

Report 2026

Environmental footprint methodology for margarine

Shadow PEFCR for the European Margarine Association

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Mérieux NutriSciences | Blonk is a leading international expert in food system sustainability, inspiring and enabling the agri-food sector to give shape to sustainability. Our purpose is to create a sustainable and healthy planet for current and future generations. We support organizations in understanding their environmental impact in the agri-food value chain by offering advice and developing tailored software tools based on the latest scientific developments and data.

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List of Abbreviations

ADP-fossil – Abiotic Depletion Potential - fossil fuels

B2B – Business to Business

B2C – Business to Consumer

CFF – Circular Footprint Formula

COD – Chemical Oxygen Demand

CPA – Classification of Products by Activity

CTUe – Comparative Toxic Unit for ecosystems

DC – Distribution Centre

DEFRA – Department for Environment, Food & Rural Affairs (UK)

EF – Environmental Footprint

EoL – End-of-Life

FU – Functional Unit

GHG – Greenhouse Gas

GLO – Global (in datasets)

ISO – International Organization for Standardization

LANCA® – Land Use Indicator Value Calculation in Life Cycle Assessment

LCA – Life Cycle Assessment

LCI – Life Cycle Inventory

LCIA – Life Cycle Impact Assessment

LDPE – Low Density Polyethylene

LHV – Lower Heating Value

MJ – Megajoule

NH₃ – Ammonia

NO₃ – Nitrate

NO_x – Nitrogen Oxides

PA66 – Polyamide 66

PAS 2050 – Publicly Available Specification 2050

PBT – Polybutylene Terephthalate

PC - Polycarbonate

PEF – Product Environmental Footprint

PEFCR – Product Environmental Footprint Category Rules

PEI - Polyetherimide



PET – Polyethylene Terephthalate

PM – Particulate Matter

PO₄ – Phosphate

POM - Polyoxymethylene

PP – Polypropylene

Pt – Points (dimensionless)

PPE – Polyphenylene Ether

PPS – Polyphenylene Sulphide

PS – Polystyrene

PVC – Polyvinyl Chloride

ReCiPe – Life Cycle Impact Assessment Methodology

RED – Renewable Energy Directive

RoW – Rest of World

SAN – Styrene Acrylonitrile

SEBS – Styrene-Ethylene-Butylene-Styrene

SO_x – Sulphur Oxides

TDS – Total Dissolved Solids

TS – Technical Secretariat

UNEP – United Nations Environment Programme

VOC – Volatile Organic Carbon

WFLDB – World Food LCA Database

WRI-WBCSD – World Resources Institute – World Business Council for Sustainable Development



Definitions

Activity data	This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF Guide it is also called “nonelementary flows”. The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data and then combined to derive the environmental footprint associated with that process. Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. In the context of PEF the amounts of ingredients from the bill of material (BOM) shall always be considered as activity data.
Acidification	EF impact category that addresses impacts due to acidifying substances in the environment. Emissions of NO _x , NH ₃ and SO _x lead to releases of hydrogen ions (H ⁺) when the gases are 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.
Aggregated dataset	This term is defined as a life cycle inventory of multiple unit processes (e.g. material or energy production) or life cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level. Aggregated datasets are also called “LCI results”, “cumulative inventory” or “system processes” datasets. The aggregated dataset can have been aggregated horizontally and/or vertically. Depending on the specific situation and modelling choices a “unit process” dataset can also be aggregated
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 14044, 2006).
Average 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 can be made. In the context of PEF, the term ‘benchmark’ refers to the average environmental performance of the representative product sold in the EU market. A benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.
Bill of materials	A bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product
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 consumer (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” (ISO 14025, 2006).
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.
Characterization factor	“Factor derived from a characterization model which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator” (ISO 14044, 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 and 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.
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/TS 14071 (2014)) (ISO/TS 14071, 2014).
Company-specific data	It refers to directly measured or collected data from one or multiple facilities (site-specific data) that are representative for the activities of the company. It is synonymous to “primary data”. To determine the level of representativeness a sampling procedure can be applied.
Comparative assertion	An environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (adapted from ISO 14025:2006).
Co-product	“Any of two or more products coming from the same unit process or product system” (ISO 14044, 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	An assessment, including 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 14044, 2006).
Data quality rating (DQR)	Semi-quantitative assessment of the quality criteria of a dataset based on Technological representativeness, Geographical representativeness, Time related representativeness, and Precision. The data quality shall be considered as the quality of the dataset as documented.



Direct elementary flows	Also named elementary flows – All output emissions and input resource use that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite.
Disaggregation	The process that breaks down an aggregated dataset into smaller unit process datasets (horizontal or vertical). Disaggregation can help making data more specific. The process of disaggregation should never compromise or threat to compromise the quality and consistency of the original aggregated dataset.
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 a release of substances with a direct effect on the health of the ecosystem.
Elementary flow	“Material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation” (ISO 14044, 2006).
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. The impact assessment methods provide impact characterisation factors for elementary flows, to aggregate the impact so as to obtain a limited number of midpoint indicators.
Environmental footprint (EF) impact assessment method	Protocol for converting life cycle inventory data into quantitative 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.
Environmental impact	Any change to the environment, whether adverse or beneficial, that wholly or partially results from an organisation’s activities, products or services.
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; and Eutrophication, marine.
Final product	Final products qualify products sold from business to consumer (B2C), for which the PEFCR provides rules from cradle-to-grave.



Functional unit	“Quantified performance of a product system for use as a reference unit” (ISO 14044, 2006).
Global warming potential	Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO ₂ -equivalent units) and specified time horizon (e.g. GWP ₂₀ , GWP ₁₀₀ , GWP ₅₀₀ , for 20, 100, and 500 years respectively). It relates to the capacity to influence changes in the global average surface-air temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.
Human toxicity, cancer	EF impact category that accounts for adverse effects on human health 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 effects on human health caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to non-cancer effects that are not caused by particulate matter/respiratory inorganics or ionising radiation.
Input flow	“Product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and coproducts”(ISO 14044, 2006).
Intermediate product	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 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).
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 or organisation 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 14044, 2006).
Life cycle inventory analysis (LCI)	“Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.” (ISO 14044, 2006).
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.

Normalisation	After the characterisation step, normalisation is the step in which the life cycle impact assessment results are multiplied 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.
Margarine	Products in the form of a solid, semi-liquid, malleable emulsion, principally of the water-in-oil type, derived from solid and/or liquid vegetable and/or animal fats suitable for human consumption (such as margarines, spreads, blends, melanges for spreading, cooking, baking) or to be used as an ingredient for other food products and food applications (B2C & B2B). Fat content 20-80% for B2C products, and 60-99% fat B2B products, in accordance with the EU Regulation 1308/2013 (see EU 1308/2013 Annex VII, Appendix II)
Output flow	"Product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases" (ISO 14044, 2006).
Ozone depletion	EF impact category that accounts for the degradation of stratospheric ozone due to emissions of ozone-depleting substances, for example longlived chlorine and bromine containing gases (e.g. CFCs, HCFCs, Halons).
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 (NO _x , SO _x , NH ₃).
PEFCR supporting study	The PEF study done on the basis of a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.
PEF screening	A preliminary study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the product category/sub-categories in scope, and any other major requirement to be part of the final PEFCR.
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 (NO _x) and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts and manmade materials through reaction with organic materials.
Primary data	This term refers to data from specific processes within the supply chain of the company applying the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply chain-specific. Primary data may be obtained through meter readings,



	purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the company applying the PEFCR. Primary data is synonym of "company-specific data" or "supply chain-specific data".
Primary packaging	Material that first envelops the product. For dairy products, primary packaging can consist either of a container (bottle, liquid packaging carton, cup, jar, pouch) and a closure (lid, cap), or of a wrapper.
Product	"Any goods or service" (ISO 14044, 2006).
Product category	"Group of products (or services) that can fulfil equivalent functions" (ISO 14025, 2006)
Product category rules	"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 (PEFCR)	Product category-specific, life-cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF guide.
Representative product	The "representative product" may or may not be a real product that one can buy on the EU market. Especially when the market is made up of different technologies, the "representative product" can be a virtual (nonexisting) product built, for example, from the average EU sales-weighted characteristics of all technologies around. A PEFCR may include more than one representative product if appropriate.
Representative sample	A representative sample with respect to one or more variables is a sample in which the distribution of these variables is exactly the same (or similar) as in the population from which the sample is a subset.
Sample	A sample is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.
Secondary data	It refers to data not from specific process within the supply chain of the company applying the PEFCR. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third-party life-cycle-inventory database or other sources. Secondary data includes industry-average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and can also be based on financial data, and contain proxy data, and other generic data. Primary data that go through a horizontal aggregation step are considered as secondary data.
Secondary packaging	Package or containment of a primary package. Multipacks and labels are considered as secondary packaging.
Sensitivity analysis	Systematic procedures for estimating the effects of the choices made regarding methods and data on the outcome of a study (ISO 14044, 2006).



Site-specific data	It refers to directly measured or collected data from one facility (production site). It is synonymous to “primary data”.
Sub processes	Those processes used to represent the activities of the level 1 processes (=building blocks). Sub-processes can be presented in their (partially) aggregated form.
Supply chain	It refers to all the upstream and downstream activities associated with the operations of the company applying the PEFCR, including the use of sold products by consumers and the end of life treatment of sold products after consumer use.
Supply chain-specific	It refers to a specific aspect of the specific supply chain of a company. For example, the recycled content value of an aluminium can produced by a specific company.
System boundary	Interface between a product system and the environment or other product systems (ISO 14040, 2006).
System boundary diagram	Graphical representation of the system boundary defined for the PEF study.
Tertiary packaging	Packaging conceived so as to facilitate handling and transport of a number of sales units or grouped packaging in order to prevent physical handling and transport damage.
Unit process dataset	Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 14044, 2006). In LCA practice, both physically not further separable processes (such as unit operations in production plants, then called “unit process single operation”) and also whole production sites are covered under "unit process", then called “unit process, black box” (ILCD Handbook).
Upstream	Occurring along the supply chain of purchased goods/ services prior to entering the system boundary.
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.
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.
Waste	Substances or objects which the holder intends or is required to dispose of (ISO 14044, 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.
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.



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1. Introduction

This document provides complete and detailed guidance on how to conduct a comprehensive environmental footprinting study for margarine and other emulsified fats.

An environmental footprinting (EF) study, also referred to as a life cycle assessment (LCA), is a framework to evaluate the environmental impact of a product or system throughout all the stages of its life cycle, from extraction of raw materials to end of life. At each life cycle stage, it quantifies the necessary inputs (such as energy, materials, water, land) and outputs (such as co-products, waste streams and emissions to air, water and soil).

EF studies are carried out to gain a better understanding of the environmental performance of a product and to identify hotspots and potential strategies that can reduce its environmental impact. The results of an EF study can be used for internal purposes but can also be used for external communication.

An EF can be sensitive to methodological and data choices made by an LCA practitioner, which can potentially lead to different outcomes of an EF performed for the same product by different practitioners. These EF guidelines reduce the number of sensitive choices. They provide a harmonised and consistent set of rules that can be used to calculate the impact of margarine, ensuring the outcomes of the EF study are reproducible and use comparable principles.

For the entire life cycle of margarine, by providing detailed guidance for each of the production steps, these guidelines explain in detail:

- What data are needed, and whether it should be based on primary or secondary sources;
- What inputs, outputs and emissions should be included, and how these can be calculated;
- How to deal with margarine-specific situations (e.g. processing methods, packaging materials, distribution channels, manufacturing conditions, and use and end-of-life scenarios);
- Methodological choices, such as allocation, carbon removals, and recycling of packaging;
- What defaults and proxies may or should be used in case of unavailable data.

This document is not an official PEFCR and cannot be used to claim PEFCR compliance. These guidelines align as much as possible with the guidance developed by the European Commission for the development of Product Environmental Footprint (PEF) studies, which build upon the international ISO LCA standards and is why they are referred to as “Shadow PEFCR”. At the time this document was developed, there was no opportunity to create an official PEFCR with the European Commission. The European Commission is currently in a transition phase, during which there is no formal application and registration for official PEFCR developments. Despite that, the aim was to stay as close as possible to current PEFCR guidelines to have a solid methodology that can serve as foundation for when a new opportunity arises to develop an official PEFCR.

For feedback on and questions about these guidelines, please contact: Davide Lucherini (davide@blonksustainability.nl)



2. General information

2.1 Development of the guidelines

This study was commissioned by the European Margarine Association (IMACE) and guided by Mérieux NutriSciences | Blonk. The content of these guidelines has been prepared and written by Mérieux NutriSciences | Blonk but has been decided upon and revised by the technical secretariat (TS) Table 1 below lists the members of the technical secretariat.

Table 1 : Members of the technical secretariat.

Organization	Members
Vandemoortele	Carine Hintjens
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The TS has been supported by several employees from Mérieux NutriSciences | Blonk, as listed in Table 2.

Table 2: Functions of Mérieux NutriSciences | Blonk employees involved in the guideline development.

Mérieux NutriSciences Blonk employees involved	Function in guideline development
Elisabeth Keijzer	Lead in set up phase
Lana Liem	Execution
Eline Disselhorst	Execution
Jasper Scholten	Support
Davide Lucherini	Lead & main author

2.2 Review statement

These guidelines were reviewed by an external party, namely, Anton Kool from Kool planet. The review statement can be found in Appendix II.

2.3 Relations to other guidelines

Wherever possible, we aligned with existing environmental footprinting standards at the European level, particularly the Commission Recommendations (EU) 2021/2279 on the use of the Environmental Footprint method (European Commission, 2021). More specifically, alignment was sought with the Product Environmental Footprint (Annexes 1 to 2), also referred to as “generic PEF” in this document. At the time of publication, there is awareness of the future publication of the updated PEF guidance in 2026. Alignment with what is expected to be proposed was retrieved from correspondence with the European Commission. When possible, from a methodological perspective, aspects are integrated. However, full alignment cannot be guaranteed. It is recommended that this guidance is reviewed once the formal application to a PEFCR is opened.

In addition to the generic PEF, this document has taken inspiration from the Product Environmental Footprint Category Rules (PEFCR) of Dairy (The European Dairy Association (EDA), 2025a) and the Feed PEFCR in regarding certain modelling choices and default data (FEFAC, 2024). Similarly, the Shadow PEFCR of Vegetable oils is used to set up the first part of the production system of margarine products (De Smet et al., 2022).

Disclaimer

This document is not an official PEFCR and cannot be used to claim PEFCR compliance. The guidelines differ from the official PEFCR development in several ways: no representative products were modelled, and no supporting studies were conducted, which are crucial for identifying relevant impact categories and life cycle stages. Instead, these were identified through literature and expert recommendations. Additionally, the guidelines were not reviewed by the European Commission's Technical Advisory Board (TAB). A public consultation was conducted. The use of the European Environmental Footprint (EF) database, typically required for PEF-compliant studies, may only be used in the context of official PEFCRs and thus is also not allowed. According to direct communication with the TAB, the right use of EF data might change when the new EF database will be published.

These guidelines aim to establish key methodological rules for measuring the environmental impact of margarine without providing exact quantifications for benchmarks. While not the main focus of the guidelines, this report provides recommended certain background datasets, subject to their specific terms and conditions. The intend of this document is to guide the reader into how to perform an LCA specific for the margarine sector. Comparisons may be relevant with products in the same category/that fulfil the same function. For the margarine sector, comparison of a products environmental performance with dairy products with similar functions is highly relevant, an annex (Annex I) to this PEFCR is developed with extra guidance on how to make equal comparisons between these products.

2.4 Terminology

(Based on generic PEF)

These guidelines use precise terminology to indicate the requirements, the recommendations and options that could be chosen when executing an EF:

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

2.5 Geographical validity

These guidelines are focused on margarine sold or used in the European Union, the UK (since the PEF framework formerly did apply to the UK before Brexit, leading to harmonized sustainability standards with the EU) and the European Free Trade Area. However, use of the guidelines is valid for all other geographical regions. It is expected that these guidelines will primarily be used by companies that manufacture or sell margarine. Products that are produced in the European Union and sold outside of the EU may also be analysed using this guidance. Additional activity data may be collected for the life cycle stages that occur outside of the EU.

2.6 Language

The guidelines are written in English. At this stage, there are no plans to make this document available in other languages. If conflicts arise between translated versions and the original English document, the English version prevails.



3. Goal and scope

3.1 Product classification

Margarine and other emulsified products can be defined as a food product made primarily from refined vegetable oils and/or fats, processed into a semi-solid or liquid form suitable for various culinary uses. The products in scope for these guidelines are margarine and other emulsified products for baking, frying, spreading, cooking and use as a greasing agent. These guidelines cover different packaging formats and functional uses of margarine and include intra-category comparisons between various margarine and other emulsified products. The exact definition of the products in scope for this PEFCR is given below:

Products in the form of a solid, semi-liquid, malleable emulsion, principally of the water-in-oil type, derived from solid and/or liquid vegetable and/or animal fats¹ suitable for human consumption (such as margarines, spreads, blends, melanges for spreading, cooking, baking) or to be used as an ingredient for other food products and food applications (B2C & B2B). Fat content 20-80% for B2C products, and 60-99% fat B2B products, in accordance with the EU Regulation 1308/2013 (see EU 1308/2013 Annex VII, Appendix II)

No products are explicitly out of scope. For reading purposes, from hereafter, margarine and other emulsified products, are referred to as margarine. It is important to use the correct legal definition in the product LCA performed in accordance with this PEFCR.

Additionally, margarine products are frequently used in a similar functionality, therefore a comparison to butter is made possible. The requirements for comparison are described in Appendix I. Note that this guidance is not intended for the modelling of dairy products such as butter. The dairy PEFCR shall be consolidated to perform an environmental footprinting assessment for butter (The European Dairy Association (EDA), 2025a).

3.2 Functional unit

The Functional Unit (FU) provides a quantitative and qualitative description of the performance of a product, and is used as a reference unit, allowing equitable comparisons between products.

Within these guidelines, the functional unit will be defined as below, more information is given in Table 3.

For (semi-)solid margarines:

1 kg of margarine for use as a spread, baking, frying or cooking fat, or use as a greasing agent.

For liquid margarines:

1 liter of margarine for use as a baking, frying or cooking fat, or use as a greasing agent*.

*For liquid margarines the functional unit may also be expressed with the mass units (kg) for comparative LCA's.

Table 3: Key aspects of the functional unit (FU).

Dimension	Definition for (semi-)solid margarines	Definition for liquid margarines
Functional Unit Quantified performance of a product system, to be used as a reference unit	1 kg of margarine for use as a spread, baking, frying or cooking fat or use as a greasing agent.	1 Liter of margarine for use as a spread, baking, frying or cooking fat or use as a greasing agent.

¹ Note that for butter a separate legal definition applies and the Dairy PEFCR shall be consulted.

What? The function/service provided	To provide a (partially) plant-based product for use as spread, baking, frying or cooking fat as a greasing agent.	To provide a (partially) plant-based product for use as spread, baking, frying or cooking fat as a greasing agent.
How much? The extent of the function or service	1 kg	1 Liter
How well? The expected level quality	For human consumption	For human consumption
How long? The duration/lifetime of the product	Until at least 2 months after production	Until at least 2 months after production
Reference flow Amount of product needed to fulfil the defined function	1 kg of margarine (2 margarine folds of 500 grams or 2 tubs of 500 grams)	1 Liter of liquid margarine (1 flask of 1 liter or 0.33 flask of 3 liter)

3.3 System boundaries

The system boundaries define which processes should be included or excluded from the study. A distinction is made between B2B and B2C products in terms of system boundaries. The B2C products are readily made at the margarine production stage and do not need further processing. B2B products have a wide variety of use cases and applications and generally need further processing before final consumption. Hence, there is little control of the margarine producer and LCA practitioners and is decided to follow different system boundaries. Both system boundaries can be applied on the Functional Units of (semi-)solid and liquid margarine.

The life cycle stages that shall be included within the system boundary for margarine are summarized below in Figure 1 and Figure 2 and Table 4 . As is seen in the figures, the scope of B2C is so called “Cradle-to-cradle” and the scope of B2B products is so called “Cradle-to-gate”.

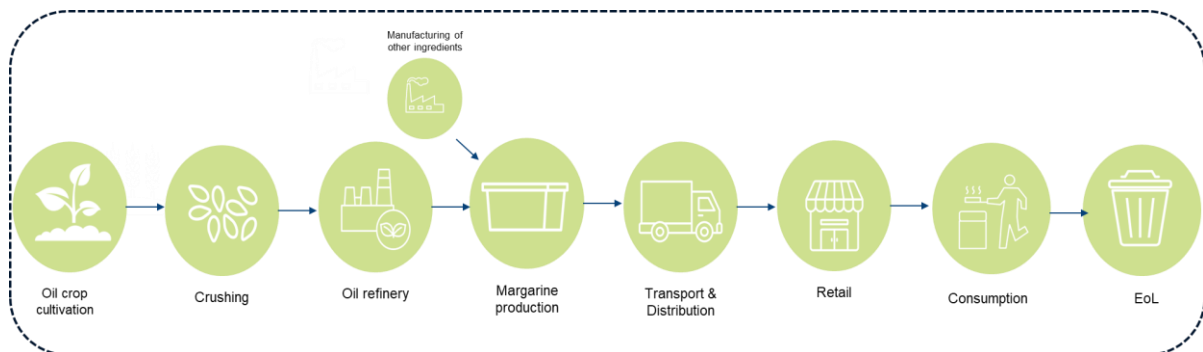


Figure 1 : System boundary diagram of the margarine life cycle for B2C product

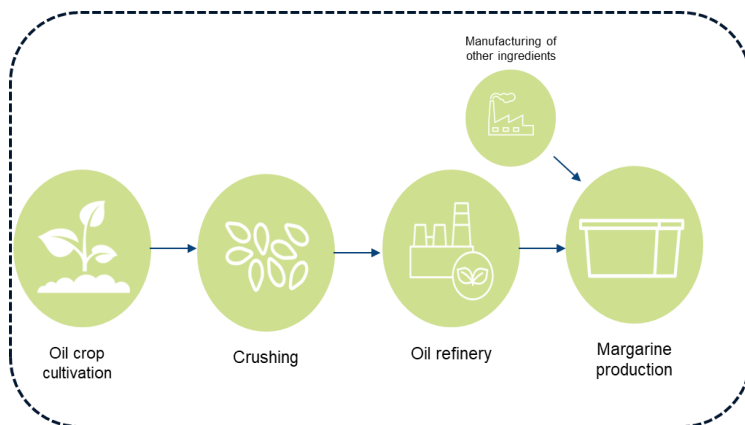


Figure 2: System boundary of the margarine life cycle for B2B products

All stages described in Table 4 below are relevant for B2C products. For B2B products, up till distribution (stage 7) is included. This means that everything up until the production of the margarine is analysed including the transport to the final client (B2B)

Table 4 : Life cycle stages of margarine

Main life cycle stage (generic PEF)	Specific life cycle stage (these guidelines)	Section (these guidelines)	Relevant activities
Agricultural inputs acquisition and pre-processing	1. Oil crop cultivation	5.1	<ul style="list-style-type: none"> • Production and inbound transport of cultivation inputs; application of the cultivation inputs (synthetic and organic fertilizers, pesticides, water, etc.); • Land use change (over a period of 20 years): shall be included and accounted for. • Cultivation: Co-products, field residues, yield, electricity use, fertilizer use, pesticide application, diesel and natural gas use • Drying: energy inputs (if relevant) • Waste & residue generation resulting from cultivation and harvest activities and its management.
	2. Oil crop pre-processing (crushing)	5.2	<ul style="list-style-type: none"> • Transport of inputs • Processing inputs; Raw materials (list of ingredients), electricity, steam, water, chemicals • Products, co-products & waste management
	3. Oil processing (refinery)	5.2	<ul style="list-style-type: none"> • Transport of inputs • Processing inputs: Raw materials (list of ingredients), electricity, steam, water, chemicals • Products, co-products & waste management
	4. Manufacturing of other ingredients / other raw material acquisition	5.3	<ul style="list-style-type: none"> • Raw material acquisition and manufacturing of other inputs: Salt, vitamins, flavourings, emulsifiers, thickeners (starch etc.), conservatives, colourants, antioxidant, minerals. • Inputs of processing of raw materials: refining steps, further processing. • Storage at manufacturing facility: energy use, refrigerant leakage, storage time
Production of the main product	5. Transport	5.4	<ul style="list-style-type: none"> • Transport of refined oil to the point of manufacturing; • All local and international transportation steps; • Transport from point of processing to the point of manufacturing. • All transport legs include distance, mode and load factor
	6. Margarine Manufacturing (Including	5.4	<ul style="list-style-type: none"> • Processing inputs: Raw materials (list of ingredients), electricity, steam, water, chemicals, energy type and amount

Main life cycle stage (generic PEF)	Specific life cycle stage (these guidelines)	Section (these guidelines)	Relevant activities
	emulsification, cooling and crystallization)		<p>Products, co-products, losses & waste management</p> <ul style="list-style-type: none"> Storage at margarine manufacturing facility: energy use and type, refrigerant leakage, storage time Mass balance
	7. Consumer/B2B packaging	5.5	<ul style="list-style-type: none"> All activities related to primary, secondary and tertiary packaging of margarine products per functional unit; Manufacturing of packaging of margarine products; Production of their raw materials, processing of recycled materials, transport of packaging materials to manufacturing facility and the packaging process itself.
Product distribution and storage	8. Distribution	5.4	<ul style="list-style-type: none"> Energy use and type, and storage time at distribution centre or storage facility Transport of packaged margarine to distribution centres Transport of packaged margarine from distribution centres to points of sale; The sale of margarine via retail stores, e-commerce etc..
	9. Retail or food service	5.5	<ul style="list-style-type: none"> Energy use and type, and storage time Losses and waste management
Use stage (only to be included if manufactured product is final product)	10. Consumption	5.6	<ul style="list-style-type: none"> Storage of product (ambient or refrigerated) Energy use and type for preparation/intended use of the product Waste generation at consumer
End-of-Life	11. End-of-Life	5.7	<ul style="list-style-type: none"> End-of-life (EoL) of packaging waste etc. Energy use and type Transport from point of disposal to point of final waste management.

3.4 Most relevant impact categories

A life cycle impact assessment (LCIA) method converts the life cycle inventory data into contributions to each of the environmental impact categories in scope of the LCA. This is also referred to as characterisation. To align as much as possible with current PEFCR guidelines, the most recent version of the EF impact assessment method shall be used for characterization of the EF. For internal purposes, also other impact assessment methods covering multiple impact categories, such as the internationally applicable ReCiPe method, may be used, either solely or in addition to the use of the EF method (Huijbregts et al., 2017).

For each individual EF study, the most relevant impact categories should be determined, jointly with the most relevant processes and elementary flows. This is part of the life cycle interpretation and serves to identify hotspots.

The most relevant impact categories are those that together contribute to at least 80% of the total environmental impact (single score). These cut-off percentages are defined in the generic PEF (European Commission, 2021).

For these guidelines, the identification of the most relevant impact categories was based on industry knowledge and the PEF report of vegetable oil and protein meal industry products written by FEDIOL (De Smet et al., 2022) and aligns with the PEF methodology. The list in Table 5 serves as the baseline set of relevant impact categories and shall be assessed when conducting an EF study in accordance with these guidelines. Depending on the goal and scope of the assessment, additional impact indicators may also be considered.

Table 5 : EF impact categories relevant to these guidelines.

Impact category	Unit	Reporting category
Climate change - Fossil	kg CO2eq	Shall
Climate change - Biogenic	kg CO2eq	Shall
Climate change - Land use and LU change	kg CO2-eq	Shall
Land use	Pt	Shall
Particulate matter	disease inc.	Shall
Ecotoxicity, freshwater	CTUe	Should
Acidification	mol H+ eq	Should
Eutrophication, terrestrial	mol N eq	Should
Eutrophication, freshwater	Kg P eq	Should
Eutrophication, marine	Kg N eq.	Should
Water use	m3 depriv.	Should

You shall report the impact categories climate change, land use and fine particulate matter. You should report freshwater ecotoxicity, acidification, freshwater, water use and terrestrial eutrophication. You may report on any other impact category. In direct comparison with dairy products it is recommended to also report the most relevant impact categories according to the dairy PEFCR. The most relevant impact categories are elaborated on below.

Note that the most relevant impact categories are based on the overall impact of margarine that cover at least 80% of the environmental burden. The LCA practitioner/company performing the LCA is encouraged to report on additional impact categories that are considered relevant in their context. external communication may focus on any chosen impact category, as long as the communicated results referred to the LCA report which discussed all most relevant categories as explained in the paragraph above.

Most relevant impact categories:



- **Acidification:** This EF impact category addresses impacts due to acidifying substances in the environment. Emissions of NO_x, NO₃ and SO_x lead to the release of hydrogen ions (H⁺) when these gases are mineralized, which in turn acidify soils and water bodies. In areas where buffering capacity is low, this may result in forest decline and lake acidification.
- **Climate change:** This impact category can be divided into three sub-categories: fossil, biogenic and land use change. According to the generic PEF, the three indicators shall be reported separately if they show a contribution of greater than 5% each to the total score of climate change; this shall apply in these guidelines too. For land use change (LUC) emissions, the generic PEF recommends using primary data. These guidelines acknowledge the dearth of primary data with regards to land use change. Primary data is strongly recommended for LUC. If there is no primary data available, secondary data may be an alternative option.
 - **Climate change – fossil:** This sub-category includes emissions from peat and calcination/carbonation of limestone.
 - **Climate change – biogenic:** This sub-category covers emissions to air originating from the oxidation and/or reduction of biomass by means of its transformation or degradation and CO₂ uptake from the atmosphere through photosynthesis during biomass growth. A simplified modelling approach shall be used when modelling the foreground emissions. Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from the atmosphere are included. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining methane.
 - **Climate change – land use and land use change:** This sub-category accounts for carbon uptakes and emissions originating from carbon stock changes caused by LUC and land use.
- **Ecotoxicity, freshwater:** This impact category addresses the ways in which the release of certain toxic substances can affect the health of an ecosystem. This is prominently occurring with the application of pesticides during cultivation.
- **Eutrophication (marine and freshwater):** Eutrophication is the enrichment of a water body with nutrients, usually an excess amount of nutrients that induces growth of plants and algae to the biomass load. The extreme growth may result in oxygen depletion of the water body and cause species to suffocate. Freshwater and marine eutrophication both have their distinct nutrients which cause excessive growth of plants and algae, since the limiting growth factor is different in both waterbodies. For freshwater waterbodies the limiting factor are phosphorus containing substances, usually from fertilizers or phosphorus containing detergents. Therefore, the reference unit for freshwater eutrophication is kg phosphor equivalents. For marine waters the limiting factor is nitrogen and therefore marine eutrophication potential is expressed in kg nitrogen equivalents. Only freshwater eutrophication is considered at end-point result for ecosystems domain
- **Land use:** This impact category refers to the land that is occupied for the production of a food product. Both land occupation for cultivation and all other steps in the life cycle are accounted for.
- **Particulate matter:** This impact category accounts for the adverse effects on human health caused by emissions of particulate matter (PM) and its precursors (NO_x, SO_x, NH₃).
- **Water use:** This impact category refers to the potential impacts of water consumption on both the environment and ecosystems, particularly due to deprivation of water resources in regions where water is scarce.

Robustness



The European commission has categorised the impact categories according to their robustness. The categorisation is as follows, from more robust to less robust. Highlighted in bold are the prescribed set of categories.

- Group 1: climate change, ozone depletion, particulate matter
- Group 2: Ionising radiation, photochemical ozone formation, acidification, eutrophication (terrestrial, marine and fresh water)
- Group 3: Land use, water use, resources use (mineral and energy carriers), ecotoxicity, human toxicity (cancer and non-cancer).

It can be noted that two of the recommended categories are in group 1, four categories are in group 2 and three are in group 3. When performing the LCA it is important to keep in mind the lower robustness of land use, water use and ecotoxicity.

3.5 Limitations

As mentioned in section 2, these guidelines are not an official PEFCR, which entail limitations regarding PEFCR compliancy and data use. The total list of deviations from the PEFCR approach was already explained in section 2.2.

Another major limitation in this document is the absence of supporting studies. Whenever these guidelines are to be further developed (for example into an official PEFCR), the execution of supporting studies would be an essential addition.

3.5.1 Methodological limitations

There is a limitation with the impact category ecotoxicity when LCA practitioners use secondary databases with generic cocktails of some active ingredients, to model the ecotoxicity impacts from pesticides. The use of these generic cocktails can lead to very inaccurate results, as ecotoxicity is highly sensitive to the specific active ingredient involved. LCA databases often use outdated cocktails of crop protection products as this is a field in which innovation moves quickly.

3.6 Claims

Reporting organizations adhering to these guidelines may make claims, provided they comply with the following rules (on top of existing regulations regarding environmental claims in the country of publishing of these claims):

- If a non-comparative claim is to be made, an external reviewer shall verify the study to ensure it complies with these guidelines as per the ISO14040/14044 (ISO 14044, 2006).
- If a comparative claim is to be made, a panel of 3 external reviewers shall verify the study, as per the ISO14040/14044 (ISO 14044, 2006).
- If a comparative claim is to be made, the product shall be compared with existing/previous relevant comparable products in the market which provide the same function (same types and number of beverages). Comparison/claims with a (future) benchmark/representative product shall not be made.
- Data quality requirements for each life cycle stage being compared shall be similar. This means that primary data shall only be compared to primary data and the same holds for secondary data. The exact data quality rating (score) shall not be of significance.
- The functional units and system boundaries being compared shall be the same and for the same type of product.
- External reviewers shall be selected based on the requirements given in ISO 14071 (ISO, 2014).
- The verifier(s) of a study shall be attentive to the communication/wording of a claim and whether it is in line with the goal and scope and final results of the study.
- Any EF study adhering to these guidelines shall be a multi-impact study to investigate potential burden shifting.

- Claims shall be supported by publicly accessible additional information and shall include, at a minimum, the following details: functional unit, period of study, LCIA method and version, system boundaries applied, impact category results (disaggregated per life cycle stage including reduction percentages), critical review panel statement.
- Claim of superiority shall not be based on an aggregated single score. This also implies that the aggregated single score results of an EF study aligned with this shadow PEFCR shall not serve as the basis to receive an EU Ecolabel (EU wide ISO 14024 Type I ecolabelling scheme).



4. Life cycle inventory

The life cycle inventory is a compilation of all input and output flows for the defined product system, including material, energy and waste flows, as well as emissions to air, water and soil. This section defines generic principles related to the life cycle inventory, whereas the next section provides detailed guidance and requirements for individual life cycle stages. For any modelling requirements not covered in these chapters, the generic PEF ((EU commission, 2021), especially section A.4.4 shall apply).

A fundamental modelling requirement stated in the generic PEF is the cut-off rule: processes and corresponding background datasets can be excluded from the model if their cumulative environmental impact across all categories is less than 3%. The cut-off rule applies to both intermediate and final products. Examples of such processes are capital goods and secondary packaging. However, if data are available for these processes, it is advisable to also include them in the scope of the study as best practice, even if they fall under the cut-off rule.

In view of the cut-off rule, it is allowed to use the results of a screening study as a reference to define the processes that fall below the cut-off level. **However, the exclusion of such processes shall be consistent with the goal and scope of the study, and it shall be ensured that these out-of-scope processes are indeed not relevant to the assessment.** When the cut-off rule is applied, processes subject to cut-off shall be made explicit and justification shall be provided.

4.1 Allocation

All life cycle stages shall use economic allocation. This entails (oil) crop cultivation, oil crop pre-processing, oil processing and manufacturing of other ingredients and all other manufacturing processes related to margarine. There is one exception, namely, the impact of transport and distribution shall be allocated based on volume (as per general PEF).

Allocation for vegetable oil

The vegetable oil shadow PEFCR is an oddity between the other PEFCRs as it uses energy allocation as the default method to allocate the environmental burdens between the oil produced and the meal (FEDIOL, 2022). The margarine sector wishes to stay in line with both the general PEF guidance as well as the FEDIOL shadow PEFCR on vegetable oil. Therefore, it is recommended to perform a sensitivity analysis to show the impacts per type of allocation for the processing of vegetable oils. In Figure 3-5, an example of several oil products is presented applying two allocation methods. The results are based on the database of Agri-Footprint 6.3 of 1 kg of oil.

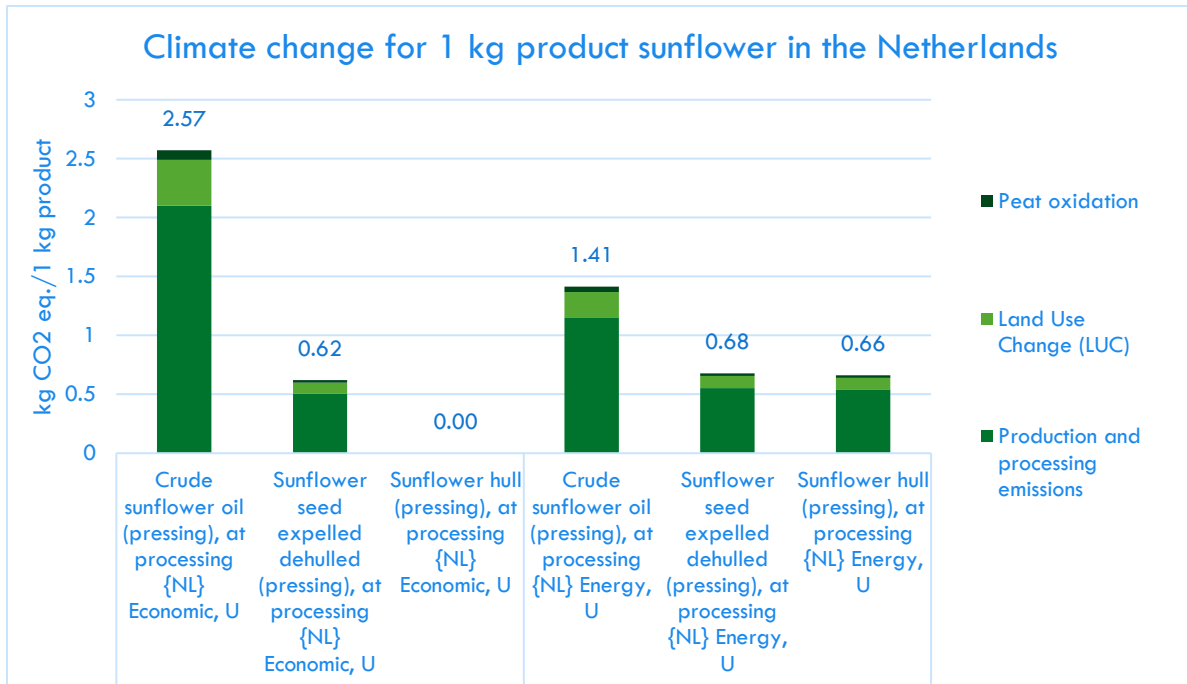


Figure 3. Climate change for 1 kg product sunflower in Netherlands

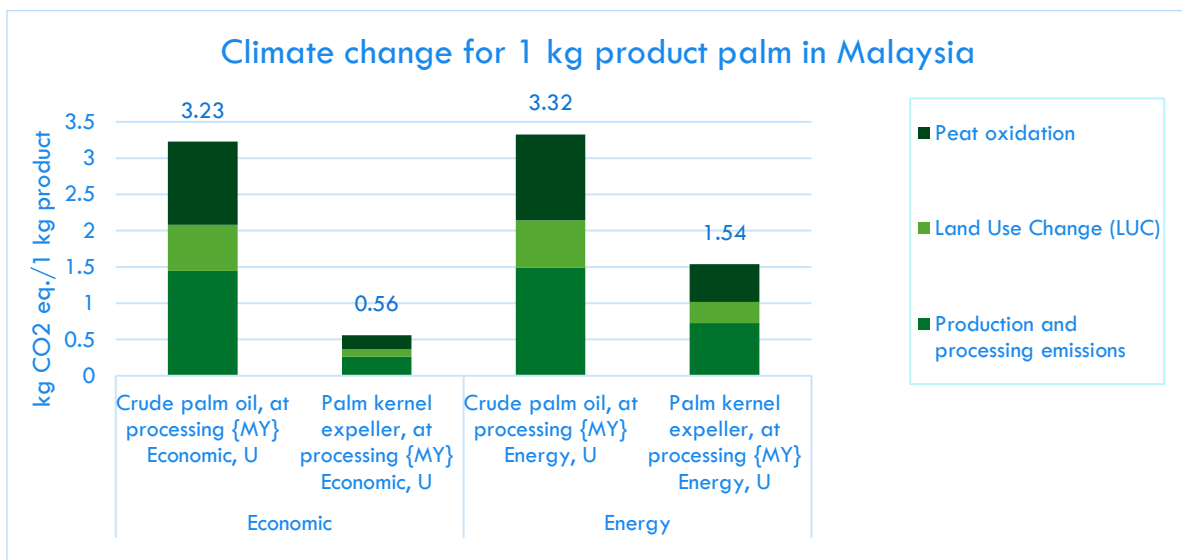


Figure 4. Climate change for 1 kg product palm in Malaysia.

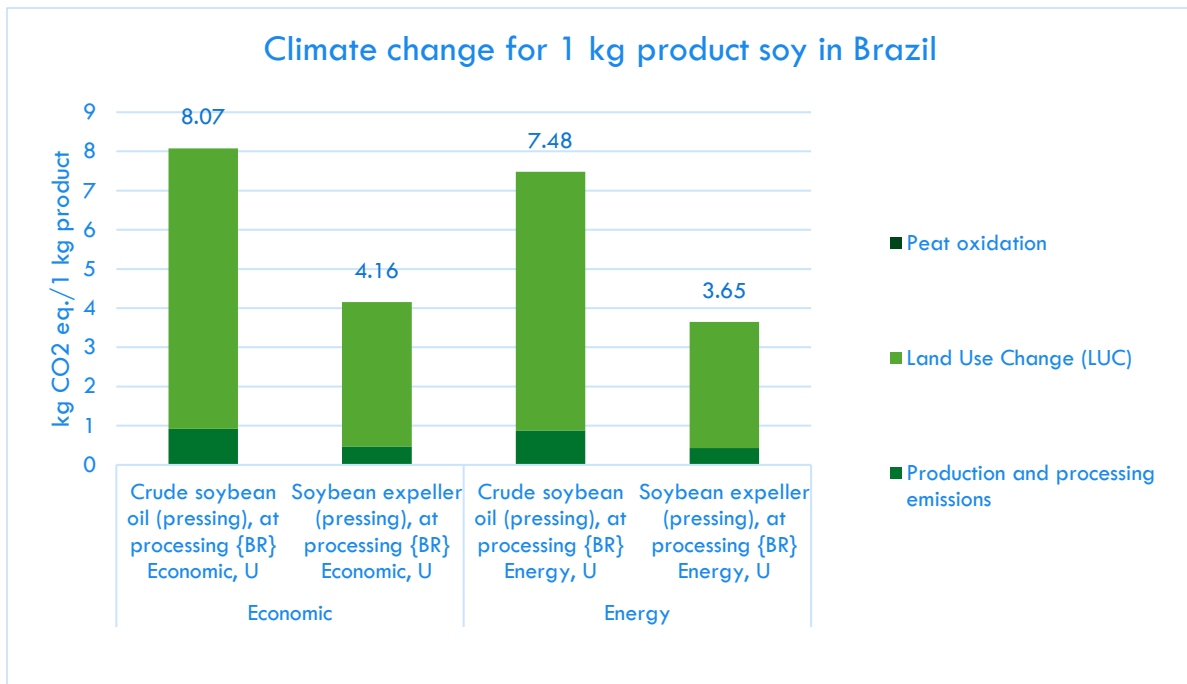


Figure 5. Climate change for 1 kg product soybean in Brazil.

For the manufacturing stage and the rest stream for feed production or energy, zero allocation, should be used as described in GFLI (Global Metrics for Sustainable Feed), if:

1. The product is sold as it is at the point of production and has a very low contribution to the turnover of the entire basket of co-products
2. (co-)production and upstream process is not deliberately modified for generating the co-products
3. If the feed ingredient is not a zero-allocation product, the method of economic allocation should be specified

4.2 List of primary & secondary data

Table 6: List of mandatory primary data and allowed secondary data lists the requirements with respect to primary data and secondary data for LCAs of margarine products. For any given data point, using secondary data or default values instead of recommended primary data shall be justified with a reasonable explanation. The impacts of all the inputs used at each life cycle stage should be calculated using background datasets. Section 4.3 outlines which databases to use, while section 5 details the specific datasets and default values. Use of alternative datasets may be permitted if there is a clear rationale and the data quality is demonstrably better than those of the default datasets recommended in these guidelines. Only those data points are required to be used, which are relevant for the product in scope.

For the life cycle stages that fall outside the company's direct sphere of control, the following hierarchy of data specificity is:

1. **Primary data from direct suppliers**
2. **Sector- or region-specific secondary data**
3. **Country-level averages**
4. **Global default or generic data**

Table 6: List of mandatory primary data and allowed secondary data

Life cycle stage	Process	Primary data	Secondary data
1. Oil crop cultivation	Fertilizers	No primary data required from this life cycle stage	Type, amount and impacts from the production of fertilizers (synthetic & organic) & soil amendments ¹
	Pesticides	No primary data required from this life cycle stage	Type, amount and impacts from the production of pesticides
	Energy	No primary data required from this life cycle stage	Amount, type and impacts from energy used by agricultural equipment.
	Irrigation	No primary data required from this life cycle stage	Amount and source of irrigation water
			Impacts from water sourcing (pumping, treatment etc.)
	Transport	No primary data required from this life cycle stage	Transport distances and modes for cultivation inputs
			Impacts from transport
	Yield	No primary data required from this life cycle stage	Yield of oil crops can be derived from secondary data only if primary data are unavailable . Planting density is recommended to validate farmer-reported data provided per hectare.
Land use	No primary data required from this life cycle stage	Area of land used for cultivation	
Land use change	Statements, satellite imagery or other adequate proof according to the Chain of Custody may be used. If LUC free cultivation is claimed for a commodity for which this is a hotspot in secondary data, adequate proof of this claim is needed (certificate). (If available, primary data are strongly recommended)	Impacts of Land Use Change on statistics from the crop and country. Land use change equally discounted impacts compliant with the PEF guidance (i.e., following the PAS 2050;1)	
2. Oil crop pre-processing (crushing) & 3. Oil processing (refining)	Oil Crushing	Inputs and outputs from processing facility. (If available, primary data are strongly recommended)	
		The volume of wastewater generated and information on the type of wastewater treatment system. (If available, primary data are strongly recommended)	Upstream burdens from waste treatment, e.g. incineration and the treatment of wastewater
		Amount and type of energy (fuel/electricity mix) used by the wet processing equipment. (If available, primary data are strongly recommended)	Upstream burdens from production and impacts from combustion of fuels
		Volume of water used. (If available, primary data are strongly recommended)	Upstream impacts from water sourcing, pumping and treatment of auxiliary processes.
	Oil refining		

Life cycle stage	Process	Primary data	Secondary data
		Amount & type of waste/residues generated and type of waste management strategy. (Primary data are only required if crushing happens in Europe)	Upstream burdens from waste treatment e.g. incineration or landfill
		Amount & type of energy (fuel/electricity mix) used (in case drying is mechanically carried out) (Primary data are only required if crushing happens in Europe)	Upstream burdens from production and impacts from combustion of fuels
	Transport	Transport distances and modes from cultivation to processing & between processing facilities (Primary data are only required if crushing happens in Europe)	If crushing occurs outside Europe: Transport distances and modes from cultivation to processing & between processing facilities
3. Manufacturing of other ingredients		Type and amount of ingredients	Impact of these ingredients (e.g. vitamins, emulsifiers, minerals) may be sourced from LCA databases such as Agri-Footprint.
4. Margarine manufacturing	Transport	Transport distances and modes of transportation from oil processing facilities to margarine manufacturing plants and between manufacturing plants. (If available, primary data are strongly recommended)	Impacts from upstream and impacts from combustion shall be added based on secondary data
	Ingredients	Entire recipe of product and amounts need to be based on primary data	For the impacts of ingredients, secondary data may be used. As described above.
	Energy	Amount of type of energy (fuel/electricity mix) used in manufacturing equipment	Impacts from energy use Energy mix if primary data are unavailable
	Raw & ancillary materials	Amount of all relevant raw & ancillary materials used in the manufacturing processes (e.g., solvents, water, cleaning agents etc.)	Upstream burdens from the production of ancillary materials
	Waste	Amount & type of waste/residues generated and type of waste management strategy	Upstream burdens from waste treatment e.g. incineration or landfill
	Wastewater	The volume of wastewater generated and information on the type of wastewater treatment system	Upstream burdens from waste treatment, e.g. incineration and the treatment of wastewater
	Packaging	Material, amount and recycling rate (if available, distinction between primary, secondary and tertiary packaging)	Upstream burdens from the production of packaging materials
	Co-products	Quantity and price of co-products	Upstream burdens from the production of co-products
	Losses	Losses at manufacturing	
Storage	Refrigerants for chilled storage, electricity use for storage, average storage time	Upstream burdens from the production of refrigerants	
5. Consumer / B2B packaging	Packaging	The type and amount of packaging material used	Impacts from packaging production

Life cycle stage	Process	Primary data	Secondary data
	Transport	Transport mode & distance of packaging materials (If available, primary data are strongly recommended)	Impacts from upstream and impacts from combustion shall be added based on secondary data
	Losses		Loss rate at packaging (losses happening when the final product is being packed)
	Packaging recycling	Post-consumer recycled content of packaging material (primary, secondary & tertiary)	Post-consumer recycled content of packaging material may be included if the circular footprint formula is applied.
6. Distribution	Transport		Transport distance and mode from factory to distribution center (ambient or chilled). Upstream impacts and impacts from combustion shall be added
	Storage at distribution		Energy and water use during storage at distribution (PEF defaults).
	Losses		Loss rates during distribution stage and type of waste treatment (PEF defaults)
	Storage		Refrigerants amount and type at distribution (PEF defaults).
7. Retail/ Food service	Transport		Transport mode & distance from factory to distribution centre/retail (ambient or chilled) if primary data are unavailable Impacts from transport
	Energy		Amount of type of energy (fuel/electricity mix) used at warehouse (PEF defaults) Amount of type of energy (fuel/electricity mix) used at retail
	Losses		Loss rates during consumer stage including restaurants (PEF defaults) and the type of waste treatment
8. Use	Use		Transport distances and mode for transport from retail to consumer home (PEF defaults)
			Amount and impact of energy use for storing of product (ambient or chilled) (PEF defaults)
			Amount and impact of energy for preparation of product (if applicable) (defaults provided in this PEFCR)
9. End-of-Life	Wastewater		Volume of wastewater at the use stage from product wasted/not consumed
	Transport		Transport mode & distance to end-of-life Impacts from transport of waste
	Waste		Impact of processing of waste

4.3 Recommended databases for secondary data

Since the use of the EF database is purposed for application in official PEFCR studies, alternative databases shall be used. The following databases should be considered:

- Ecoinvent & Agri-footprint (also suppliers to the generic EF database);
- World Food LCA Database (WFLDB)(Quantis, 2020) which is usually free to use along with SimaPro.

For the time being, no other transparent databases, either free or with a license, is considered. Other databases could be considered for use, as long as their scope aligns with these guidelines. Table 7: Summary of background databases. provides a summary of the recommended databases to use, with more detailed suggestions available for each corresponding life cycle stages. The most recent version of the databases should be used, which is at the time of writing Agri-footprint 7.0 (Blonk et al., 2024) and Ecoinvent 3.11 (Ecoinvent, 2024).

Table 7: Summary of background databases.

Data type	Recommended database
Agricultural products	Agri-footprint
Means of transport (truck, train, barge, sea ship, plane)	Agri-footprint
Energy from diesel	Agri-footprint
Energy use (electricity, heat from natural gas, heat from wood chips etc.)	Ecoinvent, cut-off
Manufacturing of other ingredients (e.g. vitamins, emulsifiers)	Ecoinvent, cut-off
Fertilizers	Agri-footprint
Other chemicals	Ecoinvent, cut-off
Solid waste treatment	Ecoinvent, cut-off
Wastewater treatment	See section 5.2.1

4.4 Data gaps

Several data gaps have been identified during the development of these guidelines. These data gaps are identified together with the members of Imace and the TS during working sessions and interviews. Most data gaps have been covered by identifying appropriate secondary datasets; however, a few data gaps remain:

- Origin of oil/ country of cultivation often unknown due to global supply chain (no segregated flows). This leads to low transparency in the supply chain, which prove especially problematic for LUC impacts, as they form an important hotspot for some commodities used in margarine production.
- Lack of secondary data of oil crop cultivation (palm), low quality secondary data available
- Land use change: The generic PEF recommends basing land use change on primary data, but primary data are not always available or reliable. Primary data refers to concrete proof that no land use change occurred in the 20 years preceding the year of assessment. This can be,

for instance, municipal documents, documents from the agricultural department, satellite high granularity images, and land survey data.

- Traceability and Chain of Custody: when collecting data on sourcing of certified ingredients (deforestation-free or coming from regenerative farming), guaranteeing traceability can be very difficult. The ISO 22095 defines several types of chain of custody models. While identity preserved and segregation imply that the used ingredients are certified, mass balance and book & claim include mixing sources of ingredients and no physical traceability. As at the time of writing this guidance the PEF has not clarified its position on the admissibility of the last two models (and if so, which type), in this LCA guidance mass balance and book & claim are not allowed.

4.5 Data quality requirements

The data quality rating of the primary and secondary data shall be calculated as prescribed by the generic PEF. For primary data, each data point shall include documented values for the following data quality indicators: Precision (P) and Representativeness in terms of Time (TiR), Technology (TeR), and Geography (GeR). For secondary data, only Representativeness (TiR, TeR, GeR) shall be reported as a minimum.² No specific DQR value is to be achieved in order to be aligned with these guidelines. However, as mentioned in the generic PEF, the DQR of primary data for all four criteria (P, TiR, TeR & GeR) cannot be greater than 3, whereas, for TeR and GeR it cannot exceed 2.

² See section 4.6.5 of Annexes 1 to 2 of the generic PEF.

5. Life cycle stages

5.1 Oil crop cultivation

This life cycle stage encompasses the cultivation and harvest of oil crops. The cultivation stage is often one of the most relevant life cycle stages in a margarine EF, especially when palm oil is used as a raw material and shall be investigated appropriately.

5.1.1 Cultivation inputs

Cultivation includes the following activities, namely:

- Application of synthetic and organic fertilizers
- Application of pesticides
- Application of lime
- Irrigation
- Land use and land use change
- Energy use in agricultural machinery

The transport of cultivation inputs from manufacturing location to the farm shall be included in the scope, e.g., through market datasets. This should ideally be farm-specific data; however, if this is unavailable, a default distance of 50 km shall be applied, assuming that this transport happens locally. An example of a secondary process that may be used to model the impacts from transport of cultivation materials is *Transport, truck >20t, EURO4, 80%LF, default/GLO* from the secondary database Agri-footprint. Packaging of cultivation inputs at point of production may be excluded from the scope. Additionally, capital goods at cultivation are considered a cut-off. This is line with the FEDIOL Vegetable oil Shadow PEF CR (De Smet, 2022).

For all inputs at cultivation, the use of secondary data is allowed. It is recommended to use Agri-Footprint as a database to determine impact of cultivation. For Land Use and Land Use Change (LUC), please see the guidance as described in this chapter. If primary data are used the generic PEF method needs to be followed to model the impacts (Haslinger & Giljum, 2012). Impacts from the application of fertilizers, lime and pesticides shall be modelled following the generic PEF. Table 8: Generic PEF recommended models to quantify emissions from fertilizers, lime & urea application. lists the mathematical models to be used as recommended by the generic PEF to model emissions from N & P fertilizers, as well as lime application. Heavy metals emissions from fertilizers and pesticides application shall be modelled following generic PEF methodology.

Table 8: Generic PEF recommended models to quantify emissions from fertilizers, lime & urea application.³

Emission	PEF recommended model	Compartment	Relevant impact category
NH ₃ volatilization (synthetic fertilizer)	(0.11*quantity of synthetic N + 0.21*quantity of organic N (compost per example)) *17/14	Air	Climate change & acidification

³ This is not an exhaustive list of methods used to calculate emissions from the cultivation stage. For a comprehensive assessment, additional guidance documents should be consulted. Specifically for GHG emissions, the IPCC provides emission factors (EFs) that vary by climate zone.



Emission	PEF recommended model	Compartment	Relevant impact category
N ₂ O direct	$((\text{synthetic N} + \text{organic N}) * 0.01) * 44/28$	Air	Climate change
N ₂ O indirect	$(\text{NH}_3 \text{ volatilization} * \text{Frac volatilisation} * 0.01 + \text{NO}_3 \text{ leaching} * 0.24 * 0.011) * 44/28$	Air	Climate change
CO ₂ from lime	$(\text{Quantity of lime} * 0.12) * 44/12$	Air	Climate change
CO ₂ from urea	$(\text{Quantity of urea} * 0.2) * 44/12$	Air	Climate change
NO ₃ leaching	$0.24 * \text{N from fertilizers/constituents} * 62/14$	Soil & water	Eutrophication
PO ₄ leaching & runoff	$0.05 * \text{quantity of P applied}$	Soil & water	Eutrophication

As for impacts from pesticide application, the generic PEF recommends using the USEtox life cycle impact assessment method to simulate their fate. The applied pesticides active ingredients shall be modelled as:

- 90% emitted to the agricultural soil compartment
- 9% emitted to air
- 1% emitted to water

However, as stated by the generic PEF, more specific emissions data should be used if available.

Irrigation water

When it comes to modelling irrigation water use, the decision tree presented in Figure 3 shall be followed. It is recommended to model this as country-average practices; however, if sub-national level data on irrigation are available, they may be used. Any energy used for the irrigation system shall be modelled along with other agricultural machinery.

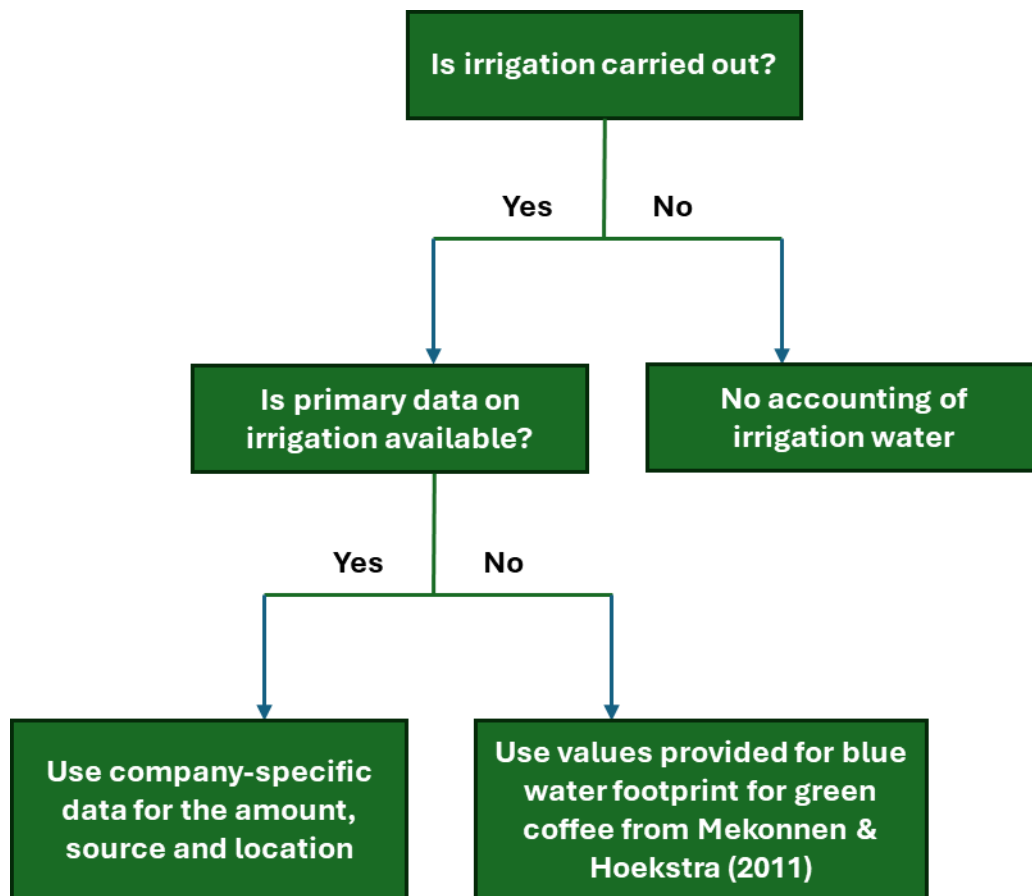


Figure 3: Decision tree for modelling irrigation water.

While Mekonnen & Hoekstra (2011) provide some global average water footprints, it should be noted that these represent very low data quality to investigate water scarcity impacts in EF which are sensitive to local conditions. Hence, it is strongly recommended to retrieve primary data for irrigation water if applicable. Alternatively, country-specific information should be used. If this is not possible and a global average is used, this shall be explicitly mentioned as a limitation in the EF study report.

Land use

The yield of oil crops should be reported per hectare of farmland. The yield should ideally be primary data, however, in case this is not possible to retrieve, then the yield can be derived from secondary data. Additionally, a reasonable explanation shall be provided for why it was not possible to collect primary data on yield.

Land use change

The generic PEF recommends basing land use change on primary data, but primary data are not always available or reliable. Primary data shall be used to prove that land use change occurred or not in the 20 years preceding the year of assessment. This can be, for instance, municipal documents, documents from the agricultural department, satellite high granularity images, and land survey data.

While identity preserved and segregation imply that the used ingredients are certified, mass balance and book & claim include mixing sources of ingredients and no physical traceability. As at the time of writing this guidance the PEF has not clarified its position on the admissibility of the last two models (and if so, which type), in this LCA guidance mass balance and book & claim are discouraged. The latest Land Sector and Removals Standard (WRI, 2026) represents the reference guidance for dealing with chain of custody.

Energy used in agricultural machinery

The amount of energy used in agricultural machinery (whether fuel/electricity) shall be modelled and shall be reported as total energy used (in MJ or kWh for fuel or electricity, respectively). The use of any renewable energy source shall be verified using proof from the energy provider (in case purchased), or proof of ownership or production (if self-produced).

5.1.2 Sampling of farms

Sampling of farms is only relevant if primary data are collected for this life cycle stage. Users of these guidelines may apply a sampling approach to reduce the number of representative oil crop farms from which data should be collected. For sampling the approach of the general PEF needs to be followed (European Commission, 2021). This means that homogeneous sub-samples need to be made from the total group of farmers. Factors to at least consider when making homogeneous sub-groups are geography, farm size and technology. From each homogeneous sub-sample, at least from the square root data needs to be collected.

5.1.3 Carbon removals

Carbon removals generally refer to processes that sequester carbon from the atmosphere and store it in a specific pool for an extended period of time. In the case of oil crop cultivation, carbon removals can for instance refer to biogenic carbon removals by palm oil plantations.

There are several methods for removals accounting, typically based on either annual quantification of carbon fluxes or annualization of the total expected removals over the long term (i.e., dividing the total by the number of years taken into account). The GHG Protocol (WRI-WBCSD, 2022) describes multiple accounting methods that work with remote sensing, empirical models, and direct measurement. In life cycle assessment methodologies within the PEF framework, there is no carbon removals accounting method that is widely recognized and used, due to the high uncertainty of the models and the difficulty in comparing actual carbon emissions to estimated removals. Also, the Carbon Removal Certification Framework Regulation (CFCFR) further specifies what carbon farming activities can be considered for carbon sequestration in agricultural activities. Carbon removals **shall not be reported as negative emissions** in the climate change impact category, following the guidance from the generic PEF. If calculated according to the CFCFR, net carbon removals may be reported **separately** in the LCA report.

In all cases, certification of offsetting is not allowed. This is because offsetting does not represent a physical reduction of emissions from a product and is mostly applied in the context of the financial transactions. Additionally, to avoid greenwashing and making misleading claims, certification of offsetting is not allowed. Lastly, offsetting is methodologically incompatible with LCA and environmental footprinting because it relates to a type of scenario analysis for which the offsets reduce the environmental impact of a product in time. General standards such as the ISO 14067 explicitly state that carbon offsetting is outside the scope of a produce analysis (ISO, 2013).

5.2 Pre-processing (crushing) & oil processing (refinery)

These life cycle stages cover the post-harvest processing steps such as oil crop crushing and oil refining. As stated in the vegetable oil PEF CR (FEDIOL, 2022):

'This life cycle stage starts with the reception and storage of the raw materials. The life cycle stage includes the production of electricity, steam, water and chemicals needed for crushing. The life cycle stage also includes emission to air (e.g. hexane emission or emissions from burning of fuels) and the release of emissions to water via wastewater treatment. Crushing uses hexane, most of which is released during the crushing process itself. However, part of the hexane will be released further down the value chain. The emissions of hexane are modelled according to the instructions of the PEF CR, which means that all hexane is emitted during the crushing phase. Crushing of palm, palm kernel and coconut does not take place in Europe by FEDIOL member companies. Data on the crushing of these products has therefore been taken from the Agri-footprint database and is for these products included

in the life cycle stages 'raw materials acquisition and preprocessing', see section 4.3.2. Life cycle inventory manufacturing: transport to oil processing The transport of crude palm, crude palm kernel and crude coconut oil is already included in the life cycle stage 'raw materials acquisition and preprocessing: crude oil and transport. In case of rapeseed, sunflower, soybean, maize, it can happen that externally crushed oils (this can concern crushing by the same company at another location or crushing by another company) are processed by the refining company. The crude oil is transported to the oil processing facility.'

5.2.1 Transport to manufacturing

This life cycle stage covers all the transportation steps that take place to transport packaged refined oil from point of processing to point of manufacturing (both domestic and international).

In case primary data on transport distances and modes is unavailable, the most up to date generic PEF defaults for combination of transport modes shall be used, at the moment of publication these are:

Within Europe:

- 130 km by truck (>32 t, EURO 4);
- 240 km by train (average freight train);
- 270 km by ship (barge)

For suppliers outside of Europe (and exporting to Europe):

- 1000 km by truck (>32 t, EURO 4);
- 18000 km by ship (transoceanic container) or 10000 km by plane (cargo);
- If producers' origin country is unknown, distance to be determined using specific calculators⁴;
- In case the supplier's location is unknown, transport to be modelled as if supplier is located outside Europe.

However, it must be noted that most of these generic PEF defaults only apply in the European context. For transportation steps occurring within the country of cultivation (non-EU countries) and within non-EU receiving countries, defaults presented here should be used.

5.3 Manufacturing of other ingredients

Other ingredients (next to oils and fats) must be incorporated in the LCA, but the use of secondary data are allowed. Other ingredients could be additives like vitamins, emulsifiers and minerals. The recommended database for these ingredients is AgriFootprint.

5.4 Margarine Manufacturing & distribution

This life cycle stage encompasses the manufacturing of refined oil to the end product: margarine

5.4.1 Manufacturing

During manufacturing different oils and fats are made into margarine by emulsification, cooling and crystallization. This life cycle stage starts with the reception and storage of raw materials. The production of electricity, steam water and chemicals are needed for manufacturing. If no specific data is available of origin of electricity and other energy sources, the residual country mix shall be used, as in line with the General PEF.

⁴ <https://www.searates.com/services/distances-time/> or https://co2.myclimate.org/en/flight_calculators/new

This life cycle stage also includes emissions to air (e.g. emissions from burning of fuel) and to water via wastewater treatment. For this life cycle stage, primary data needs to be collected. All in and outputs (products, co-products and waste) of the production process shall be based on primary data, as well as energy, refrigerant and water requirements for processing. An example of a margarine production system is shown in Figure 4.

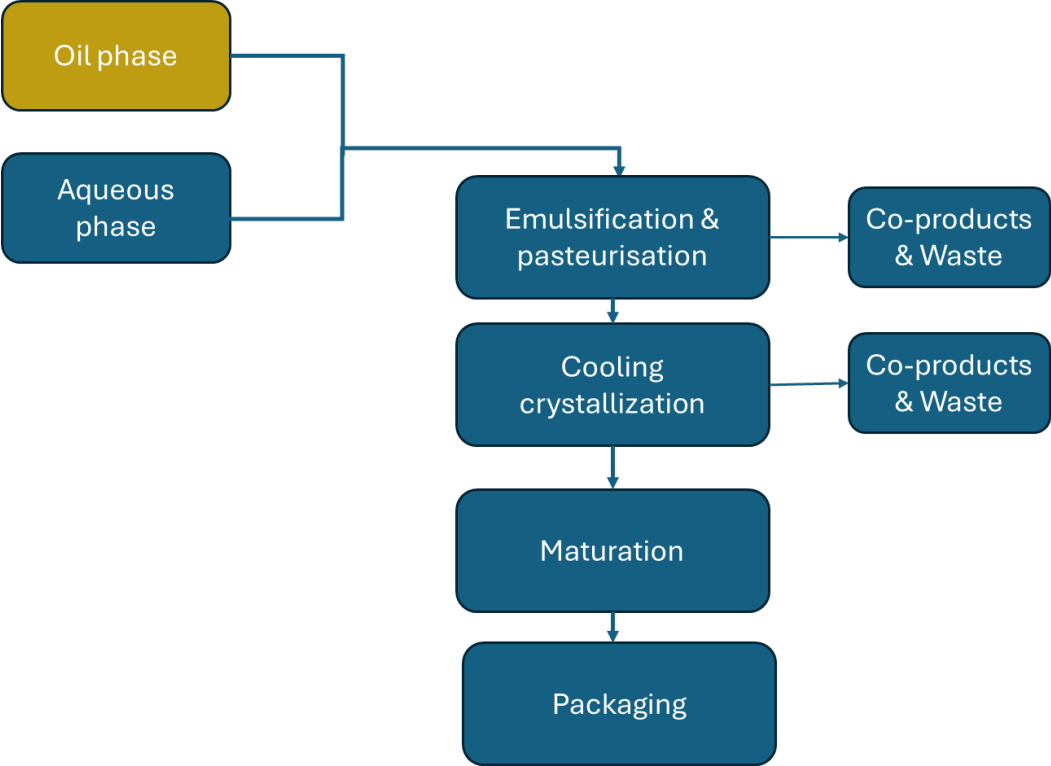


Figure 4:

Simplified visualization of margarine production process

Figure 4: Simplified visualization of margarine production process

5.4.2 Distribution

This life cycle stage includes all transport and storage activities required to deliver the packaged margarine to retail.

5.4.2.1 Distribution channels

Distribution may happen through various channels

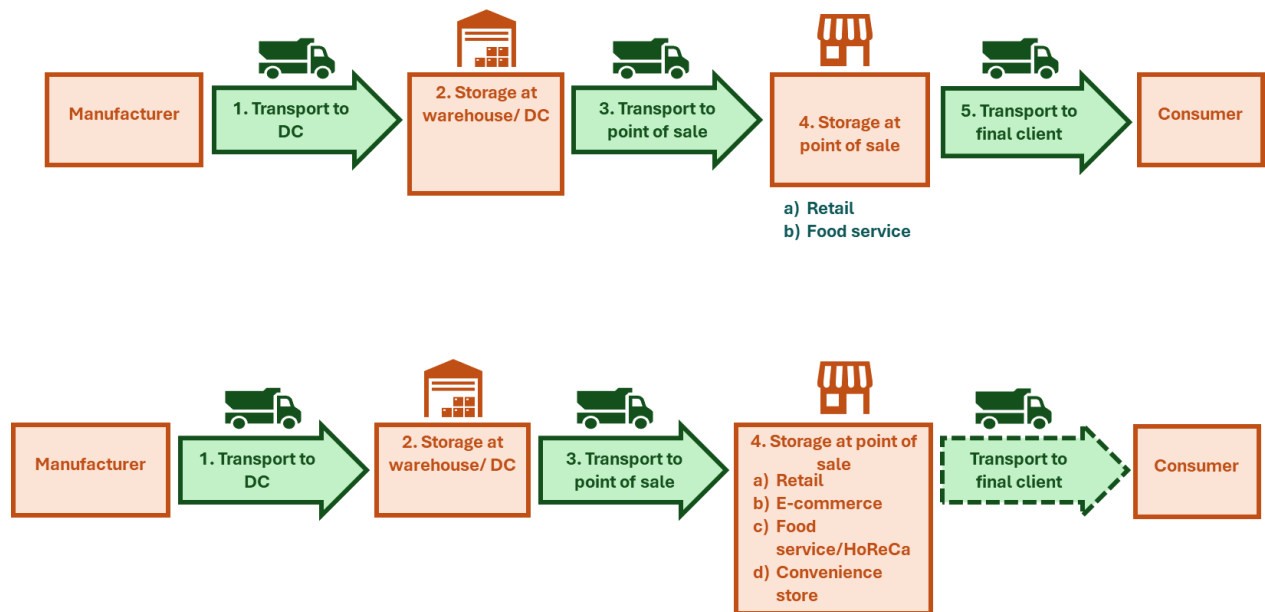


Figure 5 : Most common distribution channels for margarine.

5.4.2.2 Distribution data

For a comprehensive margarine distribution model, the following data points should be considered:

- Transportation data, encompassing modes of transport, distances travelled, fuel types and quantities used, and load factors;
- Handling data, which covers energy usage in warehouses and retail environments;
- Data on all losses during distribution.

Transportation data from manufacturing to retail

Transport distances and modes should be primary data. If unavailable, refer to the transport distance and mode specified in PEF. Optionally, tools like [SeaRates](#) may be used for more precise calculations when applicable.

Transport data from retail to the final client

Transport data from retail to consumer should be based on secondary data from generic PEF (European Commission, 2021):

- 62% traveling 5 km by passenger car (average),
- 5% covering a 5 km round trip by van (lorry <7.5 t, EURO 3 with a utilization ratio of 20%)
- 33% with no modelled impact.

Handling data

Handling data should be based on secondary data from generic PEF (European Commission, 2021):

- Energy consumption at warehouses: 30 kWh/m²·year for ambient storage and an additional 40 kWh/m³·year for chilled storage.
- Energy consumption at retail: 400 kWh/m² per year for general building energy consumption, with additional requirements of 1,900 kWh/m² per year for chilled storage and 2,700 kWh/m² per year for frozen storage.

Loss rates during distribution

Losses should be based on secondary data from generic PEF (European Commission, 2021), the category chosen is oils and fats:

- 1% loss during distribution

5.4.3 Retail / food service

Energy use for (chilled) storage at retail or food service should be included in this life cycle stage. As well as losses during this life cycle stage. The most up to date PEF defaults should be used to model this life cycle stage.

- Energy consumption at retail/food service: 300 kWh/m²·year for the entire building surface. For retail specialized in food/beverage products: 400 kWh/m²·year for the entire building surface plus energy consumption for chilled and frozen storage of 1900 kWh/m²·year and 2700 kWh/m²·year respectively.
- Refrigerant gases: Gas content in fridges and freezers is 0.29 kg R404A per m². The production and end-of-life, as well as the leakage shall be considered and 10% annual leakage

5.5 Consumer packaging

The transport from packaging materials to the manufacturing location shall be included. The distance and transport mode should be based on primary data. When primary data are not available, generic and most recent PEF defaults shall be used, at the moment of publication these are:

1. 230 km by truck (>32 t, EURO 4);
2. 280 km by train (average freight train);
3. 360 km by ship (barge).

5.6 Use

This life cycle stage is mostly modelled with defaults from the generic PEF and the dairy PEFCR. The most recent edition of these documents and defaults must be used, the numbers included here include the defaults in the PEF and dairy PEFCR at time of publication of this document. This life cycle stage starts with the consumer transporting the product to their home. This transport needs to be modelled as in the general PEF (see section 5.4.2.2). During use phase, chilled storage at consumer needs to be taken into account, ambient storage can be neglected. To be in line with the dairy PEFCR 10 storage days are accounted for (The European Dairy Association (EDA), 2025b). The storage volume is assumed to be 3 times the product volume and electricity use for chilled storage is 1350 kWh/m³/year. Energy consumption for chilled storage which is currently: 0.0037 kWh/L-day, thereby is the fridge production and end-of-life 15 years of lifetime. (European Commission, 2021, Annex 2, part D.) Losses at consumer are assumed to be 4% (according to most recent generic PEF). The impacts of the dishwasher should be modelled for one knife as allocation of 0.5% of a dishwashing cycle per piece). If the end-use of the product is unknown (for instance for margarine for baking and frying) these steps can be disregarded. In this case only the storage and waste at consumer should be modelled in the use phase.

5.7 End-of-Life (EoL)

This section examines the destination and treatment of various elements leaving the margarine life cycle after the use phase, being primarily consumer packaging like a wrap for margarine for baking/frying, or a tub for margarine for spreading, made of plastic and aluminium foil.

5.7.1 Transport to end-of-life

In many cases, waste treatment datasets already account for the transportation of materials to the recycling plant or waste treatment facility. If this is covered, there is no need to include transportation separately. It is essential to always verify this detail to ensure accurate data representation.

Unless primary data are available, the most recent generic PEF defaults should be used, at the moment of publishing these are:

- (a) consumer transport from home to sorting place: 1 km by passenger car and,
- (b) transport from collection place to methanisation: 100 km by truck (>32 t, EURO 4) and,
- (c) transport from collection place to composting: 30 km by truck (lorry <7.5 t, EURO 3).

5.7.2 Consumer packaging end-of-life

The end-of-life consumer packaging is assessed using the Circular Footprint Formula (CFF), a standardized methodology for evaluating circularity and environmental impact. This formula defines the rule to allocate the environmental burdens or benefits of recycling, reusing, or recovering energy between, for example, the supplier and the user of recycled materials implemented in the generic PEF guidance (European Commission, 2021).

In the following sections, an overview of the CFF and its key principles is first provided. This is followed by an exploration of its application to consumer packaging. Finally, the CFF parameters specific to the European average are presented.

5.7.2.1 Application of Circular Footprint Formula for packaging

(Based on generic PEF)

To facilitate application of the Circular Footprint Formula, it has been split up into 4 different components, as indicated in Figure 6. For each of these sections, exact formulae are provided that can be used in an LCA, along with guidance on how the different parameters are defined and can be.

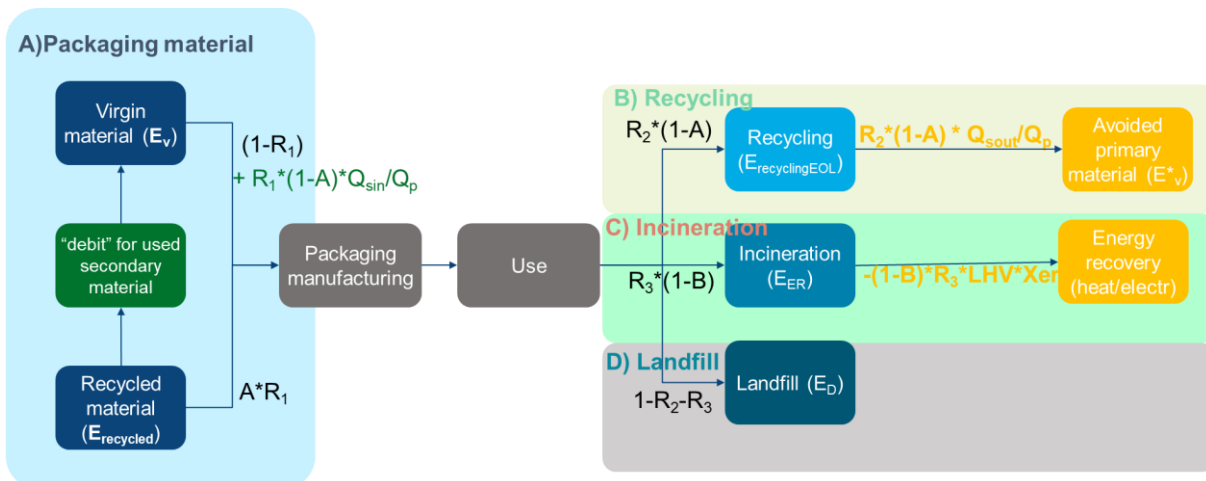


Figure 6 schematic overview of the CFF, indicating the 4 different components: A) packaging materials, B) recycling, C) incineration and D) landfill

A) Packaging materials

Packaging production needs to be modelled using the CFF since this is part of the packaging production life cycle stage.

B) Recycling

The impact of recycling, and associated avoided materials, can be calculated as follows:

Recycling:	$E_{\text{recyclingEoL}} \times \text{weight packaging material} \times (1-A) \times R_2$
Avoided primary material:	$-E_v^* \times \text{weight packaging material} \times (1-A) R_2 \times Q_{\text{sout}}/Q_p$

It should be noted that the second part of the formula, the credit for avoided primary material, results in a negative outcome. In an LCA, it can also be modelled as avoided product (in that case the minus needs to be removed).

The following explains how the different parameters can be obtained:

R_2 *Recycling rate/ recycling output rate. 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.*

A *Allocation factor of burdens and credits between supplier and user of recycled materials. It allocates burdens and credits from recycling and virgin material production between two life cycle stages: the one supplying recycled material, and the one using recycled material. It aims to reflect market realities.*

Q_{sout}/Q_p *Quality of outgoing secondary material (at the point of substitution) / Quality of primary material (at the point of substitution)*

Mostly it is assumed that E_v^ equals E_v , which means it is assumed that the recyclable material at EoL replaces the same virgin material which was used to produce the recycled material.*

If $E_v^ = E_v$, then both the quality ratios Q_{sin}/Q_p and Q_{sout}/Q_p are needed, which capture the downcycling of a material compared to the original primary material.*

If $E_v^ \neq E_v$, one quality ratio is needed: Q_{sin}/Q_p associated to the recycled content. The Q_{sout}/Q_p is already indirectly integrated in E_v^* . Also, evidence needs to be provided that a recyclable material is substituting a different virgin material than the one producing the recyclable material.*

C) Incineration

The impact of incineration, and associated energy recovery, can be calculated as follows:

Incineration:	$E_{ER} \times \text{weight packaging material} \times (1-R_2) \times R_3 \times (1-B)$
Energy recovery from incineration:	Heat: $- E_{se,heat} \times \text{weight packaging material} \times (1-R_2) \times R_3 \times (1-B) \times LHV \times X_{er,heat}$
	Electricity: $- E_{se,elec} \times \text{weight packaging material} \times (1-R_2) \times R_3 \times (1-B) \times LHV \times X_{er,elec}$

It should be noted that the second part of the formula, the energy recovery from incineration, results in a negative outcome. In an LCA, it can also be modelled as avoided product (in that case the minus needs to be removed).

In Ecoinvent (cut-off) datasets for incineration, energy recovery is often excluded and needs to be modelled separately.

Where:

R_3 Proportion of the material in the product that is used for energy recovery at EoL. Available from PEFCR's Annex C

Note that $(1-R_2)$ is added to the original formula. This is because the R_3 data as provided in Annex C concerns only the percentage of waste (non-recycled material) that goes to incineration, thus not the percentage of the total packaging going to incineration. It first needs to be multiplied by $(1-R_2)$ to account for the share of packaging going to municipal waste (= share not recycled). It is then multiplied by the percentage of waste going to incineration. E.g. If the recycling rate of a product (R_2) is 40%, this means that 60% goes to waste. If the incineration share = 90%, this means $(1-0.4) * 0.9 = 0.54$, or that 54% of the original material is going to incineration.

B allocation of energy recovery process, applying to both burdens and credits. In PEF studies the B value shall be equal to 0 as default.

E_{ER} specific emissions and resources consumed arising from the energy recovery process (e.g. incineration with energy recovery)

$E_{se,heat}$ specific emissions and resources consumed that would have arisen from the specific substituted energy source, in this case electricity

$E_{se,elec}$ specific emissions and resources consumed that would have arisen from the specific substituted energy source, in this case heat

LHV Lower heating value of the material in the product that is used for energy recovery. This is integrated in EF datasets. If no EF dataset is used, LHV can be derived from other sources, for example the Phyllis database⁵

$X_{er,heat}$ Efficiency of the energy recovery process for heat. This is integrated in EF datasets. If no EF dataset is used, X can be derived from other sources, for example from Ecoinvent datasets.

$X_{er,elec}$ Efficiency of the energy recovery process for electricity. This is integrated in EF datasets. If no EF dataset is used, X can be derived from other sources, for example from Ecoinvent datasets.

D) Landfill

Everything that is not being recycled, or going to incineration, is going to landfill. This is captured in the following formula.

Landfill:	$weight\ packaging\ material \times E_D \times (1 - R_2 - (1-R_2) \times R_3)$
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Where:

⁵ <https://phyllis.nl/Browse/Standard/ECN-Phyllis>.

E_D Specific emissions and resources consumed arising from disposal of waste material at the EoL of the analysed product, without energy recovery (landfill), these can be taken from databases such as EcolInvent.

5.7.2.2 CFF parameters for consumer packaging

The section below details the standard parameters for CFF, aligned with Annex C of the PEF guidelines.

Table 9 provides an overview of default CFF parameters on a European level for different consumer packaging material.

Table 9: Default CFF parameters, European average.

Packaging type	A	R1	R2	R3	1-R2-R3	(Qsin/Qp)	(Qsout/Qp)
Polyethylene terephthalate	0.5	0	0.42	0.32	0.26	1	1
Polyethylene, low density	0.5	0	0.275	0.40	0.33	0.75	0.75
Polypropylene	0.5	0	0.183	0.45	0.37	0.9	0.9
Aluminium, primary, ingot	0.2	0	0.60	0.22	0.18	1	1
Kraft paper	0.2	0	0.75	0.14	0.11	0.85	0.85
Packaging glass	0.2	0.52	0.66	0.19	0.15	1	1
Tin plated chromium steel sheet	0.2	0.58	0.80	0.11	0.09	1	1
Corrugated board box	0.2	0.47	0.75	0.14	0.11	0.85	0.85
EUR-flat pallet	0.8	0	0.3	0.38	0.32	1	1

5.8 Other

5.8.1 Renewable energy

While the use of renewable energy certificates has been discussed earlier, it is important to reiterate a specific requirement in cases where renewable energy falls under the scope of the Renewable Energy Directive (RED) or ISCC certification. In such cases, any energy that qualifies for a multiplier—allowing it to be sold or counted more than once—must be corrected for in the study. This ensures that a single unit of renewable energy is not double counted in the environmental assessment, preserving the accuracy of the model. This principle aligns with the guidance provided in section 4.4.2 of the generic PEF.

5.8.2 Electricity mix

For all life cycle stages it is preferred to have primary data on the type of electricity that is used (solar, wind, grid, etc.) If data is not available, the residual country mix shall be used. This is in line with the generic PEF.

6 Environmental footprint reporting

The user of this LCA guidance shall calculate the environmental footprint of its product(s) in compliance with all requirements. The following information shall be included in the final LCA report:

- life cycle inventory
- characterised, normalized, and weighted results in absolute values, for all impact categories
- the aggregated single overall score in absolute values
- interpretation of the most relevant impact categories
- limitations of the study (including data gaps)

in the case that results are externally communicated, it is mandatory that the LCA report and LCA results are verified by an external party. In all cases the independence of the verifiers shall be guaranteed. The review is performed in alignment to the requirements included in Section 9 of the Annex I of the PEF (European Commission, 2021)

6.1 Use of this guidance

This LCA guidance has been created to encourage the sector to create high quality Environmental Footprint studies of margarine and other emulsified fats. Consistency, replicability, and comparability are ensured by the correct application of this guidance. It is expected that with continuous application and practical feedback, this guidance will undergo future updates not only to align with the latest LCA methodological advancements, but to be of practical use for the sector.

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Appendix I – Direct comparison with dairy-based fat products

For the margarine sector, comparison of the environmental performance of their products with other products (e.g., dairy products) with the same function is important. Margarine offers a (mostly plant-based) alternative to butter, potentially reducing impacts by excluding the animal production system. This (shadow) PEF CR was developed with the dairy PEF CR in mind, to allow for fair comparison. This annex gives extra guidance on the comparison of the environmental performance of margarine products to dairy-based fat products.

Requirements for comparison

The ISO standards 14040 and 14044 and general PEF guidelines prescribe requirements for comparing environmental performance of different products/production systems. The most important ones are listed here and shall be followed for comparisons between butter and margarine:

- Systems shall be compared using the same functional unit
- Systems shall be compared using equivalent methodological considerations (performance, system boundary, data quality, allocation procedures, decision rules on evaluating inputs and outputs and impact assessment).
- Any differences regarding these systems shall be identified and reported.
- The LCIA shall employ a sufficiently comprehensive set of impact indicators
 - The comparison shall be conducted by category indicator.

Modelling requirements for margarine products for direct comparison with dairy-based butter

For direct comparison with the environmental performance of dairy-based fats, it is of importance that the methodology used of the environmental assessments are comparable.

For comparison the functional unit of both systems shall include the same quantity, the same function (e.g. spreading, baking or frying) and sales market. For fair comparison, the entire life cycle needs to be considered (cradle-to-end-of-life). Some life cycle stages differ greatly between dairy products and alignment is not always possible. The life cycle stage raw material acquisition is the most evident example of this. Where for dairy butter, cow's milk production needs to be modelled, while for margarine, this life cycle stage contains the modelling of cultivation of oil seed crops. Additionally, when comparing dairy and margarine products, it's important that the same impact categories are analyzed and compared. Per product, the most relevant impact categories might vary but for the comparison it is important that the same categories are compared.

Table 1 below summarizes the most important aspects to consider while modelling the environmental performance of margarine products for comparison with dairy butter.

Table 1. Specific guidance per life cycle stage to compare butter with margarine products

Main life cycle stage	Life cycle stage	Specific guidance
Agricultural inputs acquisition and pre-processing	1. Oil crop / feed cultivation	<ul style="list-style-type: none"> Ensure the data for crop cultivation for the margarine LCA is feed PEFCR aligned, to ensure alignment with dairy LCA (e.g. economic allocation between main and co-products)
	2. Oil crop pre-processing (crushing)	<ul style="list-style-type: none"> As described in main text of these guidelines
	3. Oil processing (refinery)	<ul style="list-style-type: none"> As described in main text of these guidelines
	4. Manufacturing of other ingredients / other raw material acquisition	<ul style="list-style-type: none"> As described in main text of these guidelines
Production of the main product	5. Transport	<ul style="list-style-type: none"> For refrigerated bulk transport use 0.4 L diesel/km travelled, or 0.0023 L diesel / kg oils and fats/milk transported (as per dairy PEFCR)
	6. Margarine / Butter Manufacturing (Including emulsification, cooling and crystallization)	<ul style="list-style-type: none"> Include, cleaning agents, energy, water and refrigerants
	7. Consumer/B2B packaging	<ul style="list-style-type: none"> As described in the main text of this guidance. For dairy butter, if the comparison is not to a specific product, packaging of 1.44 grams of paper per 250 grams of butter need to be considered, when comparing to a market average (as per dairy PEFCR)
Product distribution and storage	8. Distribution	<ul style="list-style-type: none"> For transport, allocation on mass should be applied For storage model 1 week chilled storage for butter at distribution For storage, a storage space of 3 times the product volume needs to be considered.
	9. Retail or food service	<ul style="list-style-type: none"> Modelling approach should be identical.

Main life cycle stage	Life cycle stage	Specific guidance
		<ul style="list-style-type: none"> Approaches in dairy PEFCR and shadow margarine PEFCR are identical Model storage time of 3 days.
Use stage (only to be included if manufactured product is final product)	10. Consumption	<ul style="list-style-type: none"> Include storage of product only if it needs to be chilled Assume spreading as intended use of butter/margarine (only use case for butter elaborated in dairy PEFCR), if this is not the use case of the margarine product, exclude the use phase Include dishwashing of one knife, as per dairy PEFCR
End-of-Life	11. End-of-Life	<ul style="list-style-type: none"> Use CFF

Environmental data quality for butter production

In practice, when a margarine producing company wants to compare their production to a dairy product, they are likely to have better access to primary data from their own production, than dairy production. Therefore, it is allowed to compare the environmental performance of their product with the environmental performance of a butter, calculated with secondary data, but only when the criteria listed here are met.

When comparing the environmental performance of a margarine product calculated according to these guidelines and the specifications of this annex, a secondary data source needs to be chosen for the environmental performance of the dairy-based fat product. This deviates from the ISO requirement that requires similar data quality used for both products. But this exemption is necessary due to data availability to the practitioner. This difference shall always be mentioned when communicating results. This should be:

- Market specific: the dairy product should be representative of the same market (data that represents the system behind the product sold in the same market as the margarine product)
- From a recognized LCA database or scientific literature
- Calculated in accordance with the Dairy PEFCR

A preferred database for the environmental performance of dairy products is Agri-footprint 7. This database covers a wide range of milk producing countries, and data are modelled in line with the dairy PEFCR, allowing for fair comparison.

Appendix II – Review statement

Critical Review Statement

Shadow PEFCR for the European Margarine Association

Compliance to the PEF Guidelines

13 March 2026

Commissioned by: IMACE

Reviewer: Anton Kool, Kool Planet

Primary References:

- PEF Guidelines (European Commission 2021)

1 General Introduction and Context

The development of this Shadow PEFCR for the European Margarine Association was commissioned by the European Margarine Association (IMACE) and supported by Mérieux NutriSciences | Blonk.

This guideline is referred to as a so-called ‘shadow’ PEFCR because it is not an official PEFCR as no formal application and registration for official PEFCR developments at European Commission was possible at the moment of development. Despite that, the aim was to stay as close as possible to current PEFCR guidelines to have a solid methodology that can serve as foundation for when a new opportunity arises to develop an official PEFCR.

The Shadow PEFCR for Margarine differs from the official PEFCR development in some aspects: no representative products were modelled, and no supporting studies were conducted, which are crucial for identifying relevant impact categories and life cycle stages. Instead, these were identified through literature and expert recommendations. Additionally, the guidelines were not reviewed by the European Commission’s Technical Advisory Board (TAB). The use of the European Environmental Footprint (EF) database, typically required for PEF-compliant studies, may only be used in the context of official PEFCRs and thus is also not allowed.

Taking into account these deviations from the general PEF Guidelines (European Commission 2021), the remaining guidance in this Shadow PEFCR is reviewed for compliance with the methodological requirements specified in the general PEF Guidelines (European Commission 2021). More generally, this review is conducted to ensure that:

- The report and described methodology is transparent and consistent,
- the methodology is scientifically and technically valid,
- where relevant the linkage between other relevant guidelines, such as the PEFCR Dairy, PEFCR Feed and the Shadow PEFCR of Vegetable oils, is interpreted and applied correctly.

The adjustments from the public consultation were also included in this review and incorporated together in the updated report. This review statement exclusively applies to this specific report's latest available version, dated 11 March 2026.

2 The Critical Reviewer

The review is performed by Anton Kool from Kool Planet. He has almost 20 years of experience in conducting LCA's and footprint assessments in agricultural and food producing sectors.



3 The Critical Review Process

The report (a MS word file) “*Environmental footprint methodology margarine*” was shared for review at 3 February 2026.

Review Round I: After reviewing the report, 66 comments were reported at 11 February 2026. In general, these comments consisted of request for clarifications, substantiation of methodological choices, suggestions for clarification and a number of corrections. No major deviations or non-conformities with the general PEF guidelines were identified.

Review Round II: The responses to the comments and the revised report and excel were submitted to the external reviewer on 5 March 2026. After reviewing the beforementioned, most of the corrections and explanations were accepted. For three points additional clarification was requested as stated in the second round of comments shared at 10 March 2026.

The final response on the second round of comments was shared at 11 March 2026 which was accepted at 12 March. This review statement was completed at 13 March 2026.

4 Concluding Statement

The two rounds of review and revision that constituted the critical review process served to improve the shadow PEFCR for Margarine report on explanation, substantiation and consistency. The shadow PEFCR for Margarine offers a clear and consistent guidance for harmonised environmental impact assessment within the European Margarine sector. Besides the earlier mentioned deviations from an official PEFCR, the shadow PEFCR for Margarine is conforming with the general PEF Guidelines (European Commission 2021).

The guidance described in the report is scientifically and technically valid, and the linkage between other relevant guidelines, such as the PEFCR Dairy, PEFCR Feed, and the Shadow PEFCR of Vegetable Oils, is interpreted and applied correctly and consistently.



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Date: 13 March 2026



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