact of all most-relevant activity data and direct elementary flows, in % (weighted, using all EF impact categories). For example, the newly developed dataset has only two most relevant activity data, contributing in total to 80% of the total environmental impact of the dataset:*

- *Activity data 1 carries 30% of the total dataset environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Activity data 2 carries 50% of the total dataset environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).*

4. *Calculate the TeR, TiR, GeR and P criteria of the newly developed dataset as the weighted average of each criteria of the most relevant activity data and direct elementary flows. The weight is the relative contribution (in %) of each most relevant activity data and direct elementary flow calculated in step 3.*

5. *The user of the PEFCR shall calculate the total DQR of the newly developed dataset using Equation B.2, where $\overline{Te_R}$, $\overline{Ge_R}$, $\overline{Ti_R}$ and $\bar{P}$, are the weighted average calculated as specified in point (4).*

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

[Equation B.2]

Table 12: How to assess the value of the DQR criteria for datasets with company-specific information

Rating	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}AD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}AD}$
1	Measured/calculated and externally verified	The data refers to the most recent annual administration period with respect to the EF report publication date	The elementary flows and the activity data reflect exactly the technology of the newly developed dataset	The activity data and elementary flows reflects the exact geography where the process modelled in the newly created dataset takes place
2	Measured/calculated and internally verified, plausibility checked by reviewer	The data refers to maximum 2 annual administration periods with respect to the EF report publication date	The elementary flows and the activity data are a proxy of the technology of the newly developed dataset	The activity data and elementary flows) partly reflects the geography where the process modelled in the newly created dataset takes place
3	Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data refers to maximum three annual administration periods with respect to the EF report publication date	Not applicable	Not applicable
4-5	Not applicable	Not applicable	Not applicable	Not applicable

P_{EF}: Precision for elementary flows; **P_{AD}**: Precision for activity data; **$Ti_{R\text{-}EF}$**: Time Representativeness for elementary flows; **$Ti_{R\text{-}AD}$**: Time representativeness for activity data; **$Te_{R\text{-}EF}$**: Technology representativeness for elementary flows; **$Te_{R\text{-}AD}$**: Technology representativeness for activity data**;** **$G_{R\text{-}EF}$**: Geographical representativeness for elementary flows; **$G_{R\text{-}AD}$:** Geographical representativeness for activity data.

5.5. DATA NEEDS MATRIX (DNM)

All processes required to model the product and outside the list of mandatory company-specific data (listed in section 5.1) shall be evaluated using the Data Needs Matrix (see Table 13). The user of the PEFCR shall apply the DNM to evaluate which data are needed and shall be used within the modelling of its PEF, depending on the level of influence the user of the PEFCR (company) has on the specific process. The following three cases are found in the DNM and are explained below:

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

*Table 13: Data Needs Matrix (DNM)[10]. *Disaggregated datasets shall be used.*

		Most relevant process	Other process
Situation 1: process run by the company using the PEFCR	Option 1	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR≤1.5) Calculate the DQR values (for each criterion + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR≤3.0) Use the default DQR values
Situation 2: process not run by the company using the PEFCR but with access to company-specific information	Option 1	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR≤1.5) Calculate the DQR values (for each criterion + total)	
	Option 2	Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤3.0)* Re-evaluate the DQR criteria within the product specific context	
	Option 3		Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤4.0)* Use the default DQR values.
Situation 3: process not run by the company using the PEFCR and without access to company- specific information	Option 1	Use default secondary data set in aggregated form (DQR≤3.0) Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary data set in aggregated form (DQR≤4.0) Use the default DQR values

5.5.1. PROCESSES IN SITUATION 1

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

[10] The options described in the DNM are not listed in order of preference.

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

Situation 1/Option 1

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

Situation 1/Option 2

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

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

5.5.2. PROCESSES IN SITUATION 2

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

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

Situation 2/Option 1

For all processes not run by the company and where the user of the PEFCR applies company- specific data, the DQR of the newly developed dataset shall be evaluated as described in section 5.4.1.

Situation 2/Option 2

The user of the PEFCR shall use company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets, starting from the default secondary dataset provided in the PEFCR.

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

The user of the PEFCR shall make the DQR context-specific by re-evaluating TeR and TiR using the table Table 14. The criteria GeR shall be lowered by 30%[11] and the criteria P shall keep the original value.

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

Situation 2/Option 3

The user of the PEFCR shall apply company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets, starting from the default secondary dataset provided in the PEFCR.

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

In this case, the user of the PEFCR shall use the default DQR values. If the default dataset to be used for the process is not listed in the PEFCR, the user of the PEFCR shall take the DQR values from the original dataset.

Table 14: How to assess the value of the DQR criteria when secondary datasets are used.

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

5.5.3. PROCESSES IN SITUATION 3

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

It is in the list of most relevant processes (situation 3, option 1);

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

Situation 3/Option 1

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

Situation 3/Option 2

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

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

5.6. HOW TO CALCULATE THE AVERAGE DQR OF THE STUDY

To calculate the average DQR of the PEF study, the user of the PEFCR shall calculate separately the TeR, TiR, GeR and P for the PEF study as the weighted average of all most relevant processes, based on their relative environmental contribution to the total single overall score. The calculation rules explained in section 4.6.5.8 of the PEF method shall be used.

5.7. ALLOCATION RULES

Systems involving multi-functionality of processes shall be modelled in accordance with the decision hierarchy provided in the PEF method (section 4.5). When allocation cannot be avoided, the allocation rules listed in Table 15 shall be applied.

Table 15: Allocation rules

Process	***Allocation rule***	***Modelling instructions***	***Allocation factor***
Agricultural processes	Energy allocation	Use agri-footprint database with energy allocated records	
Vegetable oil and proteinmeal industry processes	Energy allocation	The energy content (Lower Heating Value) of the different outputs shall be used to allocate impacts of the black-box production processes (crushing and oil processing).	See Excel file "PEFCR vegetable oil products - Life cycle inventory"

Energy allocation has been chosen as the default allocation method for both the agricultural as well as the industrial life cycle phase. Energy allocation holds the middle between mass and economic allocation. Energy allocation assigns more environmental impact to the oil than mass allocation does, but also more to the meal than economic allocation does. Basing allocation on prices (economic allocation) is considered too variable, even when average prices over larger time spans (e.g. five years) are taken.

5.8. ELECTRICITY MODELLING

The following electricity mix shall be used in hierarchical order:

1. *Supplier-specific electricity product shall be used if for a country there is a 100% tracking system in place, or if:*
    a. *available, and*
    b. *the set of minimum criteria to ensure the contractual instruments are reliable is met.*
2. *The supplier-specific total electricity mix shall be used if:*
    a. *available, and*
    b. *the set of minimum criteria to ensure the contractual instruments are reliable is met.*
3. *The 'country-specific residual grid mix, consumption mix' shall be used. Country-specific means the country in which the life cycle stage or activity occurs. This may be an EU country or non-EU country. The residual grid mix prevents double counting with the use of supplier-specific electricity mixes in (a) and (b).*
4. *As a last option, the average EU residual grid mix, consumption mix (EU-28 +EFTA), or region representative residual grid mix, consumption mix, shall be used.*

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

Set of minimum criteria to ensure contractual instruments from suppliers

A supplier-specific electricity product/ mix may only be used if the user of the PEF method ensures that the contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then country-specific residual electricity consumption-mix shall be used in the modelling.

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

Criterion 1 – Convey attributes

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

Criterion 2 – Be a unique claim

- *Be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.*
- *Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g. by an audit of contracts, third party certification, or may be handled automatically through other disclosure registries, systems, or mechanisms).*

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

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

Datasets for residual grid mix, consumption mix, per energy type, per country and per voltage are made available by data providers.

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

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

- *Activity data related to non-EU country consumption mix per detailed energy type shall be determined based on:*
    - *Domestic production mix per production technologies;*
    - *Import quantity and from which neighbouring countries;*
    - *Transmission losses;*
    - *Distribution losses;*
    - *Type of fuel supply (share of resources used, by import and / or domestic supply). These data may be found in the publications of the International Energy Agency (IEA (www.iea.org).*
- *Available LCI datasets per fuel technologies. The LCI datasets available are generally specific to a country or a region in terms of:*
    - *fuel supply (share of resources used, by import and/ or domestic supply);*
    - *energy carrier properties (e.g. element and energy contents);*
    - *technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.*

Allocation rules:

Table 16 shows which physical relationship shall be used to subdivide the electricity consumption among multiple products produced by the same process.

Table 16: Allocation rules for electricity

Process	***Physical relationship***	***Modelling instructions***
Vegetable oil and proteinmeal industry processes	Energy allocation	The energy content (Lower Heating Value) of the different outputs shall be used to allocate impacts of the black-box production processes (crushing and oil processing).

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

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

1. *If the production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site may be used.*
2. *If the production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product- specific information (measure, record, bill) may be used.*
3. *If all the products produced in the specific plant are supplied with a publicly available PEF study, the company wanting to make the claim shall make all PEF studies available. The allocation rule applied shall be described in the PEF study, consistently applied in all PEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.*

When a product is produced in different locations, the ratios of production between EU countries/regions shall be reflected in the electricity modelling. Where such data are not available, the average EU mix (EU-28 +EFTA), or region representative mix, shall be used.

On-site electricity generation:

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

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

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

- *If possible, apply subdivision. Subdivision applies both to separate electricity productions or to a common electricity production where you may allocate based on electricity amounts the upstream and direct emissions to your own consumption and to the share you sell out of your company (e.g. if a company has a windmill on its production site and exports 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the PEF study).*
- *If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[12].*
- *Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.*

5.9. CLIMATE CHANGE MODELLING

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

1. ***Climate change – fossil**: This sub-category includes emissions from peat and calcination/carbonation of limestone. The emission flows ending with '(fossil)' (e.g., 'carbon dioxide (fossil)' and 'methane (fossil)') shall be used, if available.*

2. ***Climate change – biogenic**: This sub-category covers carbon emissions to air (CO_2, CO and CH_4) originating from the oxidation and/or reduction of biomass by means of its transformation or*

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

degradation (e.g. combustion, digestion, composting, landfilling) and CO_2 uptake from the atmosphere through photosynthesis during biomass growth
– i.e. corresponding to the carbon content of products, biofuels or aboveground plant residues, such as litter and dead wood. Carbon exchanges from native forests[13] shall be modelled under sub-category 3 (incl. connected soil emissions, derived products, residues). The emission flows ending with '(biogenic)' shall be used.
A simplified modelling approach shall not be used when modelling foreground emissions.
[If a simplified modelling approach is used, include in the text: "Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. If methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane."]

The biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.

3. ***Climate change – land use and land use change**: This sub-category accounts for carbon uptakes and emissions (CO_2, CO and CH_4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (including soil carbon emissions). For native forests, all related CO_2 emissions are included and modelled under this sub-category (including connected soil emissions, products derived from native forest[14] and residues), while their CO2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.*

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

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

[13] Native forests – represents native or long-term, non-degraded forests. Definition adapted from table 8 in Annex V C(2010)3751 to Directive 2009/28/EC.
[14] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2).

direct land use change over the period shall be included in the quantification of GHG emissions of products arising from this land on the basis of equal allocation to each year of the period[15].

1. *Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out, no emissions from land use change should be included in the assessment.*
2. *Where the timing of land use change cannot be demonstrated to be more than 20 years, or a single harvest period, prior to making the assessment (whichever is the longer), it shall be assumed that the land use change occurred on 1 January of either:*
    - *the earliest year in which it can be demonstrated that the land use change had occurred; or*
    - *on 1 January of the year in which the assessment of GHG emissions and removals is being carried out.*

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

1. *where the country of production is known and the previous land use is known, the GHG emissions and removals arising from land use change shall be those resulting from the change in land use from the previous land use to the current land use in that country (additional guidelines on the calculations can be found in PAS 2050- 1:2012);*
2. *where the country of production is known, but the former land use is not known, the GHG emissions arising from land use change shall be the estimate of average emissions from the land use change for that crop in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*
3. *where neither the country of production nor the former land use is known, the GHG emissions arising from land use change shall be the weighted average of the average land use change emissions of that commodity in the countries in which it is grown.*

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

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

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

[If climate change is selected as a relevant impact category, the PEFCR shall (i) always request to report the total climate change as the sum of the three sub-indicators, and (ii) for the sub- indicators 'Climate change – fossil', 'Climate change – biogenic' and 'Climate change - land use and land use change', request separate reporting for those contributing more than 5% each to the total score.]

The sub-category 'Climate change-biogenic' shall be reported separately.

The sub-category 'Climate change-land use and land transformation' shall be reported separately.

Credits associated with temporary and permanent carbon storage and/or delayed emissions shall not be considered in the calculation of the climate change indicator. This means that all emissions

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

and removals shall be accounted for as emitted “now” and there is no discounting of emissions over time (in line with ISO 14067:2018).

5.10. MODELLING OF END OF LIFE AND RECYCLED CONTENT

This is mainly relevant for the packaging of refined oil in 1 litre bottles. *Overall, the end of life of products should be modelled and reported at the life cycle stage where the waste occurs. This section provides rules on how to model the end of life of packaging as well as the recycled content.*

The Circular Footprint Formula (CFF) is used to model the end of life of products as well as the recycled content and is a combination of "material + energy + disposal", i.e.:

Material

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

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

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

With the following parameters

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

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

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

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

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

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

R_2: *it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R_2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R_2 shall be measured at the output of the recycling plant. R_2 shall be set to zero for the vegetable oil and protein meal products packaging waste, as the use phase is not included*[16]*.*

R_3: *it is the proportion of the material in the product that is used for energy recovery at EoL. R_3 shall be set to zero for the vegetable oil and protein meal products packaging waste, as the use phase is not included*[16]*.*

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

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

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

[16] It is not zero for the packaging materials of raw materials

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

E_{ER}: *specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, etc.).*

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

E_D: *specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery. E_D shall be set to zero for the vegetable oil and protein meal products packaging waste, as the use phase is not included*[16].

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

LHV: *lower heating value of the material in the product that is used for energy recovery.*

Annex C of the PEF method provides default:

- A values. *If an application-specific or material-specific A value is not available, the A value shall be set equal to 0.5. The A-value for plastic packaging is: 0,5*
- Quality ratios (Qsin, Qsout/Qp)
- R_1 values. *They shall be set to 0% when no application-specific data are available. The R1 value for plastic packaging in Annex C is 0%*
- R_2 values (not relevant, end-of-life not included in this PEFCR)

<u>Modelling recycled content (applicable for packaging only)</u>

The following part of the Circular Footprint Formula is used to model the recycled content:

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

The R_1 values applied shall be supply-chain specific or default as provided in the Annex C of the PEF method and above, in relation with the DNM. Material-specific values based on supply market statistics are not accepted as a proxy and therefore shall not be used.

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

- *The supplier information (through e.g., statement of conformity or delivery note) shall be maintained during all stages of production and delivery at the converter;*
- *Once the material is delivered to the converter for production of the end products, the converter shall handle information through their regular administrative procedures;*
- *The converter for production of the end products claiming recycled content shall demonstrate through its management system the [%] of recycled input material into the respective end product(s).*
- *The latter demonstration shall be transferred upon request to the user of the end product. In case a PEF profile is calculated and reported, this shall be stated as additional technical information of the PEF profile.*
- *Company-owned traceability systems may be applied as long as they cover the general guidelines outlined above.*

The PEF profile shall be calculated and reported using A equal to 1 for the product in scope (for intermediate products).

6. LIFE CYCLE STAGES

6.1. RAW MATERIAL ACQUISITION AND PRE-PROCESSING

This life cycle stage consists of the cultivation of plant-based ingredients or plant based crude oils and of the transportation of crops/crude oils to vegetable oil and protein meal companies. Company specific activity data (amounts and type of crop/crude oil) are mandatory for these processes, however, the background data can consist of secondary data. In case secondary dataset are used for plant cultivation or crude oil production in case of palm, palm kernel and coconut, the secondary data shall be taken from the Agri-footprint® 5.0 database – energy allocation (Paassen et al., 2019). If a new version of Agri-footprint becomes available within the period of validity of the PEFCR or if it becomes possible to use the EF database for agricultural production in the future, these databases can also be used. It is also allowed to collect primary data for the agricultural life cycle stage and for crude oil production from palm, palm kernel and coconut. Secondary datasets on transportation shall be taken from the EF database. The default datasets and amounts per FU are provided in the Excel file *"PEFCR vegetable oil products - Life cycle inventory"*.
For the different ingredients transported from supplier to factory, the user of the PEFCR needs data on (i) transport mode, (ii) distance per transport mode, (iii) utilisation ratios for truck transport and (iv) empty return modelling for truck transport.

The user of the PEFCR shall always check the utilisation ratio applied in the default dataset and adapt it accordingly.

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

6.2. AGRICULTURAL MODELLING

Agri-footprint® 5.0 economic allocation (Paassen et al., 2019) appears to comply to all modelling guidelines of the PEF method. This is also stated on the SimaPro website: "The methodologies and data quality in Agri-footprint 5.0 are compliant with the PEF initiative of the European commission, ILCD and ReCiPe, and have been reviewed by RIVM (Dutch national institute for public health and the environment)."

The following rules apply when the user decides to gather primary data on agricultural production.

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

Use of crop type specific and country-, region- or climate-specific data for yield, water and land use, land use change, fertiliser (artificial and organic) amount (N, P amount) and pesticide amount (per active ingredient), per hectare per year, if available.

Cultivation data shall be collected over a period of time sufficient to provide an average assessment of the life cycle inventory associated with the inputs and outputs of cultivation that will offset fluctuations due to seasonal differences:

- *For annual crops, an assessment period of at least three years shall be used (to level out differences in crop yields related to fluctuations in growing conditions over the years such as climate, pests and diseases, etc.). Where data covering a three-year period is not available i.e. due to starting up a new production system (e.g. new greenhouse, newly cleared land, shift to*

another crop), the assessment may be conducted over a shorter period, but shall be not less than 1 year. Crops/plants grown in greenhouses shall be considered as annual crops/plants, unless the cultivation cycle is significantly shorter than a year and another crop is cultivated consecutively within that year. Tomatoes, peppers and other crops which are cultivated and harvested over a longer period through the year are considered as annual crops.

- *For crops that are grown and harvested in less than one year (e.g. lettuce produced in 2 to 4 months) data shall be gathered in relation to the specific time period for production of a single crop, from at least three recent consecutive cycles. Averaging over three years may best be done by first gathering annual data and calculating the life cycle inventory per year and then determining the three years average.*

Pesticide emissions shall be modelled as specific active ingredients. As a default approach, pesticides applied on the field shall be modelled as 90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water.

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

- *NH3, to air (from N-fertiliser application)*
- *N_2O, to air (direct and indirect) (from N-fertiliser application)*
- *CO_2, to air (from lime, urea and urea-compounds application)*
- *NO3, to water unspecified (leaching from N-fertiliser application)*
- *PO4, to water unspecified or freshwater (leaching and run-off of soluble phosphate from P-fertiliser application)*
- *P, to water unspecified or freshwater (soil particles containing phosphorous, from P- fertiliser application).*

The LCI for P emissions should be modelled as the amount of P emitted to water after run-off and the emission compartment 'water' shall be used. When this amount is not available, the LCI may be modelled as the amount of P applied on the agricultural field (through manure or fertilisers) and the emission compartment 'soil' shall be used. In this case, the run-off from soil to water is part of the impact assessment method.

The LCI for N emissions shall be modelled as the amount of emissions after it leaves the field (soil) and ending up in the different air and water compartments per amount of fertilisers applied. N emissions to soil shall not be modelled. The nitrogen emissions shall be calculated from nitrogen applications of the farmer on the field and excluding external sources (e.g. rain deposition).

For Nitrogen-based fertilisers, the Tier 1 emissions factors of Table 2-4 of IPCC 2006 shall be used, as reproduced in Table 17, except when better data are available. In case better data are available, a more comprehensive nitrogen field model may be used in the PEF study, provided (i) it covers at least the emissions requested above, (ii) nitrogen shall be balanced in inputs and outputs and (iii) it shall be described in a transparent way.

Table 17: Parameters to be used when modelling nitrogen emission in soil

Emission	***Compartment***	***Value to be applied***
N_2O (synthetic fertiliser and manure; direct and indirect)	*Air*	*0.022 kg N_2O/ kg N fertilizer applied*
NH_3 (synthetic fertiliser)	*Air*	*kg NH_3= kg N * FracGASF= 1*0.1* (17/14) = 0.12 kg NH_3/ kg N fertilizer applied*
NH_3 (manure)	*Air*	*kg NH_3= kg N*FracGASF= 1*0.2* (17/14) = 0.24 kg NH_3/ kg N manure applied*
NO_3^- (synthetic fertiliser andmanure)	*Water*	*kg NO_3^-= kg N*FracLEACH = 1*0.3*(62/14) = 1.33 kg NO_3^-/ kg N applied*
P based fertilisers	*Water*	*0.05 kg P/ kg P applied*

FracGASF: fraction of synthetic fertiliser N applied to soils that volatilises as NH_3 and NO_x.
FracLEACH: fraction of synthetic fertiliser and manure lost to leaching and runoff as NO_3-.

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

- *The final fate of the heavy metals elementary flows are not further considered within the system boundary: the inventory does not account for the final emissions of the heavy metals and therefore shall not account for the uptake of heavy metals by the crop[17]. For example, heavy metals in agricultural crops cultivated for human consumption end up in the plant. Within the EF context human consumption is not modelled, the final fate is not further modelled and the plant acts as a heavy metal sink. Therefore, the uptake of heavy metals by the crop shall not be modelled.*

Methane emissions from rice cultivation shall be included on basis of IPCC 2006 calculation rules.

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

The following activities shall be included:

- *Input of seed material (kg/ha)*
- *Input of lime (kg $CaCO_3$/ha, type)*
- *Input of fertilisers and pesticides (kg/ha)*
- *Input N from crop residues that stay on the field or are burned (kg residue + N content/ha)*
- *Input of irrigation water*
- *Land use and land use change*
- *Emissions to air, water and soil*

[17] The Agri-footprint® 5.0 database does take uptake into account. It is however not possible to change this in the dataset. This issue will be solved, once the EF database is made publicly available.

- *Crop yield (kg/ha)*
- *Drying and storage of products*
- *Field operations through total fuel consumption and machine production, transports to/ from the field and energy for irrigation.*

6.3. MANUFACTURING

The processes taking place in this life cycle stage are:

- PRODUCTION OF CRUDE OIL AND CO-PRODUCTS FROM RAPESEED;
- PRODUCTION OF CRUDE OIL AND CO-PRODUCTS FROM SOYBEANS;
- PRODUCTION OF CRUDE OIL AND CO-PRODUCTS FROM SUNFLOWER;
- PRODUCTION OF CRUDE OIL AND CO-PRODUCTS FROM MAIZE;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM RAPESEED;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM SOYBEANS;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM SUNFLOWER;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM MAIZE;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM PALM;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM PALM KERNEL;
- PRODUCTION OF REFINED OIL AND CO-PRODUCTS FROM COCONUT;

The default datasets and amounts per FU are provided in the Excel file "PEFCR vegetable oil products - Life cycle inventory".

According to this PEFCR, the following processes may be excluded based on the cut-off rule: capital goods for the manufacturing processes of the vegetable oil and protein meal industry, packaging of incoming auxiliary materials, storage at warehouses, resources and tools for logistic operations at the vegetable oil and protein meal industry plants and process waste (except wastewater, which needs to be included). No additional cut-off is allowed.

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

The waste of products used during the manufacturing shall be included in the modelling.

6.4. DISTRIBUTION STAGE

Transport from factory to final client (including consumer transport) shall be modelled within this life cycle stage. The final client is defined as the food producer, feed producer or other industry that uses the product of the vegetable oil and protein meal industry in their production processes.

In case supply-chain-specific information is available for one or several transport parameters, they may be applied following the Data Needs Matrix.

The default datasets and amounts per FU are provided in the Excel file "PEFCR vegetable oil products - Life cycle inventory".

Two different scenarios are available:

- Transport of bulk products, except refined oil
- Transport of bulk refined oil

7. PEF RESULTS

7.1. ENVIRONMENTAL PROFILE

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

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

REFERENCES

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RVIM. 2017. ReCiPe 2016 v1.1 A harmonized life cycle impact assessment method at midpoint and endpoint level. National Institute for Public Health and the Environment.

ANNEXES

ANNEX 1 – LIST OF ACRONYMS AND DEFINITIONS

ACRONYMS

AF	allocation factor
AR	allocation ratio
B2B	business to business
B2C	business to consumer
BoC	bill of components
BoM	bill of materials
BSI	British Standards Institution
CF	characterization factor
CFCs	Chlorofluorocarbons
CFF	Circular Footprint Formula
CPA	Classification of Products by Activity
DC	distribution centre
DMI	dry matter intake
DNM	Data Needs Matrix
DQR	Data Quality Rating
EC	European Commission
EF	Environmental Footprint
EI	environmental impact
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management Systems
EoL	End of life
EPD	Environmental Product Declaration
FU	functional unit
GE	gross energy intake
GHG	greenhouse gas
GR	geographical representativeness
GRI	Global Reporting Initiative
GWP	global warming potential
ILCD	International Reference Life Cycle Data System
ILCD-EL	International Reference Life Cycle Data System – Entry Level
IPCC	Intergovernmental Panel on Climate Change
ISIC	international standard industrial classification
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature and Natural Resources
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCDN	Life Cycle Data Network
LCI	life cycle inventory
LCIA	life cycle impact assessment
LCT	life cycle thinking
LT	lifetime
NACE	Nomenclature Générale des Activités Economiques dans les Communautés Européennes
NDA	non-disclosure agreement
NGO	non-governmental organisation

NMVOC	non-methane volatile compounds
P	precision
PAS	Publicly Available Specification
PEFCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PEF-RP	PEF study of the representative product
RF	reference flow
RP	representative product
SB	system boundary
SMRS	sustainability measurement & reporting system
SS	supporting study
TeR	technological representativeness
TiR time	representativeness
TS	Technical Secretariat
UNEP	United Nations Environment Programme
UUID	Universally Unique Identifier
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

DEFINITIONS

Activity data - This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data[18] and then combined to derive the environmental footprint associated with that process. Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. Synonym of "non-elementary flow.

Acidification - EF impact category that addresses impacts due to acidifying substances in the environment. Emissions of NOx, NH_3 and SOx lead to releases of hydrogen ions (H+) when the gases are mineralised. The protons contribute to the acidification of soils and water when they are released in areas where the buffering capacity is low, resulting in forest decline and lake acidification.

Additional environmental information - Environmental information outside the EF impact categories that is calculated and communicated alongside PEF results.

Additional technical information - Non-environmental information that is calculated and communicated alongside PEF results.

Aggregated dataset - Complete or partial life cycle of a product system that next to the elementary flows (and possibly not relevant amounts of waste flows and radioactive wastes) lists in the input/output list exclusively the product(s) of the process as reference flow(s), but no other goods or services. Aggregated datasets are also called "LCI results" datasets. The aggregated dataset may have been aggregated horizontally and/or vertically.

Allocation - An approach to solving multi-functionality problems. It refers to "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).

[18] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2011).

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

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

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

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

Benchmark - A standard or point of reference against which any comparison may be made. In the context of PEF, the term 'benchmark' refers to the average environmental performance of the representative product sold in the EU market.

Bill of materials - A bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture the product in scope of the PEF study. In some sectors it is equivalent to the bill of components.

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

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

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

Characterisation factor - Factor derived from a characterisation model which is applied to convert an assigned life cycle inventory result to the common unit of the EF impact category indicator (based on ISO 14040:2006).

Classification - Assigning the material/energy inputs and outputs tabulated in the life cycle inventory to EF impact categories according to each substance's potential to contribute to each of the EF impact categories considered.

Climate change - All inputs or outputs that result in greenhouse gas emissions. The consequences include increased average global temperatures and sudden regional climatic changes. Climate change is an impact affecting the environment on a global scale.

Co-function - Any of two or more functions resulting from the same unit process or product system.

Commissioner of the EF study - Organisation (or group of organisations) that finances the EF study in accordance with the PEF method and the relevant PEFCR, if available (definition adapted from ISO 14071/2014, point 3.4).

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

Company-specific dataset - It refers to a dataset (disaggregated or aggregated) compiled with company-specific data. In most cases the activity data are company-specific while the underlying sub-processes are datasets derived from background databases.

Comparative Assertion - An environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (including the benchmark of the product category) (adapted from ISO 14044:2006).

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

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

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

Cradle to Grave - A product's life cycle that includes raw material extraction, processing, distribution, storage, use, and disposal or recycling stages. All relevant inputs and outputs are considered for all of the stages of the life cycle.

Critical review - Process intended to ensure consistency between a PEFCR and the principles and requirements of the PEF method.

Data Quality - Characteristics of data that relate to their ability to satisfy stated requirements (ISO 14040:2006). Data quality covers various aspects, such as technological, geographical and time-related representativeness, as well as completeness and precision of the inventory data.

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

Delayed emissions - Emissions that are released over time, e.g. through long use or final disposal stages, versus a single emission at time t.

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

Direct land use change (dLUC) - The transformation from one land use type into another, which takes place in a unique land area and does not lead to a change in another system.

Directly attributable - Refers to a process, activity or impact occurring within the defined system boundary.

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

Downstream - Occurring along a product supply chain after the point of referral.

Ecotoxicity, freshwater - Environmental footprint impact category that addresses the toxic impacts on an ecosystem, which damage individual species and change the structure and function of the ecosystem. Ecotoxicity is a result of a variety of different toxicological mechanisms caused by the release of substances with a direct effect on the health of the ecosystem.

EF communication vehicles - It includes all the possible ways that may be used to communicate the results of the EF study to the stakeholders (e.g. labels, environmental product declarations, green claims, websites, infographics, etc.).

EF compliant dataset - Dataset developed in compliance with the EF requirements provided at http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml.

Electricity tracking - Electricity tracking is the process of assigning electricity generation attributes to electricity consumption.

Elementary flows - In the life cycle inventory, elementary flows include "material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation" (ISO 14040, 3.12). Elementary flows include, for example, resources taken from nature or emissions into air, water, soil that are directly linked to the characterisation factors of the EF impact categories.

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

Environmental Footprint (EF) Impact Assessment - Phase of the PEF analysis aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (based on ISO 14044:2006). The impact assessment methods provide impact characterisation factors for elementary flows in order to aggregate the impact to obtain a limited number of midpoint indicators.

Environmental Footprint (EF) Impact Assessment method - Protocol for quantitative translation of life cycle inventory data into contributions to an environmental impact of concern.

Environmental Footprint (EF) Impact Category - Class of resource use or environmental impact to which the life cycle inventory data are related.

Environmental Footprint (EF) impact category indicator - Quantifiable representation of an EF impact category (based on ISO 14000:2006).

Environmental impact - Any change to the environment, whether adverse or beneficial, that wholly or partially results from an organisation's activities, products or services (EMAS regulation).

Environmental mechanism - System of physical, chemical and biological processes for a given EF impact category linking the life cycle inventory results to EF category indicators (based on ISO 14040:2006).

Eutrophication - Nutrients (mainly nitrogen and phosphorus) from sewage outfalls and fertilised 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 substances emitted into a common measure expressed as the oxygen required for the degradation of dead biomass. Three EF impact categories are used to assess the impacts due to eutrophication: Eutrophication, terrestrial; Eutrophication, freshwater; Eutrophication, marine.

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

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

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

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

Foreground Processes - Refer to those processes in the product life cycle for which direct access to information is available. For example, the producer's site and other processes operated by the

producer or its contractors (e.g. goods transport, head-office services, etc.) belong to the foreground processes.

Functional unit - The functional unit defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions “what?”, “how much?”, “how well?”, and “for how long?”.

Gate to Gate - A partial product supply chain that includes only the processes carried out on a product within a specific organisation or site.

Gate to Grave - A partial product supply chain that includes only the distribution, storage, use, and disposal or recycling stages.

Global warming potential - Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO2-equivalent units) and specified time horizon **(**e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years respectively)**.** It relates to the capacity to influence changes in the global average surfaceair temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.

Horizontal averaging - it is the action of aggregating multiple unit process datasets or aggregated process datasets in which each provides the same reference flow in order to create a new process dataset (UN Environment, 2011).

Human toxicity - **cancer** - EF impact category that accounts for adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to cancer.

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

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

Indirect land use change (iLUC) - It occurs when a demand for a certain land use leads to changes, outside the system boundary, i.e. in other land use types. These indirect effects may be mainly assessed by means of economic modelling of the demand for land or by modelling the relocation of activities on a global scale.

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 - Output form a unit process that is input to other unit processes that require further transformation within the system (ISO 14040:2006). An intermediate product is a product that requires further processing before it is saleable to the final consumer.

Ionising radiation, human health - EF impact category that accounts for the adverse health effects on human health caused by radioactive releases.

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

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

Life cycle - Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal (ISO 14040:2006).

Life cycle approach - Takes into consideration the spectrum of resource flows and environmental interventions associated with a product from a supply-chain perspective, including all stages from raw material acquisition through processing, distribution, use, and end of life processes, and all relevant related environmental impacts (instead of focusing on a single issue).

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

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

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

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

Loading rate - Ratio of actual load to the full load or capacity (e.g. mass or volume) that a vehicle carries per trip.

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

Multi-functionality - If a process or facility provides more than one function, i.e. it delivers several goods and/or services ("co-products"), then it is “multifunctional”. In these situations, all inputs and emissions linked to the process will be partitioned between the product of interest and the other co-products according to clearly stated procedures.

Non-elementary (or complex) flows - In the life cycle inventory, non-elementary flows include all the inputs (e.g. electricity, materials, transport processes) and outputs (e.g. waste, by-products) in a system that need further modelling efforts to be transformed into elementary flows. Synonym of activity data.

Normalisation - After the characterisation step, normalisation is the step in which the life cycle impact assessment results are divided by normalisation factors that represent the overall inventory of a reference unit (e.g. a whole country or an average citizen). Normalised life cycle impact assessment results express the relative shares of the impacts of the analysed system in terms of the total contributions to each impact category per reference unit. When displaying the normalised life cycle impact assessment results of the different impact topics next to each other, it becomes evident which impact categories are affected most and least by the analysed system. Normalised life cycle impact assessment results reflect only the contribution of the analysed system to the total impact potential, not the severity/relevance of the respective total impact. Normalised results are dimensionless, but not additive.

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).

Ozone depletion - EF 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).

Partially disaggregated dataset - A dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield a complete aggregated LCI data set.

Partially disaggregated dataset at level-1 - A partially disaggregated dataset at level- 1 contains elementary flows and activity data of one level down in the supply chain, while all complementing underlying datasets are in their aggregated form.

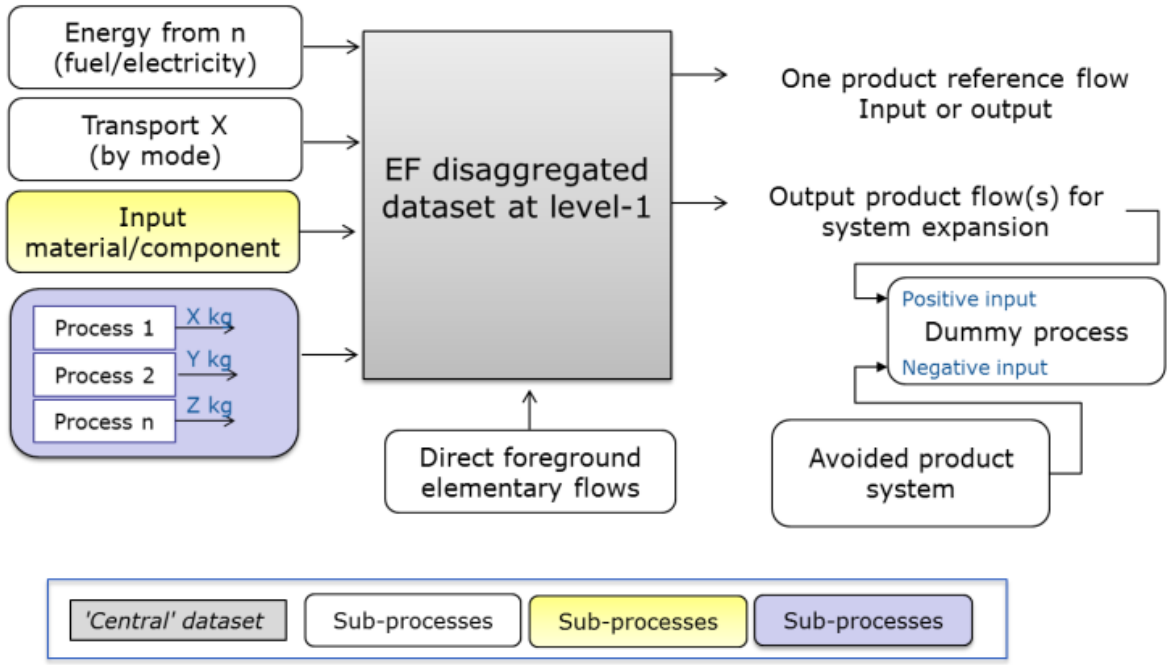

Figure 8: Example of dataset partially disaggregated at Level-1

Particulate Matter - EF impact category that accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NOx, SOx, NH_3).

PEFCR supporting study - PEF study based on a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.

PEF profile - The quantified results of a PEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to report.

PEF report - Document that summarises the results of the PEF study.

PEF study of the representative product (PEF-RP) - PEF study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and any other major requirements needed for the definition of the benchmark for the product category/ sub-categories in scope of the PEFCR.

PEF study - Term used to identify the totality of actions needed to calculate the PEF results. It includes the modelling, the data collection, and the analysis of the results. It excludes the PEF report and the verification of the PEF study and report.

Photochemical ozone formation - EF 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 (NOx) and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts and manmade materials through reaction with organic materials.

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

Primary data[19] - This term refers to data from specific processes within the supply chain of the user of the PEF method or user of the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply chain specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the user of the PEF method or user of the PEFCR. In this method, primary data are synonym of "company-specific data" or "supply-chain specific data".

Product - Any goods or services (ISO 14040:2006).

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

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

Product Environmental Footprint Category Rules (PEFCRs) - Product category specific, life cycle based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF method. Only the PEFCRs listed on the European Commission website (http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm) are recognised as in line with this method.

Product flow - Products entering from or leaving to another product system (ISO 14040:2006).

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).

Raw material - Primary or secondary material that is used to produce a product (ISO 14040:2006).

Reference flow - Measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit (based on ISO 14040:2006).

Releases - Emissions to air and discharges to water and soil (ISO 14040:2006).

Representative product (model) - The RP may be a real or a virtual (non-existing) product. The virtual product should be calculated based on average European market salesweighted characteristics of all existing technologies/materials covered by the product category or sub-category. Other weighting sets may be used, if justified, for example weighted average based on mass (ton of material) or weighted average based on product units (pieces).

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

Resource use, fossil - EF impact category that addresses the use of non-renewable fossil natural resources (e.g. natural gas, coal, oil).

Resource use, minerals and metals - EF impact category that addresses the use of non-renewable abiotic natural resources (minerals and metals).

[19] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2011).

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

Secondary data[20] - It refers to data not from a specific process within the supply-chain of the company performing a PEF study. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third party LCI 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 may 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.

Sensitivity analysis - Systematic procedures for estimating the effects of the choices made regarding methods and data on the results of a PEF study (based on 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".

Specific Data - Refers to directly measured or collected data representative of activities at a specific facility or set of facilities. Synonymous with "primary data."

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

Sub-population - Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study that constitutes a homogenous sub-set of the whole population. Synonymous with "stratum".

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

Sub-sample - A sample of a sub-population.

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

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

System boundary - Definition of aspects included or excluded from the study. For example, for a "cradle-to-grave" EF analysis, the system boundary includes all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages.

System boundary diagram - Graphic representation of the system boundary defined for the PEF study.

Temporary carbon storage - happens when a product reduces the GHGs in the atmosphere or creates negative emissions, by removing and storing carbon for a limited amount of time.

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

[20] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2011)

Uncertainty analysis - Procedure to assess the uncertainty in the results of a PEF study due to data variability and choice-related uncertainty.

Unit process - Smallest element considered in the LCI for which input and output data are quantified (based on ISO 14040:2006).

Unit process, black box - Process chain or plant level unit process. This covers horizontally averaged unit processes across different sites. Covers also those multifunctional unit processes, where the different co-products undergo different processing steps within the black box, hence causing allocation problems for this dataset.

Unit process, single operation - Unit operation type unit process that cannot be further subdivided. Covers multi-functional processes of unit operation type.

Upstream - Occurring along the supply chain of purchased goods/ services prior to entering the system boundary.

User of the PEFCR - a stakeholder producing a PEF study based on a PEFCR.

User of the PEF method - a stakeholder producing a PEF study based on the PEF method.

User of the PEF results - a stakeholder using the PEF results for any internal or external purpose.

Verification - Conformity assessment process carried out by an environmental footprint verifier to demonstrate whether the PEF study has been carried out in compliance with the most updated version of the PEF method adopted by the Commission.

Validation - Confirmation by the environmental footprint verifier, that the information and data included in the PEF study, PEF report and the communication vehicles are reliable, credible and correct.

Validation statement - Conclusive document aggregating the conclusions from the verifiers or the verification team regarding the EF study. This document is mandatory and shall carry the electronic or handwritten signature of the verifier or, in case of a verification panel, of the lead verifier.

Verification report - Documentation of the verification process and findings, including detailed comments from the verifier(s), as well as the corresponding responses. This document is mandatory, but it may be confidential. The document shall carry the electronic or handwritten signature of the verifier, or in case of a verification panel, of the lead verifier.

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

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

Vertical aggregation - Technical- or engineering-based aggregation refers to vertical aggregation of unit processes that are directly linked within a single facility or process train. Vertical aggregation involves combining unit process datasets (or aggregated process datasets) together linked by a flow (UN Environment, 2011).

Waste - Substances or objects which the holder intends or is required to dispose of (ISO 14040:2006).

Water use - It represents the relative available water remaining per area in a watershed, after the demand of humans and aquatic ecosystems has been met. It assesses the potential of water deprivation, to either humans or ecosystems, building on the assumption that the less water remaining available per area, the more likely another user will be deprived (see also https://wulca-waterlca.org/aware/).

Weighting - Weighting is a step that supports the interpretation and communication of the results of the analysis. PEF results are multiplied by a set of weighting factors, which reflect the perceived

relative importance of the impact categories considered. Weighted EF results may be directly compared across impact categories, and also summed across impact categories to obtain a single overall score.

ANNEX 2 – LIST OF EF NORMALISATION AND WEIGHTING FACTORS

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

[The TS shall provide the list of normalisation and weighting factors that the user of the PEFCR shall apply. Normalisation and weighting factors are available at: http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml]

Impact category	Unit	Normalisation factors (unit/person)	Weighting factors (%)
Climate change, total	kg CO2 eq	8,10E+03	21,06%
Ozone depletion	kg CFC-11 eq	5,36E-02	6,31%
Particulate matter	disease incidence	5,95E-04	8,96%
Ionising radiation, human health	kBq U^{235} eq	4,22E+03	5,01%
Photochemical ozone formation, human health	kg NMVOC eq	4,06E+01	4,78%
Acidification	mol H^+ eq	5,56E+01	6,20%
Eutrophication, terrestrial	mol N eq	1,77E+02	3,71%
Eutrophication, freshwater	kg P eq	1,61E+00	2,80%
Eutrophication, marine	kg N eq	1,95E+01	2,96%
Human toxicity, cancer	CTUh	1,69E-05	2,13%
Human toxicity, non-cancer	CTUh	2,30E-04	1,84%
Ecotoxicity	CTUe	4,27E+04	1,92%
Land use	Dimensionless (pt)	8,19E+05	7,94%
Water use	m^3 world eq	1,15E+04	8,51%
Resource use, minerals and metals	kg Sb eq	6,36E-02	7,55%
Resource use, fossils	MJ	6,50E+04	8,32%

ANNEX 3 – PEF STUDY TEMPLATE

Product Environmental Footprint Report

Vegetable oil and proteinmeal industry product

Table of contents

Acronyms

[List in this section all the acronyms used in the PEF study. Those already included in the latest version of the PEF method shall be copied in their original form. The acronyms shall be provided in alphabetical order.]

Definitions

[List in this section all the definitions that are relevant for the PEF study. Those already included in the latest version of the PEF method shall be copied in their original form. The definitions shall be provided in alphabetical order.]

SUMMARY

[The summary shall include as a minimum the following elements:

- The goal and scope of the study, including relevant limitations and assumptions;
- A short description of the system boundary;
- Relevant statements about data quality,
- The main results of the LCIA: these shall be presented showing the results of all EF impact categories (characterized, normalized, weighted);
- A description of what has been achieved by the study, any recommendation 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.]

GENERAL

[The information below should ideally be placed on the front-page of the study:

- Name of the product (including a photo),
- Product identification (e.g. model number),
- Product classification (CPA) based on the latest CPA list version available,
- Company presentation (name, geographic location),
- Date of publication of the PEF study (the date shall be written in extended format, e.g. 25 June 2015, to avoid confusion over the date format),
- Geographic validity of the PEF study (countries where the product is consumed/sold),
- Compliance with the PEF method,
- Conformance to other documents, additional to the PEF method,

- Name and affiliation of the verifier(s)]

GOAL OF THE STUDY

[Mandatory reporting elements include, as a minimum:

- Intended application(s);
- Methodological limitations;
- Reasons for carrying out the study;
- Target audience;
- Commissioner of the study;
- Identification of the verifier]

SCOPE OF THE STUDY

[The scope of the study shall identify the analysed system in detail and address the overall approach used to establish: i) functional unit and reference flow, ii) system boundary, iii) list of EF impact categories, iv) additional information (environmental and technical) iv) assumptions and limitations.]

Functional/declared unit and reference flow

[Provide the functional unit, defining the four aspects:

- The function(s)/service(s) provided: "**what**";
- The extent of the function or service: "**how much**";
- The expected level of quality: "**how well**";
- The duration/life time of the product: "**how long**";

Provide the declared unit, in case the functional unit cannot be defined (e.g. if the product in scope is an intermediate product)

Provide reference flow]

System boundary

[This section shall include as a minimum:

- All life-cycle stages that are part of the product system. In case the naming of the default life cycle stages has changed, the user shall specify to which default life cycle stage it corresponds. Document and justify if life cycle stages were split and/or new ones were added.
- The main processes covered in each life cycle stage (details are in the LCI section A.5). The co-products, by-products and waste streams of at least the foreground system shall be clearly identified.
- The reason for and potential significance of any exclusion.
- A system boundary diagram with the processes that are included and those excluded, highlight those activities which falls respectively under situation 1, 2, and 3 of the Data Needs Matrix, and highlight where company-specific data are used.]

Environmental Footprint impact categories

[Provide a table with the list of EF impact categories, units, and EF reference package used (see http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml for further details).

For climate change, specify if the results of the three sub-indicators are reported separately in the results section.]

Additional information

[Describe any additional environmental information and additional technical information included in the PEF study. Provide references and exact calculations rules adopted.

Explain if biodiversity is relevant/not relevant for the product in scope.

When the product in scope is an intermediate product, additional technical information shall include:

a) Recycled content (R1).

Assumptions and limitations

[Describe all limitations and assumptions. Provide list of data gaps, if any, and the way in which these gaps were filled. Provide list of proxy datasets used.]

LIFE CYCLE INVENTORY ANALYSIS

[This section shall describe the compilation of the Life Cycle Inventory (LCI) and include:

- Screening step, if performed,
- List and description of life cycle stages,
- Description of modelling choices,
- Description of allocation approaches applied,
- Description and documentation of data used and sources,
- Data quality requirements and rating]

Modelling choices

[Describe all modelling choices for the applicable aspects listed below (more can be added, when relevant):

- Agricultural production (PEF studies which have agricultural modelling in scope and have tested the alternative approach described in section 4.4.1.5 and Table 4 of the PEF method, shall report the results in an Annex of the PEF report);
- Transport and logistics: all data used shall be provided in the report (e.g. transportation distance, payload, re-use rate for packaging, etc.). If default scenarios were not used in the modelling, provide documentation of all specific data used;
- Storage and retail;
- Electricity use;
- Sampling procedure (report if a sampling procedure was applied and indicate the approach taken);
- Greenhouse gas emissions and removals (report if a simplified approach was not used to model biogenic carbon flows);
- Offsets (if reported as additional environmental information).]

Handling multi-functional processes

[Describe the allocation rules used in the PEF study and how the modelling/calculations were made. Provide the list of all allocation factors used for each process and the detailed list of processes and datasets used, in case substitution is applied.]

Data collection

[This section shall include as a minimum:

- Description and documentation of all company-specific data collected:
    - list of processes covered by company-specific data indicating to which life cycle stage they belong;
    - list of resource use and emissions (i.e. direct elementary flows);
    - list of activity data used;
    - link to detailed bill of materials and/or ingredients, including substance names, units and quantities, including information on grades/ purities and other technically and/or environmentally relevant characterisation of these;
    - company-specific data collection/estimation/calculation procedures;
- List of all secondary datasets used (process name, UUID, dataset source (node on Life Cycle Data Network, data stock) and compliance with the EF reference package);
- Modelling parameters;
- Cut-off applied, if any;
- Sources of published literature;
- Validation of data, including documentation;
- If a sensitivity analysis has been conducted, this shall be reported.]

Data quality requirements and rating

[Provide a table listing all processes and their situation according to the Data Needs Matrix (DNM).

Provide the DQR of the PEF study.]

IMPACT ASSESSMENT RESULTS [CONFIDENTIAL, IF RELEVANT]

PEF results

[This section shall include as a minimum:

- Characterised results of all EF impact categories shall be calculated and reported as absolute values in the PEF report. The sub-categories 'climate change –fossil', 'climate change – biogenic' and 'climate change - land use and land use change', shall be reported separately if they show a contribution of more than 5% each to the total score of climate change);
- Normalised and weighted results as absolute values;
- Weighted results as single score;

Additional information

[This section shall include:

- Results of the additional environmental information;
- Results of the additional technical information.]

INTERPRETING PEF RESULTS

[This section shall include as a minimum:

- Assessment of the robustness of the PEF study;
- List of most relevant impact categories, life cycle stages, processes and elementary flows (see tables below);
- Limitations and relationship of the EF results relative to the defined goal and scope of the PEF study,
- Conclusions, recommendations, limitations and improvement potentials)].

Item	At what level does relevance need to be identified?	Threshold
Most relevant impact categories	Normalised and weighted results	Impact categories cumulatively contributing at least **80%** of the total environmental impact
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 (along the entire life cycle) more than **80%** to that impact category, considering absolute values.
Most relevant elementary flows	For each most relevant process	All elementary flows contributing cumulatively at least to 80% to the total impact for each most relevant processes. If disaggregated data are available: for each most relevant process, all direct elementary flows contributing cumulatively at least to **80%** to that impact category (caused by the direct elementary flows only)

Example:

Most relevant impact category	[%]	Most relevant life cycle stages	[%]	Most relevant processes	[%]	Most relevant elementary flows	[%]
IC 1		End of life		Process 1		el. flow 1	
						el. flow 2	
				Process 2		el. flow 2	

		Raw material acquisition and p.p.		Process 4		el. flow 1	
IC 2		Manufacturing		Process 1		el. flow 2	
						el. flow 3	
IC 3		Manufacturing		Process 1		el. flow 2	
						el. flow 3	

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;
- Detailed life cycle inventory analysis (optional if considered sensitive and communicated separately in the confidential annex, see below)
- Detailed assessment of data quality: Provide i) Data Quality Rating per process in accordance with the PEF Method and ii) Data Quality Rating for the newly created EF-compliant datasets. In case information is confidential, it shall be included in Annex II.]
-

ANNEX II – CONFIDENTIAL REPORT

[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.]

ANNEX 4 – SAMPLING PROCEDURE

In some cases, a sampling procedure is needed to limit the data collection only to a representative sample of plants, farms etc. The user of the PCR shall (i) specify in the PEF report if sampling was applied, (ii) follow the requirements described in this section and (iii) indicate which approach was chosen.
Examples of cases when the sampling procedure may be needed are in case multiple production sites are involved in the production of the same product. E.g., in case the same raw material/input material comes from multiple sites or in case the same process is outsourced to more than one subcontractor/ supplier.
The representative sample shall be derived via a stratified sample, i.e. one that ensures that sub-populations (strata) of a given population are each adequately represented within the whole sample of a research study. Using a stratified sample allows to achieve greater precision than a simple random sample, provided that the sub-populations have been chosen so that the items of the same sub-population are as similar as possible in terms of the characteristics of interest. In addition, a stratified sample guarantees better coverage of the population[21].

The following procedure shall be applied in order to select a representative sample as a stratified sample:
(1) define the population;
(2) define homogeneous sub-populations (stratification);
(3) define the sub-samples at sub-population level;
(4) define the sample for the population starting from the definition of sub-samples at sub-population level.

1 How to define homogeneous sub-populations (stratification)

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

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

Additional aspects to be taken into consideration may be added.

The number of sub-populations shall be identified as:

$$Nsp=g*t*c$$

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

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

[21] The researcher has control over the sub-populations that are included in the sample, whereas simple random sampling does not guarantee that sub-populations (strata) of a given population are each adequately represented within the final sample. However, one main disadvantage of stratified sampling is that it may be difficult to identify appropriate sub-populations for a population.

Example 1
Identify the number of sub-populations for the following population:
350 farmers located in the same region in Spain, all the farmers have more or less the same annual production and are characterized by the same harvestings techniques.

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

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

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

Example 2
350 farmers are distributed in three different countries (100 in Spain, 200 in France and 50 in Germany). There are two different harvesting techniques that are used that differ in a relevant way (Spain: 70 technique A, 30 technique B; France: 100 technique A, 100 technique B; Germany: 50 technique A). The capacity of the farmers in term of annual production varies between 10,000t and 100,000t. According to expert judgement/ relevant literature, it has been estimated that farmers with an annual production lower than 50,000t are completely different in terms of efficiency compared to the farmers with an annual production higher than 50,000t. Two classes of companies are defined based on the annual production: class 1, if production is lower than 50000 and class 2, if production if higher than 50,000. (Spain: 80 class 1, 20 class 2; France: 50 class 1, 150 class 2; Germany: 50 class 1).
Table 18 includes the details about the population.

Table 18: Identification of the sub-population for Example 2

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

In this case:

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

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

It is possible to identify maximum 12 sub-populations that are summarized in Table 19:

Table 19: Summary of the sub-population for example 2

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

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

Once the sub-populations have been identified, for each sub-population the size of sample shall be calculated (the sub-sample size) based on the number of sites/farms/plants involved in the sub-population:
The required sub-sample size shall be calculated using the square root of the sub-population size.

$$n_{SS}=\sqrt{n_{SP}}$$

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

Example

Table 20: Example: how to calculate the number of companies in each sub-sample

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

3 How to define the sample for the population

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

4 What to do in case rounding is necessary

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

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

ANNEX 5 – REVIEW STATEMENT

Critical Review Statement

PRODUCT ENVIRONMENTAL FOOTPRINT CATEGORY RULES FOR VEGETABLE OIL AND PROTEINMEAL INDUSTRY PRODUCTS

Commissioned by*:*	FEDIOL - European vegetable oil and proteinmeal industry association, Belgium
Prepared by:	VITO, Belgium
Reviewer:	Prof. Dr. Matthias Finkbeiner, Germany
References	Product Environmental Footprint (PEF) method including Zampori, L. and Pant, R., Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-00654-1, doi:10.2760/424613, JRC115959.

Scope of the Critical Review

The reviewer had the task to assess whether the PEFCR is consistent with the PEF method. The review was performed concurrently to the PEFCR development. This review statement is only valid for this PEFCR in its final version V1.0 dated April 2022.

Outside the scope of this review were

- the verification of assumptions made for the types and properties of vegetable oil and proteinmeal products including the representative product
- the underlying LCA model and
- the verification of individual LCI datasets.

Review process

The review process was coordinated between FEDIOL, VITO and the reviewer. As a first step in the review process, the first draft of the PEFCR was submitted to the reviewer on 24.08.2021. The reviewer provided 27 comments of general, technical and editorial nature to VITO and FEDIOL by 19.09.2021.

As a next step, VITO provided the second draft of the PEFCR and responses to the review comments on 09.03.2022. The reviewer provided 35 comments of general, technical and editorial nature and sent them to the

commissioner by 20.03.2022. A critical review meeting with VITO (web conference) was held on 28.03.2022 to address the comments that needed additional information or agreement on how they are supposed to be implemented. VITO provided a revised and final PEFCR and documentation on the implementation of the review comments on 02.05.2022.

Most critical issues and several of the recommendations of the reviewer were addressed in this revision. Several reviewer comments intended to improve the scientific and technical validity of the PEFCR were not implemented as the PEF method prescribed a different approach or wording. The reviewer acknowledges the unrestricted access to all requested information as well as the open and constructive dialogue during the critical review process.

General evaluation

The scope of this PEFCR are products of the vegetable oil and proteinmeal industry. FEDIOL members represent more than 85% of EU vegetable oil and proteinmeal production. For this PEFCR, thirteen FEDIOL member companies were involved, who participated in meetings and provided feedback on the draft documents. Ten member companies provided data for the life cycle assessment of the sector average products and representative product. The provided data are applicable to 33% of the EU vegetable oil sector.

The PEFCR was developed in a professional manner using the PEF method as a baseline approach. As transparently documented in the PEFCR itself, the following aspects should be noted for a proper interpretation and for potential future updates of the study:

- This PEFCR is not fully compliant with the PEF method as the official process of developing a PEFCR has not been followed. The document is thus no official PEFCR.
- Because of the PEFCR not being fully compliant with PEF, studies performed according to this PEFCR are not fully compliant either.
- In December 2021 the European Commission has published the Recommendation on the use of Environmental Footprint methods including methodological updates. As this was released after the main part of this PEFCR was done, this update was not considered.
- Some data sources are not fully PEF compliant.

Conclusion

The PEFCR is to a large extent compliant with Product Environmental Footprint (PEF) method.

16th May 2022