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Product Environmental Footprint Category Rules

for Dairy Products

Dairy PEFCR update prepared by the ***Technical Secretariat****:*

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Executive Summary

Through its initiative, "Building the Single Market for Green Products", the European Commission (EC) aims to harmonise the communication of environmental performances of products and organisations for producers and consumers alike. Member States and the private sector are encouraged to test a life cycle assessment (LCA)-based method developed by the European Commission's Joint Research Centre (JRC) to measure the environmental performance of products throughout their life cycles, known as the Product Environmental Footprint (PEF).

The Product Environmental Footprint (PEF) method provides detailed and comprehensive technical rules on how to conduct PEF studies that are more reproducible, consistent, robust, verifiable and comparable. The European Commission also issued guidelines for developing PEF Category Rule (PEFCR), which define the methodology for calculating the environmental footprint of a specific product group. In line with the next phase of PEF, involving a partial update of the pilot PEFCR, this study is a partial revision of the existing PEFCR for dairy products (The European Dairy Association, 2018), which was developed in the PEF pilot phase and expired on December 31, 2020.

The Technical Secretariat (TS) of this PEFCR update consists of the following companies and organisations: The European Dairy Association (EDA), the Alliance for Beverage Cartons and the Environment (ACE); Association de la Transformation Laitière Française (ATLA), Savencia (under ATLA); Blonk Sustainability, a Mérieux NutriSciences Company (Blonk); Arla Foods (under Danish Dairy Board); Deutsches Milchkontor GmbH (DMK); the European Container Glass Federation (FEVE); Fonterra; Lactalis; Milchindustrie-Verband e.V. (MIV); FrieslandCampina (under NZO); Royal A-ware (under NZO[1]); and Zbornica kmetijskih in živilskih podjetij (GZS).

This PEFCR covers the full life cycle (cradle to grave) for dairy products sold on the European + EFTA + UK market. The following sub-categories are considered: liquid milk, dried whey products, cheeses, fermented milk products, and butterfat products. A PEF screening study was conducted for each of these sub-categories, identifying hotspots and relevant impact categories. Six supporting studies were then conducted in 2014 by by Bel Group, CLS, Danone, DMK GROUP, Fonterra and FrieslandCampina to test

[1] Nederlandse Zuivel Organisatie (https://www.nzo.nl/)

the applicability of the PEFCR on real products. The PEFCR provides detailed guidance related to the use of primary and secondary data, data quality requirements, allocation rules, impact categories that shall be addressed and further environmental information to be provided when assessing the PEF of dairy products. Although all dairy products could not be included in this pilot project, the TS advice is that the future development of PEFCRs for other dairy products complies with the content of this PEFCR. Moreover, this PEFCR may be used as a guidance document for PEF studies of dairy products not covered by this PEFCR. However, in that case, compliance cannot be claimed.

The PEFCR shall enable comparative assessment of different products from the same sub-category. It is not meant for comparing dairy products from different subcategories or comparing dairy and non-dairy products. The use of the present PEFCR is optional for in-house applications, it is recommended for external applications without comparison or comparative assertions, while it is mandatory for external applications with comparisons or comparative assertions.

This present document involves only a partial revision of the existing PEFCR for dairy (The European Dairy Association, 2018). A Full revision of PEFCRs is planned for 2025/2026, when the new PEF guidance is available.

Table of Contents

List of figures

List of tables

Acronyms

ACE	Alliance for Beverage Cartons and the Environment
ADEME	Agence de l'environnement et de la maîtrise de l'énergie (French Environment and Energy Management Agency)
AF	Allocation factor
AFNOR	Association Française de Normalisation (French national organisation for standardisation)
ATLA	Association de la Transformation Laitière Française (French Dairy Processors Association)
B2B	Business to business
B2C	Business to consumer
BOM	Bill of Materials
CFF	Circular Footprint Formula
CGDD	Commissariat Général au Développement durable (French Ministry of Environment
CH_4	Methane
CLS	Coopérative Laitère de la Sèvre (Dairy Cooperative of the Sèvre)
CNIEL	Centre National Interprofessionnel de l'Economie Laitière (French Dairy Interbranch Organisation)
CO_2	Carbon dioxide
COD	Chemical oxigen demand
CPA	Classification of Products by Activity
CTU	Comparative toxic units
DC	Distribution centre
DM	Dry matter
DMI	Dry matter intake
DMK	Deutsches Milchkontor GmbH
DNM	Data Needs Matrix
DQR	Data Quality Rating
EC	European Commission
EDA	European Dairy Association
EF	Environmental Footprint
EFTA	European Free Trade Association

ELCD	European reference Life Cycle Database
EoL	End of life
FAO	Food and Agriculture Organisation of the United Nations
FEVE	European Container Glass Federation
FPCM	Fat- and protein-corrected milk
FPE	Flexible Packaging Europe
FU	Functional unit
g	Gram
GHG	Greenhouse gas
GR	Geographical representativeness
GWP	Global warming potential
GZS	Zbornica kmetijskih in živilskih podjetij
HDPE	High density polyethylene
IDELE	Institut Français de l'Elevage (French Livestock Institute)
IDF	International Dairy federation
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	Joint Research Centre
kg	Kilogram
km	Kilometre
kWh	Kilowatt hour
l	litre
LCA	Life Cycle Assessment
LCDN	Life Cycle Data Network
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LDPE	Low density polyethylene
LEAP	Livestock Environmental Assessment and Performance

LPB	Liquid packaging board
m	Metre
m^2	Square metre
m^3	Cubic metre
MIV	Milchindustrie-Verband e.V.
MJ	mega joules
ml	Millilitre
N_2O	Nitrous oxide
NACE	Nomenclature Générale des Activités Economiques dans les Communautés Européennes
NH_3	Ammonia
NMVOC	Non-methane volatile compounds
NO_x	Nitrogen oxides
NZO	Nederlandse Zuivel Organisatie
OEF	Organisation Environmental Footprint
OEFSR	Organisation Environmental Footprint Sector Rule
P	Precision
PCR	Product Category Rule
PE	Polyethylene
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rule
PET	Polyethylene terephthalate
PM	Particulate matter
PP	Polypropylene
PSR	Pressure State Response
PWG	Packaging Working Group
PYR	The Environmental Register of Packaging PYR Ltd
RP	Representative product
SMGP	Single Market for Green Products
t	Tonne

TAB	Technical Advisory Board
TeR	Technological Representativeness
TiR	Time Representativeness
tkm	Tonne kilometre
TS	Technical Secretariat
TSC	The Sustainability Consortium
UUID	Universal Unique Identifier
WRAP	Waste and Resources Action Programme

Definitions

This glossary defines key terms used in this PEFCR. Most of the terms are based on the Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint (EF) methods to measure and communicate the life cycle environmental performance of products and organisations (European Commission, 2021) and (ISO 14044, 2006).

Activity data	This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF Guide it is also called "non-elementary flows". The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data 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 released in areas where the buffering capacity is low, resulting in forest decline and lake acidification.
Additional environmental information	Environmental information outside the EF impact categories that is calculated and communicated alongside PEF results.
Additional technical information	Non-environmental information that is calculated and communicated alongside PEF results.
Aggregated dataset	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 understudy and one or more other product systems*" (ISO 14044, 2006).
Average data	It refers to a production-weighted average of specific data.
Background processes	Refers to those processes in the product life cycle for which no direct access to information is possible. For example, most of the upstream life-cycle processes and generally all processes further downstream will be considered part of the background processes.
Benchmark	A standard or point of reference against which any comparison 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 Consumers (B2C)	Describes transactions between business and consumers, such as between retailers and consumers. According to ISO 14025 (2006), a consumer is defined as "an individual member of the general public purchasing or using goods, property or services for private purposes" (ISO 14025, 2006).
Calves <1 year	Young cattle of either sex, less than one year of age.
Calves 1-2 year	Young cattle from one up to two years of age.
Characterisation	Calculation of the magnitude of the contribution of each classified input/output to their respective EF impact categories, and aggregation of contributions within each category. This requires a linear multiplication of the inventory data with characterisation factors for each substance and EF impact category of concern. For example, with respect to the EF impact category "climate change", CO_2 is chosen as the reference substance and kg CO_2-equivalents as the reference unit.
Characterisation factor	"*Factor derived from a 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).

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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).
Composite product	Food product containing a certain fraction of milk. Typical examples of composite products are milk-based desserts, butter cookies, infant formula, edible ice, pizza, etc.
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.
Dairy ingredient	Dairy part of a composite product.

Dairy product	"Dairy product" or "Milk product" defines a product derived exclusively from milk, on the understanding that substances necessary for their manufacture may be added provided that those substances are not used for the purpose of replacing, in whole or in part, any milk constituent. (Regulation (EU) No 1308/2013).
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.
Environmental aspect	"*Element of an organisation's activities or products or services that interacts or can interact with the environment*" (ISO 14044, 2006).
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) compliant dataset	Dataset developed in compliance with the EF requirements provided at https://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

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 footprint (EF) report	Document that summarises the results of the EF study. For the EF report the template provided as annex to the PECFR Guidance shall be used. In case the commissioner of the EF study decides to communicate the results of the EF study (independently from the communication vehicle used), the EF report shall be made available for free through the commissioner's website. The EF report shall not contain any information that is considered as confidential by the commissioner, however the confidential information shall be provided to the verifier(s).
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.
Foreground elementary flows	Direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.
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. GWP20, GWP100, GWP500, 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.
Heifers	Heifers are defined as animals that are older than 2 years, but before their first calving.
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 co-products*"(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)	"*Phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product 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
Milk	"Milk", or "Raw milk", means exclusively the normal mammary secretion obtained from one or more milkings without either addition thereto or extraction therefrom. (Regulation (EU) No 1308/2013).
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 long-lived chlorine and bromine containing gases (e.g. CFCs, HCFCs, Halons).
Partially disaggregated dataset	A dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield

	a complete aggregated LCI data set. We refer to a partially disaggregated dataset at level 1 in case the LCI contains elementary flows and activity data, while all complementing underlaying dataset are in their aggregated form.
Particulate matter	EF impact category that accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NOx, SOx, NH_3).
PEFCR Supporting study	The PEF study done on the basis of a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.
PEF profile	The quantified results of a PEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to be reported.
PEF screening	A preliminary study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the product category/sub-categories in scope, and any other major requirement to be part of the final PEFCR.
Photochemical ozone formation	EF impact category that accounts for the formation of ozone at the ground level of the troposphere caused by photochemical oxidation of volatile organic compounds (VOCs) and carbon monoxide (CO) in the presence of nitrogen oxides (NOx) and sunlight. High concentrations of ground-level tropospheric ozone damage vegetation, human respiratory tracts and manmade materials through reaction with organic materials.
Population	Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study.
Primary data	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 (PCR)	*"Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories"* (ISO 14025, 2006)
Product environmental footprint category rules (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 (non-existing) product built, for example, from the average EU sales-weighted characteristics of all technologies around. A PEFCR may include more than one representative product if appropriate.
Representative sample	A representative sample with respect to one or more variables is a sample in which the distribution of these variables is exactly the same (or similar) as in the population from which the sample is a subset.
Sample	A sample is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.
Secondary data	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.
Type III environmental declaration	An environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information (ISO 14025, 2006). The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044.
Unit process dataset	Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 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 [2].
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.

[2] https://wulca-waterlca.org/

1 Introduction

The Product Environmental Footprint (PEF) Guide provides detailed and comprehensive technical guidance on how to conduct a PEF study. PEF studies may be used for a variety of purposes, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this PEFCR the user shall refer to the Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations (European Commission, 2021).

The compliance with the present PEFCR is optional for PEF in-house applications, whilst it is mandatory whenever the results of a PEF study or any of its content is intended to be communicated.

Terminology: shall, should and may

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

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

In 2013, the European Commission (EC) launched the Product Environmental Footprint (PEF) method in order to introduce a standardised way of measuring the environmental performance of products (European Commission, 2018). As part of the pilot phase, 19 Product Environmental Footprint Category

Rules (PEFCRs) were developed, amongst which the PEFCR for dairy products (The European Dairy Association, 2018).

In line with the next phase of PEF, involving a partial update of the pilot PEFCR, this study is a partial revision of the existing PEFCR for dairy products (The European Dairy Association, 2018), which was developed in the PEF pilot phase and expired on December 31, 2020.

This present document involves only a partial revision of the existing PEFCR for dairy products (The European Dairy Association, 2018). A full revision of the existing PEFCR is planned for 2024/2025, when the new PEF guidance is available.

2 General information about the PEFCR

2.1 Technical Secretariat

The Technical Secretariat (TS) responsible for the development of a partial revision of the PEFCR for dairy products is composed of the following organisations (Table 1):

Table 1: Members of the Technical Secretariat (TS)

Name of the organisation	Type of organisation	Name of the members
European Dairy Association (EDA)	Industry association	Alberto Babolin
Alliance for Beverage Carton and the Environment (ACE)	Industry association	Michel Steinecke
Association de la Transformation Laitière Française (ATLA)	Industry association	Pierre Barrucand
Savencia *(under ATLA)*	Industry	Auriane Pouvreau
Blonk Sustainability, Mérieux NutriSciences Company (Blonk)	Industry	Naomi Buijs, Iana Câmara Salim, Jasper Scholten
Arla Foods *(under Danish Dairy Board)*	Industry	Maiken Voigt
Deutsches Milchkontor GmbH (DMK)	Industry	Dirk Von Aschwege
European Container Glass Association (FEVE)	Industry association	Fabrice Rivet Giulia Gallo
Fonterra	Industry	Andrew Fletcher
Lactalis	Industry	Marie-Laure Brandy
Milchindustrie-Verband e.V. (MIV)	Industry association	Astrid Stein
FrieslandCampina *(under NZO)*	Industry	Sanne Dekker (coordinated by NZO)
Royal A-ware *(under NZO)*	Industry	Raoul Schiffer (coordinated by NZO)
Zbornica kmetijskih in živilskih podjetij	Industry association	Barbara Rupnik

Name of the organisation	Type of organisation	Name of the members
(GZS)		

2.2 Consultation and stakeholders

This PEFCR is a partial revision of the 2018 PEFCR for dairy products (The European Dairy Association, 2018), which was developed in the PEF pilot phase and which expired on 31st of December 2020. This update has been developed in a transparent manner and with the information on the different steps made available on the dedicated wiki page of the EU pilots' website:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/Dairy+PEFCR

The Technical Secretariat of the partial revision of the PEFCR for dairy products has invited relevant stakeholders to participate in the PEFCR development. The relevant stakeholders for the PEFCR development include, amongst others, representatives from suppliers, farm and trade associations, consumers, government representatives, non-governmental organisations (NGOs), public agencies, independent parties and certification bodies. The identified relevant stakeholders were proactively informed by the Technical Secretariat about the opportunity to take part in the different public consultations (See Table 2).

Table 2: Consultations and stakeholders

	First consultation
Type	Online
Start	September 04, 2024
End	October 11, 2024
Duration	5 weeks

Number of participating stakeholders (online)	5
Number of participating stakeholders (physical)	0
Number of comments	69
Organisations that have provided comments	1) Studio Fieschi & soci - - - 2) Pre Sustainability 3) IRTA - Institute of Agrifood Research and Technology (IRTA) 4) Natural Resources Institute Finland (Luke) 5) Glimpact

2.3 Review panel and review requirements

Table 3 lists the reviewers of the partial PEFCR for dairy products.

Table 3. Partial revision Product Environmental Footprint Category Rule (PEFCR) review panel

	Chair	Expert #2	Expert #3
Name	Greg Thoma	Jude Capper	Judith Brouwer
Affiliation	University of Arkansas	Livestock Sustainability Consultancy	Milieu Centraal
Expertise/Role	LCA and dairy expert	LCA and dairy expert	NGO representative

The reviewers have verified that the following requirements have been fulfilled:

(a) The PEFCR has been developed in accordance with the requirements provided in Annex I and Annex II of Commission Recommendation (EU) 2021/2279; (European Commission, 2021);

(b) The PEFCR supports the creation of credible, relevant and consistent PEF profiles;

(c) The PEFCR scope and the representative products are adequately defined;

(d) The functional unit, allocation and calculation rules are adequate for the product category under consideration;

(e) Datasets used in the PEF-RPs and the supporting studies are relevant, representative, reliable, and in compliance with data quality requirements;

(f) The selected additional environmental and technical information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in Annex I of Commission Recommendation (EU) 2021/2279; (European Commission, 2021);

(g) The model of the RP and corresponding benchmark (if applicable) represent correctly the product category or sub-category;

(h) The RP models, disaggregated in line with the PEFCR and aggregated in ILCD format, are EF compliant following the rules available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml;

(i) The RP model in its corresponding excel version is compliant with the rules outlined in section A.2.3 of Annex II of Commission Recommendation (EU) 2021/2279; (European Commission, 2021);

(j) The Data Needs Matrix is correctly implemented;

(k) The classes of performance, if identified, are appropriate for the product category.

The public review reports are provided in Annex 3 of this PEFCR.

2.4 Review statement

This PEFCR was developed in compliance with the PEF Method adopted by the Commission on 2021 and EF reference package 3.1.

The representative product correctly describes the average product sold in Europe (EU+EFTA+UK) for the product category in scope of this PEFCR.

PEF studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions (see section on limitations).

2.5 Geographic validity

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

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

2.6 Language of PEFCR

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

2.7 Conformance to other documents

This PEFCR has been prepared in conformance with the following documents:

- The 2018 PEFCR for dairy products (incl. additional files and corrigendum);
- A common carbon footprint approach for Dairy. The IDF guide to standard life cycle assessment methodology for the dairy sector (IDF, 2015)[3];
- The EF3.1 reference packages (See https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml);
- The checklist for the partial revision procedure as discussed at the Technical Advisory Board (TAB);
- Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations (European Commission, 2021).

While the already existing IDF Guide solely focuses on carbon footprint, this PEFCR covers a wide range of environmental indicators and aims to complement the French Guidance (AFNOR, 2014) in a way that reflects the diversity of dairy products in the EU. These two reference documents are however not totally aligned with the PEFCR because they do not fully fulfil all mandatory requirements set by the EC (e.g. some stages are excluded from the product life cycle or default EF impact categories are not included). Nevertheless, these documents represent very useful sources of information and are used as references when relevant.

[3] An update to the IDF (IDF, 2022), published in 2022, introduced modifications to the allocation at the farm gate. However, as this study is a partial update of the pilot PEFCR and does not include changes to the modelling process, the new IDF was not considered but is required to be applied when this PEFCR is fully revised.

3 PEFCR scope

The product category for this PEFCR is **dairy products**, which includes the following:

- Liquid milk
- Dried whey products
- Cheeses
- Fermented milk products
- Butterfat products

It is important to note that the dairy products in this study only consider those made from cow's milk. Products from other animals are not included. Moreover, other dairy products are not covered by this PEFCR (see section 3.1). This PEFCR could however be used for calculating - the whole or part of - the PEF of other dairy products. However, an EF study carried out for a product not in scope of this PEFCR cannot be declared in compliance with it.

The following definitions[4] apply to the product category:

- **Raw milk**, or, as defined in EU regulation, "**Milk** means exclusively the normal mammary secretion obtained from one or more milkings without either addition thereto or extraction therefrom" (Regulation (EU) No 1308/2013)
- **Dairy products**, or, as defined in EU regulation, "**Milk products** means products derived exclusively from milk, on the understanding that substances necessary for their manufacture may be added provided that those substances are not used for the purpose of replacing, in whole or in part, any milk constituent." (Regulation (EU) No 1308/2013). Dairy products can include non-dairy ingredients such as salt, sweeteners, fruit preparations, etc.
- **Composite product** means any food product containing a certain fraction of milk. Typical examples of composite products are milk-based desserts, butter cookies, infant formula, edible ice, pizza, etc.
- **Dairy ingredient** means the dairy part of a composite product.

[4] The definitions from the EU Regulation No 1308/2013 are adapted from the Codex Alimentarius (WHO and FAO, 2011). It should therefore be understood that the definitions used in the PEFCR also apply to a regulatory context wider than the EU.

This PEFCR covers the dairy ingredients of composite products, when these dairy ingredients can be assimilated to dairy products that are explicitly included in the scope.

Specific non-dairy ingredients added to dairy products are included in this PEFCR and are a part of the product environmental footprint. However, this PEFCR does not provide detailed guidance on how to model the upstream production of these ingredients. Rules on how to include those ingredients in the PEF of dairy products (e.g. amounts) are provided in this PEFCR, together with some relevant secondary data that fulfils the required quality standard. Typical examples of non-dairy ingredients added to dairy products are fruit preparation in yoghurt or salt in cheese.

The PEFCR covers raw milk produced by cattle only, and its derived dairy products. The full life cycle (cradle to grave) for dairy products sold on the EU market are within the scope of this PEFCR.

The main function of dairy products is to provide nutritional and health benefits to humans or animals. Nutritional benefits found in dairy products include energy (calories), proteins, carbohydrates, fat, calcium, phosphorus and vitamins, among others. Several applications of dairy products are distinguished, corresponding to the product sub-categories shown in Table 4 where “F” stands for “final products” and “I” for “intermediate product”.

Table 4: Sub-categories of dairy products

Sub-category	Type	Typical products
Liquid milk	F	Standardised milk (skimmed, semi-skimmed, whole milk)
Dried whey products	I	Whey powder, whey protein powder, lactose powder
Cheeses	F	Ripened cheese (soft and hard), unripened cheese (spoonable, spreadable, solid)
Fermented milk products	F	Spoonable yoghurt (set, stirred), fermented milk drinks (liquid yoghurt, kefir)
Butterfat products	F	Butter (salted, unsalted), spreadable dairy fats

These sub-categories were defined with the aim to make the complexity of the dairy sector understandable for all types of stakeholders: consumers, dairy producers, retailers, food processors and regulators. To ensure alignment with the PEF guidance, all dairy products could however not be included in the scope of this PEFCR. For those dairy products that are covered, the following reasoning was followed:

- From a consumer perspective, each sub-category corresponds to a different type of product with its own application (i.e. products from different sub-categories are not exchangeable)
- These sub-categories correspond to different sets of process stages
- A clear and systhematic process diagram can be made of each of these sub-categories

Most dairy products can either be final or intermediate products used as ingredients into composite products. In the PEFCR, only products from the sub-category “dried whey products” are considered as intermediate product. Others are considered as final products.

The PEFCR shall enable comparative assessment of different products from the same sub-category. The PEFCR shall not serve comparisons of products from different sub-categories, or with non-dairy products in general.

Packaging is included in the scope of the PEFCR and is an integral part of the final dairy products (including dried whey products). Packaging is a multi-functional product: according to a report of the UNEP/SETAC Life Cycle Initiative, "the most important role of packaging is to protect and contain the product during distribution and storage. When designed intelligently, it can ensure product safety—particularly important for food and beverages—and minimize losses. In the food and beverage industry, packaging also serves to preserve the product and prevent spoilage, provide information, provide convenience and portion control, and market to the consumer"[5].

As it is recognized that the multi-functionality of packaging is not fully captured by the current LCA and PEF methodology[6,7], the dairy PEFCR is not meant to support specific comparison or comparative assertion between packaging formats. Once this limitation is taken into account, the PEFCR can still be used to compare the global environmental performance of different dairy products. Efforts should be made to correctly estimate the functionality of the dairy packaging formats under study, especially regarding food waste. If this is not possible due to lack of data, the results regarding packaging should be interpreted with care.

3.1 Product classification

This section lists categories and codes from the Classification of Products by Activity (CPA) that are covered by this PEFCR (Table 5). Terminology used here is from the CPA, which is not necessarily consistent with the terminology used in this PEFCR.

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[5] UNEP/SETAC Life Cycle Initiative, 2013: An Analysis of Life Cycle Assessment in Packaging for Food & Beverage Applications (https://www.lifecycleinitiative.org/wp-content/uploads/2013/11/food_packaging_11.11.13_web.pdf)

[6] Technische Universität Berlin, Prof. Dr. Matthias Finkbeiner, 2016: High-Level-Analysis Of Gaps For Comparability Of Packaging Materials In The EU Product Environmental Footprint (PEF) (Finkbeiner, 2016).

[7] Outcomes of the EF TAB meeting, 31st May 2016

Table 5: Classification of Products by Activity (CPA) codes covered by the Product Environmental Footprint Category Rule (PEFCR)

CPA code	Coverage
10.5 Dairy products	Partly covered (see below)
10.51 Dairy and cheese products	Partly covered (see below)
10.51.1 Processed liquid milk and cream	Liquid milk covered. Cream not covered
10.51.11 Processed liquid milk	Covered
10.51.12 Milk and cream >6% fat, not concentrated or sweetened	Not covered
10.51.2 Milk in solid forms	Not covered
10.51.3 Butter and dairy spreads	Covered
10.51.4 Cheese and curd	Cheese covered. Curd not covered.
10.51.5 Other dairy products	Partly covered (see below)
10.51.51 Milk and cream, concentrated or containing added sugar or other sweetening matter, other sweetening matter, other than in solid forms	Not covered
10.51.52 Yoghurt and other fermented or acidified milk or cream	Covered, except acidified cream
10.51.53 Casein	Not covered
10.51.54 Lactose and lactose syrup	Covered, dried
10.51.55 Whey	Covered, dried

The following list (not exhaustive) of products are not covered by this PEFCR:

- Dried milks (powders and concentrate)
- Creams
- Sweetened or flavoured milk-based drinks
- Whey drinks
- Processed cheese
- Greek-style yoghurts
- Milk-based desserts

- Casein products
- Butteroils
- Composite products (only the dairy ingredients included in composite products are covered)
- Edible ice or ice cream (only milk, as an ingredient of edible ices, is covered, but ice cream is not)
- Infant formula (milk, as an ingredient of infant formula, is covered, but not infant formula)
- Milk and dairy products from other mammals than cattle (e.g. water buffalo, sheep or goat).

Despite that the above products are not officially within the scope of this PEFCR, the TS recommends that it is used as a starting point when calculating their PEF. The TS initially had the intention to include most of these in the scope but could not due to procedural constraints inherent to the pilot phase.

3.2 Representative products

Five different representative products are considered in this PEFCR (Table 6), one for each of the product sub-categories. All representative products are virtual products.

These representative products characterise what is potentially sold on the European market, not what is produced within the European Union. For products that are more largely exported from, or imported to the EU, this nuance may have significant effects on assumptions made transportation, storage, use and end of life.

Table 6: Representative products for each sub-category

Sub-category	Representative product	
Liquid milk	RP1	Liquid milk, standardised to specific fat content, and thermally treated (pasteurized), homogenised, unsweetened and unflavoured, packaged and conditioned.
Dried whey products	RP2	Whey, whey protein or lactose powder, standardised, with average lactose, protein and dry matter content, average packaging (partly packaged, partly bulk)
Cheeses	RP3	Average of unripened and ripened (soft, semi-hard, hard) cheese, standardised protein and fat, packaged and conditioned

Fermented milk products	RP4	Fermented milk, standardised, cultured, average of skimmed/plain, spoonable/liquid, plain/flavoured/fruited (strawberry), packaged and conditioned
Butterfat products	RP5	Average of butter, half-fat butter and dairy spreads, unsalted/salted, packaged and conditioned

3.3 Functional unit and reference flow

The functional unit (FU) is specified in Table 7, where key aspects are presented to further define the FU.

Table 7: Key aspects of the Functional unit (FU)

Product	Aspect detail	Dairy products PEFCR
What?	Function provided	To provide nutritional and health benefits (protein, calcium, vitamins, etc.) to humans
How much?	Magnitude of the function	Mass, volume, serving size or specific nutritional aspect (fat, calcium, protein, etc.) relevant to the study objectives
How well?	Expected level of quality	Fit for human consumption
How long?	Duration of the product provided	From milking to consumption: duration is related to the product conservation (i.e. up to the expiration date), which depends on multiple parameters such as type of processing, thermal treatment or packaging

The PEFCR provides rules for the assessment of PEF studies conducted by various stakeholders, with diverse scopes and multiple targeted audiences. The appropriate functional unit shall be chosen in relation to the scope of the PEF study and the factors driving the decision-making process (e.g. buying product A versus product B). The following rules shall be applied when defining the functional unit for dairy products:

- **By default**, the functional unit shall be per **mass** or per **volume,** depending on the reference used on the product packaging.

- **When justified by the study objectives**, **additional functional units can be selected**, such as the **serving size** (e.g. portion, consumption unit, unit sold) or **nutritional value** (e.g. energy content, protein content, fat content). In such cases, the decision tree in Figure 1 should be followed as to select the appropriate alternative functional unit, in PEF studies conducted in B2B and B2C contexts.

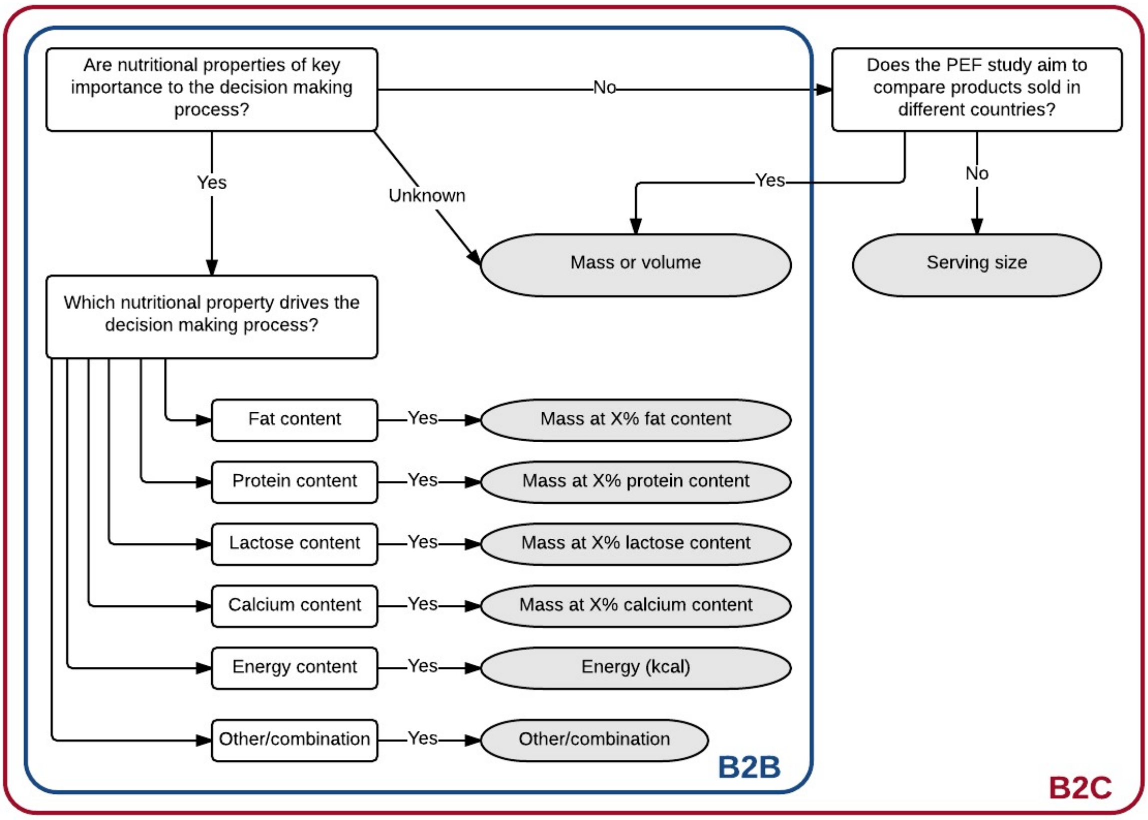

Figure 1: Decision tree to select appropriate functional unit in Business to Business (B2B) and Business to Consumer (B2C) contexts

The reference flow is the amount of product needed to fulfil the defined function and shall be measured with specific units. All quantitative input and output data collected in the study shall be calculated in relation to this reference flow. The default functional unit and associated reference flow for each sub-category is defined in Table 8.

Table 8: Default functional unit and reference flow for each sub-category

Sub-category	Functional unit	Reference flow
Liquid milk	Liquid milk, consumed at home as final product without heating, cooking or further transformation	1000 ml
Dried whey products	Dried whey product, at plant gate, for further processing into final products	1000 kg
Cheeses	Cheese, consumed at home as final product without cooking or further transformation	10 g dry matter equivalent
Fermented milk products	Fermented milk or yoghurt, consumed at home as final product without cooking or further transformation	125 g
Butterfat products	Butterfat product, consumed at home as final product without cooking or further transformation	50 g

Packaging is accounted in the functional unit described above, as it is an integral part of the final dairy products (including dried whey products). Packaging provides different functions, of which the main are:

- To contain a certain amount of food or beverage; this function is accounted for by the "how much" parameter.
- To protect food or beverage quality (e.g., taste) and preserve it over time; these functions are partially accounted for by, respectively, the "how well" and "how long" parameters.

3.4 System boundary

3.4.1 Life cycle stages

The entire life cycle, from cradle to grave, shall be assessed for the following sub-categories: liquid milk, cheeses, fermented milk products and butterfat products. The system includes seven life cycle stages: 1) "Raw milk", 2) "Dairy processing", 3) "Non-dairy ingredients supply", 4) "Packaging", 5) "Distribution", 6) "Use" and 7) "End of life" (

Table 9). Dried whey products are considered as "intermediate products", and therefore only stages 1, 2, 3 and 4 shall be included.

Table 9: Life cycle stages and included activities

Life cycle stage	Activities
1. Raw milk supply	Feed production (incl. pesticide and fertiliser inputs and emissions, energy, irrigation water, land transformation, feed processing, etc.)
	Milk production (incl. direct emissions at the farm)
	Milk collection and transport to dairy processing unit
2. Dairy processing	Dairy products processing (incl. energy use and wastewater treatment)
	Dairy ingredients processing (incl. energy use and wastewater treatment)
	Dairy ingredients transport to dairy processing unit
	Container filling or product packing
	On-site warehousing (storage)
3. Non-dairy ingredients supply	Production of non-dairy ingredients
	Non-dairy ingredients packaging manufacturing
	Non-dairy ingredients transport to dairy processing unit
4. Packaging	Raw materials production
	Packaging manufacturing (primary and secondary)
	Packaging transport to dairy processing unit
5. Distribution	Transport to the distribution centre
	Warehousing at distribution centre (storage, incl. refrigeration where relevant)
	Transport to point of sale
	Retailing at point of sale (storage, incl. refrigeration where relevant)
	Transport to final user
6. Use	Chilling operations in domestic refrigerator (at final user) and dishwashing
7. End of life	Household waste: packaging (and food) waste transport and treatment

"Packaging" is considered a separate life cycle stage from other raw materials acquisition given that it gives distinctive set of properties to the final dairy product as it typically influences the duration of the product. Also, packaging type, size and shape are key components differentiating brands.

3.4.2 *Foreground and background systems*

Figure 2 illustrates the system boundaries for dairy products in the view of a traditional LCA. The foreground system is greyed while the background (upstream and downstream) system is in white. This distinction is made in the perspective of dairy processors, but when other stakeholders (e.g. dairy farmers, retailers, restaurants, food processors) are using the current PEFCR, the actual foreground and background systems may differ.

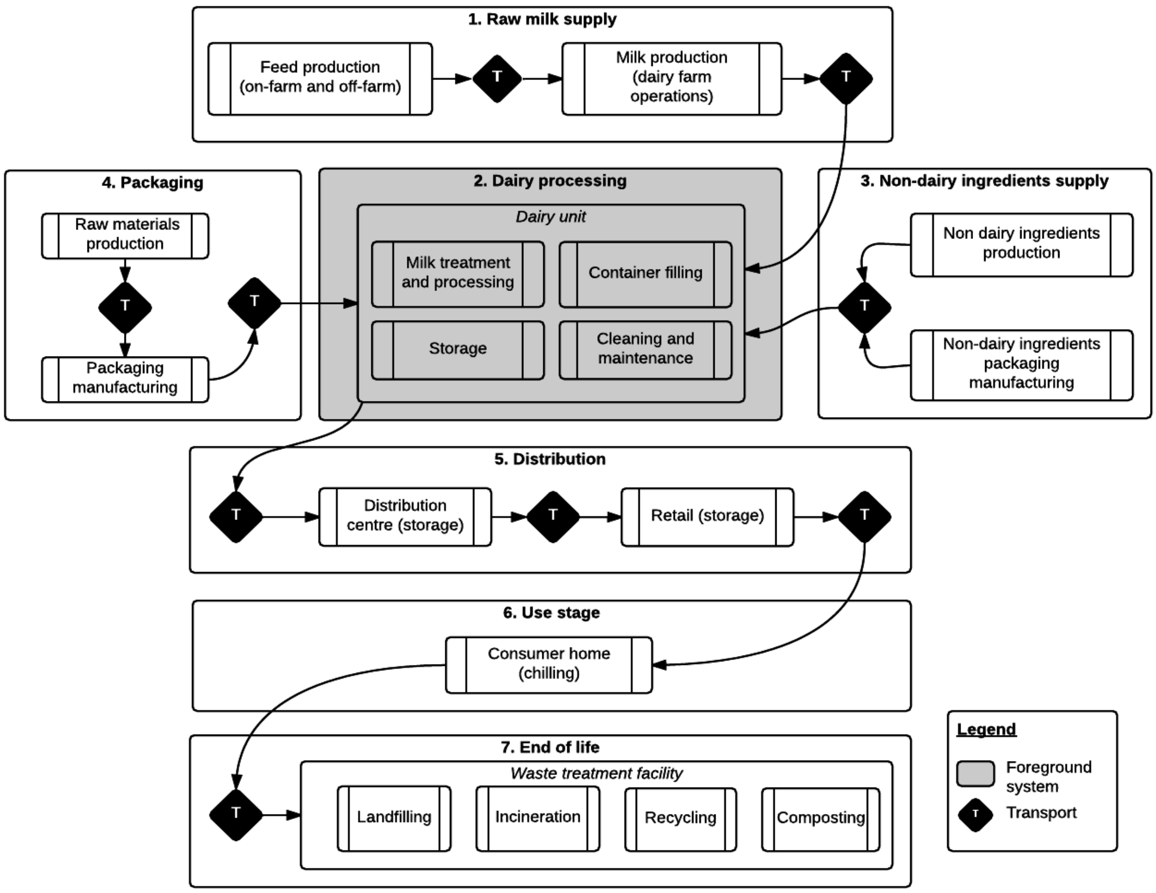

Figure 2: System boundaries diagram for dairy products (traditional Life Cycle Assessment (LCA) view)

In the PEF context, the foreground and background systems shall however be defined in relation to the so-called "materiality approach", which considers a) the relevance of the processes/stages driving the environmental impact, and b) the level of influence that the company performing the PEF study has on them. The Data Needs Matrix (DNM) combines information on the level of relevance to the environmental footprint (most-relevant or not) and the level of influence of the company performing the study. See section 5.5 for more details.

3.4.3 Overview of inputs and outputs for the LC stage "raw milk supply"

This section provides a simplified overview of main inputs and outputs related to the production of raw milk. For detailed data collection requirements, see section 5.2.1. An illustration of material and energy flows in dairy farming system is shown in Figure 3.

Inputs to the dairy farm

- Feed (grass, fodder, concentrate)
- Mineral fertilisers and pesticides for feed production
- Water used
- Animals for dairy production
- Bed materials (straw, paper, sand)
- Manure
- Fuel for machinery
- Production of energy used at the farm
- Refrigerants used at farm
- Farming equipment (capital goods) & barn

Outputs and emissions from the dairy farm

- Raw milk
- "Meat", or live animals for slaughter or further fattening (cull cows and calves)
- Manure
- Renewable energy
- Wastewater
- Emissions from combustion of fossil fuels
- Emissions from enteric fermentation
- Emissions from manure storage

- Emissions from manure application[8]
- Emissions from mineral fertilisers and pesticides application
- Emissions from mineral and organic soils[9]

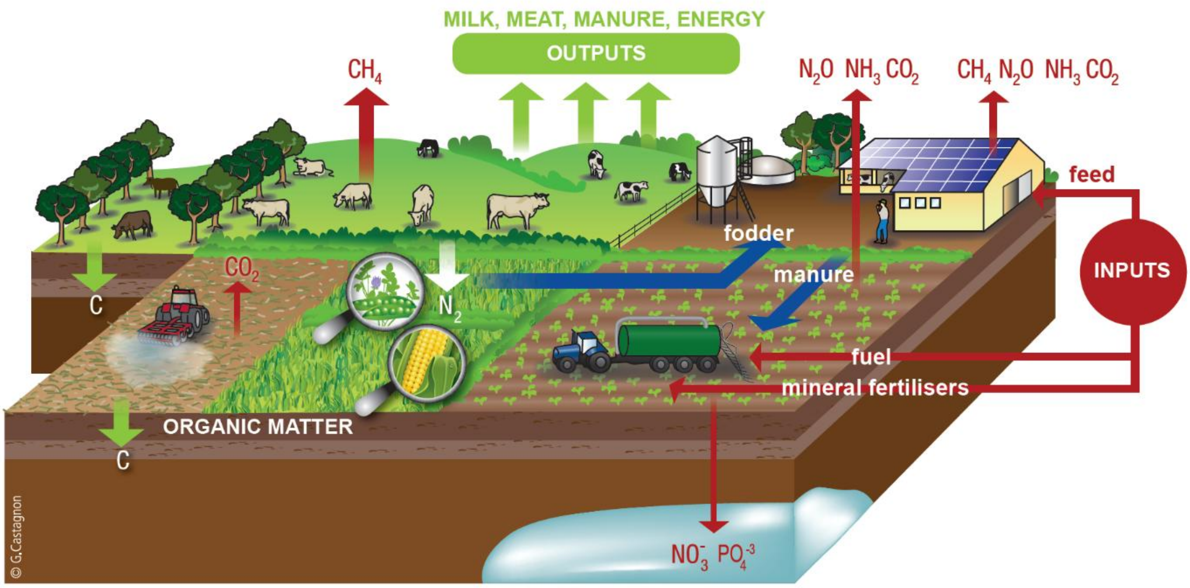

Figure 3: Illustration of material and energy flows in dairy farming system

3.4.4 Overview of inputs and outputs for the LC stage "dairy processing"

The main inputs and outputs related to the dairy processing stage can be summarised as follows:

Inputs to the dairy processing unit

- Raw milk
- Dairy ingredients (i.e. intermediate dairy products)

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[8] Emissions from manure application are allocated to the crop in accordance with LEAP guidance (FAO LEAP, 2016), but both the crop production and the dairy farm are within the system boundary. See also Section 4.5.1.2 "Allocation within the farm module for cattle" in the Commission Recommendation (EU) 2021/2279 of 15 December 2021 (European Commission, 2021).

[9] These emissions come from grazing. Emissions from crops produced on these soils are included in the feed production system.

- Non-dairy ingredients (i.e. salt, sugar, fruit preparation, herbs) (treated in life cycle stage “Non-dairy ingredients supply”)
- Cleaning agents
- Packaging (treated in life cycle stage "packaging")
- Energy (i.e. heat and electricity)
- Water
- Refrigerant gases

Outputs

- Dairy products
- Wastewater
- Waste materials (to recycling or disposal)
- Emissions to air and water

Process diagrams for the stage "Dairy processing" of every sub-category are detailed in the Figure 4Figure 5Figure 6Figure 7Figure 8.

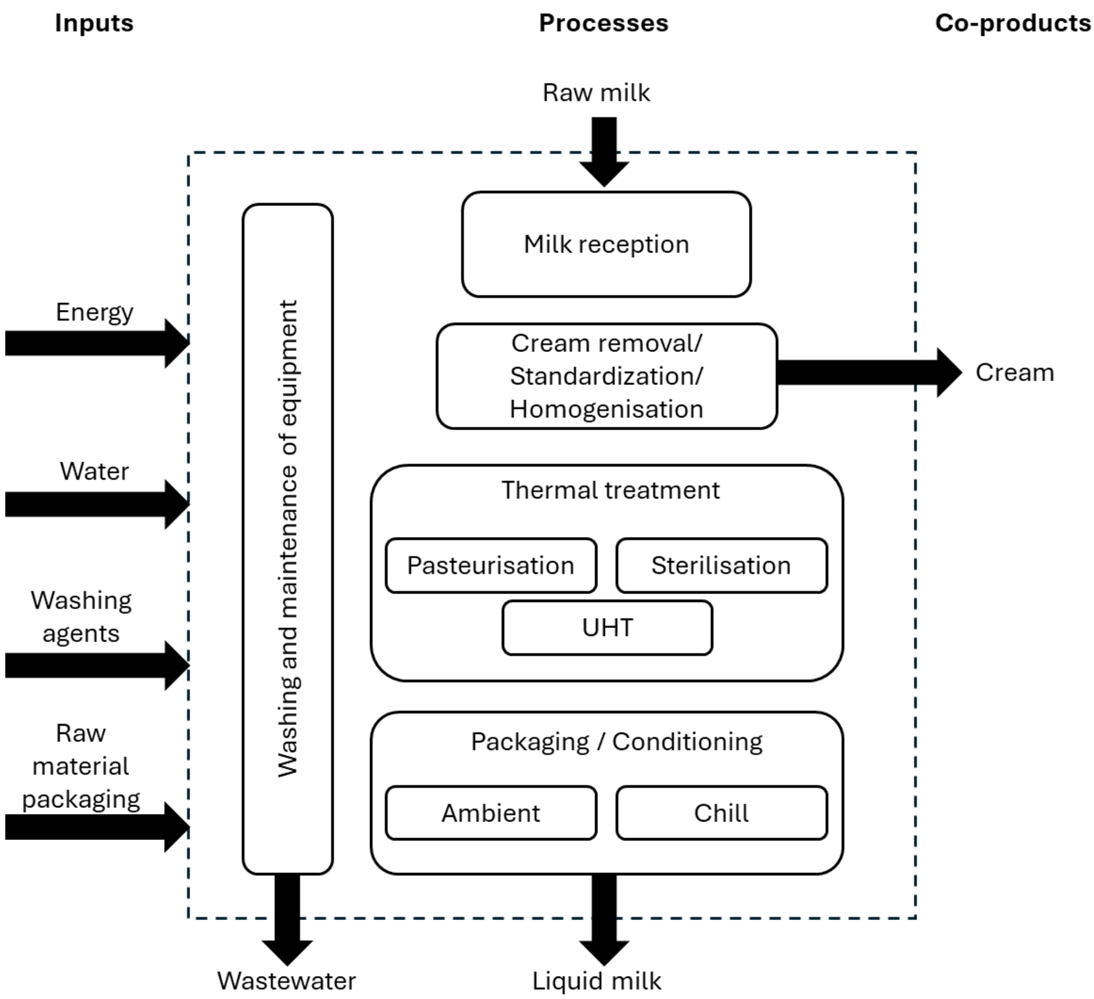

Figure 4: Process diagram for liquid milk. UHT = Ultra high temperature

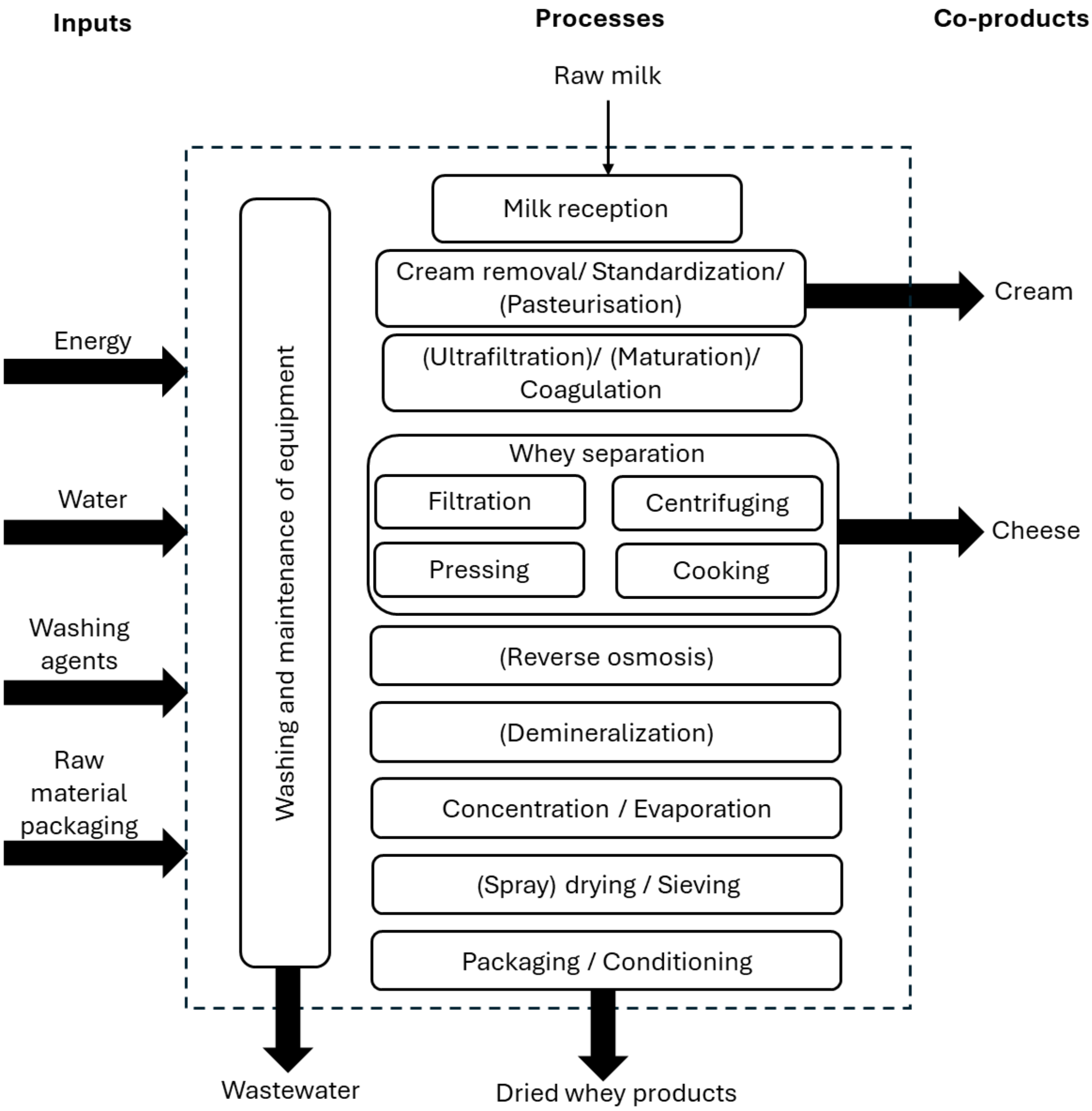

Figure 5: Process diagram for dried whey products

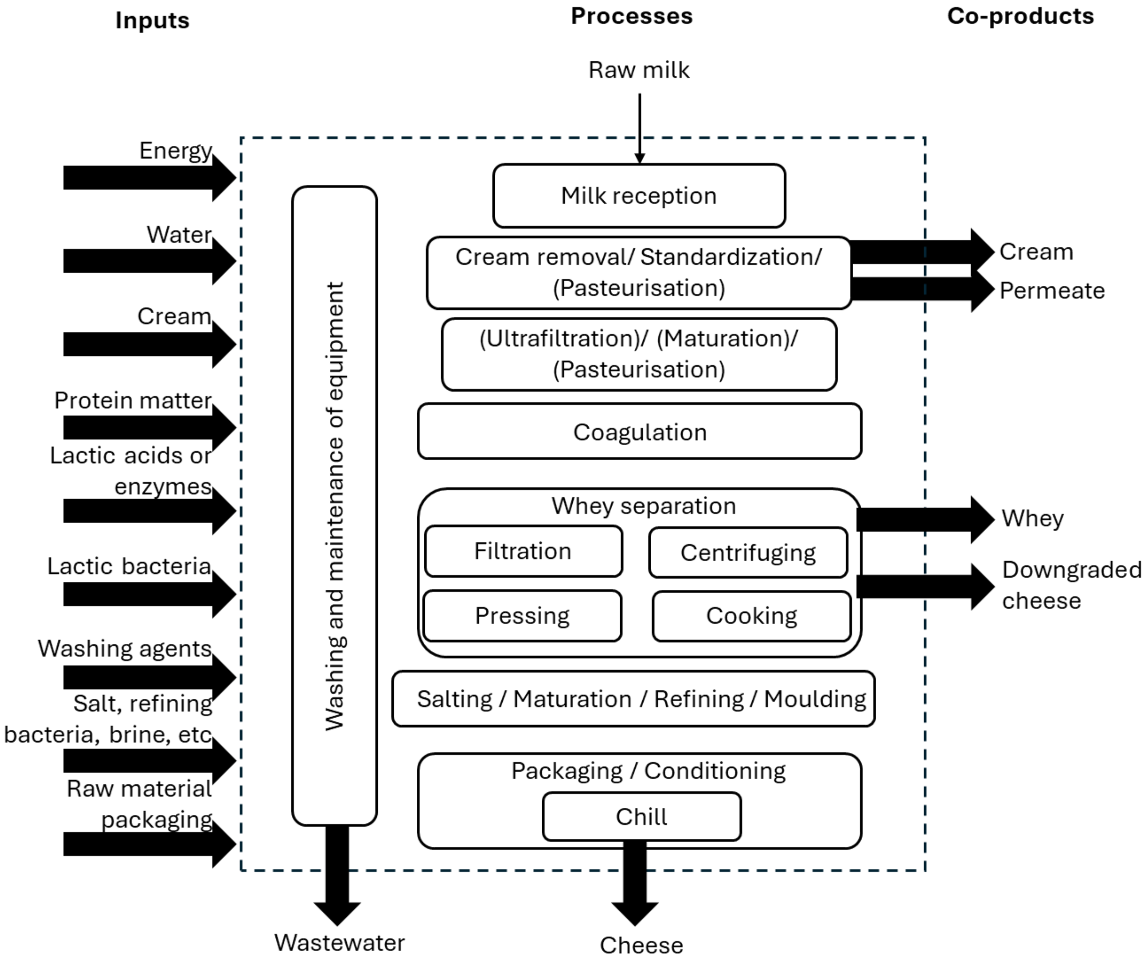

Figure 6: Process diagram for cheeses

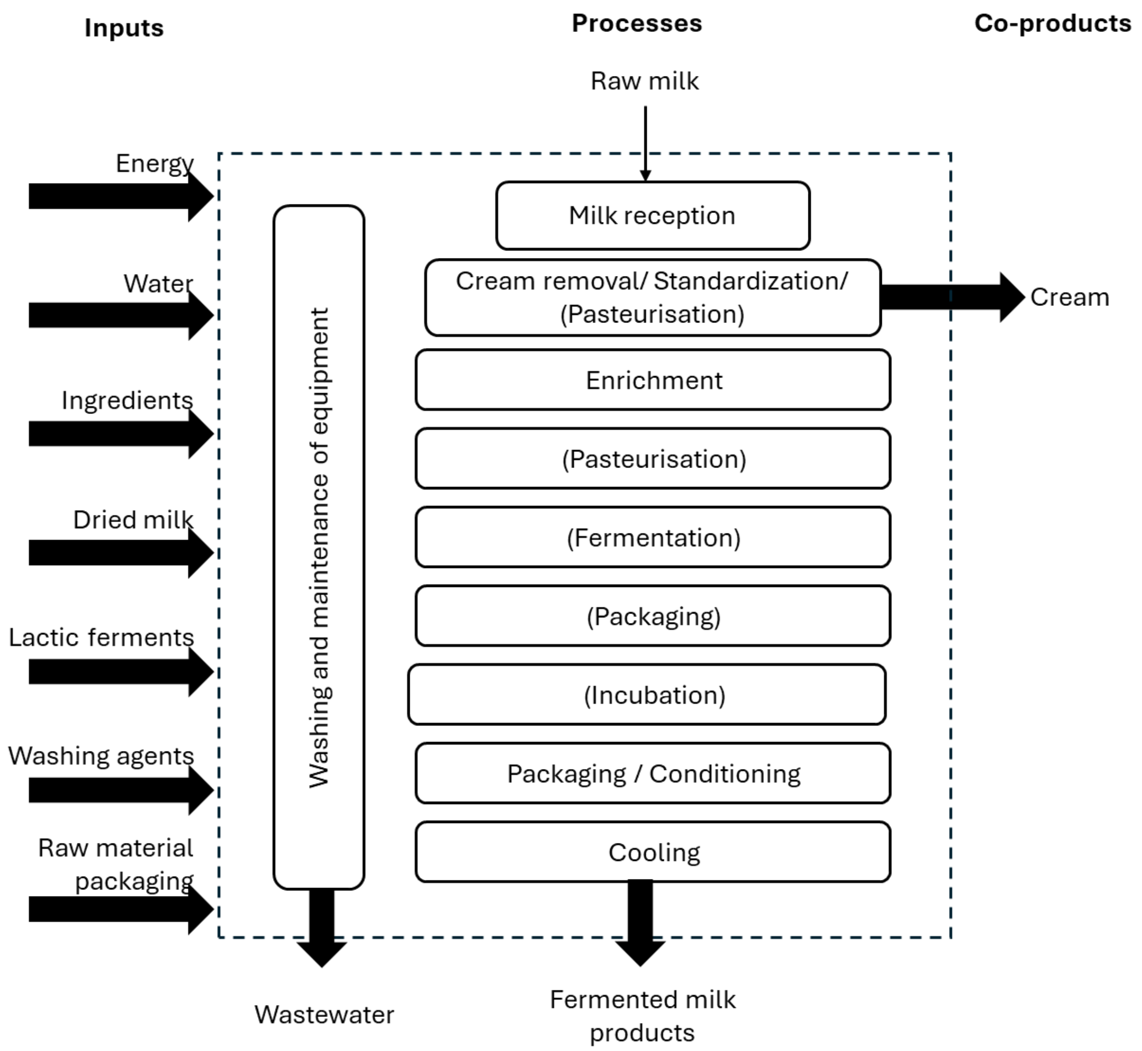

Figure 7: Process diagram for fermented milk products

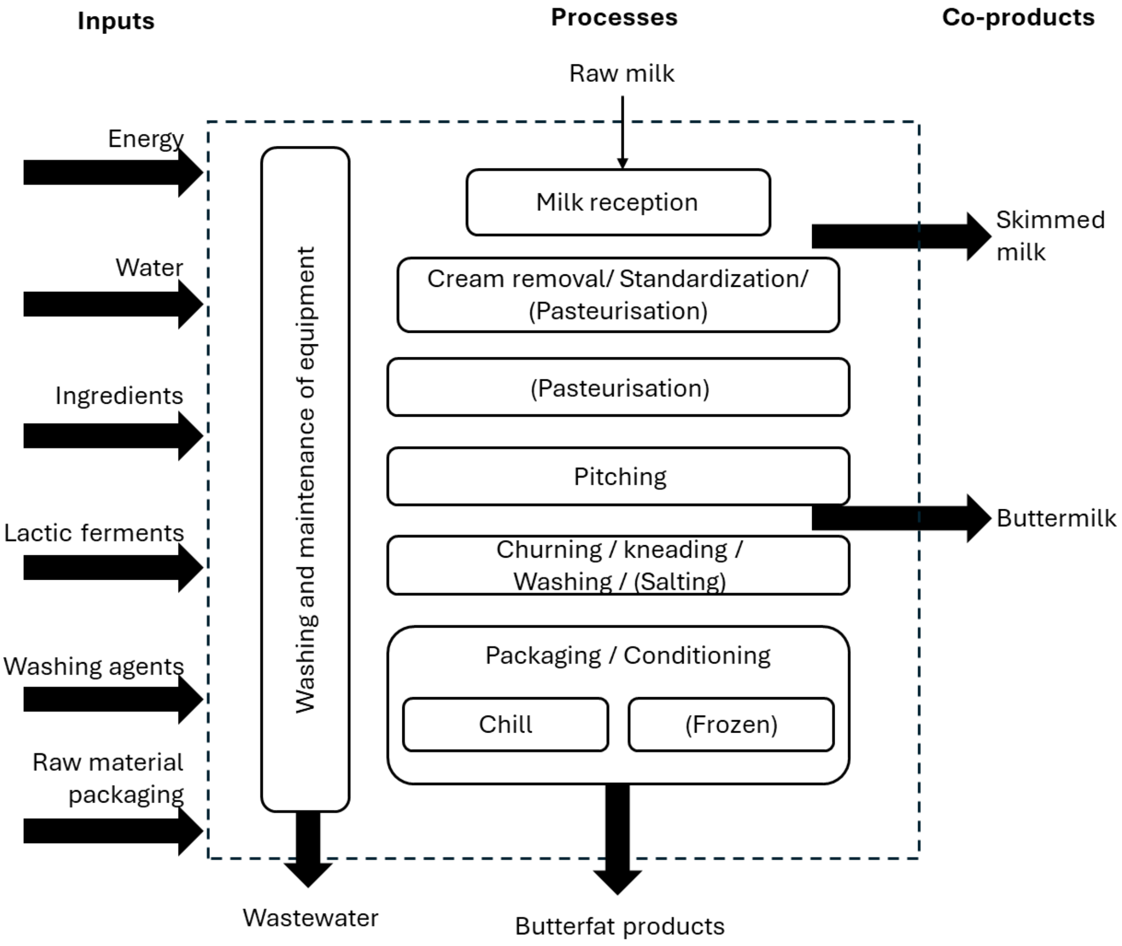

Figure 8: Process diagram for butterfat products

3.4.5 Exclusions and cut-off

The evaluation focuses on significant contributions to the overall footprint. Small contributions do add up however, so this PEFCR attempts to avoid exclusions whenever possible. Due to their minimal contribution and/or the absence of developed methodology for quantification, the following processes can be excluded according to this PEFCR's cut-off rule:

- Cattle insemination and administration of medicine or antibiotics
- Cleaning products at the dairy farm
- Refrigerants at the dairy farm
- Lactic ferments production
- Rennet production
- Yeast and bacteria production
- Transportation of input products to the dairy processing unit accounting for less than 1% in mass
- Solid waste at the dairy processing unit
- Capital goods at the dairy processing unit
- Capital goods at distribution centre and at retail
- Ambient storage at the consumer home
- Cutlery for dairy products consumption at consumer home

According to this PEFCR, no additional cut-offs are allowed by the user of the PEFCR.

3.5 List of EF impact categories

Each PEF study carried out in compliance with this PEFCR shall calculate the PEF-profile including all EF impact categories listed in
Table 10.

Table 10: Environmental Footprint (EF) 3.1 midpoint impact categories with their indicator, unit, and underlying life cycle impact assessment (LCIA) method. *updated in the EF3.1 and described in the report (Andreasi Bassi et al., 2023). The adaptation of all the other impact categories can be found in (Fazio et al., 2018).

Impact category	Indicator	Unit	Recommended default LCIA method
Climate change* - Climate change-biogenic - Climate change – land use and land transformation	Radiative forcing as Global Warming Potential (GWP100)	kg $CO_{2\ eq}$	*Bern model - Global warming potential(GWP) over a 100-year time horizon based on IPCC 2021* (Forster et al., 2021)
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	*EDIP model based on the ODPs of the World Meteorological Organisation (WMO) over an infinite time horizon* (WMO, 2014)
Human toxicity, cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	*Based on USEtox model 2.1* (Fantke et al., 2017; Rosenbaum et al., 2008) *as in* (Saouter et al., 2018)
Human toxicity, non-cancer*	Comparative Toxic Unit for humans (CTU_h)	CTUh	*Based on USEtox model 2.1* (Fantke et al., 2017; Rosenbaum et al., 2008) *as in* (Saouter et al., 2018)

Impact category	Indicator	Unit	Recommended default LCIA method
Particulate matter	Impact on human health	disease incidence	UNEP recommended model (Fantke et al 2016)
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq U^{235} $_{eq}$	*Human health effect model as developed by* (Dreicer et al., 1995) *and published in* (Frischknecht et al., 2000)
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe (Huijbregts et al., 2016)
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Posch et al., 2008; Seppälä et al., 2006)
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Posch et al., 2008; Seppälä et al., 2006)
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P $_{eq}$	EUTREND model (Struijs et al., 2009) as implemented in ReCiPe (Huijbregts et al., 2016)
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N $_{eq}$	EUTREND model (Struijs et al., 2009) as implemented in ReCiPe (Huijbregts et al., 2016)
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	Based on USEtox model 2.1, (Fantke et al., 2017) *as in* (Saouter et al., 2018)
Land use	Soil quality index[10]	Dimensionless (pt)	*Soil quality index based on LANCA model* (De Laurentiis et al., 2019)*and on the LANCA CF version 2.5* (Horn & Maier, 2018)

[10] This index is the result of the aggregation, performed by JRC, of the 4 indicators (Biotic production, erosion resistance, mechanical filtration and groundwater replenishment) provided by LANCA model as indicators for land use as reported in De Laurentiis et al., 2019.

Impact category	Indicator	Unit	Recommended default LCIA method
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq}$	Available WAter REmaining (AWARE) model (Boulay et al., 2018; UNEP, 2016)
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	(Guinée et al., 2002; van Oers et al., 2002) *as in* CML 2002 method v.4.8

The list of normalisation and weighting factors is available in Annex 1.

3.6 Limitations

Some dairy products listed in section 3.1 are not part of the scope of this PEFCR. However, as long as no specific PEFCR is addressing creams, milk-based drinks, milk powders, fruited yogurts other than with strawberry or milk-based desserts, companies desiring to assess the PEF of their products are invited to be aligned as much as possible with this PEFCR. However, an EF study carried out for one of these products cannot claim compliance with this PEFCR.

Another main limitation of this PEFCR is the scarce availability of data on land use (LU), land use change (LUC) and water use for crop production in supplying markets, and the way these data are reflected in the impact categories “land use” and “water use”. Typically, traceability of LU and LUC in feed supply chains is very complex, hence data generally account for LU and LUC using statistical information at national scale. LUC from cattle grazing on pasture is also sparsely taken into account in secondary datasets.

Default data provided through this PEFCR has limited applicability to products or materials imported from outside the EU. This may have significant effects on results. Default datasets can be tested against geographically adequate alternatives in sensitivity analyses for nuanced results reporting.

Since the multi-functionality of packaging is not fully captured by the current PEF methodology, the dairy PEFCR is not meant to support specific comparison or comparative assertion between the secondary datasets of raw milk and/or packaging.

The results of any PEF study based on the current PEFCR may be used for supply chain management, product design, optimization, and, under specific conditions, for comparative assertions among dairy products from the same sub-category (see limitations below). The PEFCR is designed for dairy products only and is not designed to support comparative claims between dairy and non-dairy products.

The following limitations are particularly relevant to the dairy sector and must be reported by the PEF applicant when relevant:

- Inconsistent use of data for raw milk supply (i.e. primary vs secondary) may lead to misinterpretation of the PEF results. As a consequence, the current PEFCR may only support comparative assertions (i.e. comparative claims) among dairy products from the same sub-category, and only under the following conditions:
  - Primary data for raw milk supply is used for all products compared, or
  - Secondary data for raw milk supply is used for all products compared, or
  - Primary or secondary data for raw milk supply is used for comparison but only against the benchmark
- Impact of feed production is a key driver for most impact categories. Therefore, whenever primary data is used for modelling this sub-stage, the PEFCR for “Feed for food producing animals” shall be used;
- Impacts of dairy systems (and their supply chain) on biodiversity are only partly covered by LCA impact categories. The current PEFCR therefore recommends a simple framework with additional indicators which can be reported in addition to the mandatory impact categories (See Section 7.4.1);
- The choice of functional unit may significantly affect the PEF results. It is therefore recommended to assess additional functional units (based on relevant nutritional criteria) as sensitivity analyses. This recommendation should only be followed when justified, as explained in Section 3.3 and illustrated in Figure 2

4 Most relevant impact categories, life cycle stages and processes

The most relevant impact categories for all five product sub-categories in scope of this PEFCR are:

- Climate change
- Ecotoxicity, freshwater
- Particulate matter
- Acidification
- Eutrophication, terrestrial
- Eutrophication, marine
- Resource use, fossils
- Water use

Additional impact sub-categories that shall be reported separately (since they contribute to over 5% of the total climate change impact):

- Climate change – biogenic
- Climate change – land use and land transformation

According to Commission Recommendation (EU) 2021/2279 of 15 December 2021 , the identification of the most relevant impact categories is based on the normalised and weighted results of the representative product(s) as recalculated after the remodelling (European Commission, 2021). The most relevant impact categories shall be identified as all impact categories that cumulatively contribute to at least 80% of the total environmental impact. This should start from the largest to the smallest contributions. The TS may add more impact categories to the list of the most relevant ones, but none shall be deleted. In the current PEFCR, the TS decided to add the impact category "Water use".

The most relevant life cycle stages for each of the five product sub-categories in scope of this PEFCR are the following (Table 11):

Table 11: Most relevant life cycle stages for each product sub-category

Sub-category	Raw milk supply	Dairy processing	Non-dairy ingredients supply	Packaging	Distribution	Use stage	End of life
Liquid milk	Yes	No	No	Yes	No	Yes	No
Dried whey products	Yes	Yes	No	No	n/a	n/a	n/a
Cheeses	Yes	No	No	No	No	No	No
Fermented milk products	Yes	Yes	Yes	Yes	Yes	No	No
Butterfat products	Yes	No	No	No	No	No	No

According to the Commission Recommendation (EU) 2021/2279 of 15 December 2021, the most relevant life cycle stages are the life cycle stages which together contribute to at least 80% of any of the most relevant impact categories previously identified (European Commission, 2021).

The most relevant processes for the different product sub-categories in scope of this PEFCR are presented in the following tables (From Table 12 to Table 16). According to the Commission Recommendation (EU) 2021/2279 of 15 December 2021, the most relevant processes are those that collectively contribute at least with 80% to any of the most relevant impact categories identified. See Section 6.1.3 of Annex II of the Commission Recommendation (EU) 2021/2279 of 15 December 2021 for details (European Commission, 2021).

Table 12: List of the most relevant processes for the sub-category "Liquid milk"

Impact category	Processes
Climate change	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
Climate change - biogenic	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Climate change - land use and transformation	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Ecotoxicity, freshwater	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Particulate matter	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Acidification	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, terrestrial	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, marine	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Water use	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Tap water {EU+EFTA+UK} | average technology mix | consumption mix, at consumer | Technology mix for supply of drinking water to users | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
Resource use, fossils	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")

Impact category	Processes
	HDPE granulates {EU+EFTA+UK} | Polymerisation of ethylene | production mix, at plant | 0.91- 0.96 g/cm3, 28 g/mol per repeating unit | LCI result (from LC stage "Packaging")
	Beverage carton {EU+EFTA+UK} | precursor material processing, carton assembling and printing | production mix, at plant | grammage: 0.338 kg/m2 | LCI result (from LC stage "Packaging")
	Waste incineration of PE {EU+EFTA+UK} | waste-to-energy plant with dry flue gas treatment, including transport and pre-treatment | production mix, at consumer | polyethylene waste | LCI result
	Kraft paper, uncoated {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying | production mix, at plant | <120 g/m2 | LCI result
	Corrugated box, uncoated {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying | production mix, at plant | 280 g/m2, R1=88% | LCI result

Table 13: List of the most relevant processes for the sub-category "Dried whey products"

Impact category	Processes
Climate change	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Climate change - biogenic	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Climate change - land use and transformation	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Ecotoxicity, freshwater	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Particulate matter	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Acidification	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, terrestrial	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, marine	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Water use	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")

Impact category	Processes
	Tap water {EU+EFTA+UK} | average technology mix | consumption mix, at consumer | Technology mix for supply of drinking water to users | LCI result (from LC stage “Dairy processing”)
	Dairy processing of whey powder (65-85%% dry matter) (without raw milk input)| standardisation, concentration, drying, conditioning| consumption mix| {EU-28+3} [Unit process, single operation] (Dairy Dried whey) from LC stage “Dairy processing”)
	Treatment of effluents from potato starch production {EU+EFTA+UK} | waste water treatment including sludge treatment | production mix, at plant | 1m3 of waste water treated | LCI result
Resource use, fossils	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage “Raw milk supply”)
	Thermal energy from natural gas {EU+EFTA+UK} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result (from LC stage “Dairy processing”)
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stage “Dairy processing”)

Table 14: List of the most relevant processes for the sub-category "Cheeses"

Impact category	Processes
Climate change	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Climate change - biogenic	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Climate change - land use and transformation	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Ecotoxicity, freshwater	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Particulate matter	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Acidification	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Eutrophication, terrestrial	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Eutrophication, marine	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Water use	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
	Tap water {EU+EFTA+UK} | average technology mix | consumption mix, at consumer | Technology mix for supply of drinking water to users | LCI result(from LC stage "Dairy processing")
Resource use, fossils	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")

Impact category	Processes
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Ascorbic acid production {EU+EFTA+UK} | technology mix | production mix, at plant | 100% active substance | LCI result (from LC stage "Dairy processing") (*)
	Thermal energy from natural gas {EU+EFTA+UK} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result (from LC stage "Dairy processing")

(*) Ascorbic acid was used a proxy for additives and vitamins, hence accuracy is limited.

Table 15: List of the most relevant processes for the sub-category "Fermented milk products"

Impact category	Processes
Climate change	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Thermal energy from natural gas {EU+EFTA+UK} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result (from LC stage "Dairy processing")
	Sugar, from sugar beet {EU+EFTA+UK} | from sugar production | production mix | LCI result (from LC stage "Non-dairy ingredients supply")
	Polystyrene production, high impact {GLO w/o EU+EFTA+UK} | polymerisation of styrene | production mix, at plant | 1.05 g/cm3 | LCI result (from LC stage "Packaging")
Climate change - biogenic	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Climate change - land use and transformation	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")
Ecotoxicity, freshwater	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply") (from LC stage "Raw milk supply")

Impact category	Processes
	Maize {EU+EFTA+UK} | at farm, crop cultivation | production mix | LCI result (from LC stage "Non-dairy ingredients supply") (*)
	Sugar, from sugar beet {EU+EFTA+UK} | from sugar production | production mix | LCI result
Particulate matter	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Acidification	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
Eutrophication, terrestrial	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, marine	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Water use	Maize {EU+EFTA+UK} | at farm, crop cultivation | production mix | LCI result (from LC stage "Non-dairy ingredients supply") (*)
	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Sugar, from sugar beet {EU+EFTA+UK} | from sugar production | production mix | LCI result (from LC stage "Non-dairy ingredients supply")
	Dairy processing of yoghurt, spoonable, fruited, full fat (without raw milk input)| standardisation, enrichment, fermentation, conditioning, cooling| consumption mix| {EU-28+3} [Unit process, single operation] (Dairy Fermented cow milk) (from LC stage "Dairy processing")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Treatment of effluents from potato starch production {EU+EFTA+UK} | waste water treatment including sludge treatment | production mix, at plant | 1m3 of waste water treated | LCI result

Impact category	Processes
Resource use, fossils	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Polystyrene production, high impact {GLO w/o EU+EFTA+UK} | polymerisation of styrene | production mix, at plant | 1.05 g/cm3 | LCI result (from LC stage "Packaging")
	Thermal energy from natural gas {EU+EFTA+UK} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result (from LC stage "Dairy processing")
	Sugar, from sugar beet {EU+EFTA+UK} | from sugar production | production mix | LCI result (from LC stage "Non-dairy ingredients supply")
	Articulated lorry transport, Euro 5, Total weight 28-32 t, cooled diesel driven {EU+EFTA+UK} | diesel driven, Euro 5, cooled cargo | consumption mix, to consumer | 28 - 32t gross weight / 21,4t payload capacity | LCI result (from LC stage "Distribution")
	HDPE granulates {EU+EFTA+UK} | Polymerisation of ethylene | production mix, at plant | 0.91- 0.96 g/cm3, 28 g/mol per repeating unit | LCI result (from LC stage "Packaging")
	PET granulates, amorphous {EU+EFTA+UK} | Polymerisation of ethylene | production mix, at plant | 0.91- 0.96 g/cm3, 28 g/mol per repeating unit | LCI result
	Kraft paper, uncoated {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying | production mix, at plant | <120 g/m2 | LCI result

(*) Maize (corn grain) was used a proxy for strawberry production, in the absence of more appropriate EF compliant secondary dataset, hence accuracy is limited.

Table 16: List of the most relevant processes for the sub-category "Butterfat products"

Impact category	Processes
Climate change	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Climate change - biogenic	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Climate change - land use and transformation	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Ecotoxicity, freshwater	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")

Impact category	Processes
Particulate matter	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Acidification	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, terrestrial	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Eutrophication, marine	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Water use	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
Resource use, fossils	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm | FPCM (Fat Protein Corrected Milk) | LCI result (from LC stage "Raw milk supply")
	Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result (from LC stages "Dairy processing", "Distribution" and "Use stage")
	Thermal energy from natural gas {EU+EFTA+UK} | technology mix regarding firing and flue gas cleaning | production mix, at heat plant | MJ, 100% efficiency | LCI result

5 Life cycle inventory

5.1 List of mandatory company-specific data

The complete list of mandatory company-specific activity data (processes and elementary flows) and the processes to be modelled with company-specific data are listed in the Sections 5.1.1 for dairy processing 5.1.2 for non-dairy ingredients and 5.1.3 for packaging. Details for all mandatory company-specific data to be collected with the complete DQRs and the UUIDs are provided in Annex 6.

An example for raw milk as input to dairy processing is provided in Table 17 below. The activity data required include the amount of fat- and protein-corrected milk (FPCM) used in the product formulation. For the representative product, the European average dataset was used but datasets for more specific geographies exist and shall be used when relevant.

Table 17: Data collection requirements for an example mandatory process

Requirements	Data type	Example
For data collection purposes	Activity data to be collected	Quantity of fat- and protein-corrected corrected milk (FPCM)
	Specific requirements (e.g., frequency, measurement standard, etc.)	Company-specific primary data on mass (in g) required per FU that are no older than 5 years old
For modelling purposes	Unit of measure	g/FU
	Default dataset to be used	Cow milk {EU+EFTA+UK} | typical (average) production | production mix, at farm
	Dataset source (i.e. node)	https://lcdn.blonkconsultants.nl/
	UUID	afcdc981-5840-5495-b6d3-7cbea6da4657
	TiR (average)	2.2
	TeR	2.3
	GR	2.4
	P	2.4
	DQR	2.3

All newly created processes shall be EF-compliant.

5.1.1 Dairy processing

Mandatory company-specific data shall be used to model dairy processing. The manufacturing of dairy products is typically a multi-processes activity, starting with a single common input (raw milk) and resulting in numerous products with various nutritional properties. Section 5.8.3 details how multi-functionality of dairy processing shall be handled. Foreground specific data required for dairy processing is presented in Table 18. Details (DQRs, UUIDs, etc.) are provided in Annex 6.

Table 18: Foreground specific activity data required for dairy processing

Item	Complementary information	Unit
Input parameters		
FPCM	Quantity of fat- and protein-corrected corrected milk (FPCM)	kg/y
Other dairy inputs	Mass and dry matter content of any other dairy input in the product's formulation (e.g. cream, skimmed milk, milk powder, whey, etc.)	kg/y
Chemicals	Mass and types of chemicals (cleaning agents and reactants) used in the dairy processing unit	kg/y
Refrigerants	Mass and types of refrigerants used in the dairy processing unit	kg/y
Energy	Amount and type of fuel (natural gas, fuel oil, diesel, biogas, etc.) for heat and electricity use (from grid, produced on-site) for all activities at the dairy processing unit, including storage at the local warehouse.	kWh/y or MJ/y
Water	Volume of water used. A regionalized (i.e. minimally country-specific) water flow shall be used in the model.	m^3/y
Output parameters		
Co-products	Mass and dry matter content of every co-product	kg/y
Wastewater	Volume, COD content of wastewater released to treatment	m^3/y
Direct emissions	Amount of different direct emissions to air not due to energy use (e.g. refrigerants) and to water (e.g. PO_4^{3-}).	kg/y

Guidance to assess the data quality of dairy processing modelled with primary data is provided in Table 19.

Table 19: Data Quality Rating (DQR) guidance for dairy processing

Quality rating	Time representativeness	Technological representativeness	Geographical representativeness
1	0-1.9 years (age of data) with respect to 2023	All amounts and types of inputs and outputs are known and reported. Energy and water use are attributable to specific products.	Origin of all materials and energy carriers are known and reported
2	2-4.9 years with respect to 2023	All amounts and types of inputs and outputs are known and reported. Energy and water use are reported for an entire process line or the whole dairy processing unit.	Origin of >60% of materials (in kg) and energy carriers (in MJ) are known and reported
3	5-9.9 years with respect to 2023	Amounts and types of all main inputs and outputs (raw milk, dairy ingredients, energy, sugar, fruits, co-products, wastewater) are known and reported. Proxys are used for other inputs or outputs. Energy and water use are attributable to specific products.	Origin of 40-60% of materials (in kg) and energy carriers (in MJ) are known and reported
4	10-14.9 years with respect to 2023	Amounts and types of all main inputs and outputs (raw milk, dairy ingredients, energy, sugar, fruits, co-products, wastewater) are known and reported. Energy and water use are reported for an entire process line or the whole dairy processing unit.	Origin of 20-39% of materials (in mass) and energy carriers (in MJ) are known and reported
5	>15 years with respect to 2023	n/a	Origin of materials and energy carriers are not reported.

Specific requirements for wastewater at dairy processing

The effluent from a dairy processing unit is essentially composed of wastewater from pre-rinse, inter-rinse and clean-in-place rinse-down operations together with material losses from the dairy products. Dairy residues in the wastewater essentially drive an organic-rich effluent waste with a high chemical oxygen demand (COD). Wastewater from dairies can be treated in municipal sewage treatment plants. However, no EF-compliant life cycle inventory (LCI) data representative of such treatment is yet available. To evaluate the surplus energy required for the treatment of dairy wastewater due to the excess COD, a dilution factor should be applied. The rationale is that sewage treatment plants are characterized by an input COD reduction capacity and an output COD level; therefore, treating a higher-COD wastewater can be approximated by treating a higher volume of same-COD-level wastewater. The dilution factor is calculated as the ratio of the effluent COD at the dairy processing unit and the COD input in a reference LCI dataset.

The EF-compliant dataset "*Treatment of effluents from potato starch production; waste water treatment including sludge treatment; production mix, at plant, EU-28+EFTA+UK*" (UUID: 2c42b213-0e00-4d8f-8a02-bda8c3f9b652) shall be used as reference.

5.1.2 Non-dairy ingredients

Mandatory company-specific data shall be used to model the supply chain of non-dairy ingredients (e.g. sugar, fruit preparation, salt, yeast, ferments, rennet, vegetal oils). Typically, the following data should be collected:

- Mass of each non-dairy ingredient in the product's formulation (mandatory)
- Country of production of each non-dairy ingredient (non-mandatory)
- Transport mode and distance to the dairy processing unit (non-mandatory)
- Packaging type and amount of each non-dairy ingredient (non-mandatory)

For sugar, it shall be specified if originates from sugar beet or from sugarcane. EF-compliant secondary datasets may be used to represent the production of the non-dairy ingredients (see Annex 6), their transport and packaging. Section 6.2 provides guidance on default data to be used in the PEF of dairy products.

5.1.3 Packaging

Mandatory company-specific data shall be used for the mass and volume of primary packaging.

5.2 List of processes expected to be operated by the company

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

- Raw milk production (only for companies with direct access to dairy farmers such as cooperatives)
- Raw milk transport to the dairy processing unit (only for companies with direct access to dairy farmers such as cooperatives)
- Primary packaging (Company-specific data should be used to model the production of dairy products primary packaging)
- Dairy processing (from raw milk delivery to shipping of packaged products)

Other stakeholders such as retailers or food processors may however use this PEFCR, in which case the perimeter of their direct activities will differ from the above. However, without the mandatory company-specific data listed in Section 5.1, a stakeholder cannot claim compliance with this PEFCR. Details on the data collection requirements are provided in following sections.

5.2.1 Raw milk production

Modelling of raw milk production shall be based on the following tables. Table 20 shall be used to determine which purchased farm inputs have to be included in raw milk modelling, whereas Table 21 shall be used to calculate on farm emissions and Table 22 to determine which farm products have to be considered including the allocation method to be used. National Inventory Reports should be used as a leading document for country-specific modelling parameters. Annex 6 lists the secondary datasets, universally unique identifiers (UUIDs) and DQRs to be linked to each data input.

Table 20: Included and excluded inputs on the dairy farm[1]

Farm inputs	Subtype	Comment
Included		
Mineral fertilisers	Nitrogen fertiliser	Including all N-containing fertilisers
	Phosphorus fertiliser	Including all P-containing fertilisers
	Potassium fertiliser	Including all K-containing fertilisers
	Lime	Including all Ca-containing fertilisers
Organic fertilisers	Manure	Only emissions from manure application and manure storage should be accounted for[2].
	Organic fertilisers	Any bio-based fertiliser, such as plant-based fertiliser, manure pellets, biochar.
Dairy cattle	Dairy cattle	Dairy cows (dry and lactating), calves, youngstock until 1 year of age and youngstock over 1 year, heifers.
Energy	Electricity	Country-specific (from grid) or produced on-site
	Diesel	Diesel used at farm
	Natural gas	Natural gas used at farm
	Other energy	Any other energy input such as propane, wood pellets, etc.
Feed	Compound feed	All types of compound feed (i.e. feed concentrate)
	Roughage	All roughage types
	Other feeds	All purchased other feeds, such as single ingredients, (wet/dry) by-products from industry
Other	Bedding material	All types of bedding material used to house dairy cattle
	Pesticides	All pesticides, i.e. herbicides, insecticides, nematocides, fungicides
	Silage plastic	Packaging etc.
Water	Irrigation	On farm irrigation for feed crops. differentiate between ground, surface and tap water
	Drinking and cleaning water	Differentiate between ground, surface and tap water
Excluded		
Capital goods	Stables	Excluded due to low relevance and lack of background data[1]
	Machinery	Excluded due to low relevance and lack of background data[1]

Farm inputs	Subtype	Comment
Refrigerants	Milk cooling	Excluded due to low relevance
Others		➢ Cattle insemination and administration of medicine or antibiotics ➢ Cleaning products at the dairy farm

[1]Included in the EF-compliant datasets for cow milk, hence included in the benchmark calculation

[2]Manure is also an output from a dairy farm system, which can be considered as a residual product, co-product, or waste. If manure has no economic value, it is considered that manure is to treat it as a residual stream, resulting in no environmental burden or benefit attributed to manure. This default approach is suggested by the (FAO LEAP, 2016). No allocation is necessary as it is assumed that the manure is acquired at no cost.

Table 21: Included and excluded on-farm resources use and emissions

Substance	Process	Minimum requirement[1]	Optional
Included			
Water	Irrigation water Drinking water	ISO 14046: Annual water consumption at country scale (with proper regionalization tag)	Monthly water consumption at country scale (with proper regionalization tag)
Land occupation and trans-formation	Feed production	Type and surface of agricultural land occupied for feed production Type and surface of agricultural land transformed from natural land (i.e. primary forest, secondary forest or natural grassland) for feed production	Type and surface of agricultural land transformed from previous agricultural use for feed production
	Grazing	Surface of grassland used for grazing Surface of grassland transformed from natural or agricultural land (i.e. primary forest, secondary forest or arable land) for pasture	n/a

Substance	Process	Minimum requirement[1]	Optional
Methane (CH_4), emitted to air	Enteric fermentation	IPCC Tier 2: Animal numbers and animal feeding type (e.g. feedlot cattle, cattle grazing) are taken into account. It is based on emission factors (Ym) per animal types and on Gross Energy intake (GE). Emission = GE x Ym.	IPCC Tier 3 (considering national specificities): Total dry matter intake (DMI) and digestibility of feed are added to equation used in Tier 2 or utilize alternative estimation methods based on country-specific methodology.
	Manure storage (and pre-treatment)	IPCC Tier 2: Detailed information about the manure characteristics (calculated based on gross energy intake, digestibility of the feed) and manure management practices (default values).	IPCC Tier 3: Country-specific methodologies and emission factors are used.
Direct nitrous oxide (N_2O), emitted to air	Manure storage (and pre-treatment) Manure excretion on the pasture	IPCC Tier 1: the total amount of nitrogen excretion in each type of manure management system is multiplied by an emissions factor for that type of manure management system (default values used).	IPCC Tier 2: As Tier 1 but country-specific data for some or all variables are used. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
	Manure application Nitrogen fertiliser application Crop residues[4]	IPCC Tier 1: Amount of nitrogen from manure, artificial fertiliser or crop residues applied to soils is multiplied by a default emission factor.	IPCC Tier 2: As Tier 1 but with country-specific emission factors. IPCC Tier 3: Utilizes alternative estimation methods based on

Substance	Process	Minimum requirement[1]	Optional
			country-specific methodology.
	Organic soils (peat)	IPCC Tier 1: Hectares of managed or drained organic soils multiplied by a default emission factor.	IPCC: Tier 2: As Tier 1 but with country-specific emission factors. IPCC: Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
	Mineral soils	IPCC: Tier 1: Amount of nitrogen in mineral soils that is mineralized multiplied by a default emission factor.	IPCC Tier 2: As Tier 1 but with country-specific emission factors. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
Indirect nitrous oxide due to N volatilization (ammonia and nitric oxides)[2], emitted to air	Manure storage (and pre-treatment)	IPCC Tier 1: Nitrogen volatilization multiplied by a default emission factor.	IPCC Tier 2: As Tier 1 but country-specific emission factor used. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
	Manure application		
	Manure excretion in the pasture		
	Nitrogen fertiliser application		

Substance	Process	Minimum requirement[1]	Optional
Indirect nitrous oxide due to N leaching[3], emitted to air	Manure application Manure excretion in the pasture Nitrogen fertiliser application Crop residues[4]	IPCC Tier 1: Nitrogen leaching multiplied by a default emission factor.	IPCC Tier 2: As Tier 1 but country-specific emission factor used. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
Ammonia (NH_3) and nitric oxides (NOx) , emitted to air	Manure storage (and pre-treatment) Manure application Manure excretion in the pasture Nitrogen fertiliser application	EMEP/EEA Tier 2: based on livestock numbers; total nitrogen excretion rates (calculated based on IPCC guidelines); proportion of nitrogen excreted in livestock buildings, uncovered yards and grazing; proportion of nitrogen excreted as total ammoniacal nitrogen (TAN) and proportion of the excretion place; amount of manure handled as slurry or as solid manure; use of bedding for animals; manure storage system; and amount of manure and nitrogen fertiliser spread on fields	EMEP/EEA Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
Phosphate (PO_4-), emitted to ground and surface water	Manure application Manure excretion in the pasture Artificial fertiliser application	Amount of phosphorus applied	Utilizes alternative estimation methods based on country-specific methodology.
	Manure application	Amount of phosphorus applied	Utilizes alternative estimation methods

Substance	Process	Minimum requirement[1]	Optional
Phosphorous(P), emitted to surface water	Manure excretion in the pasture Artificial fertiliser application		based on country-specific methodology.
Particulate matter (PM2.5), emitted to air	Animal housing	EMEP EAA Tier 2: based on share of time animals spend in the animal house and share of population kept in slurry-based systems	EMEP EAA Tier 3: country-specific emission factors or methods.
Non-methane volatile solids (NMVOC), emitted to air	Silage feeding Housing Grazing	EMEP EAA Tier 2: based on gross feed intake (country-specific or default), time animals spend indoors during a year, fraction of silage feed during housing, volatile solid excreted (country-specific if possible)	EMEP EAA Tier 3: country-specific emission factors or methods.
Nitrate (NO_3), emitted to ground water	Manure application Manure excretion in the pasture Artificial fertiliser application Crop residues[4]	IPCC Tier 1: Nitrate leaching is based on multiplication of the amount of nitrogen excreted or added to soils by a default fraction of leached nitrogen.	IPCC Tier 2: As Tier 1 but country-specific leaching factor and or nitrogen excretion. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
Carbon dioxide (CO_2), emitted to air	Application of lime	IPCC Tier 1: Amount of lime (limestone or dolomite) applied multiplied by a default emission factor.	IPCC: Tier 2: As Tier 1 but with country-specific emission factors. IPCC Tier 3: Utilizes alternative estimation

Substance	Process	Minimum requirement[1]	Optional
			methods based on country-specific methodology.
	Application of urea	IPCC Tier 1: Amount of urea applied multiplied by a default emission factor.	IPCC: Tier 2: As Tier 1 but with country-specific emission factors. IPCC Tier 3: Utilizes alternative estimation methods based on country-specific methodology.
	Peat drainage	IPCC Tier 1: Drained inland organic soils	IPCC: Tier 2: As Tier 1 but with country-specific emission factors.
	Fuel combustion	Depending on available dataset. Use fuel and country-specific heating values and emission factors.	
Heavy metals, emitted to groundwater and soil	Application of manure	Heavy metal emissions from field inputs shall be modelled as emission to soil and/or leaching or erosion to water. The inventory to water shall specify the oxidation state of the metal (e.g., Cr+3, Cr+6). As crops assimilate part of the heavy metal emissions during their cultivation and since the inventory does not account for the final emissions of the heavy metals (after human consumption), it shall not either account for the uptake of heavy metals by the crop. Different models exist for calculating heavy	

Substance	Process	Minimum requirement[1]	Optional
		metal partitioning to waters and soil. One recommended model is (Freiermuth, 2006). (Kühnholz, 2001) also gives a comparison of such partitioning models.	
Pesticides, emitted to soil	Application of pesticides	Country and crop-specific amounts of active component from pesticides applied. 100% of pesticides applied emitted to the soil.	
Excluded			
Refrigerants, emitted to air	Milk cooling	Excluded, due to lack of data.	
Carbon dioxide (CO_2), emitted to air	Carbon sequestration	Excluded: Changes in soil carbon levels are regarded as changes in carbon stocks, and therefore, shall not be included in the PEF impact category 'climate change', unless the changes are related to land use change that happened in the 20 years or a single harvest period that last longer than 20 years (for instance, for perennial crops) prior to the assessment year (See Section 5.10).	

[1] If a PEF study concerns a comparative assertion, methods to calculate emissions shall be identical.

[2] N volatilization in line with NH_3 and NO_x emission elsewhere in this table.

[3] N leaching in line with nitrate leaching elsewhere in this table.

[4] Include crop residues occurring during harvesting, meadowing, grassland renewal, crop rotation and plant fertilisers.

Table 22: Allocation methods to be used for products produced on dairy farms

Farm products	Description	Allocation method
Raw milk	Raw milk delivered for consumption.	Biophysical allocation (IDF, 2015)[11]

[11] An update to the IDF (IDF, 2022), published in 2022, introduced modifications to the allocation at the farm gate. However, as this study is a partial update of the pilot PEFCR and does not include changes to the modelling process, the new IDF was not considered but is required to be applied when this PEFCR is fully revised.

Farm products	Description	Allocation method
Dairy products produced on farm	Any dairy product directly sold for consumption.	If both raw milk and dairy products are produced on the farm use system subdivision for on farm dairy processing.
Sold live dairy cattle	Dairy cattle sold for slaughter, fattening or replacement of dairy cattle.	Biophysical allocation (IDF, 2015)
Dead dairy cattle leaving the farm	Dairy cattle that died on the farm.	No allocation (However, all input/output emissions must be included in the PEFCR and allocated to the other co-products from this table that have an allocation associated with them).
Manure as residual product	Manure is exported from the farm as product with no economic value.	No allocation: burden allocated to other products produced at farm, including pre-treatment of manure.
Manure as co-product	Manure is exported from the farm as product with economic value.	Economic allocation of the upstream burden shall be used for manure by using the relative economic value of manure compared to milk and live animals at the farm gate, provided proof is given that it is sold and used for fertiliser replacement at optimal rates for crops (i.e. if excess is applied it is treated as a Residual). Biophysical allocation based on IDF rules shall be applied to allocate the remaining emissions between milk and live animals. Environmental burden from manure treatment is fully allocated to manure as co-product.
Manure as waste	Manure is not used to produce products but treated as waste.	Apply end-of-life formula and allocate environmental burden to other products produced on the farm, including treatment of manure.
Sold non-dairy products.	Sold feed, arable products and non-dairy animal	If both raw milk and non-dairy products are produced on the farm use system subdivision for non-dairy farming activities.

Farm products	Description	Allocation method
	products, non-dairy animals.	
Energy produced on farm	Any type of energy produced at farm, such as solar energy, biogas, heat-recovery and wind energy.	If both raw milk and energy are produced on the farm use system subdivision for on farm energy production. Within the assessed system boundary, energy may be produced from renewable sources. If renewable energy is produced in excess of the amount consumed for dairy production and it is provided to third parties, this may only be credited to the dairy products assessed provided that the credit has not already been taken into account in other schemes.

All modelling requirements shall be aligned with the Commission Recommendation (EU) 2021/2279 of 15 December 2021.

Specific requirements:

- **Regionalization**: all inputs and processes should be regionalized whenever the location is known or can be assumed (e.g. country tags should be used for water flows, adequate electricity mixes should be used, etc.)
- **Feed production**: priority should be given to specific data, whenever possible. Feed production should be handled in conformance with the requirements from the PEFCR on "Feed for food producing animals" and country of origin of each feed material should be specified. See Annex 6 for complete list.
- **Water use:** for irrigation and drinking water should be regionalized whenever the origin of the feed is known or can be assumed.
- **Land use change, deforestation and land degradation**: land use change (or land conversion) shall be assessed in the upstream feed production, in accordance with the PEF Guidance: all carbon emissions and removals shall be modelled following the modelling guidelines of PAS 2050:2011 (BSI, 2011) and the supplementary document PAS2050-1:2012 (BSI, 2012) for horticultural products. Land use change related to cattle grazing should be considered whenever robust supporting information is available. The PEF guide prescribes to include land use change related

CO_2 emissions, but allows only to separately report land use effects as 'Additional Environmental Information'. The difference between land use and land use change can be confusing. In the case of dairy, land use change (LUC) refers to any long-term change in the type of use of a plot of land directly required to produce dairy. In relation to dairy there are four categories of land use between which changes in use are possible: 1) land used for infrastructure or buildings, 2) natural land use, 3) arable land use and 4) grassland use. Land use (LU) refers to the changes in carbon stock in soils without changing between these four types of land use. For raw milk production land use change due to deforestation is most relevant in relation to production of certain feed ingredients (mainly soy and palm oil). On the dairy farm itself often both arable (mainly maize silage production) and grassland use occur. Often the plot of land used for arable production is changed between different years. The changes in carbon stock that occur from these kind of crop rotations, however, should be classified as land use and not land use change, since over the long term (i.e. over 100 years) the net amount of farmland used for arable or grassland does not change. Only if share of grass- and arable-based roughage in the diet of the cow is actually changing over time, this should be considered to result in land use change.

- **Fat and protein content**: shall be documented and the corresponding amount of fat- and protein-corrected raw milk (FPCM) shall be reported. See section 5.8.2 for details.

Raw milk used in dairy products generally comes from multiple dairy farms. A representative sample of farms in the supply chain should be defined, in a way that properly represents the variability of the dairy systems. Main aspects influencing such variability, and which should be taken considered when defining the samples, are:

- Geographic aspect: Location/Country
- Breed;
- Feed supply and rations;
- Yield (average milk production per cow);
- Grazing vs. non-grazing systems;
- Manure management systems.

Given the seasonal variability, all data should be collected for a minimum of 1 year of activity data of each dairy farm. Average data collected over 2+ years is preferable, when available. The origin of feed used in the rations should be reported, particularly for soy-based meals.

Table 23 summarizes the data that typically have to be collected when modelling raw milk production with primary data:

Table 23: Foreground specific activity data required for raw milk modelling

Parameter	Unit
General information	
% of supply chain	% (of kg FPCM)
Breed	-
Number of lactating cows	-
Age at first calving	months
Replacement rate	%
Dairy farm area	ha
Manure management system	-
Time spent in stable	days/y
Input parameters	
Feed for lactating cows as grazed grass	kg/y
Feed for lactating cows as hay or haylage	kg/y
Feed for lactating cows as grass silage	kg/y
Feed for lactating cows as maize silage	kg/y
Feed for lactating cows as wheat silage	kg/y
Feed for lactating cows as soybean meal	kg/y
Feed for lactating cows as compound feed	kg/y
Feed for lactating cows as agricultural by-products	kg/y
Feed for heifers and dry cows as grazed grass	kg/y
Feed for heifers and dry cows as hay or haylage	kg/y
Feed for heifers and dry cows as grass silage	kg/y
Feed for heifers and dry cows as maize silage	kg/y

Parameter	Unit
Feed for heifers and dry cows as wheat silage	kg/y
Feed for heifers and dry cows as soybean meal	kg/y
Feed for heifers and dry cows as compound feed	kg/y
Feed for heifers and dry cows as agricultural by-products	kg/y
Milk powder for calves	kg/y
Bedding materials	kg/y
Drinking water	m^3/y
Cleaning water	m^3/y
Electricity used on farm (for general operations vs. for dairy cattle)	kWh/y
Fuel oil used on farm (for general operations vs. for dairy cattle)	MJ/y
Natural gas used on farm (for general operations vs. for dairy cattle)	MJ/y
Output parameters	
Milk production (total sold)	kg/y
Milk fat content	g/l
Milk protein content	g/l
Production of cull cows sold to slaughter or further fattening	kg live weight/y
Production of calves sold	kg live weight/y

Guidance to assess the data quality of raw milk modelled with primary data is provided in Table 24.

Table 24: Data Quality Rating (DQR) guidance for raw milk production

Quality rating	Time representativeness (TiR)	Technological representativeness (TeR)	Geographical representativeness (GR)
1	Production average over 2+ years, in the previous 5 years, with respect to the year the study was commissioned	Sample of farms representing >50% of total supply chain in volume	All areas in supply chain
2	Production average over 2+ years, in the previous 10 years, with respect to the year the study was commissioned	Sample of farms representing 40-49% of total supply chain in volume	Selected areas representing >50% of supply chain in volume

Quality rating	Time representativeness (TiR)	Technological representativeness (TeR)	Geographical representativeness (GR)
3	Production average for a single year, in the previous 5 years, with respect to the year the study was commissioned	Sample of farms representing 30-39% of total supply chain in volume	Single area representing 30-49% of supply chain in volume
4	Production data for a single year, in the previous 10 years, with respect to the year the study was commissioned	Sample of farms representing 10-29% of total supply chain in volume	Single area representing <30% of supply chain in volume
5	Production data for an unknown period or a period lower than 1 year	Single farm or sample of farms representing <10% of total supply chain in volume	Unknown or proxy

In situations where several raw milk supply chains are involved in the life cycle of a single dairy product (e.g. raw milk is supplied from local farms but milk powder is supplied from the market), separate DQR assessment should be made for each supply chain and documented accordingly.

5.2.2 Transport from dairy farm to processing unit

Raw milk is typically collected from several farms on a daily basis. A tanker truck leaves the dairy processing unit and gets filled up while collecting raw milk at the different dairy farms. A weighted average transport distance should be calculated and associated to appropriate secondary dataset for refrigerated bulk transport (**0.4 L diesel/km travelled,** or **0.0023 L diesel/kg milk transported**).
In cases where company-specific data for raw milk collection is not available, section 6.1 provides guidance on default secondary data to be used.

5.2.3 Packaging

Dairy products are sold in a wide variety of packaging materials and formats. Some products, such as dried whey products, are also sold in bulk. Company-specific data should be used to model the production of dairy products primary packaging: site-specific data for packaging are presented the following Table 25. Secondary and tertiary packaging can be modelled using secondary data (see section 6.3). Annex 6 lists the secondary datasets, UUIDs and DQRs to be linked to each data input.

Table 25: Foreground specific activity data required for packaging

Item	Complementary information	Unit
Bill of materials	Mass of every material contained in the packaging, including recycled content	g/unit
Capacity	Volume or mass of product in each packaging unit	l or g
Energy	Amount and types of fuel for heat and electricity used for manufacturing the packaging	kWh/unit or MJ/unit
Water	Volume of water used for manufacturing the packaging	m^3/unit
Transport	Transport mode and distance from packaging manufacturing plant to dairy processing unit	km

Guidance to assess the data quality of packaging modelled with primary data is provided in the following Table 26.

Table 26: Data Quality Rating (DQR) guidance for packaging

Quality rating	Time representativeness	Technological representativeness	Geographical representativeness
1	0-1.9 years with respect to 2023	Complete bill of materials is known and reported. Energy and water use for packaging manufacturing are known.	Packaging manufacturing place is known and origin of main materials is reported.
2	2-4.9 years with respect to 2023	Complete bill of materials is known and reported. Energy and water use for packaging manufacturing are estimated from published sources or extrapolated.	Packaging manufacturing place is known and origin of main materials is estimated.
3	5-9.9 years with respect to 2023	Bill of materials is partly known and reported. Energy and water use for packaging manufacturing are estimated from published sources or extrapolated.	Packaging manufacturing place is unknown and origin of main materials is estimated.
4	10-14.9 years with respect to 2023	Only the main materials are known and reported. Energy and water use for packaging manufacturing are unknown.	n/a
5	>15 years with respect to 2023	Proxys are used for main materials. Energy and water use for packaging manufacturing are unknown.	n/a

For container glass, the quality rating for time representativeness between 2 and 4.9 years, with respect to 2023 is considered equivalent to 1, as current technologies for container glass production have a time representativeness of 5 years (i.e., no major technological changes are foreseen in shorter time period).

5.3 Data gaps

In this PEFCR, recommendations are provided for default data to be used when primary data is not available. Only a few data gaps are anticipated:

- Strawberry production (used in fermented milk products): in the absence of representative data, the EF-compliant dataset "*Maize; at farm, crop cultivation; production mix, EU-28+EFTA+UK*" (UUID: 932089f4-4561-4992-9caf-84c3be3540c6) is used as proxy. Since there are no fruit products similar to strawberry in the EF 3.1 database, maize was selected instead.
- Food additives such as flavourings, emulsifiers and vitamins: in the absence of representative data, the EF-compliant dataset "*Ascorbic acid production; technology mix; production mix, at plant; 100% active substance, EU-28+EFTA+UK*" (UUID: 2a7985b0-bf14-40ff-bf5b-70536980ce87) is used as proxy. Ascorbic acid was chosen because it is a recognized food additive.
- Treatment of wastewater from dairy processing unit: in the absence of representative data, the EF-compliant dataset "*Treatment of effluents from potato starch production; waste water treatment including sludge treatment; production mix, at plant, EU-28+EFTA+UK*" (UUID: 2c42b213-0e00-4d8f-8a02-bda8c3f9b652) is used as proxy. This dataset was chosen as it is the closest process related to wastewater treatment in the EF 3.1 database.

5.4 Data quality requirements

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

$$\mathrm{DQR} = \frac{\overline{\mathrm{Te}_R}+\overline{\mathrm{G}_R}+\overline{\mathrm{Ti}_R}+\overline{\mathrm{P}}}{4} \qquad \text{[Equation 2]}$$

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

The next sections of this current Chapter 5 define the criteria to be used for the semi-quantitative assessment of each parameter. If a dataset is constructed with company-specific activity data, company-specific emission data and secondary sub-processes, the Data Quality Rating (DQR) of each shall be assessed separately.

The DQR shall correspond to a data quality level defined as follows:

- Overall data quality rating (DQR) up to 1.5: excellent quality
- Overall data quality rating (DQR) from 1.5 to 2.0: very good quality
- Overall data quality rating (DQR) from 2.0 to 3.0: good quality
- Overall data quality rating (DQR) from 3.0 to 4.0: fair quality
- Overall data quality rating (DQR) > 4.0: poor quality

This semi-quantitative assessment shall be done at least for the datasets related to the most relevant processes identified by the analysis.

5.4.1 Company-specific datasets

The score of P (see equation 2) cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (the DQR score shall be ≤1.5). The DQR shall be calculated at the level-1 disaggregation, before any aggregation of sub-processes or elementary flows is performed. The DQR of mandatory processes shall be calculated as follows:

1) Select the most relevant sub-processes and direct elementary flows that account for at least 80% of the total environmental impact of the mandatory process, listing them from the most contributing to the least contributing one.

2) Calculate the DQR parameters TeR, TiR, GR and P for each most relevant process and each most relevant direct elementary flow. The values of each parameter shall be assigned based on Table 27.

2.a) Each most relevant elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, evaluate the 4 DQR parameters named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF} in Table 27. Examples of elements to be evaluated include the timing of the flow measured, the technology for which the flow was measured and in which geographical area the measurement was made.

2.b) Each most relevant process is a combination of activity data and the secondary dataset used. For each most relevant process, the DQR is calculated by the user of the PEFCR as a combination of the 4 DQR parameters for activity data and the secondary dataset: (i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}) and (ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary dataset used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}SD}$ and $G_{R\text{-}SD}$) As Ti_R is evaluated twice, the mathematical average of Ti_{R-AD} and Ti_{R-SD} represents the Ti_R of the most relevant process.

3) The user of the PEFCR shall calculate the Te_R, Ti_R, G_R and P of the mandatory process dataset as the weighted average of the parameters for each most relevant process and direct elementary flow, based on their relative environmental contribution to the total single score. For example, the most-relevant processes and elementary flows account for 82.5% of the total environmental impact (single score). The 82.5% is rescaled to 100% together with the weights for the processes and elementary flows contributing. These are the weights used to average the Te_R, Ti_R, G_R and P.

4) The user of the PEFCR shall calculate the total DQR of the newly developed dataset using the equation 2, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ are the weighted average calculated as specified in point 3).

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\overline{P}}{4} \qquad \text{[Equation 3]}$$

Table 27: How to assign the values to Data Quality Rating (DQR) criteria when using company-specific information. No criteria shall be modified.

	P_{EF} and P_{AD}	***Ti_{R-EF} and Ti_{R-AD}***	***Te_{R-EF} and Te_{R-SD}***	***G_{R-EF} and G_{R-SD}***
1	Measured/calculated and externally verified	The data refers to the most recent annual administration period with respect to the EF report publication date	The elementary flows and the activity data explicitly depict the technology of the newly developed dataset	The activity data and elementary flows reflect the exact geography where the process modelled in the newly created dataset takes place
2	Measured/calculated and internally verified, plausibility checked by reviewer	The data refers to maximum 2 annual administration periods with respect to the EF report publication date	The elementary flows and the activity data are a proxy of the technology of the newly developed dataset	The activity data and elementary flows partly reflect the geography where the process modelled in the newly created dataset takes place

3	Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data refers to maximum three annual administration periods with respect to the EF report publication date	Not applicable	Not applicable
4-5	Not applicable	Not applicable	Not applicable	Not applicable

P$_{EF}$: Precision for elementary flows; **P$_{AD}$:** Precision for activity data; **TiR$_{-EF}$:** Time Representativeness for elementary flows; **TiR$_{-AD}$:** Time representativeness for activity data; **TeR$_{-EF}$:** Technology representativeness for elementary flows; **TeR$_{-AD}$:** Technology representativeness for activity data; **GeR$_{-EF}$:** Geographical representativeness for elementary flows; **GeR$_{-AD:}$** Geographical representativeness for activity data.

5.5 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific shall be evaluated using the Data Needs Matrix (Table 28). The DNM shall be used by the PEFCR applicant to evaluate which data is needed and shall be used within the modelling of its PEF, depending on the level of influence the company has on the specific process. The following three cases can be found in the DNM and are explained below:

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

Table 28: Data Needs Matrix (DNM). *Disaggregated datasets shall be used.

		Most relevant process	Other process
Situation 1: process operated by the company applying the PEFCR	**Option 1**	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR ≤1.5)[12] Calculate the DQR values (for each criterion + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process not operated by the company applying the PEFCR but with access to (company-)specific information	**Option 1**	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR ≤1.5). Calculate the DQR values (for each criterion + total)	
	Option 2	Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply chain-specific PEF-compliant datasets (DQR ≤3.0).* Re-evaluate the DQR criteria within the product specific context	
	Option 3		Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply chain-specific PEF-compliant datasets (DQR ≤4.0). Use the default DQR values

[12] Company-specific datasets shall be made available to the Commission.

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		Most relevant process	Other process
Situation 3: process not operated by the company applying the PEFCR and without access to (company)-specific information	**Option 1**	Use default secondary dataset, in aggregated form (DQR ≤3.0). Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤4.0) Use the default DQR values

Each PEF study done in accordance with this PEFCR shall provide in the PEF study a diagram indicating the organisational boundary, to highlight those activities under the control of the organisation and those falling into Situation 1, 2 or 3 of the data needs matrix.

5.5.1 Processes in situation 1

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

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

Situation 1/Option 1

For all processes operated by the company and where the company applying the PEFCR uses company-specific data. The DQR of the newly developed dataset shall be evaluated as described in Section 5.4.

Situation 1/Option 2

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

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

5.5.2 Processes in situation 2

When a process is not operated by the company applying the PEFCR, but there is access to company-specific data, then there are two possible options:

- The company applying the PEFCR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[13] (Option 1);
- The company has some supplier-specific information and wants to make some minimal changes (Option 2).
- The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 3).

Situation 2/Option 1

For all processes operated by the company and where the company applying the PEFCR uses company-specific data. The DQR of the newly developed dataset shall be evaluated as described in Section 5.4.

Situation 2/Option 2

Company-specific activity data for transport are used and the sub-processes used for electricity mix and transport with supply chain-specific PEF-compliant datasets are substituted starting from the default secondary dataset provided in the PEFCR.

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

The user of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R and Ti_R, using the table(s) provided. The criteria G_R shall be lowered by 30%[14] and the criteria P shall keep the original value.

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[13] The review of the newly created dataset is optional

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

Situation 2/Option 3

For the non-most relevant processes, the user may use the corresponding secondary dataset listed in the PEFCR together with its DQR values (Table 29).

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

Table 29: How to assign the values to parameters in the Data Quality Rating (DQR) formula when secondary datasets are used

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

5.5.3 Processes in situation 3

When a process is not operated by the company applying the PEFCR and the company does not have access to company-specific data, there are two possible options:

- It is in the list of most relevant processes (situation 3, option 1)
- It is not in the list of most relevant processes (situation 3, option 2)

Situation 3/Option 1

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

Situation 3/Option 2

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

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

5.6 Which datasets to use?

The secondary datasets to be used by the user are those listed in the MS Excel Annex "**PEFCR-partial update DairyProducts_Version1- Life cycle inventory**" available at: http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm. Whenever a dataset needed to calculate the PEF-profile is not among those listed in this PEFCR, then the user shall choose between the following options (in hierarchical order):

- Use an EF-compliant dataset available on one of the following nodes (See https://eplca.jrc.ec.europa.eu/LCDN/contactListEF.xhtml):
  - http://lcdn.blonkconsultants.nl (raw milk, fodder, fertilisers, pesticides, feed crops and compounds);
  - http://eplca.jrc.ec.europa.eu/EF-node/;
  - http://lcdn.thinkstep.com/Node (energy, transports, packaging materials, waste treatment, wastewater treatment, glass production);

  - http://ecoinvent.lca-data.com (chemicals not used as fertilisers or pesticides; plastics);
- Use an EF-compliant dataset available in a free or commercial source;
- Use another EF-compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitation" section of the PEF report;
- Use an ILCD-entry level-compliant dataset that has been modelled according to the modelling requirements included in the Commission Recommendation (EU) 2021/2279 of 15 December 2021. In such case this information shall be included in the "limitations" section of the PEF report;
- Use an ILCD-entry level-compliant dataset. In such case this information shall be included in the "data gap" section of the PEF report.

5.7 How to calculate the average DQR of the study

In order to calculate the average DQR of the EF study, the user shall calculate separately the T_eR, T_iR, GR and P for the EF study as the weighted average of all most relevant processes, based on their relative environmental contribution to the total single score. The calculation rules explained in section 5.4 shall be used.

5.8 Allocation rules

5.8.1 Multi-functionality decision hierarchy

The following decision hierarchy recommended by the Commission Recommendation (EU) 2021/2279 is in accordance with ISO 14044 (ISO 2006a), the international reference standard for LCA.

Decision hierarchy

Step 1: **wherever possible, subdivision or system expansion should be used to avoid allocation. Subdivision** refers to disaggregating multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output. **System expansion** refers to expanding the system by including additional functions related to the co-products. It shall be investigated first whether it is possible to subdivide or expand the analysed process. Where subdivision is possible, inventory data shall be collected only for those unit processes directly attributable to the goods/services of concern. Or, if the system may be expanded, the additional functions shall be included in the analysis.

Step 2: Allocation based on a relevant underlying physical relationship.

Where it is not possible to apply subdivision or system expansion, allocation should be applied: the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects relevant underlying physical relationships between them.

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

Step 3: Allocation based on some other relationship.

Allocation based on some other relationship may be possible. For example, economic allocation refers to allocating inputs and outputs associated with multi-functional processes to the co-product outputs in proportion to their relative market values. The market price of the co-functions should refer to the specific condition and point in which the co-products are produced.

Stages with multifunctional products and multiproduct processes in the life cycle of dairy products

The following life cycle stages involve dealing with multi-functionality:

i) Raw milk production at the dairy farm

ii) Dairy products processing at the dairy processing unit

iii) Transportation from retail to consumer home

iv) Materials recycling, or incineration with energy recovery at the end of life.

5.8.2 Multi-functionality at the dairy farm

At the dairy farm, the following outputs are considered:

- Raw milk
- Dairy products produced on farm
- Live animals leaving the farm (for slaughter or further fattening or replacement of dairy cattle), including dry cows, culled cows and calves

- Dead animals leaving the farm (See Table 22)
- Manure
- Sold non-dairy products (feed and arable products)
- Energy produced on the farm

In accordance with the Commission Recommendation (EU) 2021/2279 of 15 December 2021, upstream burdens and activities are allocated to raw milk and live animals based on the IDF biophysical allocation method (IDF, 2015). Dead animals and all products from dead animals shall be regarded as waste and the circular footprint formula (See Section 5.11) shall be applied.

According to the Commission Recommendation (EU) 2021/2279 of 15 December 2021, manure exported to another farm shall be used as one of the following:

(a) Residual (default option): if manure does not have an economic value at the farm gate, it is regarded as residual without allocation of an upstream burden. The emissions related to manure management up to the farm gate are allocated to the other farm outputs where manure is produced.

(b) Co-product: when exported manure has an economic value[15] at the farm gate, an economic allocation of the upstream burden shall be used for manure by using the relative economic value of manure compared to milk and live animals at the farm gate. However, biophysical allocation based on IDF rules shall be applied to allocate the remaining emissions between milk and live animals.

(c) Manure as waste: when manure is treated as waste (e.g. landfilled), the circular footprint formula (See Section 5.11) shall be applied.

If manure is treated in an anaerobic digester at the farm, manure shall be regarded residual when it goes to the anaerobic digester. The emissions of the anaerobic digestion process shall be assigned to the electricity and heat produced (and used at the farm or sold out of the farm). The residues of the anaerobic digestion process that are used as a fertiliser at the farm shall be regarded residual without allocation of the impacts of the digestion process. In the case that the residues of the anaerobic digestion process are exported, the same allocation rules that are used for untreated manure shall apply.

The allocation factor (AF) between milk and meat at the dairy farm (IDF, 2015) is calculated as follows:

[15] It is important to note that the use of manure could lead to a reduction in on-farm synthetic fertilizer use.

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

Where M_{meat} is the mass of live weight of all animals sold including bull calves and culled mature animals per year, and M_{milk} is the mass of fat- and protein-corrected milk (FPCM) sold per year (corrected to 4% fat and 3.3% protein).

The FPCM (corrected to 4% fat and 3.3% protein) (IDF, 2015) is calculated with Equation 5:

$$FPCM\left(\frac{kg}{yr}\right) = Production\left(\frac{kg}{yr}\right) \times (0.1226 \times True\ Fat + 0.0776 \times True\ Protein + 0.2534) \qquad \text{[Equation 5]}$$

5.8.3 Multi-product processes at dairy processing

Dairy manufacturing plants usually produce more than one product, because the fat content in raw milk exceeds the product specification for milk powders or fresh milk products (e.g. market milk, yoghurt or dairy desserts). The excess milk fat can be further processed into butter or anhydrous milk fat (AMF). Another typical example of co-production in the dairy industry is the production of cheese and whey. This creates the need to allocate the environmental impact of production and transport of raw milk and processing to different dairy co-products produced in a specific dairy production plant. In addition, many of the process units (e.g. pasteurization, separation or spray drying) are subsequently used to process different dairy product flows (e.g. skimmed milk, whey, caseinate). The data collection for each process unit within the plant is resource-intensive and in some cases impossible due to insufficient metering on a process unit level. In some cases, resource use or emission data are only available on a 'whole-of-factory' basis.

Allocation of raw milk and transport from farm to processing plant

Allocation of the environmental footprint embodied in the raw milk as it comes into the processing plant (i.e. including farm to processing plant transport) should be done by mass allocation using the **dry weight** (i.e. dry matter content) of the product under study and its co-products (IDF, 2015).

More concentrated products such as butter or milk powder thus get allocated a higher proportion of the processing impacts than less concentrated products, since a greater quantity of raw milk has gone through upstream processing operations. This is reasonable given that for dairy products upstream processing operations (heat treatment, skimming, etc.) are those that require the most energy.

The allocation factor (AF) based on dry matter content can be calculated for each product (i) using the following Equation 6:

$$AF_i = \frac{DM_i \times Q_i}{\sum_{i=1}^{n} (DM_i \times Q_i)}$$ [Equation 6]

Where:

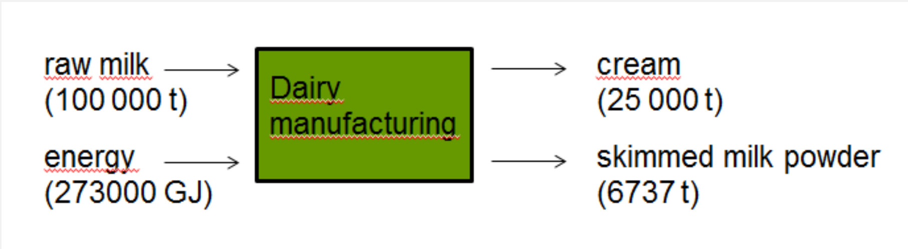
- AFi allocation factor for product i;
- DMi dry matter content of product i (expressed as % dry matter or as weight by mass of dry matter/weight by mass of product i). This is semi-specific data: the values proposed are default values (see Annex 5);
- Qi quantity of product i output to the production site or from the unit operation (in kg of product i).

Example

In this hypothetical example, a dairy company wants to calculate the carbon footprint of cream. The dairy company produces 25000 tonnes of cream (with 42% dry matter) and 6737 tonnes of skimmed milk powder (with 96% dry matter) using 100000 tonnes of raw milk and 273000 GJ of heat.

Because data are only available for the whole dairy processing unit, allocation of raw milk is done based on the milk solid content of the cream and the skimmed milk powder (i.e. Equation 6).

The carbon footprint of 1 tonne of raw milk is known to be 1100 kg CO_2-eq and the carbon footprint of 1 GJ heat 66.9 kg CO_2-eq.



Example of allocation of co-products during manufacturing.

- The allocation factor of cream using Equation 6:

$$AF_{cream} : \frac{42*25\ 000}{42*25\ 000+96*6735} = 0.62$$

- The calculated Carbon Footprint for cream is:

$$CF_{cream} : \frac{100000 * 1100 * 0.62 + 273000 * 66.9 * 0.62}{25000} = 3181\ kg\ CO_2eq\ per\ tonne\ cream$$

Processing allocation - situation A: detailed data are available on specific processes

Energy use, and materials others than raw milk and emissions at the factory shall be allocated as much as possible to specific processing stages and product flows (step 1 in ISO 14044). If several products result from a single dairy flow in a specific joint process unit (i.e. production of butter and buttermilk; production of cheese and whey; production of skimmed milk and cream), allocation shall be based on dry matter content (Equation 6).

Processing allocation - situation B: detailed data are available on some processes and co-products, while other data are available at the dairy processing unit level

In this case, detailed process and co-product data shall be assigned to specific products first, subtract assigned detailed process and co-product data from the factory total and then allocate the remainder based on milk solids (i.e. find where the milk solids go in the various products and use the distribution of the milk solids as the basis for distribution of the environmental burdens).

Processing allocation - situation C: data is only available at the company or dairy processing unit level

When data is only available at the level of a company or of a whole dairy processing unit, i.e. only the inputs (e.g. raw milk, energy) and the outputs (e.g. various dairy products) of the entire operation are known, all energy use shall be allocated proportionally to the dry weight (milk solids content) of the co-products. In almost all processing scenarios, energy goes primarily toward heating, cooling and drying processes. In that case, the milk solids content (dry matter) of the final products will properly reflect the share in energy use. No distinction is made regarding types of milk solids (i.e. protein, fat, lactose), since in the case of heating, cooling and drying only the amount of milk solids in the product influences the process, but not the type of milk solids. Other inputs that can generally be directly associated with a specific product (e.g. packaging, ingredients) shall not be allocated between co-products. For all other material inputs where allocation is required (e.g. water use, chemicals, cleaning agents, wastewater) allocation shall be done based on the dry matter content of all co-products.

Default values for the dry matter content of dairy products

The exact dry matter content of the real product assessed needs to be used for the calculation of the PEFCR. In the rare cases where there is no access to the primary data of the dairy product, default values for the dry matter content of dairy products may be used. These default values for the dry matter content of dairy products are provided in Annex 5. The use of a default value shall be an exceptional case, and the correct subcategory needs to be chosen. Therefore, when primary data on the actual product assessed are unavailable, information shall be provided on data unavailability and reasons for it.

5.8.4 Transportation of raw milk and distribution of packaged dairy products

For transportation of raw milk to the dairy processing unit and transportation of packaged dairy products to the sales point, allocation on mass (i.e. fresh mass) shall be applied.

5.8.5 Transportation from retail to consumer home

Transportation of goods in a personal car requires allocating the journey to the different products transported. As default approach, allocation based on the volume occupied is applied, as detailed in section 6.4.

5.9 Electricity modelling

The guidelines in this section shall only be used for the processes where company-specific information is collected (situation 1 / Option 1 & 2 / Option 1 of the DNM).

5.9.1 Electricity mix choices in hierarchical order

The following electricity mix shall be used in hierarchical order:

(a) Supplier-specific electricity product shall be used if there is a 100% tracking system in place, or if:
  (i) available, and
  (ii) the set of minimum criteria to ensure the contractual instruments are reliable is met.

(b) The supplier-specific total electricity mix shall be used if:
  (i) available, and
  (ii) the set of minimum criteria that to ensure the contractual instruments are reliable is met.

(c) The "country-specific residual grid mix, consumption mix" shall be used (available at http://lcdn.thinkstep.com/Node/). Country-specific means the country in which the life cycle stage or activity occurs. This may be an EU country or non-EU country. The residual grid mix prevents double counting with the use of supplier-specific electricity mixes in (i) and (ii).

(d) As a last option, the average EU residual grid mix, consumption mix (EU+EFTA+UK), or region representative residual grid mix, consumption mix, shall be used.

Note: for the use stage, the consumption grid mix shall be used.

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

5.9.2 Set of minimal criteria to ensure contractual instruments from suppliers

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

A contractual instrument used for electricity modelling shall:

1. Convey attributes:
   - Convey the energy type mix associated with the unit of electricity produced.
   - The energy type mix shall be calculated based on delivered electricity, incorporating certificates sourced and retired on behalf of its customers. Electricity from facilities for which the attributes have been sold off (via contracts or certificates) shall be characterized as having the environmental attributes of the country residual consumption mix where the facility is located.
2. Be a unique claim:
   - Be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.
   - Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g. by an audit of contracts, third-party certification, or may be handled automatically through other disclosure registries, systems, or mechanisms).
3. Be as close as possible to the period to which the contractual instrument is applied.

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

Datasets for residual grid mix, per energy type, per country and per voltage have been purchased by the European Commission and are available in the dedicated node (http://lcdn.thinkstep.com/Node/). In case the necessary dataset is not available, an alternative dataset shall be chosen according to the procedure described in Section 5.9.1. If no dataset is available, the following approach may be used:

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

- Activity data related to non-EU country consumption mix per detailed energy type shall be determined based on:
    - Domestic production mix per production technologies
    - Import quantity and from which neighbouring countries
    - Transmission losses
    - Distribution losses
    - Type of fuel supply (share of resources used, by import and / or domestic supply)

These data can be found in the publications of the International Energy Agency (IEA).

- Available LCI datasets per fuel technologies in the node. The LCI datasets available are generally specific to a country or a region in terms of:
    - Fuel supply (share of resources used, by import and / or domestic supply),
    - Energy carrier properties (e.g. element and energy contents)
    - Technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.

5.9.4 Allocation rules

Electricity use in the different processes should be allocated following the rules described in section 5.8. If the consumed electricity comes from more than one electricity mix, each mix source shall be used in terms of its proportion in the total kWh consumed. For example, if a fraction of this total kWh consumed is coming from a specific supplier a supplier-specific electricity mix shall be used for this part. See Section 5.9.5 for on-site electricity use.

A specific electricity type can be assigned to one specific product in the following conditions:

a) The production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site can be used.

b) The production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product specific information (measure, record, bill) can be used.

c) All the products produced in the specific plant are supplied with a public available PEF study. The company who wants to make the claim shall make all PEF studies available. The allocation rule applied shall be described in the PEF study, consistently applied in all PEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.

5.9.5 *On-site electricity generation*

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

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

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

- If possible, apply subdivision. Subdivision applies both to separate electricity productions or to a common electricity production where you can allocate based on electricity amounts the upstream and direct emissions to your own consumption and to the share you sell out of your company (e.g. if a company has a wind mill on its production site and export 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the PEF study).
- If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[16].

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

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

5.10 Climate change modelling

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

1. **Climate change – fossil**: This sub-category includes emissions from peat and calcination/carbonation of limestone. The emission flows ending with '(fossil)' (e.g., 'carbon dioxide (fossil)'' and 'methane (fossil)') shall be used if available.
2. **Climate change – biogenic**: This sub-category covers carbon emissions to air (CO_2, CO and CH_4) originating from the oxidation and/or reduction of biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO_2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or aboveground plant residues such as litter and dead wood. Carbon exchanges from native forests[17] shall be modelled under sub-category 3 (incl. connected soil emissions, derived products, residues). The emission flows ending with '(biogenic)' shall be used. All biogenic carbon emissions and removals shall be modelled separately. However, note that the corresponding characterisation factors for biogenic CO_2 uptakes and emissions within the EF impact assessment method are set to zero. This is because the uptake and emissions of biogenic CO_2 are part of a short cycle. For intermediate products only (i.e. dried whey products), the biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.
3. **Climate change – land use and land transformation**: This sub-category accounts for carbon uptakes and emissions (CO_2, CO and CH_4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (incl. soil carbon emissions). For native forests, all related CO_2 emissions are included and modelled under this sub-category (including

[17] Native forests – represents native or long-term, non-degraded forests. Definition adapted from table 8 in Annex VC(2010)3751 to Directive 2009/28/EC (https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF)

connected soil emissions, products derived from native forest[18] and residues), while their CO_2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.

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

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

[18] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2) (IPCC, 2013)(https://www.ipcc.ch/site/assets/uploads/2018/03/KP_Supplement_Entire_Report.pdf)

1) Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out, no emissions from land use change should be included in the assessment.

2) Where the timing of land use change cannot be demonstrated to be more than 20 years, or a single harvest period, prior to making the assessment (whichever is the longer), it shall be assumed that the land use change occurred on 1 January of either:

- the earliest year in which it can be demonstrated that the land use change had occurred; or
- on 1 January of the year in which the assessment of GHG emissions and removals is being carried out.

The following hierarchy shall apply when determining the GHG emissions and removals arising from land use change occurring during a period of 20 years or a single harvest period that last longer than 20 years, prior to making the assessment:

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

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

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

The sub-category ‘Climate change-biogenic’ shall be reported separately

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

5.11 Modelling of end of life and recycled content

The waste of products used during the manufacturing, distribution, retail, the use stage or after use shall be included in the overall modelling of the life cycle of the products. Overall, this should be modelled and reported at the life cycle stage where the waste occurs. This section gives guidelines on how to model the End of Life of products as well as the recycled content.

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

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

Material

[Equation 7]

Energy

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

[Equation 8]

Disposal

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

[Equation 9]

With the following parameters:

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

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

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

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

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

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

R_2: it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.

R_3: it is the proportion of the material in the product that is used for energy recovery at EoL.

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

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

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

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

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

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

E_D: specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.

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

LHV: Lower Heating Value of the material in the product that is used for energy recovery.

6 Life cycle stages

6.1 Raw milk supply

6.1.1 Raw milk production

In situations where raw milk production does not fall in situation 1 or 2 of the DNM, the following guidance shall be followed.

Step 1: Identification of dairy systems relevant to the supply chain. If it can be determined that a specific dairy system, or combination of dairy systems is relevant to the supply chain of raw milk used in the dairy product(s) assessed, secondary data representative of such dairy systems can be used (or combined) provided they comply with all requirements from this PEFCR (e.g. emissions modelling, allocation, land use change. The selection of those systems should be properly justified and documented.

Step 2: Use of national average. When the nature and specificities of the upstream dairy farming systems cannot be determined, an existing inventory dataset representative of the national average should be used. EF-compliant secondary datasets are available for the main dairy producers in the EU: France, Netherlands, Italy, Germany and the UK. National LCI datasets from other commercial LCI databases can be used for other countries providing they comply with all requirements from this PEFCR (e.g. emissions modelling, allocation, land use change), though it must be declared that they are not EF-compliant.

Step 3: Use of EU-28+EFTA+UK average. When no EF-compliant data exists or can be modelled from published literature, representing the national average raw milk production, the **EU-28+EFTA+UK** (for EU context) EF-compliant secondary dataset shall be used as a placeholder: *cow milk; typical (average) production; production mix, at farm; FPCM (Fat- and Protein-Corrected Milk) , EU28+EFTA+UK*(UUID: afcdc981-5840-5495-b6d3-7cbea6da4657).

6.1.2 Raw milk transport from dairy farm to processing unit

In situations where raw milk collection and transport to the dairy processing unit does not fall in situation 1 or 2 of the DNM, a default distance of 60 km shall be used in combination with the EF-compliant dataset

"*Articulated lorry transport, Euro 5, Total weight 28-32 t, cooled; diesel driven, Euro 5, cooled cargo; consumption mix, to consumer; EU-28+EFTA+UK*" (UUID: 6006c4e5-2d64-4e53-9bd0-f2f200e8b22f).

6.2 Dairy processing and non-dairy ingredients supply

6.2.1 Liquid milk

The production of liquid milk shall be based on mandatory company-specific data. Table 30 provides an example of such data:

Table 30: Example list of ingredients for 1 l of liquid milk, unpackaged

	Whole milk	Semi-skimmed milk	Skimmed milk
Ingredient	Amount (g)	Amount (g)	Amount (g)
Raw milk	1000	1000	1000

For skimming of liquid milk, the following ratios of co-product may be used, based on an input of 1 kg raw milk:

- Skimmed milk: 900 g / kg raw milk
- Cream 42%: 100 g / kg raw milk

6.2.2 Dried whey products

The production of dried whey products shall be based on mandatory company-specific data. Table 31 provides an example of such data:

Table 31: Example list of ingredients for 1 kg of dried whey products, unpackaged

Ingredient	Whey powder	Lactose powder	Whey protein concentrate (WPC)	Whey protein isolate powder	High fat whey protein concentrate powder
	Amount (kg DM+)	Amount (kg DM)	Amount (kg DM)	Amount (kg DM)	Amount (kg DM)
Whey (thin or thick)*	0.97	1	0.97	0.72	0.5
Fat**	0.03	0	0.03	0.28	0.5

** Whey can be thick or thin whey*

*** Fats can be milk fat or vegetable fats such as soybean oil or palm oil, depending on the product recipe*

+DM = Dry matter

The following typical dry matter content of each input and product may be used:

- Thin whey: 4.8%
- Thick whey: 26.5%
- Whey powder: 96.5%
- Lactose powder: 99.8%
- Whey protein concentrate (WPC): 94.0%
- Whey protein isolate powder: 95.0%
- High fat whey protein concentrate powder: 98.0%

The dry matter content of WPC can range between product varieties from 65% to 94%.

6.2.3 Cheeses

The production of cheese shall be based on mandatory company-specific data. Table 32 provides an example of such data:

Table 32: Example list of ingredients for 1 kg of cheese, unpackaged

	Fresh cheese	Soft cheese	Semi-hard cheese	Hard cheese
Ingredient	Amount (g)	Amount (g)	Amount (g)	Amount (g)
Raw milk	2500	7000	9000	10000
Cream	500	0	0	0
Salt	0.2	14	12	8
Calcium chloride	0	0.2	0.2	0.2
Rennet (excluded)	0	2	2.5	2
Bacteria and yeast (excluded)	0.05	0.15	0.15	0.15

Whey (or thin whey) is a co-product from cheese production. The following default ratios of whey per kg of cheese may be used:

- Fresh cheese: 1.5 kg whey / kg
- Soft cheese: 6 kg whey / kg
- Semi-hard cheese: 7.5 kg whey / kg
- Hard cheese: 9 kg whey / kg

6.2.4 Fermented milk products

The production of fermented milk products shall be based on mandatory company-specific data. Table 33 provides an example of such data:

Table 33: Example list of ingredients for 1 kg of fermented milk products, unpackaged

	Spoonable, plain	Spoonable, flavoured	Spoonable, fruited
Ingredients	Amount (g)	Amount (g)	Amount (g)
Skimmed milk	950	860	700
Cream 42% fat	30	30	80
Skimmed milk powder	20	15	30
Ferments (excluded)	0.15	0.15	0.15
Sugar	0	100	40
Flavours	0	4	0
Fruit preparation	0	0	150

6.2.5 Butterfat products

The production of butterfat products shall be based on mandatory company-specific data. Table 34 provides an example of such data:

Table 34: Example list of ingredients for 1 kg of butterfat products, unpackaged

	Butter, unsalted	Butter, salted	Dairy spreads
Ingredient	Amount (g)	Amount (g)	Amount (g)
Raw milk	20000	20000	0
Butter	0	0	400
Buttermilk	0	0	250
Skimmed milk	0	0	250
Salt	0	20	0
Ferments (excluded)	-	-	-

Buttermilk and skimmed milk are co-products from butter production. A default ratio of 1 kg buttermilk per kg of butter and 18 kg skimmed milk per kg butter may be used.

6.2.6 Consumables

Consumables (energy, water, cleaning agents and refrigerants) shall be based on mandatory company-specific data. Table 35 provides an example of such data.

Table 35: Example data for consumables used in dairy processing

Consumable	Unit	Liquid milk	Dried whey products	Cheeses	Fermented milk products	Butterfat products
Electricity	Wh/kg product	77	430	413	137	435
Thermal energy	kJ/ kg product	441	10753	1938	590	1947
Total Energy	kJ/ kg product	718	12301	3425	1083	3513
Water	L/ kg product	1.6	1.5	6.7	3.2	14.1
Cleaning agents (acid)	g/ kg product	30	30	30	30	30
Cleaning agents (base)	g/ kg product	60	60	60	60	60
Refrigerants	g/ kg product	5.00E-6	1.00E-6	5.00E-6	5.00E-6	5.00E-6

6.2.7 Wastewater treatment

When primary data on the amount of wastewater to be treated and its COD content are not available, the default values in Table 36 shall be used.

Table 36: Default data for wastewater from dairy processing

Consumable	Unit	Liquid milk	Dried whey products	Cheeses	Fermented milk products	Butterfat products
Wastewater to treatment	l/kg product	1.6	11.5	9.4	4.6	14.12
COD content	g/ kg product	4.25	32.50	30.00	20.70	45.40

The procedure described in section 5.1.1 shall be applied, for the modelling of the wastewater flow.

6.2.8 Transport of non-dairy ingredients to the dairy processing unit

The following transport scenarios from supplier to factory shall be used for suppliers located with Europe:

- 130 km by truck (>32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98), default utilisation ratio = 64%; and
- 240 km by train (average freight train; UUID 4cedf877-89c5-4b4d-8014-5b7d099a2095); and
- 270 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

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

- 1,000 km by truck (>32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98), for the sum of distances from harbour/airport to factory outside and inside Europe. default utilisation ratio = 64%; and
- 18000 km by ship (transoceanic container; UUID 6ca61112-1d5b-473c-abfa-4accc66a8a63) or 10,000 km by plane (cargo; UUID 1cc5d465-a12a-43da-aa86-a9c6383c78ac).
- If producers country (origin) is known: the adequate distance for ship and airplane should be determined using http://www.searates.com/services/routes-explorer or https://co2.myclimate.org/en/flight_calculators/new

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

6.3 Packaging

Packaging shall be based on mandatory company-specific data. Table 37 provides an example of such data.

Table 37: Example bill of materials for dairy products primary packaging

Sub-category	Packaging	Amount product	Packaging material	Amount (g)
Liquid milk	Liquid Packaging	1000 ml	LPB	21.2
			Aluminium	1.38

Sub-category	Packaging	Amount product	Packaging material	Amount (g)
	Carton (UHT)		LDPE	5.315
			HDPE (closure)	1.34
			PP (closure)	1.39
	Liquid Packaging Carton (Pasteurized) for fresh milk	1000 ml	LPB	22.75
			LDPE	3.24
			HDPE (closure)	1.38
			LDPE (closure)	1.25
	Plastic (HDPE et PP) bottle	1000 ml	HDPE or PP	40
			Aluminium (closure)	0.04
			HDPE (closure)	3
	Returnable glass bottle	1000 ml	Glass, white	650
			Aluminium (closure)	0.04
			LDPE (label)	1
	Stand-up pouch	1000 ml	LDPE	3.81
			PP	5.82
			Other (PP)	6.1
	Plastic (PET) bottle	1000 ml	PET	40
			HDPE (closure)	1.7
			Aluminium (closure)	0.04
			LDPE (label)	1
Dried whey products	Big bag	1000 kg	PP	1.93
			Plastic (LDPE) film	0.887
	Kraft paper bag	25 kg	Plastic (LDPE) film	0.073
			Kraft paper, bleached	0.256
Cheeses	Plastic foil	250 g	PP	5
	Plastic box	250 g	PET	7.32
	Aluminium paper wrap	60 g	Aluminium	0.19
			Wax	0.03

Sub-category	Packaging	Amount product	Packaging material	Amount (g)
			Paper	0.10
	Paper foil	250 g	Paper	1.44
	Wooden box	250 g	Wood	15
Fermented milk products	Plastic cup	125 g	PS	3.66
			Aluminium (closure)	0.47
			PP (closure)	0.25
	Plastic cup	500 g	PET	14.64
			Aluminium (closure)	0.86
			PP (closure)	0.45
	Glass jar	125 g	Glass	133
			Aluminium (closure)	0.47
			PP (closure)	0.25
	Paper cup	125 g	Paper	10.2
			Aluminium (closure)	0.47
			PP (closure)	0.25
	Plastic bottle	100 ml	HDPE	5.2
			Board	13
			Aluminium (closure)	15
	Plastic bottle	1000 ml	HDPE	40
			PP (closure)	4
			LDPE (label)	1
	Liquid Packaging Carton	1000 ml	LPB	22.15
			Aluminium foil	0.2
			LDPE	4.6
			HDPE (closure)	1.38
			LDPE (closure)	1.25
Butterfat products	Aluminium foil laminated paper	250 g	Aluminium	0.76
			Lacquer	0.06
			Wax	0.4
			Paper	1.44

Sub-category	Packaging	Amount product	Packaging material	Amount (g)
			Ink	0.7
	Plastic cup	250 g	PET	7.32
			PET (closure)	2
	Aluminium foil laminated paper	10 g	Aluminium	0.152
			Lacquer	0.012
			Wax	0.08
			Paper	0.288
			Ink	0.14
	Preformed plastic cup	10 g	PET	1
			PP (closure)	0.01
	Butter paper	250 g	Paper	1.44

(c) = closure; (l) = label; LDPE = Low Density Polyethylene; LPB = Liquid Packaging Board; HDPE = High Density Polyethylene; PET = Polyethylene Terephthalate; PP = Polypropylene; PS = Polystyrene; UHT = Ultra High Temperature

The recycled content (R1) of each packaging material shall be default be aligned with the Annex C of the Commission Recommendation (EU) 2021/2279 of 15 December 2021. These default values are summarised in Table 38 for main packaging materials used with dairy products.

Table 38: Default R1 parameters (recycled content) for main packaging materials

Packaging material	Recycled content (R1)
Liquid packaging carton (i.e. liquid packaging board)	0%
Plastic bottle (HDPE or PET)	0%
Plastic cups (PET, PS or PP)	0%
Glass bottle or jar, unspecified colour	52%
Glass bottle or jar, flint colour	50%
Flexible packaging (foil, wrapper, paper)	0%

The default transport distances to be used for the transport of packaging materials from supplier to dairy processing unit are the following:

For packaging materials from manufacturing plants to filler plants (beside glass)

- 230 km by truck (>32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98), default utilization ratio = 64%
- 280 km by train (average freight train; UUID 4cedf877-89c5-4b4d-8014-5b7d099a2095); and
- 360 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

For empty glass bottles:

- 350 km by truck (>32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98), default utilisation ratio = 64%
- 39 km by train (average freight train; UUID 4cedf877-89c5-4b4d-8014-5b7d099a2095); and
- 87 km by ship (barge; UUID 4cfacea0-cce4-4b4d-bd2b-223c8d4c90ae).

The default parameters to be used for returnable glass bottles are listed in Table 39.

Table 39: Default parameters for returnable glass bottles

Parameter	Amount	Unit
Reuse rates (number of re-use)[19]	17.5 in UK context of milk delivery 20 (for company owned pools) 30 (for third party operated pools)	-
Tap water	0.8	l/bottle/washing cycle
Natural gas	0.07	MJ/bottle/washing cycle
Electricity	0.06	kWh/bottle/washing cycle
Sodium hydroxide	1	g/bottle/washing cycle
Hydrochloric acid	0.3	g/bottle/washing cycle

For secondary and tertiary packaging, the default data from Table 40 should be used.

[19] Packaging Working Group guidance document, version 1.0 – May 2016

Table 40: Default parameters for secondary and tertiary packaging, per kg of dairy product

Material	Amount	Unit	Recycled content (R1)
Carton boxes (corrugated board)	24	g/kg product	88%
Separators (corrugated board)	1.6	g/kg product	88%
LDPE plastic wrap	1.5	g/kg product	0%
Wooden pallet	6	g/kg product	0%

6.4 Distribution

When primary data on distribution is not available, the default parameters from the Commission Recommendation (EU) 2021/2279 of 15 December 2021 shall be used, as follows:

From dairy processing unit to retail, through distribution centre (DC):

- Local supply chain: 1,200 km by truck
    - Refrigerated: 28-32 t, cooled, EURO 5; UUID 6006c4e5-2d64-4e53-9bd0-f2f200e8b22f
    - Non-refrigerated (UHT liquid milk only): >32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98, default utilisation ratio = 64%
- Intracontinental supply chain: 3,500 km by truck
    - Refrigerated: 28-32 t, cooled, EURO 5; UUID 6006c4e5-2d64-4e53-9bd0-f2f200e8b22f
    - Non-refrigerated (UHT liquid milk only): >32 t, EURO 4; UUID e1ded83e-a02f-42cd-92f9-81cce21a3a98, default utilisation ratio = 64%

From retail to final client:

- 62%: 5 km, by passenger car (average; UUID 1ead35dd-fc71-4b0c-9410-7e39da95c7dc) with the following allocation factors (based on the utilisation ratio for each FU, dividing the product volume by 0.2 m^3)
    - Liquid milk: volume of 1 FU equals 1 L. Allocation factor = 0.005
    - Cheese: volume of 1 FU equals 0.02 L. Allocation factor = 0.0001
    - Fermented milks: volume of 1 FU equals 0.125 L. Allocation factor = 0.000625
    - Butterfat products: volume of 1 FU equals 0.05 L. Allocation factor = 0.00025

- 5%: 5 km round trip, by van (lorry <7.5t, EURO 3 with utilisation ratio of 20%; UUID 8c6dc5a6-02b7-4356-b924-988059f991c2)
- 33%: no impact modelled

The default parameters to be used for dairy products storage in the distribution stage are listed in Table 41.

Table 41: Parameters for dairy products storage in the distribution stage

Parameter	Liquid milk	Dried whey products	Cheeses	Fermented milk products	Butterfat products
Storage duration at dairy processing warehouse (*)	1 day, refrigerated or 7 days, ambient	7 days, ambient temperature	3 days, refrigerated	3 days, refrigerated	3 days, refrigerated
Storage duration at distribution centre	1 week	n/a	1 week	1 week	1 week
Storage volume at distribution centre	3 times the product's volume	n/a	3 times the product's volume	3 times the product's volume	3 times the product's volume
Storage duration at point of sale	3 days, refrigerated or 14 days, ambient	n/a	5 days, refrigerated	3 days, refrigerated	5 days, refrigerated
Storage volume at point of sale	3 times the product's volume	n/a	3 times the product's volume	3 times the product's volume	3 times the product's volume

(*) Energy use for storage at the dairy processing unit is already included in the stage "dairy processing".

Default values for energy and refrigerants consumption (

Table 42) are retrieved from Commission Recommendation (EU) 2021/2279 of 15 December 2021. A ceiling height of 5 m (at the distribution centre) 2 m (for refrigerators) is considered as to convert from surface to volume references.

Table 42: Energy and refrigerants consumption at the distribution centre and at retail

Parameter	Per surface area (per m^2.y)	Per volume occupied (per m^3.y)
General electricity consumption at distribution centre	30 kWh	6 kWh
General energy at distribution centre (natural gas burned in boiler)	360 MJ	72 MJ
Refrigerated storage at distribution centre (additional electricity)	80 kWh	40 kWh
General electricity consumption at retail	400 kWh	200 kWh
Refrigerated storage at retail (additional electricity)	1900 kWh	950 kWh
Refrigerant gases (leaks)	0.029 kg R404A	0.0145 kg R404A

Refrigerant leaks shall be modelled as input refrigerant and as direct emissions to air. Capital goods can be neglected.

6.5 Use stage

The default use stage scenario considers that dairy products are chilled in a refrigerator, with the exception of UHT liquid milk, which is stored at ambient temperature and only chilled when opened. Washing of a glass or cutlery is included since it is product-dependent (i.e. several single-portion dairy products are specifically designed not to require the use of a glass – for drinking – or a knife/spoon – for eating). Heating, cooking or further transformation of dairy products at the consumer home are excluded but may be assessed in sensitivity analysis. Food waste at the consumer home is discussed in section 6.6. Default parameters for the use stage are retrieved from Commission Recommendation (EU) 2021/2279 of 15 December 2021 and are presented in Table 43.

Table 43: Default parameters for dairy products storage at the consumer home

Parameter	Liquid milk	Dried whey products	Cheeses	Fermented milk products	Butterfat products
Storage duration at the consumer home	5 days, refrigerated (fresh or pasteurised); 30 days, ambient and 2 days, refrigerated (UHT)	n/a	10 days, refrigerated	7 days, refrigerated	10 days, refrigerated
Storage volume at the consumer home	3 times the product's volume	n/a	3 times the product's volume	3 times the product's volume	3 times the product's volume
Electricity use for chilled storage ($kWh/m^3.y$)[20]	1350	n/a	1350	1350	1350
Dishwashing	Glass washed in dishwasher (allocation 2.5% of a dishwashing cycle per piece. 1 piece= 1/5 FU)	*n/a*	Knife washed in dishwasher (allocation 0.5% of a dishwashing cycle per piece. 1 piece= 10 FU)	Spoon washed in dishwasher (allocation 0.5% of a dishwashing cycle per piece. 1 piece= 1 FU)	Knife washed in dishwasher (allocation 0.5% of a dishwashin g cycle per piece. 1 piece= 5 FU)

Energy use for ambient storage at the consumer home can be neglected.

[20] 0.0037 kWh/L.day (ANIA and ADEME, 2012) is equivalent to 1350 $kWh/m^3.y$

6.6 End of life

The End of life stage is a life cycle stage that in general includes the waste of the product in scope, such as the food waste, primary packaging, or the product left at its end of use.

The end of life shall be modelled using the circular footprint formula and rules provided in chapter 'End of life modelling' (Section 5.11) of this PEFCR together with the default parameters..

Before selecting the appropriate R_2 value, an evaluation for recyclability of the material shall be done and the PEF study shall include a statement on the recyclability of the materials/products. The statement on the recyclability shall be provided together with an evaluation for recyclability that includes evidence for the following three criteria (as described by ISO 14021:1999, section 7.7.4 'Evaluation methodology'):

1. The collection, sorting and delivery systems to transfer the materials from the source to the recycling facility are conveniently available to a reasonable proportion of the purchasers, potential purchasers and users of the product;
2. The recycling facilities are available to accommodate the collected materials;
3. Evidence is available that the product for which recyclability is claimed is being collected and recycled.

Point 1 and 3 can be proven by recycling statistics (country-specific) derived from industry associations or national bodies. Approximation to evidence at point 3 can be provided by applying for example the design for recyclability evaluation outlined in EN 13430 Material recycling (Annexes A and B) or other sector-specific recyclability guidelines if available[21].

Following the evaluation for recyclability, the appropriate R_2 values (supply chain-specific or default) shall be used. If one criterion is not fulfilled or the sector-specific recyclability guidelines indicate a limited recyclability an R_2 value of 0% shall be applied.

Company-specific R_2 values (measured at the output of the recycling plant) shall be used when available. If no company-specific values are available and the criteria for evaluation of recyclability are fulfilled (see below), application-specific R_2 values shall be used as listed in the table below,

a) If an R_2 value is not available for a specific country, then the European average shall be used.

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

b) If an R_2 value is not available for a specific application, the R_2 values of the material shall be used (e.g. materials average).

c) In case no R_2 values are available, R_2 shall be set equal to 0 or new statistics may be generated in order to assign an R_2 value in the specific situation.

The applied R_2 values shall be subject to the PEF study verification.

The parameters to be used by the user to implement the CFF are all default values from the Commission Recommendation (EU) 2021/2279 of 15 December 2021, Annex C.

The reuse rate determines the quantity of packaging material (per product sold) to be treated at end of life. The amount of packaging treated at end of life shall be calculated by dividing the actual weight of the packaging by the number of times this packaging was reused.

Food losses and waste

Food wastage throughout the distribution chain is recognised as a potentially important issue, with regards to the environmental footprint of dairy products. Losses occurring within and between the life cycle stages, from the dairy farm to retail, and at the consumer home, are however not documented at European scale. Experience from the dairy industry shows that important variations may occur from one site to another, and from one market to another. Food wastage is seen as a wider issue for the agri-food sector as a whole; the Technical Secretariat therefore encourages the European Commission to propose a consistent approach to document the amount of food losses and waste and to be applied transversally by all food-related sectors.

In the PEF screening study, FAO data on food losses and waste in the Europe and Russia (FAO, 2011) was used to assess the impact of food wastage in a sensitivity analysis. As long as a consistent transversal approach is not defined and endorsed by the EC, it is suggested to use this data in sensitivity analyses.

Whenever available, primary data for food losses should be used, and the default factors in Table 44 should be applied in case such data is not available.

The relevant definition of food losses and waste is given by FAO: Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain (Parfitt et al., 2010). Food losses occurring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behaviour (Parfitt et al., 2010). "Food" waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in the part of food chains leading to "edible products going to human consumption". Therefore, food that was originally meant to human consumption, but which fortuity gets out the human food chain is considered as food loss or waste even if it is then directed to a non-food use (e.g. animal feed, bioenergy, etc.). This approach distinguishes "planned" non-food uses to "unplanned" non-food uses, which are hereby accounted under losses. With regard to food losses during processing it is important to distinguish between dairy that is waste treated and dairy of which the quality is degraded to a lower quality, but that still will be used for a different purpose than the product under study. In the case of cheese for example the cheese is cut prior to packaging which results in cutting losses that are subsequently used as pet food or cheese spreads. These types of products should not be considered as food waste, but as co-products.

Table 44: Food loss and waste rates of dairy products

Parameter	Liquid milk	Dried whey products	Cheeses	Fermented milk products	Butterfat products
Food losses from farm to retail	5%	2% (*)	5%	5%	5%
Food waste at consumer home	7%	n/a	7%	7%	7%

(*) Assumed, from farm to dairy processing

7 PEF results

7.1 Benchmark values

Benchmarks are provided as characterised results, normalised results and weighted results, as requested in the Commission Recommendation (EU) 2021/2279 of 15 December 2021. One benchmark was calculated for each sub-category. Since no detailed market study on dairy products exists at the EU level, the benchmarks correspond to the representative products defined in the screening study. It should therefore be seen as a first attempt to provide sectorial and sub-sectorial benchmarks, as different approaches may be necessary for different subcategories.

As a matter of principle, the TS does not question the merits of a benchmark approach as a tool among others to enable final consumers to assess the EF of products placed on the market. However, the TS considers that, at the current stage of development of the PEF methodology, a mandatory and stringent benchmark approach would be premature, and its immediate implementation might give an inaccurate perception to consumers and a wrong incentive to the industry, at least for some of the sub-categories.

In fact, a number of uncertainties related to the PEF methodology have been identified by the TS and need further assessment. The results of the supporting studies tend to confirm these gaps, which is fully understandable in a pilot phase. The benchmark values listed in the next Sections 7.1.1 for characterised benchmark values, Section 7.1.2 for normalised benchmark values and Section 7.1.3 for weighted benchmark values should therefore be seen as an indicative guide only. When the improved PEF methodology is used, better PEF results will become available, yielding a better benchmark .

7.1.1 Characterised benchmark values

The characterised benchmark values are presented in

Table 45 for liquid milk, Table 46 for dried whey products, Table 47 for cheeses, Table 48 for fermented milk products and Table 49 for butterfat products.

Table 45: Characterised benchmark values for liquid milk (1000 ml)

Impact category	Unit	Life cycle excl. Use stage	Use stage
Climate change	kg $CO_{2\ eq}$	1.49E+00	8.23E-02
Climate change - biogenic		5.82E-01	1.48E-03
Climate change – land use and land transformation		2.72E-01	9.75E-05
Ozone depletion	kg CFC-11 $_{eq}$	4.50E-09	3.43E-10
Human toxicity, cancer	CTUh	8.99E-10	5.65E-11
Human toxicity, non-cancer	CTUh	4.13E-08	1.09E-09
Ecotoxicity, freshwater	CTUe	1.73E+02	1.12E+00
Particulate matter	disease incidence	1.85E-07	2.63E-09
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	5.46E-02	3.24E-02
Photochemical ozone formation,	kg NMVOC $_{eq}$	4.41E-03	1.41E-04
Acidification	mol H+ $_{eq}$	1.64E-02	2.54E-04
Eutrophication, terrestrial	mol N $_{eq}$	7.16E-02	5.29E-04
Eutrophication, freshwater	kg P $_{eq}$	1.48E-04	1.07E-05
Eutrophication, marine	kg N $_{eq}$	9.14E-03	7.49E-05
Land use	Dimensionless (pt)	1.19E+02	4.28E-01
Water use	m^3 world $_{eq}$	3.88E-01	4.18E-02
Resource use, minerals and metals	kg Sb $_{eq}$	2.90E-07	5.54E-08
Resource use, fossils	MJ	6.29E+00	1.37E+00

Table 46: Characterised benchmark values for dried whey products (1000 kg)

Impact category	Unit	Life cycle excl. Use stage	Use stage
Climate change	kg $CO_{2\ eq}$	1.03E+04	n/a
Climate change - biogenic		4.05E+03	n/a
Climate change – land use and land transformation		1.98E+03	n/a
Ozone depletion	kg CFC-11 $_{eq}$	8.23E-05	n/a
Human toxicity, cancer	CTUh	4.26E-06	n/a
Human toxicity, non-cancer	CTUh	2.99E-04	n/a
Ecotoxicity, freshwater	CTUe	1.24E+06	n/a
Particulate matter	disease incidence	1.24E-03	n/a
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	3.24E+02	n/a
Photochemical ozone formation	kg NMVOC $_{eq}$	2.92E+01	n/a
Acidification	mol H+ $_{eq}$	1.13E+02	n/a
Eutrophication, terrestrial	mol N $_{eq}$	4.92E+02	n/a
Eutrophication, freshwater	kg P $_{eq}$	1.19E+00	n/a
Eutrophication, marine	kg N $_{eq}$	6.32E+01	n/a
Land use	Dimensionless (pt)	7.46E+05	n/a
Water use	m^3 world $_{eq}$	3.21E+03	n/a
Resource use, minerals and metals	kg Sb $_{eq}$	3.41E-03	n/a
Resource use, fossils	MJ	4.08E+04	n/a

Table 47: Characterised benchmark values for cheeses (10 g dry matter)

Impact category	Unit	Life cycle excl. Use stage	Use stage
Climate change	kg $CO_{2\ eq}$	1.19E-01	7.65E-05
Climate change - biogenic		4.97E-02	7.27E-07
Climate change – land use and land transformation		2.36E-02	8.30E-08
Ozone depletion	kg CFC-11 $_{eq}$	2.38E-09	7.94E-13
Human toxicity, cancer	CTUh	5.29E-11	3.74E-14
Human toxicity, non-cancer	CTUh	3.62E-09	7.53E-13
Ecotoxicity, freshwater	CTUe	1.49E+01	8.67E-04
Particulate matter	disease incidence	1.54E-08	2.44E-12
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	3.18E-03	3.09E-05
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	3.56E-04	1.29E-07
Acidification	mol H+ $_{eq}$	1.41E-03	2.33E-07
Eutrophication, terrestrial	mol N $_{eq}$	6.15E-03	4.77E-07
Eutrophication, freshwater	kg P $_{eq}$	1.34E-05	4.36E-09
Eutrophication, marine	kg N $_{eq}$	7.92E-04	5.50E-08
Land use	Dimensionless (pt)	9.05E+00	3.74E-04
Water use	m^3 world $_{eq}$	3.46E-02	3.13E-05
Resource use, minerals and metals	kg Sb $_{eq}$	3.67E-08	9.54E-11
Resource use, fossils	MJ	3.80E-01	1.31E-03

Table 48: Characterised benchmark values for fermented milk products (125 g)

Impact category	Unit	Life cycle excl. Use stage	Use stage
Climate change	kg $CO_{2\,eq}$	1.83E-01	7.04E-03
Climate change - biogenic		5.25E-02	7.08E-05
Climate change – land use and land transformation		2.49E-02	7.68E-06
Ozone depletion	kg CFC-11 $_{eq}$	1.22E-09	7.02E-11
Human toxicity, cancer	CTUh	9.53E-11	3.54E-12
Human toxicity, non-cancer	CTUh	4.54E-09	7.09E-11
Ecotoxicity, freshwater	CTUe	1.98E+01	8.08E-02
Particulate matter	disease incidence	1.82E-08	2.25E-10
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	1.18E-02	2.84E-03
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	4.97E-04	1.19E-05
Acidification	mol H+ $_{eq}$	1.64E-03	2.14E-05
Eutrophication, terrestrial	mol N $_{eq}$	7.05E-03	4.40E-05
Eutrophication, freshwater	kg P $_{eq}$	1.66E-05	4.35E-07
Eutrophication, marine	kg N $_{eq}$	9.51E-04	5.15E-06
Land use	Dimensionless (pt)	1.13E+01	3.45E-02
Water use	m^3 world $_{eq}$	9.69E-02	2.93E-03
Resource use, minerals and metals	kg Sb $_{eq}$	3.32E-07	8.52E-09
Resource use, fossils	MJ	1.27E+00	1.20E-01

Table 49: Characterised benchmark values for butterfat products (50 g)

Impact category	Unit	Life cycle excl. Use stage	Use stage
Climate change	kg $CO_{2\ eq}$	4.49E-01	3.13E-03
Climate change - biogenic		1.91E-01	2.20E-05
Climate change – land use and land transformation		9.06E-02	3.31E-06
Ozone depletion	kg CFC-11 $_{eq}$	1.48E-09	3.82E-11
Human toxicity, cancer	CTUh	1.90E-10	1.35E-12
Human toxicity, non-cancer	CTUh	1.34E-08	2.76E-11
Ecotoxicity, freshwater	CTUe	5.69E+01	3.34E-02
Particulate matter	disease incidence	5.87E-08	9.98E-11
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	1.22E-02	1.27E-03
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	1.35E-03	5.25E-06
Acidification	mol H+ $_{eq}$	5.37E-03	9.47E-06
Eutrophication, terrestrial	mol N $_{eq}$	2.36E-02	1.94E-05
Eutrophication, freshwater	kg P $_{eq}$	4.97E-05	1.12E-07
Eutrophication, marine	kg N $_{eq}$	3.02E-03	2.08E-06
Land use	Dimensionless (pt)	3.46E+01	1.50E-02
Water use	m^3 world $_{eq}$	1.23E-01	1.19E-03
Resource use, minerals and metals	kg Sb $_{eq}$	1.91E-07	4.43E-09
Resource use, fossils	MJ	1.31E+00	5.39E-02

7.1.2 Normalised benchmark values

The normalised benchmark values are presented in Table 50 for liquid milk, Table 51 for dried whey products, Table 52 for cheeses, Table 53 for fermented milk products and Table 54 for butterfat products.

Table 50: Normalised benchmark values for liquid milk (1000 ml)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	1.97E-04	1.09E-05
Ozone depletion	8.61E-08	6.55E-09
Human toxicity, cancer	2.61E-05	1.64E-06
Human toxicity, non-cancer	1.60E-04	4.25E-06
Ecotoxicity, freshwater	1.53E-03	9.84E-06
Particulate matter	3.10E-04	4.42E-06
Ionising radiation, human health	1.29E-05	7.68E-06
Photochemical ozone formation, human health	1.08E-04	3.46E-06
Acidification	2.95E-04	4.57E-06
Eutrophication, terrestrial	4.05E-04	2.99E-06
Eutrophication, freshwater	9.18E-05	6.63E-06
Eutrophication, marine	4.68E-04	3.83E-06
Land use	1.46E-04	5.22E-07
Water use	3.38E-05	3.64E-06
Resource use, minerals and metals	4.56E-06	8.71E-07
Resource use, fossils	9.68E-05	2.11E-05

Table 51: Normalised benchmark values for dried whey products (1000 kg)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	1.36E+00	n/a
Ozone depletion	1.57E-03	n/a
Human toxicity, cancer	1.23E-01	n/a
Human toxicity, non-cancer	1.16E+00	n/a
Ecotoxicity, freshwater	1.09E+01	n/a
Particulate matter	2.08E+00	n/a
Ionising radiation, human health	7.69E-02	n/a
Photochemical ozone formation, human health	7.15E-01	n/a
Acidification	2.03E+00	n/a
Eutrophication, terrestrial	2.78E+00	n/a
Eutrophication, freshwater	7.54E-01	n/a
Eutrophication, marine	3.23E+00	n/a
Land use	9.10E-01	n/a
Water use	2.80E-01	n/a
Resource use, minerals and metals	5.36E-02	n/a
Resource use, fossils	6.27E-01	n/a

Table 52: Normalised benchmark values for cheeses (10 g dry matter)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	1.57E-05	1.01E-08
Ozone depletion	4.54E-08	1.52E-11
Human toxicity, cancer	1.53E-06	1.09E-09
Human toxicity, non-cancer	1.41E-05	2.92E-09
Ecotoxicity, freshwater	1.31E-04	7.64E-09
Particulate matter	2.58E-05	4.10E-09
Ionising radiation, human health	7.54E-07	7.31E-09
Photochemical ozone formation, human health	8.71E-06	3.16E-09
Acidification	2.53E-05	4.18E-09
Eutrophication, terrestrial	3.48E-05	2.70E-09
Eutrophication, freshwater	8.32E-06	2.71E-09
Eutrophication, marine	4.05E-05	2.82E-09
Land use	1.10E-05	4.56E-10
Water use	3.01E-06	2.73E-09
Resource use, minerals and metals	5.77E-07	1.50E-09
Resource use, fossils	5.84E-06	2.01E-08

Table 53: Normalised benchmark values for fermented milk products (125 g)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	2.42E-05	9.32E-07
Ozone depletion	2.34E-08	1.34E-09
Human toxicity, cancer	2.76E-06	1.02E-07
Human toxicity, non-cancer	1.76E-05	2.75E-07
Ecotoxicity, freshwater	1.74E-04	7.12E-07
Particulate matter	3.06E-05	3.77E-07
Ionising radiation, human health	2.80E-06	6.72E-07
Photochemical ozone formation, human health	1.22E-05	2.91E-07
Acidification	2.95E-05	3.85E-07
Eutrophication, terrestrial	3.99E-05	2.49E-07
Eutrophication, freshwater	1.03E-05	2.70E-07
Eutrophication, marine	4.86E-05	2.64E-07
Land use	1.38E-05	4.21E-08
Water use	8.45E-06	2.55E-07
Resource use, minerals and metals	5.21E-06	1.34E-07
Resource use, fossils	1.95E-05	1.85E-06

Table 54: Normalised benchmark values for butterfat products (50 g)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	5.94E-05	4.15E-07
Ozone depletion	2.83E-08	7.30E-10
Human toxicity, cancer	5.49E-06	3.92E-08
Human toxicity, non-cancer	5.21E-05	1.07E-07
Ecotoxicity, freshwater	5.01E-04	2.95E-07
Particulate matter	9.87E-05	1.68E-07
Ionising radiation, human health	2.90E-06	3.01E-07
Photochemical ozone formation, human health	3.32E-05	1.28E-07
Acidification	9.67E-05	1.71E-07
Eutrophication, terrestrial	1.33E-04	1.10E-07
Eutrophication, freshwater	3.09E-05	6.95E-08
Eutrophication, marine	1.55E-04	1.06E-07
Land use	4.22E-05	1.83E-08
Water use	1.07E-05	1.04E-07
Resource use, minerals and metals	3.00E-06	6.97E-08
Resource use, fossils	2.02E-05	8.29E-07

7.1.3 Weighted benchmark values

The weighted benchmark values are based on the weighting factors provided in Annex 1. The weighted benchmark values are presented in Table 55 for liquid milk, Table 56 for dried whey products, Table 57 for cheeses, Table 58 for fermented milk products and Table 59 for butterfat products.

Table 55: Weighted benchmark values for liquid milk (1000 ml)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	4.15E-05	2.30E-06
Ozone depletion	5.43E-09	4.14E-10
Human toxicity, cancer	5.55E-07	3.49E-08
Human toxicity, non-cancer	2.95E-06	7.82E-08
Ecotoxicity, freshwater	2.93E-05	1.89E-07
Particulate matter	2.78E-05	3.96E-07
Ionising radiation, human health	6.49E-07	3.85E-07
Photochemical ozone formation, human health	5.16E-06	1.65E-07
Acidification	1.83E-05	2.83E-07
Eutrophication, terrestrial	1.50E-05	1.11E-07
Eutrophication, freshwater	2.57E-06	1.86E-07
Eutrophication, marine	1.38E-05	1.13E-07
Land use	1.16E-05	4.14E-08
Water use	2.88E-06	3.10E-07
Resource use, minerals and metals	3.45E-07	6.57E-08
Resource use, fossils	8.06E-06	1.76E-06
SINGLE SCORE	**1.81E-04**	**6.41E-06**

Table 56: Weighted benchmark values for dried whey products (1000 kg)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	2.87E-01	n/a
Ozone depletion	9.92E-05	n/a
Human toxicity, cancer	2.63E-03	n/a
Human toxicity, non-cancer	2.13E-02	n/a
Ecotoxicity, freshwater	2.10E-01	n/a
Particulate matter	1.86E-01	n/a
Ionising radiation, human health	3.85E-03	n/a
Photochemical ozone formation, human health	3.42E-02	n/a
Acidification	1.26E-01	n/a
Eutrophication, terrestrial	1.03E-01	n/a
Eutrophication, freshwater	2.11E-02	n/a
Eutrophication, marine	9.57E-02	n/a
Land use	7.23E-02	n/a
Water use	2.38E-02	n/a
Resource use, minerals and metals	4.05E-03	n/a
Resource use, fossils	5.22E-02	n/a
SINGLE SCORE	**1.24E+00**	**n/a**

Table 57: Weighted benchmark values for cheeses (10 g dry matter)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	3.31E-06	2.13E-09
Ozone depletion	2.86E-09	9.57E-13
Human toxicity, cancer	3.26E-08	2.31E-11
Human toxicity, non-cancer	2.59E-07	5.38E-11
Ecotoxicity, freshwater	2.52E-06	1.47E-10
Particulate matter	2.31E-06	3.67E-10
Ionising radiation, human health	3.78E-08	3.66E-10
Photochemical ozone formation, human health	4.16E-07	1.51E-10
Acidification	1.57E-06	2.59E-10
Eutrophication, terrestrial	1.29E-06	1.00E-10
Eutrophication, freshwater	2.33E-07	7.60E-11
Eutrophication, marine	1.20E-06	8.33E-11
Land use	8.77E-07	3.62E-11
Water use	2.57E-07	2.32E-10
Resource use, minerals and metals	4.35E-08	1.13E-10
Resource use, fossils	4.86E-07	1.67E-09
SINGLE SCORE	**1.49E-05**	**5.82E-09**

Table 58: Weighted benchmark values for fermented milk products (125 g)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	5.10E-06	1.96E-07
Ozone depletion	1.48E-09	8.46E-11
Human toxicity, cancer	5.88E-08	2.18E-09
Human toxicity, non-cancer	3.24E-07	5.07E-09
Ecotoxicity, freshwater	3.35E-06	1.37E-08
Particulate matter	2.74E-06	3.38E-08
Ionising radiation, human health	1.40E-07	3.37E-08
Photochemical ozone formation, human health	5.81E-07	1.39E-08
Acidification	1.83E-06	2.39E-08
Eutrophication, terrestrial	1.48E-06	9.24E-09
Eutrophication, freshwater	2.90E-07	7.57E-09
Eutrophication, marine	1.44E-06	7.80E-09
Land use	1.09E-06	3.34E-09
Water use	7.19E-07	2.17E-08
Resource use, minerals and metals	3.94E-07	1.01E-08
Resource use, fossils	1.62E-06	1.54E-07
SINGLE SCORE	**2.12E-05**	**5.36E-07**

Table 59: Weighted benchmark values for butterfat products (50 g)

Impact category	Life cycle excl. Use stage	Use stage
Climate change	1.25E-05	8.73E-08
Ozone depletion	1.87E-09	4.60E-11
Human toxicity, cancer	1.18E-07	8.34E-10
Human toxicity, non-cancer	9.58E-07	1.97E-09
Ecotoxicity, freshwater	9.62E-06	5.66E-09
Particulate matter	8.86E-06	1.50E-08
Ionising radiation, human health	1.50E-07	1.51E-08
Photochemical ozone formation, human health	1.59E-06	6.14E-09
Acidification	6.01E-06	1.06E-08
Eutrophication, terrestrial	4.95E-06	4.06E-09
Eutrophication, freshwater	8.68E-07	1.95E-09
Eutrophication, marine	4.58E-06	3.14E-09
Land use	3.38E-06	1.45E-09
Water use	9.15E-07	8.83E-09
Resource use, minerals and metals	2.27E-07	5.26E-09
Resource use, fossils	1.73E-06	6.90E-08
SINGLE SCORE	**5.65E-05**	**2.36E-07**

7.2 PEF profile

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

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

Together with the PEF report, the user of the PEFCR shall develop an aggregated EF-compliant dataset of its product in scope. This dataset shall be made available to the European Commission and may be made public. The disaggregated version may remain confidential.

7.3 Additional technical information

For intermediate products only (i.e. dried whey products), the biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.

7.4 Additional environmental information

Applicants should report additional environmental information as described below:

a) Certification scheme for any ingredients (e.g. organic);
b) Information on local/site-specific impacts on biodiversity (see Section 7.4.1);

Additionally, information regarding the company work with social/environmental responsibility but also data about specific environmental characteristics of the product may be added.

7.4.1 Impact on biodiversity

Livestock production plays an important role on biodiversity with either positive or negative impact depending on farming practices: grassland management, agricultural practices, land use change and agro-ecological infrastructures.

In the European context of dairy farming, the biodiversity “hotspots” could be summarised in the four following topics:

1) Maintaining pastures ;
2) Semi-natural habitats (hedges, trees, wild strips, river banks);
3) Deforestation and land conversion in the feed supply chain (mainly soybean and palm meal);
4) Natural habitat degradation through emission of ecotoxic, eutrophying, acidifying substances and greenhouse gases (covered by LCA impact categories), overstocking, soil compaction and soil erosion (not covered).

Therefore, and as highlighted by the FAO LEAP “Principles for the assessment of livestock impacts on biodiversity” (LEAP, 2015), LCA does not cover the entire array impacts on biodiversity. A combined approach with additional criteria is therefore proposed.. This approach will hopefully be improved in the future when international scientific consensus is reached on the topic, possibly following the Pressure State Response (PSR) framework once operational guidance is published (see LEAP (2015b) for more information on the PSR approach).

Due to lack of consistent statistical data at European level and acknowledging for the fact that all dairy companies – such as SMEs - are technically not able to gather such data, the proposition is worded as a recommendation rather than a mandatory reporting requirement. At current stage, practitioners may therefore report on the following four additional indicators:

1) Share of total intake from pasture in the feed ration, in % of total Dry matter intake (DMI);
2) Semi-natural habitats, in % of the dairy farms area: tools such as the French CAP2ER[22] can be used for that purpose;
3) Share of feed with possible risk of deforestation in its supply chain within the feed ration, in % of total DMI: calculated as the sum of DMI from non-certified soybean from Brazil and Argentina and non-certified palm meal from Southeast Asia, divided by the total DMI in the feed ration;
4) Schemes related to biodiversity: a description of the different schemes (certified or not) in the raw milk supply chain (i.e. at the dairy farm and in upstream feed production) and how they relate to biodiversity conservation may be provided (see Table 60).

[22] https://hub.bovine-eu.net/tools-for-calculating-and-improving-environmental-sustainability-on-beef-cattle-farms/cap2er

Table 60: Typical information to be provided on schemes related to biodiversity

Scheme	Relevance to biodiversity conservation	% of total raw milk supply in product
Name of scheme (mandatory)	*Description of the scheme (i.e. applicability, scope, website, etc.) and of how the scheme relates to biodiversity conservation (mandatory)*	*(optional)*
…	*…*	*…*

8 Verification

The verification of a PEF study/ report carried out in compliance with this PEFCR shall be done according to all the general requirements included in section 9 of the Annex I of Commission Recommendation (EU) 2021/2279, including part A of this Annex, and the requirements listed below.

The verifier(s) shall verify that the PEF study is conducted in compliance with this PEFCR.

In case policies implementing the PEF method define specific requirements regarding verification and validation of PEF studies, reports and communication vehicles, the requirements in said policies shall prevail.

The verifier(s) shall validate the accuracy and reliability of the quantitative information used in the calculation of the study. As this can be highly resource intensive, the following requirements shall be followed:

1) The verifier(s) shall check if the correct version of all impact assessment methods was used. For each of the most relevant EF impact categories (ICs), at least 50% of the characterisation factors shall be verified, while all normalisation and weighting factors of all ICs shall be verified. In particular, the verifier(s) shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with[23]. This may also be done indirectly, for example:

   a) Export the EF-compliant datasets from the LCA software used to do the PEF study and run them in Look@LCI[141] to obtain LCIA results. If Look@LCI results are within a deviation of 1% from the results in the LCA software, the verifier(s) may assume that the implementation of the characterisation factors in the software used to do the PEF study was correct;

   b) Compare the LCIA results of the most relevant processes calculated with the software used to do the PEF study with the ones available in the metadata of the original dataset. If the compared results are within a deviation of 1%, the verifier(s) may assume that the implementation of the characterisation factors in the software used to do the PEF study was correct;

2) Cut-off applied (if any) fulfils the requirements at section 4.6.4 of Annex I of Commission Recommendation (EU) 2021/2279;

3) all datasets used shall be checked against the data requirements (sections 4.6.3 and 4.6.5. of Annex I) of Commission Recommendation (EU) 2021/2279;

[23] Available at: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

[141] https://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

4) For at least 80% (in number) of the most relevant processes (as defined in section 6.3.3 of Annex I), the verifier(s) shall validate all related activity data and the datasets used to model these processes. If relevant, CFF parameters and datasets used to model them shall also be validated in the same way. The verifier(s) shall check that the most relevant processes are identified as specified in section 6.3.3 of Annex I of Commission Recommendation (EU) 2021/2279;
5) For at least 30% (in number) of all other processes (corresponding to 20% of the processes as defined in section 6.3.3 of Annex I) the verifier(s) shall validate all related activity data and the datasets used to model these processes. If relevant, CFF parameters and datasets used to model them shall also be validated in the same way;
6) The verifier(s) shall check that the datasets are correctly implemented in the software (i.e. LCIA results of the dataset in the software are within a deviation of 1% to the ones in the metadata). At least 50% (in number) of the datasets used to model most relevant processes and 10% of those used to model other processes shall be checked.

In particular, verifier(s) shall verify if the DQR of the process satisfies the minimum DQR as specified in the DNM for the selected processes.

These data checks shall include, but should not be limited to, the activity data used, the selection of secondary subprocesses, the selection of the direct elementary flows and the CFF parameters. For example, if there are 5 processes and each one of them includes 5 activity data, 5 secondary datasets and 10 CFF parameters, then the verifier(s) has to check at least 4 out of 5 processes (70%) and, for each process, (s)he shall check at least 4 activity data (70% of the total amount of activity data), 4 secondary datasets (70% of the total amount of secondary datasets), and 7 CFF parameters (70% of the total amount of CFF parameters), i.e. the 70% of each of data that could be subject to a check.

The verification of the PEF report shall be carried out by randomly checking enough information to provide reasonable assurance that the PEF report fulfils all the conditions listed in section 8 of Annex I of Commission Recommendation (EU) 2021/2279, including part A of this Annex.

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ANNEX 1 – List of EF normalisation and weighting factors

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

The full list of characterization factors for EF 3.1 is available at this link: https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml [24]

Normalization (Table 61) and weighting factors (Table 62) are also available at: https://eplca.jrc.ec.europa.eu/permalink/EF3_1/Normalisation_Weighting_Factors_EF_3.1.xlsx

Table 61: EF 3.1 normalization factors

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness
Climate change	kg $CO_{2\ eq}$	5.21E+13	7.55E+03	I	II	I
Ozone depletion	kg CFC-11 $_{eq}$	3.61E+08	5.23E-02	I	III	II
Human toxicity, cancer	CTUh	1.19E+05	1.73E-05	III	III	III
Human toxicity, non-cancer	CTUh	8.88E+05	1.29E-04	III	III	III
Particulate matter	disease incidence	4.11E+06	5.95E-04	I	I/II	I /II
Ionising radiation, human health	kBq U^{235} $_{eq}$	2.91E+13	4.22E+03	II	II	III

[24] Please note that the weighting factors are expressed in % and thus shall be divided by 100 before applying in the calculations.

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	2.82E+11	4.09E+01	II	III	I/II
Acidification	mol H+ $_{eq}$	3.83E+11	5.56E+01	II	II	I/II
Eutrophication, terrestrial	mol N $_{eq}$	1.22E+12	1.77E+02	II	II	I/II
Eutrophication, freshwater	kg P $_{eq}$	1.11E+10	1.61E+00	II	II	III
Eutrophication, marine	kg N $_{eq}$	1.35E+11	1.95E+01	II	II	II/III
Land use	pt	5.65E+15	8.19E+05	III	II	II
Ecotoxicity, freshwater	CTUe	3.91E+14	5.67E+04	III	III	III
Water use	m^3 world $_{eq}$	7.91E+13	1.15E+04	III	I	II
Resource use, fossils	MJ	4.48E+14	6.50E+04	III	I	II
Resource use, minerals and metals	kg Sb $_{eq}$	4.39E+08	6.36E-02	III		

Weighting factors for Environmental Footprint

Table 62: EF 3.1 Weighting factors

WITHOUT TOX CATEGORIES	Aggregated weighting set (50:50)	Robustness factors (scale 1-0.1)	Calculation	Final weighting factors
	A	B	C=A*B	C scaled to 100
Climate change	12.9	0.87	11.18	**21.06**
Ozone depletion	5.58	0.6	3.35	**6.31**
Human Toxicity, cancer	6.8	0.17	1.13	**2.13**
Human Toxicity, non-cancer	5.88	0.17	0.98	**1.84**
Particulate matter	5.49	0.87	4.76	**8.96**
Ionizing radiation, human health	5.7	0.47	2.66	**5.01**
Photochemical ozone formation, human health	4.76	0.53	2.54	**4.78**
Acidification	4.94	0.67	3.29	**6.2**
Eutrophication, terrestrial	2.95	0.67	1.97	**3.71**
Eutrophication, freshwater	3.19	0.47	1.49	**2.8**
Eutrophication, marine	2.94	0.53	1.57	**2.96**
Ecotoxicity, freshwater	6.12	0.17	1.02	**1.92**
Land use	9.04	0.47	4.22	**7.94**
Water use	9.69	0.47	4.52	**8.51**
Resource use, minerals and metals	6.68	0.6	4.01	**7.55**
Resource use, fossils	7.37	0.6	4.42	**8.32**

ANNEX 2 – Check list for the PEF study

Each PEF study shall include this annex, completed with all the requested information.

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
[This column shall list all the items that shall be included in PEF studies. One item per row shall be listed. This column shall be completed by the TS]	[The PEF study shall indicate if the item is included or not in the study]	[The PEF study shall indicate in which section of the study the item is included]	[The PEF study shall indicate in which page of the study the item is included]
Summary			
General information about the product			
General information about the company			
Diagram with system boundary and indication of the situation according to DNM			
List and description of processes included in the system boundaries			
List of co-products, by-products and waste			
List of activity data used			

ITEM	*Included in the study (Y/N)*	*Section*	*Page*
List of secondary datasets used			
Data gaps			
Assumptions			
Scope of the study			
(Sub)category to which the product belongs			
DQR calculation of each dataset used for the most relevant processes and the new ones created.			
DQR (of each criteria and total) of the study			

ANNEX 3 – Critical review report of the PEFCR

Critical Review Statement on the update of the 'PEFCR for dairy products'

5 November 2024

On behalf of the European Dairy Association (EDA) an update of the 'PEFCR for dairy products' is conducted, supported by Blonk Consultants. The draft final PEFCR is dated 5 November 2024. This update is externally reviewed to comply with the PEF guidelines. In line with PEF-requirements is performed by an external review-panel.

The external review panel for this update of the PEFCR is composed of the following members:

Name of the member	*Affiliation*	*Role*
Greg Thoma	Colorado State University	Chair
Jude Capper	Livestock Sustainability Consultancy	Member
Judith Brouwer	Milieu Centraal	Member

The reviewers have verified that the following requirements have been fulfilled:

a) The PEFCR has been updated in accordance with the Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations (European Commission 2021);
b) The PEFCR supports the creation of credible, relevant and consistent PEF profiles;
c) Datasets used in the updated PEF RPs and the supporting studies are relevant, representative, reliable, and in compliance with data quality requirements;
d) The selected additional environmental and technical information is appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in ANNEX I;
e) The model of the RP and corresponding benchmark (if applicable) represent correctly the product category or sub-category;
f) The RP models, disaggregated in line with the PEFCR and aggregated in ILCD format, are EF compliant following the rules available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml;
g) The RP model in its corresponding excel version is compliant with the rules outlined in section A.2.3 of Annex II;
h) The Data Needs Matrix is correctly implemented;
i) The classes of performance, if identified, are appropriate for the product category.

The detailed review report is provided separately in the excel file:
Light_Review_PEFCR_Dairy_28.10.2024.xls

Review statement:

The update of the PEFCR for dairy products has been developed in compliance with the Commission Recommendation (EU) 2021/2279 of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations (European Commission 2021).

The representative products correctly describe the average product(s) sold in Europe (EU+EFTA) for the product category/sub-category in scope of this PEFCR.

PEF studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions (see section on limitations in the PEFCR).

We, the review panel, declare no conflicts of interest with respect to concerned products and any involvement in previous work (PEFCR development, Technical Secretariat membership, consultancy work carried out for the user of the PEF method) during the last three years.

The objective of this verification/ validation is to check whether the update to the 'Product Environmental Footprint Category Rules for Dairy Products' has been carried out in compliance with the most recent version of the PEF method and that the information and data included in the PEFCR for Dairy Products are reliable, credible and correct.

We, the review panel following the review procedure, consider:

- This PEFCR report of the Representative Product for Dairy Products has been developed in accordance with the latest JRC PEFCR guideline
- Secondary datasets are appropriate.
- The identified LCA data and additional environmental information give a description of the significant environmental aspects associated with this product.
- The comments given on the draft PEFCR-study were seriously worked on leading to changes or explanations. Overall, the Technical Secretariat has addressed all concerns raised by the review panel with clear and sufficient responses.
- Some recommendations given in the public and review panel which were not adopted in this update are nonetheless very relevant for the next full update of the PEFCR for Dairy Products which are available in the detailed comments and responses.

Greg Thoma	Judith Brouwer	Jude Capper
AgNext, Colorado State University	Milieu Centraal	Livestock Sustainability Consultancy

ANNEX 4 – Benchmarks definition and parameters

Annex 4 provides the details for the calculation of each benchmark. One benchmark was calculated for each sub-category.

Since no detailed market study on dairy products exists at the EU level, the benchmarks were assumed to be corresponding to the representative products defined in the screening study. It should therefore be seen as a first attempt to provide sectorial and sub-sectorial benchmarks, though the dairy sector sees several limitations to the proposed approach.

Each representative product was determined based on available data for major EU national markets, or corporate market statistics, which were then weighted or extrapolated to represent the EU market average. Expert knowledge from the Technical Secretariat was used when no market data was available. Tables IV-1 to IV-6 summarise the data used for the composition and packaging of each representative product. The column "EU-28" displays the weights of each parameter used to define the virtual representative product.

Virtual representative products were calculated from individual products and then averaged based on market shares.

Table IV-1: Composition of the representative product for liquid milk

Liquid milk	FR	DE	UK	Other EU	EU-28
Market share (1)	11%	17%	22%	50%	100%
Fat content	*market data (2)*	*market data (4)*	*market data (5)*	*expert est. (b)*	*weighted avg*
Skimmed (<0.3%)	6%	2%	10%	6%	**6%**
Semi-skimmed (1.5-1.8%)	85%	52%	70%	61%	**61%**
Whole milk (3.5%)	9%	46%	20%	33%	**33%**
Thermal treatment	*market data (2)*	*market data (4)*	*market data (5)*	*expert est. (c)*	*weighted avg*
Pasteurised or filtered	2%	31%	95%	30%	**41%**
UHT	98%	69%	5%	70%	**59%**
Packaging	*market data (3)*	*expert est. (a)*	*market data (6)*	*expert est. (d)*	*weighted avg*

Liquid milk	FR	DE	UK	Other EU	EU-28
Multilayer liquid packaging carton 1000 ml	53%	100%	11%	70%	**60%**
Plastic bottle 1000 ml	47%	0%	78%	25%	**35%**
Glass bottle, returnable 1000 ml	0%	0%	11%	5%	**5%**

1 EUROSTAT (2013) – production data

2 EAL (2013) Enquête Annuelle Laitière - French annual dairy survey (production data)

3 IRI (2013) IRI survey 2013

4 German market (DMK) 2012, ZMB 2013

5 DairyCo (2014) – consumption data

6 WRAP (2010a) Life cycle assessment of example packing systems of milk

a Expert estimate from DMK GROUP

b Expert estimate: weighted average from FR, DE and UK (together 50% of EU production)

c Expert estimate based on 2007 data from Elliott, Valerie «The UHT route to long-life planet». London: Times Online, weighted by production shares

d Expert estimate based on shares of thermal treatments and data for FR, DE and UK

According to WRAP (2010b), the average trippage rate (i.e. number of re-use) of returnable glass bottles in the UK is 17.5. This value is judged representative of other EU countries using similar packaging.

Table IV-2: Composition of the representative product for dried whey products

Dried whey products	Whey powder	Whey protein powder	Lactose powder	EU-28
Market share [(1)]	70%	10%	20%	100%
Dry matter content				
85-95%	100%	100%	-	**80%**
>98%	-	-	100%	**20%**

1 Market shares are estimated based on existing data for most recent years: 2012 EU consumption of whey powder, 2005-2009 average EU production of whey protein powder (i.e. whey protein concentrates and isolates), 2011 EU production of lactose. Source: EUROSTAT (2013), confidential and ZMB (2013)

Table IV-3: Packaging of the representative product for dried whey products

Dried whey products	
Packaging	*corporate data (1)*
Bulk	70%
Big bag (1000 kg)	14%
Kraft paper bag (25 kg)	16%

1 Corporate data from the Netherlands - confidential

Table IV-4: Composition of the representative product for cheeses

Cheeses	**FR**	**DE**	**IT**	**UK**	**NL**	**Other EU**	**EU-28**
Market share (1)	20%	23%	16%	5%	4%	33%	100%
Maturation	*market data (2)*	*market data (3)*	*expert estimate (a)*	*expert estimate (b)*	*expert estimate (c)*	*expert estimate*	*weighted avg*
Unripened	39%	35%	50%	10%	35%	40%	**39%**
Ripened	61%	65%	50%	90%	65%	60%	**61%**
Packaging	*default assumption*	*default assumption*	*default assumption*	*default assumption*	*default assumption*	*default assumption*	*default assumption*
Plastic foil	100%	100%	100%	100%	100%	100%	**100%**

1 ZMB Jahrbuch MILCH (2013)

2 EAL (2013) Enquête Annuelle Laitière - French annual dairy survey (production data)

3 German market (DMK) 2012, BLE 2014

a Expert estimate based on statement from Massimo Forino, director of Assolatte, and italian production data from Assolatte and CLAL.it

b Expert estimate extrapolated from DairyCo (2011)

c Expert estimate: assumed same as DE

Table IV-5: Composition of the representative product for fermented milk products

Fermented milk products	EU-28
Fat content	*market data (1)*
Skimmed (0-1% fat)	17%
Plain	83%
Spoonable/liquid	*market data (3)*
Spoonable	75%
Liquid	25%
Flavours	*market data (3)*
Plain, unsweetened	32%
Flavoured (with flavourings)	18%
Fruited (with strawberry preparation)	51%
Packaging	*expert estimate (a) based on market data (1)*
Spoonable - plastic cup (125 g)	53%
Spoonable - plastic cup (500 g)	18%
Spoonable - glass jar (125 g)	3%
Spoonable - paper cup (125 g)	1%
Liquid - Plastic bottle (100 ml)	5%
Liquid - Plastic bottle (1000 ml)	10%
Liquid – Liquid packaging carton (1000 ml)	10%

1 IRI (2013) IRI survey 2013 (France)

2 EAL (2013) Enquête Annuelle Laitière - French annual dairy survey (production data)

3 Corporate market data (2014) - confidential

a Expert estimate: extrapolation from French market data

Table IV-6: Composition of the representative product for butterfat products

Butterfat products	FR	DE	NL	Other EU	EU-28
Market share [(1)]	24%	25%	3%	47%	100%
Fat content	*market data (2)*	*expert estimate (a)*	*expert estimate (a)*	*expert estimate (a)*	*Default value*
Dairy spreads (<40%)	4%	4%	4%	4%	**4%**
Half-fat butter (40-65%)	10%	10%	10%	10%	**10%**
Butter (> 65%)	86%	86%	86%	86%	**86%**
Salt content	*market data (2)*	*expert estimate (b)*	*corporate data (3)*	*expert estimate (b)*	*weighted avg*
Unsalted	61%	90%	70%	90%	**82%**
Salted	39%	10%	30%	10%	**18%**
Packaging	*market data (2)*	*expert estimate (a)*	*expert estimate (a)*	*expert estimate (a)*	*Default value*
Aluminium foil laminated paper (250 g)	86%	86%	86%	86%	**86%**
Preformed plastic cup (250 g)	14%	14%	14%	14%	**14%**

1 ZMB Jahrbuch MILCH (2013)

2 IRI (2013) IRI survey 2013 (France)

3 Corporate data - confidential

a Expert estimate: same as FR

b Expert estimate

ANNEX 5 – Default dry matter content of dairy products

Default values for main dairy products

Liquid milk			
	Whole milk	Semi-skimmed milk	Skimmed milk
Average dry matter (g/100g)	12.3	10.5	9.1

Whey products								
	Whey (unspecified)	Thin whey	Thick whey	Whey powder	Lactose powder	Whey protein concentrate (WPC)	Whey protein isolate powder	High fat whey protein concentrate powder
Average dry matter (g/100g)	6.8	4.8	26.5	96.5	99.8	94	95	98

Cheeses				
	Fresh cheese	Soft cheese	Semi-hard cheese	Hard cheese
Average dry matter (g/100g)	23	49	59.9	66

Fermented milk products			
	Spoonable, plain	Spoonable, flavoured	Spoonable, fruited
Average dry matter (g/100g)	12.2	20.6	23.3

Butterfat products			
	Butter, unsalted	Butter, salted	Dairy spreads
Average dry matter (g/100g)	84.4	84.1	42.7

Additional values for specific dairy products

Milk and whey	*Average dry matter (g/100g)*
Raw milk	12.5
Milk, skimmed, UHT pasteurized	9.1
Milk, semi-skimmed, pasteurized	10.7
Milk, semi-skimmed, UHT pasteurized	10.3
Milk, whole, UHT pasteurized	12.3
Whey sweet fluid	6.8
Buttermilk natural	10.0
Buttermilk flavoured	16.8

Cheeses	*Average dry matter (g/100g)*
Cottage cheese 40% fat in dry mass (fidm), made of whole milk	21.4
Petit-Suisse type cheese 20% fidm, plain, made of half-skimmed-milk	18.2
Ricotta cheese	26.5
Uncured cheese product, low-fat	30.3
Uncured cheese spread 40% fidm, salted, 13% fat	34.1
Mozzarella cheese	42.6
Quark, fresh cheese, 20% fidm	20.5
Quark, fresh cheese, 40% fidm	26.1
Fresh cheese, 50% fidm	40.7
Cheese spread, light	25.9
Cheese spread	33.5
Uncured cheese spread 60% fidm, salted, 42% fat	52.0
Mascarpone	54.7
Camembert and similar cheese 50% fidm, 26% fat	49.1
Manchego cheese	59.7
Edam cheese	58.3
Maasdam cheese	59.1

Cheeses	*Average dry matter (g/100g)*
Tomme cheese	58.2
Raclette cheese	58.0
Gouda cheese	58.9
Cheddar cheese	63.3
Processed cheese 25% fidm, 15% fat	41.1
Processed cheese 45% fidm, 22% fat	48.9
Processed cheese snack with breadsticks, for children	57.4
Emmental cheese	63.8
Gruyere cheese	65.5
Comté cheese	68.5
Cheese Stilton	63.8
Parmesan cheese	73.8
Parmigiano cheese	69.1
Provolone cheese	62.0
Pecorino cheese	66.5
Blue cheese	54.7
Asiago	67.5
Bel paese	54.5
Gorgonzola	60.0
Grana	67.5
Munster	57.0
Tilsit	49.0

Dried products	*Average dry matter (g/100g)*
Milk, semi-skimmed, dried	96.4
Milk, skimmed, dried	96.0
Milk, whole, dried	96.8
Whey sweet dried	96.4

Fermented milk products	*Average dry matter (g/100g)*
Yoghurt, low-fat, plain	11.4
Yoghurt, non fat, plain	10.7
Yoghurt, whole milk, plain	12.2
Fermented milk, whole milk, Bifidus, plain	13.5
Yoghurt, whole milk, with cream, plain	16.7
Yoghurt, low-fat, with fruit	19.9
Fermented milk, whole milk, Bifidus, flavoured, sweetened	20.6
Yoghurt, whole milk, with fruit	23.1
Fermented milk, whole milk, Bifidus, with fruit	24.8
Yoghurt, whole milk, with cream, flavoured	25.8
Yoghurt, Greek	21.7
Kefir	12.0
Yogurt Bulgarian - cow's full fat milk	11.8
Yogurt Bulgarian - sheep's full fat milk	16.5
Yogurt Bulgarian - buffalo's full fat milk	16.0
Yogurt Bulgarian - goat's full fat milk	11.0

Butterfat products and cream	*Average dry matter (g/100g)*
Butter spread, low-fat 60-62% fat, salted (0,5-3%)	60.5
Butter spread, low-fat 60-62% fat	63.3
Butter, unsalted	84.4
Butter, salted (0,5-3%)	84.1
Cream, "light", 8% fat, thick or fluid	17.4
Cream, fluid, 15-20% fat, UHT pasteurized	24.1
Cream, fluid, 30% fat, UHT pasteurized	37.6
Cream, 38% fat	42.4
Dairy spread 25% fat	31.2
Dairy spread, 39-41% fat	45.2
Dairy spread, 39-41% fat, salted (0,5-3%)	49.0

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Single cream	23.0
Whipping cream	45.5
Double cream	53.1
Clotted cream	67.8
Extra thick cream	31.0
Crème fraiche	44.2

Data sources

Ciqual	FR	https://pro.anses.fr/TableCIQUAL/
NEVO	NL	http://www.rivm.nl/
SFK	DE	http://www.sfk-online.net/
DTU	DK	http://www.foodcomp.dk/
BEDCA	ES	https://www.bedca.net/
BDA	IT	http://www.bda-ieo.it/
coF IDS	UK	http://tna.europarchive.org/
del Prato	*IT*	Ottavio Savlvadori del Prato, "trattato di Tecnologia Casearia"
IDF Bulgaria	*BL*	Bulgarian National standard for BULGARIAN YOGURT
Uokik	*PL*	Data based on the “Report on consumers and food stuff market” December 2009 https://uokik.gov.pl

ANNEX 6 – EF-compliant secondary datasets

See Excel file: **PEFCR-partial update DairyProducts_Version1- Life cycle inventory** available at http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR.htm

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