Product Environmental Footprint Category Rules (PEFCRs)

Prepared Pet Food for Cats and Dogs

Updated version *(post positive opinion of the EF Steering Committee on December 18th 2024)*

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Prepared by the ***Technical Secretariat****:*

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Executive Summary

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

The European Commission launched a four-year pilot testing period for both the non-food and food sectors through a multi-stakeholder process to develop product-specific rules, Product Environmental Footprint Category Rules (PEFCRs), and organisation-specific rules, Organisation Environmental Footprint Sector Rules (OEFSRs).

In May 2014, the European Commission supported the pilot project to develop PEFCRs for prepared pet food for cats and dogs. A first PEFCR was edited in 2018, for the next 3 years. These rules had to be updated upon the arrival of the EF3.1 Datasets, with a revision of the PEFCR, in continuity of the 1st guidelines of 2018 and taking into account advancements in the environmental calculations available in 2021-2022. The Technical Secretariat (TS) of the updated PEFCR is composed of the following organisations: FEDIAF, Pet Select, IVH, FACCO, Normandise Pet Food, Mars Pet care, Hills Pet Nutrition, Affinity Pet care, Nestlé Purina Pet care Europe, and Blonk.

The main objective of this PEFCR is to develop a consistent set of rules to calculate the relevant environmental impacts of prepared pet food products for cats and dogs.

The product category for this PEFCR is prepared pet food for cats and dogs which includes the full life cycle (cradle to grave) for complete meals for cats and dogs sold in the EU market for the following four sub-categories: wet cat food, dry cat food, wet dog food and dry dog food. Thus, four screening studies were conducted for each of these products that also serve as the virtual representative products, or benchmarks, for this PEFCR. Most relevant impact categories were determined for each sub-category as part of the screening study and subsequent remodelling work. Additionally, four supporting studies for products from each of the four sub-categories were also conducted using the draft PEFCR on products produced by each of the four pet food manufacturing companies in the TS. The findings from the supporting studies were used to improve the PEFCR.

The system boundaries that will be considered include the following life cycle stages: ingredients, packaging production, pet food manufacturing, distribution, use and packaging end-of-life (EOL). The bills of ingredients (BOI) and packaging splits used for each representative product were determined based on primary data from pet food manufacturers and from EU market statistics.

This updated PEFCR provides detailed guidance on the use of primary and secondary data, data quality requirements, allocation rules, as well as which impact categories shall be included when assessing a PEF of prepared pet food for cats and dogs. The updated PEFCR includes the most updated emission factors and remodelling of specific processes.

The PEFCR shall enable comparative assessment of different products from the same sub-category. 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.

Acronyms and abbreviations

µm	micrometre
AWARE	Available WAter REmaining
Blonk	Blonk, a Mérieux NutriScience Company
BOI	bill of ingredients
BSI	British Standards Institution
CFs	characterization factors
CFF	Circular Footprint Formula
CMWG	Cattle Model Working Group
CO_2	carbon dioxide
CPA	Classification of Products by Activity
CTUe	comparative toxic units for ecosystems
CTUh	comparative toxic units for human health
DC	distribution centre
DNM	data needs matrix
DQR	data quality rating
EC/DG-ENV	European Commission/Directorate-General for the Environment
EF	Environmental Footprint
EFTA	European Free Trade Association
EOL	end of life
FACCO	Chambre Syndicale des Fabricants d'Aliments pour Chiens, Chats, Oiseaux et autres Animaux Familiers (the French Pet Food Association for Dogs, Cats, Birds and Other Domestic Pets)
FAO	Food and Agriculture Organisation of the United Nations
FEDIAF	European Pet Food Industry Association
FPCM	fat and protein corrected milk
FU	functional unit
g	gram
GHGs	greenhouse gases
GR	geographical representativeness
GR_{SD}	geographical representativeness evaluated at the level of the secondary dataset
IDF	International Dairy Federation
ILCD	International reference Life Cycle Data system
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardization
JRC	Joint Research Centre
kBq U^{235} eq	kilobecquerel uranium-235 equivalent

kcal	kilocalorie
kg	kilogram
kg CFC-11 eq	kilogram of trichlorofluoromethane or freon-11 equivalent
kg CO_2-eq	kilogram of carbon dioxide equivalent
kg N eq	kilogram of nitrogen equivalent
kg NMVOC eq	kilogram of non-methane volatile organic compounds equivalent
kg P eq	kilogram of phosphorus equivalent
kg Sb eq	kilogram of antimony equivalent
km	kilometre
kWh	kilowatt-hour
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Inventory Assessment
LHVs	lower heating values
LUC	land use change
m^3	cubic metre
$MC_{default}$	moisture content of the default ingredient in percent
$MC_{ingredient}$	moisture content of the ingredient in percent
ME	metabolizable energy
MJ	megajoule
mol H^+	mole of hydrogen ion
mol N eq	mole of nitrogen equivalent
NGO	non-governmental organisation
NRC	National Research Council
ODP	ozone depletion potential
OEF	Organisation Environmental Footprint
OEFSRs	Organisation Environmental Footprint Sector Rules
P	precision/uncertainty
P_{AD}	precision evaluated at the level of the activity data
PE	polyethylene
PEF	Product Environmental Footprint
PEFCRs	Product Environmental Footprint Category Rules
PET	polyethylene terephthalate
PM	particulate matter
Pt	point for dimensionless values
RP	representative product
SMGP	Single Market for Green Products
T	tonne

TAB	Technical Advisory Board
TeR	technological representativeness
TeR_{SD}	technological representativeness evaluated at the level of the secondary dataset
TiR	time representativeness
TiR_{AD}	time representativeness evaluated at the level of the activity data
TiR_{SD}	time representativeness evaluated at the level of the secondary dataset
tkm	tonne kilometre
TS	Technical Secretariat
UUID	Universally Unique Identifier
WMO	World Meteorological Organisation
WRAP	Waste and Resources Action Programme

Glossary

This glossary defines key terms used in this PEFCR. Many of the terms are based on the Commission Recommendation (EU) of 2021 that provides guidelines on the use of Environmental Footprinting methods (European Commission, 2021).

Activity data	This term refers to information that is associated with processes while modelling life cycle inventories (LCIs). In the PEF Guide, activity data are 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 ingredients (BOI) 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.
Aggregated dataset	This term is defined as a LCI 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 may be 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).
Application specific	Application specific refers to the generic aspect of the specific application in which a material is used, e.g., the average recycling rate of polyethylene terephthalate (PET) in bottles.
Background system	This term refers to those processes in the product life cycle for which no direct access to specific information is possible. The background process is outside the direct influence of the producer or service operator of the analysed system/product (Galatola and James, 2015).
Benchmark	A standard 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.
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". Definition based on* (ISO 14044, 2006).
Classification	Assigning the material/energy inputs and outputs tabulated in the life cycle inventory to EF impact categories according to each substance's potential to contribute to each of the EF impact categories considered.
Climate change	All inputs and outputs that result in greenhouse gas emissions. The consequences include increased average global temperatures and sudden regional climatic changes. Climate change is an impact affecting the environment on a global scale.
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 with 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).
Comparison	A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of a PEF study and supporting PEFCRs or the comparison of one or more products against the benchmark, based on the results of a PEF study and supporting PEFCRs. Note that only products within the same sub-category can be compared.

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.
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). The disaggregation can help make 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.
Dry pet food	Pet food with a moisture content of 14% or less (long-standing industry definition).
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.
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).
EF study	Term used to identify the totality of actions needed to calculate the EF results. It includes the modelisation, the data collection, and the analysis of the results.
Electricity tracking	Electricity tracking is the process of assigning electricity generation attributes to electricity consumption. https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii
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.

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.
Foreground system	This term refers to those processes in the product life cycle for which direct access to specific information is available. For example, the producer's site and other processes operated by the producer or its contractors (e.g., goods transport, head-office services, etc.) belong to the foreground processes (Galatola and James, 2015).
Functional unit	The functional unit (FU) defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated.
Global warming potential	Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, CO2-equivalent units) and specified time horizon (e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years respectively). It relates to the capacity to influence changes in the global average surface-air temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.
Human toxicity, cancer	EF impact category that accounts for adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to cancer.
Human toxicity, non-cancer	EF impact category that accounts for the adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to non-cancer effects that are not caused by particulate matter/respiratory inorganics or ionising radiation.
Ionising radiation, human health	EF impact category that accounts for the adverse health effects on human health caused by radioactive releases.
Land use	EF impact category related to use (occupation) and conversion (transformation) of land area by activities such as agriculture, forestry, roads, housing, mining, etc. Land occupation considers the effects of the land use, the amount of area involved and the duration of its occupation (changes in quality multiplied by area and duration). Land transformation considers the extent of changes in land properties and the area affected (changes in quality multiplied by the area).
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	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14040:2006).
Life cycle inventory 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.
Metabolizable Energy (ME)	Metabolizable energy is the digestible energy minus the energy lost in urine and fermentable gases (National Research Council (NRC), 2006).
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.
Output flows	Product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases (ISO 14040:2006).
Ozone depletion	EF impact category that accounts for the degradation of stratospheric ozone due to emissions of ozone-depleting substances, for example long-lived chlorine and bromine containing gases (e.g. CFCs, HCFCs, Halons).
Partially disaggregated dataset	A dataset with a LCI that contains elementary flows and activity data, and that only in combination with its complementing underlying datasets yield a complete aggregated LCI data set. We refer to a partially disaggregated dataset at level 1 in case the LCI contains elementary flows and activity data, while all complementing underlying datasets 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).
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 metre 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. In these PEFCRs, primary data are synonymous with company-specific data or supply-chain-specific data.

Primary packaging	Material that immediately covers the product. For example, primary packaging can consist of a can, a lid and a label. Note that some consider the label to be secondary packaging.
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.
Secondary data	Secondary data refer 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.
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.
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.
System boundary	Definition of aspects included or excluded from the study. For example, for a "cradle-to-grave" environmental footprint analysis, the system boundary should include all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages.
System boundary diagram	Graphic representation of the system boundary defined for the PEF study.

Tertiary packaging	Packaging conceived so as to facilitate handling and transport of a number of sales units or grouped packaging in order to prevent physical handling and transport damage.
Unit process dataset	Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 14040:2006). 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 before the point of referral.
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 [1].
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 (Sala et al., 2018). Weighted EF results may be directly compared across impact categories, and also summed across impact categories to obtain a single overall score.

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

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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.

The results of any PEF study based on the current Product Environmental Footprint Category Rules (PEFCRs) may be used for supply chain management, product design, optimization, and, under specific conditions, for comparative assertions among pet food products from the same sub-category. The PEF could be compared to the benchmark results for the representative products provided in this updated PEFCR to understand the main differences.

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.

For all requirements not specified in this PEFCR, the applicant shall refer to the documents with which this PEFCR is in conformance (see Section 2.7 for details).

The current PEFCR aims to provide detailed instructions on how to evaluate the environmental impacts of prepared pet food for cats and dogs sold in Europe, applying a harmonised approach, in order to obtain comparable results.

This updated PEFCR uses specific terminology to indicate the requirements, the recommendations and the options that could be selected when a PEF study is conducted:

- The term "**shall**" is used to indicate what is required in order for a PEF study to be in conformance with this PEFCR;
- The term "**should**" is used to indicate a recommendation rather than a requirement. Any deviation from a "should" requirement has to be justified when developing the PEF study and made transparent; and
- 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.

The key updates and expansions in this PEFCR include:

- The glossary has been expanded to provide clearer definitions and explanations of terms used throughout the document.
- A review statement has been added to enhance the transparency and reliability of the PEF study process.

- The emissions of the most important processes have been updated to reflect the latest data and methodologies.
- For impact assessment, the climate change indicator has been split into three distinct categories: biogenic, land use transformation, and fossil.
- For land use, the indicators have been updated. For example, the soil quality index based on the LANCA method has been revised to improve accuracy.
- Ecotoxicity has been added to the list of the most relevant impact categories, ensuring a more comprehensive assessment of environmental impacts.
- The most relevant life cycle stages, both weighted and normalized, have been added to provide a clearer understanding of the overall environmental impact.
- The mass fraction and allocation percentage for meats have been updated based on the European Commission recommendations of 2021, ensuring alignment with current standards and practices.
- The characterized results have been updated, as reflected in Tables 34-37, to provide the most accurate and up-to-date data for PEF studies.

2. General information about the PEFCR

2.1. Technical Secretariat

The technical secretariat (TS) responsible for the development of the update of the PEFCRs for prepared pet food for cats and dogs is composed of the organisations and representatives listed in Table 1 below.

Table 1 Technical Secretariat members

Organisation	Type of Organisation (specific role)	Year joined	Main contact
FEDIAF	Industry association (Leader)	2023	Alice Tempel Costa
IVH	Industry association	2023	Christian Schünemann
FACCO	Industry association	2023	Stéphanie Roux
Mars PetCare	Industry (Product Category Coordinator)	2023	Sara Kroopf; Helena Skinn; Leone Marco Maria Distefano
Nestlé Purina PetCare	Industry	2023	Aurélien Duval
Normandise Pet Food	Industry	2023	Fanny Bouteloup
Pet Select	Industry	2023	Amaya Lopez Sastre
Hill's PetCare	Industry	2023	Irina Derksen
Affinity PetCare	Industry	2023	Mireia Garcia
Blonk	Consultancy	2023	Davide Lucherini

2.2. Consultations and stakeholders

The development of this updated PEFCR can be followed on the dedicated page for the PEFCR for prepared pet food for cats and dogs through this main page:

- https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/

In order to obtain access to the pet food pilot stakeholder workspace, one must first register for an ECAS account and then register as a stakeholder before access will be granted.

The process of developing PEFCRs is open and transparent for all stakeholders which may include, but are not limited to, material suppliers, manufacturers, trade associations, purchasers, users, consumers, government representatives, non-governmental organisations (NGOs), public agencies and, when relevant, independent parties and certification bodies (European Commission, 2021).

Stakeholders were invited to participate in the PEFCR development via a virtual consultation process through the EF virtual consultation forum. Stakeholder comments were accepted for a 30-day period after each consultation was launched and all comments were addressed publicly via this Forum.

Stakeholders were encouraged to participate in a public physical meeting at the beginning of the PEFCR process (mainly to discuss the PEFCR scope). The final consultation, which was a virtual consultation only, was held at the end of the process (mainly to discuss the final PEFCR).

Figures regarding the number of participants (where a participant is considered to be a person that provided comments for the virtual consultations and a person that was physically present for the physical consultation) for each consultation and the number of registered stakeholders for this pilot are provided in Table 2 below.

Table 2 Consultations and stakeholders

	virtual consultation
Start date	23 April 2024
End date	17 May 2024
Number of participants	2
Number of comments received	39
Number of stakeholders	2
Organisations that commented/ participated	• MB University • EF Helpdesk (Studio Fieschi & soci)

In addition to the public consultations, the screening study was reviewed by the European Commission and Studio Fieschi (Ugo Pretato), sustainability consultants mandated by the European Commission for this task, and the PEFCR was reviewed by an external critical review panel in January 2017 and February/March 2018. All four supporting studies were performed by Blonk, and Mars's and Nestlé Purina's PetCare supporting studies were verified by Ernst & Young. Ernst & Young is a consulting company that was selected by the European Commission to design and test verification methodologies in order to assess the reliability and consistency of data published by companies in the framework of the PEF pilot testing phase.

2.3. Review panel and review requirements of the PEFCR

The PEFCR was reviewed by a third-party panel in two review rounds: the first took place in March and the second took place in July 2024 for the following the public consultation. The review panel consists of three reviewers as listed in Table 3 below.

Table 3 Review panel

Review panel member update 2023	Affiliation	Role
Tom Gloria	Industrial Ecology Consultancy	LCA expert and Chair
Emily Moberg	World Wildlife Fund WWF	NGO expert
Aurelie De Ratuld	Symrise Pet Food	Industry expert

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

- The updated PEFCR has been developed in accordance with the requirements provided in the European Recommendations of 2021 (European Commission, 2021);
- The functional unit (FU), allocation and calculation rules are adequate for the product category under consideration;
- Company-specific and secondary datasets used to develop this PEFCR are relevant, representative, and reliable;
- The selected Life Cycle Inventory Assessment (LCIA) indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in the EF 2021 Recommendations;
- The benchmarks are correctly defined; and
- Both LCA-based data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product.

The detailed review report is provided in Annex III – Critical PEFCR Review Report.

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 products correctly describe the average products sold in Europe for the product group in the scope of this PEFCR.

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(s) correctly describe the average product(s) sold in Europe (EU+AFTA) for the product category in the 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 3.6 for limitations).

The reviewers have verified that the following requirements are fulfilled:

(a) The PEFCR has been developed in accordance with the requirements provided in Annex I and Annex II of the PEF Method;

(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-Representative Products (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 requirements stated in Annex I,

(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 the PEF Method;

(j) The Data Needs Matrix is correctly implemented;

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

2.5. Geographic validity

This PEFCR is valid for products in scope that are sold/consumed in the EU member states and European Free Trade Association (EFTA) countries.

This updated PEFCR, which is prepared using European data where available, is designed for products sold on the European market however it could be applied globally. The main limitation to applying these PEFCRs to products exported out of the EU member states/EFTA countries or to products manufactured and sold elsewhere is that Environmental Footprint (EF)-approved datasets may not exist for the manufacturing stage, nor the use and end-of-life (EOL) stages, respectively. For example, a product sold to a consumer in Canada would not undergo the same EOL fate as a product sold in the EU market and thus a suitable EF-compliant dataset might not be available because compliant datasets generally focus on the EU market. For extension of PEF calculation out of EU, then it is still relevant to

stick on rules and relevant impacts, definitions and functional units that will not be different. Only datasets, representative products, assumptions & hypothesis for calculations will be different. So, to summarize, while the rules can be applied in other geographic contexts, the datasets, scenarios and benchmarks would not be applicable.

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

2.6. Language

The PEFCR is written in English. It is not foreseen to make this document available in other languages. However, should others translate the document and should there be any discrepancy between different translations of these PEFCRs, the original version 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 (in prevailing order):

- PEF Annex; Recommendation on the use of Environmental Footprint methods, 16 December 2021.
- Pet Food PEFCR (2018)

The TS identified two sectorial guidance documents for prepared pet food for cats and dogs and there are no core conflicts between the PEF guide and these reference documents.

A brief overview of these two documents is presented below.

1. **Testing of the EU ENVIFOOD Protocol: Final Report (BIO Intelligence Service, 2013)**

   In 2013, BIO Intelligence Service was commissioned by the FEDIAF to test the ENVIFOOD Protocol (European Food SCP Round Table, 2013). This report has not been made publicly available to date, but it has been consulted because it is highly relevant for the development of the PEFCRs for prepared pet food for cats and dogs. Key elements discussed in this report pertaining to this PEFCR are summarized below:

   - **Representative products**: Only two representative products were included in this study: one wet and one dry. No distinction between cat food and dog food was made in terms of the life cycle inventory. A 400-gram (g) tin can of wet pet food and a 4-kilogram (kg) plastic bag of dry pet food were considered.

- **Functional unit**: Supports the FU proposed in this PEFCR (a sensitivity analysis between "1 daily ration" and "100 g" was performed)
- **System boundaries**: Consumer transport and infrastructure were excluded
- **Allocation**: Recommends the use of economic allocation (a sensitivity analysis between mass and economic allocation was performed)

3. PEFCR scope

The product category for this update of the PEFCR is prepared pet food for cats and dogs which is defined as follows:

- **Complete prepared pet food, either wet or dry in its respective packaging, intended for oral feeding of cats and dogs without any additional preparation steps**

The full life cycle (cradle to grave) for complete pet food, wet or dry, sold in the EU market for cats and dogs are within the scope of this PEFCR. Additionally, this PEFCR could also be used to assess partial life cycle impacts of products included in this category.

Per EU Regulation No 767/2009, complete pet food is considered to be pet food that, by reason of its composition, is sufficient for a daily ration.

The main function of the product is to provide complete meals to satisfy the daily nutritional requirements of a cat or dog, but alternative technologies (production of wet and dry pet foods) delivering the same function are available. Thus, four different sub-categories are included in this PEFCR: wet cat food, dry cat food, wet dog food and dry dog food and thus representative products for each sub-category were established as shown in Figure 1 below.

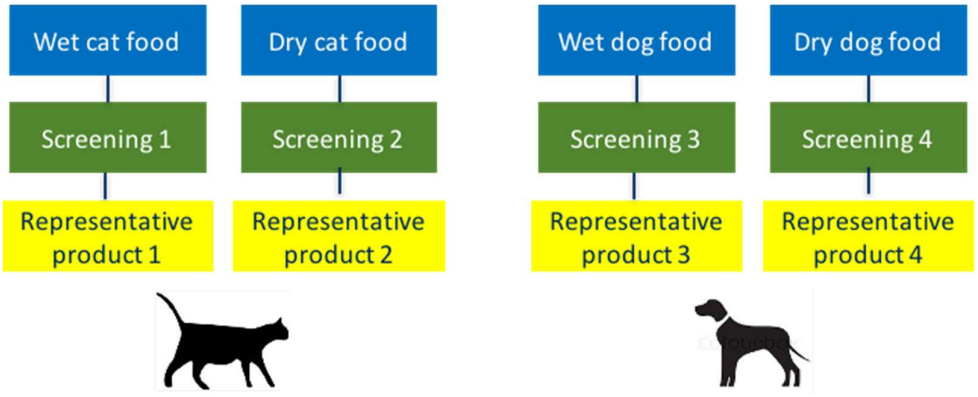


Figure 1 Sub-categories for prepared pet food for cats and dogs

Representative products have been modelled in accordance with the updated European Guidelines(European Commission, 2021) as benchmarks. Benchmarks are by definition in the context of the EF pilot phase, “the average environmental performance of the representative product sold in the EU market” (European Commission, 2021). Values for adult cats and dogs are calculated from NRC (2006) recommendations by assuming a moderate-sized lean adult dog of 15 kg bodyweight and a moderate-sized lean adult cat of 4 kg bodyweight.

The PEFCRs shall enable comparative assessment of different products from the same sub-category. The PEFCRs shall not serve comparisons of products from different sub-categories.

Wet and dry pet food, being for dogs or cats, are separate markets which respond to different pet needs and hold very different characteristics. For instance, wet pet food promotes urinary output and is more suitable for pets with defective teeth while dry pet food has dental benefits and reduces occurrence tartar. Moreover, wet pet food moisture content is above 80% while dry pet food moisture content is below 14% which serves individual sensory preferences (e.g., smell, taste haptic) of animals. Wet pet food has a high palatability while dry pet food is perceived as less palatable. In other words, wet and dry pet food are very different products which should be seen as complementary rather than in competition with each other. It was therefore decided by the TS that these products should not be compared to prevent inaccurate interpretations and conclusions on the overall benefits of wet and dry pet food products.

Based on sales data for the mass of pet food sold in France, Germany and the UK, the split for cat food is 60% dry and 40% wet and the split for dog food is 82% dry and 18% wet (Nielsen, 2014). These three markets were selected because together they account for more than 55% of the EU market and collectively, all package sizes and formats of complete pet food for cats and dogs sold in the EU market are accounted for.

3.1. Product classification

The Classification of Products by Activity (CPA) code for the products included in this PEFCR (prepared pet food for cats and dogs) is shown in Figure 2 below.



Figure 2 CPA Section C and its divisions

This PEFCR covers prepared pet food for cats and dogs, as defined by the CPA code C10.92.1 Prepared pet foods.

3.2. Representative products

For this PEFCR, four virtual representative products are proposed based on two different technologies: one for wet pet food and one for dry pet food for both a cat and a dog as shown in Table 4 below.

Table 4 Representative products considered

Pet	Food type	Representative product
Cat	Wet	Average wet cat food sold in Europe
	Dry	Average dry cat food sold in Europe
Dog	Wet	Average wet dog food sold in Europe
	Dry	Average dry dog food sold in Europe

The reason for this split is that dogs and cats cannot be compared, and comparisons will only be made between products of the same sub-category. Note that while there is no significant difference in the inventory considered for a dry cat food and a dry dog food in this PEFCR, they are separated nonetheless due to the differences in the reference flow for each representative product to satisfy the functional unit (i.e., an average cat requires much fewer calories than an average dog in one day).

An average recipe (or bill of Ingredients (BOI)) for each type of pet food was determined based on primary data received from pet food manufacturers that are members of the TS to ensure that all common ingredients are included despite the quantity actually used in each product. Thus, all four representative products are virtual products.

All packaging options for each representative product were considered and the packaging split for each representative product will be based on sales data for the mass of pet food sold in France, Germany

and the UK (Nielsen, 2014) which were converted to total kilocalories (kcal) sold using the average nutritional densities of dry and wet products approved by FEDIAF (FEDIAF, 2016).

The package size for each representative product is based on the most popular package size in terms of mass sold for each sub-category of pet food based on the Nielsen market data (Nielsen, 2014).

The following packaging types will be considered for each of the four representative products:

- Wet cat food: plastic pouch, metal can and aluminium tray
- Dry cat food: plastic bag, paper bag and carton box
- Wet dog food: plastic pouch, metal can, aluminium tray and sausage (sausage-shaped tube)
- Dry dog food: plastic bag, paper bag and carton box

Details for the packaging considered for each representative product are shown in Table 5 below.

Table 5 Packaging based on market share considered for each of the four representative products

Specification	Cat		Dog	
	Wet	Dry	Wet	Dry
Product weight (g)	400	2'000	400	8'000
Plastic bag/pouch	43%	73%	1%	89%
Paper bag	--	4%	--	5%
Carton box	--	23%	--	6%
Metal can	46%	--	77%	--
Aluminium tray	11%	--	20%	--
Sausage	--	--	2%	--

Thus, as an example, the representative product packaging for the wet cat food sub-category will be a mix of a plastic pouch, metal can and aluminium tray and it will contain 400 g of wet cat food as shown in Figure 3 below. The product weight for each representative product was determined based on the most commonly sold package size based on mass for each category per the Nielsen market data.

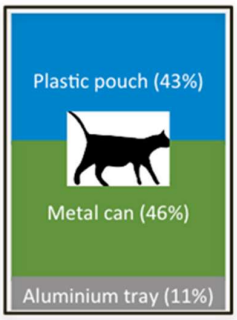


Figure 3 Representative product packaging for wet cat food

Note that since the multi-functionality of packaging is not fully captured by the current PEF methodology, the PEFCR shall not support specific comparisons or comparative assertions between packaging formats.

The screening study is available upon request to FEDIAF which has the responsibility of distributing it with an adequate disclaimer about its limitations.

3.3. Functional unit and reference flow

Key aspects regarding "what?", "how much?", "how well?", and "for how long?" that were used to define the function provided by prepared pet food are summarized in Table 6 below. This information was then used to determine the functional unit.

Table 6 Key aspects of the functional unit

Product	Aspect detail	Pet food PEFCR
What?	Function provided	To serve the recommended daily intake in kilocalories of metabolizable energy (kcal ME) ("daily ration") of prepared pet food to a cat or dog
How much?	Magnitude of the function	Daily ration
How well?	Expected level of quality	To meet the daily caloric and nutritional requirements of an average cat or dog (where average refers to the pet weight: 4 kg for a cat and 15 kg for a dog)
How long?	Duration of the product provided	1 day of serving prepared pet food to a cat or dog

The reason for choosing daily rations over a fixed mass when answering "how much?" is that it better integrates the function of pet food; a daily ration considers the average nutritional density of the product and the daily recommended energy intake for an average cat or dog, thus allowing for fair comparisons between products of the same sub-category.

While there are many possible answers to the question "how well?", this PEFCR only considers meeting the daily nutritional requirements of an average cat or dog and does not consider palatability or other such considerations. The reason why a consumer may choose a wet product over a dry product or vice-versa is not necessarily related to feeding their pet its daily nutritional requirements. Wet food may be preferred by certain pets or necessary for certain pets that are not able to chew dry food easily. A daily ration does not take into account the complete function of a product, which can bring certain benefits to pets (such as superior nutrition). For these PEFCRs, only one main function can be selected. Thus, for the complete life cycle of prepared pet food for cats and dogs, the following functional unit will be considered for this PEFCR:

- **Serving the recommended daily intake in kilocalories of metabolizable energy (kcal ME) ("daily ration") of prepared pet food to a cat or dog**

The reference flow is the amount of product needed to fulfil the defined function and shall be measured in grams (g) per day. All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.

The reference flow shall be calculated using the metabolizable energy content (kcal ME) of the pet food in accordance with the FEDIAF's Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs (FEDIAF, 2016).

The reference flows for each product category for the benchmarks were calculated using daily energy requirements of cats and dogs (secondary data) and considering average product energy densities (secondary data) for both wet and dry varieties of pet food.

In Table 7 below, daily energy requirements for the representative products were calculated in accordance with FEDIAF's Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs (FEDIAF, 2016) (FEDIAF, 2021) and based on average pet weights (secondary data).

Table 7 Reference flows for the representative products

	Cat	Dog
Formula	100 [kcal] x cat weight$^{0.67}$ [kg]	110 [kcal] x dog weight$^{0.75}$ [kg]
Average pet weight *	4 kg	15 kg
Daily energy requirements (calculation)	253 kcal ME	838 kcal ME
Dry product reference flows (3'600 kcal ME/kg)**	70 g/day	233 g/day
Wet product reference flows (800 kcal ME/kg)**	316 g/day	1048 g/day

* Secondary data

** Primary data or by default secondary data as stated

For example, for a dry cat food product with an energy density of 3’445 kcal ME /kg, the reference flow will be 253 kcal ME/ 3’445 kcal ME/1’000 g = 73 g/day.

Note that for the screening study, the dry pet food products contained 3’800 kcal ME/kg (67 g/day for cat food and 221 g/day for dog food) and the wet pet food products contained 950 kcal ME/kg (266 g/day and 883 g/day for cats and dogs, respectively).

3.4. System boundaries

The entire life cycle (from cradle to grave) of prepared pet food for cats and dogs is considered and the following life cycle stages are included: ingredients, packaging production, pet food manufacturing, distribution, use and packaging end-of-life. The system boundaries as shown in Figure 4 below and the main processes for each life cycle stage that are considered in the data collection for the life cycle inventory (LCI) are indicated.

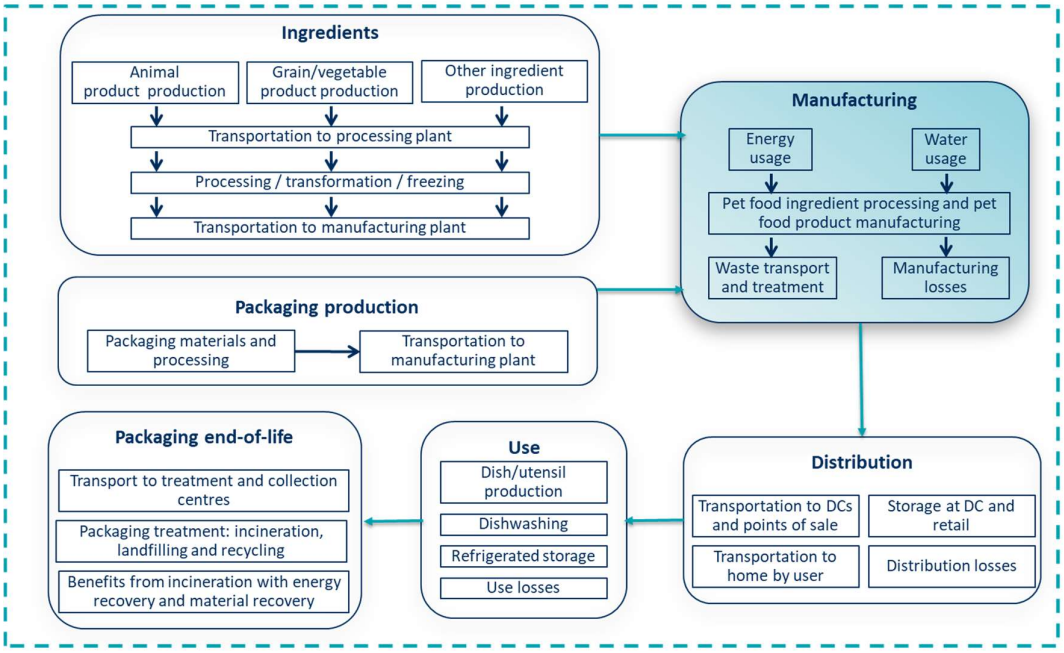


Figure 4 System boundaries and key activities where the foreground is highlighted in blue

The life cycle stages and processes listed in Table 8 below shall be included in the system boundary.

Table 8 Life cycle stages

Life cycle stage	Short description of the processes included
Ingredients	Animal product production
	Grain/vegetable product production
	Other ingredient production including water
	Upstream freezing energy or other processing not included in datasets
	Ambient ingredient transport
	Frozen ingredient transport
Packaging production	Primary packaging production (e.g., aluminium tray, steel can, lids, plastic bag, plastic pouch, plastic tube, paper bag, paper labels, carton box)
	Secondary/tertiary packaging production (e.g., corrugated box, plastic film, pallets)
	Packaging transport
Manufacturing	Water usage
	Energy usage: electricity, natural gas and fuel oil
	Waste treatment and transport (incineration, landfilling, recycling, hazardous waste treatment, solvent waste treatment and wastewater treatment)
	Manufacturing losses
Distribution	Transport from plant to distribution centre (DC)
	Transport from DC to point of sale
	Storage at retailer and DC
	Distribution chain losses
	Transport from retail to consumer home
Use stage	Pet food dish production
	Hand washing and dishwasher use
	Refrigeration of unused portions of pet food
	Use losses
End-of-life	Transport
	Recycling
	Landfilling
	Incineration
	Treatment of food losses

Note that infrastructure is included in many background processes by default but infrastructure is not included in the foreground.

From the perspective of pet food manufacturers, the ingredients and packaging production stages are considered to be upstream processes whereas the distribution, use and packaging end-of-life stages are considered to be downstream processes. Note that when other stakeholders (e.g., retailers) are using the current PEFCR, the upstream and downstream processes may differ.

Within each of these stages, the LCA considers all identifiable upstream inputs to provide a comprehensive view of the product system. For example, transportation does not only include the operation (fuel consumption and tail pipe emissions), but also upstream processes such as fuel production, truck production as well as maintenance and road construction. Also, the ingredient stage includes all relevant upstream processes for animal breeding and crop production. In this way, the production chains of all inputs are traced back to the original extraction of raw materials.

In the PEF context, the foreground and background systems shall be defined in relation to the so-called "materiality principle" which considers (European Commission, 2021):

- the relevance of the processes/stages driving the environmental impact, and
- the level of influence that the company performing the PEF study has on them.

The outcome of this principle for pet food manufacturers is summarized in Table 9 below based on the results after the remodelling exercise:

Table 9 Application of the "materiality principle" for pet food manufacturers

Life cycle stage	Company's level of influence	Relevance to impact
Ingredients	Medium	High
Packaging production	Low/medium	Low for dry pet foods and high for wet pet foods
Manufacturing	High	Low
Distribution	Low	Medium/high
Use	Low	Low
Packaging end-of-life	Low	Medium

Different stakeholders using the current PEFCR may have different levels of influence on each life cycle stage, and should therefore adapt their foreground and background systems accordingly.

All processes to be included in the PEF if applicable are listed in Annex IV – LCI data to ensure consistency.

According to this PEFCR, the following processes may be excluded based on the cut-off rule[2]:

- Infrastructure at the manufacturer, distribution centre and retailer
- Ambient storage at the consumer home

[2] Processes and elementary flows may be excluded up to 3.0% (cumulatively) based on material and energy flows and the level of environmental significance (single overall score) (European Commission, 2021)

Each PEF study performed in accordance with this PEFCR shall provide a diagram in the PEF study indicating the organisational boundary, to highlight the activities under the control of the organisation and those falling into situation 1, 2 or 3 of the data needs matrix (DNM) described in Section 5.5.

3.5. EF impact assessment

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

The following sub-indicators shall be reported separately because their contribution to the total climate change impact, based on the benchmark results, is more than 5% each:

- Climate change-fossil
- Climate change – biogenic
- Climate change – land use and land use change (LULUC)

Table 10 EF3.1 midpoint impact categories with their indicator, unit, and underlying life cycle impact assessment (LCIA) method

Impact category	Model	Unit	Recommended default LCIA method
Climate change – fossil	Radiative forcing as Global Warming Potential (100 years)	kg CO_2 eq	Bern model - Global warming potential(GWP) over a 100-year time horizon based on IPCC 2021 (Forster et al., 2021)
Climate change – biogenic			
Climate change – land use and land transformation			
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 Steady-state ODPs 1999 as in WMO assessment (WMO, 2014)
Human toxicity, cancer*	Comparative toxic unit for humans (CTUh)	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 (CTUh)	CTUh	*Based on USEtox model 2.1* (Fantke et al., 2017) *as in* (Saouter et al., 2018)
Particulate matter (PM)	Impact on human health	disease incidence	United Nations Environment Programme 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)

Impact category	Model	Unit	Recommended default LCIA method
			(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
Acidification	Accumulated exceedance	mol H^+ eq	*Accumulated Exceedance* Seppälä et al., 2006; Posch et al., 2008
Eutrophication, terrestrial	Accumulated exceedance	mol N eq	*Accumulated Exceedance* Seppälä et al., 2006; Posch et al., 2008
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (phosphorus)	kg P eq	EUTREND model (Struijs et al., 2009) as implemented in ReCiPe
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (nitrogen)	kg N eq	EUTREND model (Struijs et al., 2009) as implemented in ReCiPe
Freshwater ecotoxicity*	Comparative toxic unit for ecosystems (CTUe)	CTUe	*Based on USEtox model 2.1* (Fantke et al., 2017) *as in* (Saouter et al., 2018)
Land use	Soil quality index[3]	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)
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, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)[4]	MJ	(Guinée et al., 2002; van Oers et al., 2002) *as in CML 2002 method, v.4.8*
Resource use, minerals and metals[5]	Abiotic resource depletion (ADP ultimate reserves)	kg Sb eq	(Guinée et al., 2002; van Oers et al., 2002) *as in CML 2002 method, v.4.8*

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

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

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

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

Brief descriptions for each impact category are provided in Table 11 below and the full list of characterization factors is available here:

- http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

Table 11 Impact category descriptions

Impact category	Description per the PEF guide (European Commission, 2021) unless otherwise stated	Unit
Climate change	A change in the state of the climate that can be identified and that persists for an extended period (IPCC).	kg CO_2 eq
Ozone depletion	Accounts for the degradation of stratospheric ozone due to emissions of ozone-depleting substances such as long-lived chlorine and bromine containing gases (e.g., CFCs, HCFCs, halons).	kg CFC-11 eq
Human toxicity, cancer effects	Accounts for the adverse health effects on human beings caused by the intake of toxic substances through air inhalation, food/water ingestion, penetration through skin insofar as they are related to cancer.	CTUh
Human toxicity, non-cancer effects	Accounts for the adverse health effects on human beings caused by the intake of toxic substances through inhalation of air, food/water ingestion, penetration through the skin insofar as they are related to non-cancer effects that are not caused by particulate matter/respiratory inorganics or ionising radiation.	CTUh
Particulate matter	Accounts for the adverse health effects on human health caused by emissions of particulate matter and its precursors (NOx, SOx, NH_3).	disease incidence
Ionising radiation, human health	Accounts for the adverse health effects on human health caused by radioactive releases.	kBq U^{235} eq
Photochemical ozone formation, human health	Accounts for the formation of ozone at the ground level of the troposphere caused by photochemical oxidation of volatile organic compounds and carbon monoxide 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.	kg NMVOC eq
Acidification	Addresses impacts due to acidifying substances in the environment. Emissions of NOx, NH_3 and SOx lead to releases of hydrogen ions (H+) when the gases are mineralised. The protons contribute to the acidification of soils and water when they are released in areas where the buffering capacity is low, resulting in forest decline and lake acidification.	mol H+ eq
Eutrophication, terrestrial	Accounts for impacts related to excess nutrients (mainly nitrogen) released to soil which leads to flora disturbance on soil when oxygen is consumed to degrade dead biomass. N emissions are mostly due to the application of fertilizers to land and to fuel combustion producing NOx (transport and industry).	mol N eq

Impact category	Description per the PEF guide (European Commission, 2021) unless otherwise stated	Unit
Eutrophication, freshwater	Accounts for impacts related to excess nutrients (mainly phosphorus) released to freshwater mainly from detergents in wastewater and agricultural fertilizers leading to algae growth and loss of biodiversity.	kg P eq
Eutrophication, marine	Accounts for impacts related to excess nutrients (mainly nitrogen) released to oceans/seas mainly from detergents in wastewater and agricultural fertilizers leading to algae growth and loss of biodiversity.	kg N eq
Freshwater ecotoxicity	Addresses the toxic impacts on an ecosystem, which damage individual species and change the structure and function of the ecosystem. Ecotoxicity is a result of a variety of different toxicological mechanisms caused by the release of substances with a direct effect on the health of the ecosystem.	CTUe
Land use	Related to use (occupation) and conversion (transformation) of land area by activities such as agriculture, roads, housing, mining, etc. Land occupation considers the effects of the land use, the amount of area involved and the duration of its occupation (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).	pt
Water use	Addresses use and availability of water throughout the entire life cycle of the product following Available WAter REmaining (AWARE) methodology at the county level.	m^3 world eq
Resource use, fossils	Addresses the use of fossil resources throughout the entire life cycle of the product.	MJ
Resource use, minerals and metals	Addresses the use of non-renewable mineral and metal resources throughout the entire life cycle of the product.	kg Sb eq

3.6. Limitations

Comparisons and comparative assertions

This section includes the conditions under which a comparison or comparative assertion may be made.

As a reminder, the aim of PEFCR is to enable comparisons and comparative assertions, provided that the following conditions are met:

- The same product category definition and description are used (i.e.: only products within the same sub-category can be compared);
- The same functional unit is applied;
- Equivalent technical performance and use are ensured
- Methodology, Scope & assumptions for the calculation are similar (ex: use of primary data vs secondary data) and in line with the rules mentioned in the guideline.

4. Most relevant impact categories, life cycle stages and processes

The most relevant life cycle impact categories for all sub-categories in this PEFCR were determined in accordance with the European Recommendations from 2021 based on the normalised and weighted results after the remodelling exercise. At least three relevant impact categories shall be identified as most relevant ones. The use of the PEF method may add more impact categories to the list of the most relevant ones, but none shall be deleted. The impact categories that together contribute to at least 80% of the single overall score should be reported. The most relevant impact categories are as follows for all four sub-categories:

- Climate change (total climate change as the sum of the three sub-indicators)
- Particulate matter
- Acidification
- Eutrophication, terrestrial
- Water use
- Resource use, fossils
- Ecotoxicity, freshwater

The most relevant life cycle stages per representative product and impact category are provided in Table 12 below. For more information, see supplementary material on petfood most relevant processes.

Table 12 Most relevant life cycle stages per representative product

Most relevant life cycle stages (weighted)							
	Ingredients	Packaging	Manufacturing	Distribution	Use	End-of-Life	total
Dry cat food	78%	3%	5%	11%	3%	-1%	**100%**
Dry dog food	80%	2%	5%	12%	1%	0%	**100%**
Wet cat food	42%	36%	6%	20%	6%	-10%	**100%**
Wet dog fod	43%	40%	6%	18%	2%	-10%	**100%**

Table 13 Most relevant impact categories (weighted) per representative product

Most relevant impact categories (weighted)				
Impact category	**dry cat**	**dry dog**	**wet cat**	**wet dog**
Acidification	6%	7%	7%	7%
Climate change	19%	17%	27%	25%
Ecotoxicity, freshwater	25%	24%	9%	9%
Eutrophication, freshwater	1%	1%	1%	1%
Eutrophication, marine	5%	5%	4%	4%
Eutrophication, terrestrial	5%	5%	5%	5%
Human toxicity, cancer	0%	0%	1%	1%
Human toxicity, non-cancer	2%	2%	2%	2%
Ionising radiation	0%	1%	1%	1%
Land use	3%	3%	2%	2%
Ozone depletion	0%	0%	0%	0%
Particulate matter	9%	8%	11%	12%
Photochemical ozone formation	3%	2%	4%	4%
Resource use, fossils	9%	8%	16%	14%
Resource use, minerals and metals	0%	0%	5%	7%
Water use	13%	16%	7%	6%
TOTAL	**100%**	**100%**	**100%**	**100%**

Overall, the following **life cycle stages** were identified as the most relevant:

- Ingredients
- Distribution
- Packaging production for wet pet food only
- Packaging EOL for wet pet food only
- Manufacturing

In summary, the **most relevant processes,** i.e., those that contribute to at least 80% of the overall impact for the most relevant impact categories after the remodelling exercise, are listed in Table 14 through Table 17 below.

The final row of each table shows the total process contribution to each impact category (to reach the minimum 80% threshold), and the final column of each table shows the total of the weighted contributions of each process to all the most relevant impact categories. All percentages are based on the normalized and weighted results. Note that it is possible for this final column to be greater than 100% because the contribution share (%) is for one category, however, is summed over all categories to calculate the total.

Table 14 List of the most relevant processes for wet cat food

Unit process	Life cycle stage	acidification	climate change	ecotoxicity	particulate matter	resource, fossils	water use	Total
Aluminium tray {EU+EFTA+UK} | primary aluminium production, processing of foil/ tray | production mix, at plant | 2.7 g/cm3 | LCI result	Distribution	3%	3%		2%	3%		11%
Barge {EU+EFTA+UK} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result	Distribution	8%	7%	11%	15%	9%		49%
Diesel mix at refinery {EU+EFTA+UK} | from crude oil | production mix, at refinery | 10 ppm sulphur, 7.23 wt.% bio components | LCI result	Distribution			5%		13%		18%
Beef cattle {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	19%	6%	11%	14%	1%		51%
Broiler {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg live-weight | LCI result	Ingredients	3%	3%	11%	10%		3%	30%
Sheep {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	8%			4%			11%
Swine {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg live weight | LCI result	Ingredients	3%		4%				7%
Wheat flour {GLO} | from dry milling | production mix | LCI result	Ingredients	9%	3%	30%	6%		57%	105%
Maize starch, dried {GLO} | from wet milling (starch drying) | production mix | LCI result	Ingredients			4%				4%
Starch potato {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients			4%				4%
Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result	Manufacturing	6%	10%		4%	14%	4%	38%
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	Manufacturing		8%			9%		17%
De-ionised water production {EU+EFTA+UK} | technology mix | production mix, at plant | 100% active substance | LCI result	Manufacturing						3%	3%
Treatment of residential wastewater, small plant {EU+EFTA+UK} | waste water treatment including sludge treatment | production mix, at plant | 1m3 of waste water treated | LCI result	Manufacturing						3%	3%
Aluminium ingot (magnesium main solute) {EU+EFTA+UK} | primary production, aluminium casting and alloying | single route, at plant | 2.7 g/cm3 | LCI result	Packaging	1%	2%	3%	1%	2%		9%
Can food, body tin plated steel {EU+EFTA+UK} | tin- plated steel production, can forming, cleaning, drying, printing and varnishing, baking | production mix, at plant | body tin plated steel | LCI result	Packaging	10%	14%	2%	14%	10%		49%
Corrugated box, uncoated {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying | production mix, at plant | 280 g/m2, R1=88% | LCI result	Packaging	5%	7%			6%		17%
Cap, ECCS steel {EU+EFTA+UK} | metal production, cap manufacturing | production mix, at plant | ESSC steel | LCI result	Packaging		3%					3%
Packaging film, High barrier {EU+EFTA+UK} | raw material production, lamination process | single route, at plant | thickness: 12 um PET, 12um alu, 75um PE; grammage 115 g/m2 | LCI result	Packaging		4%			7%		11%
Carton box {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying, box manufacturing | production mix, at plant | 280 g/m2, R1=47% | LCI result	Packaging						4%	4%
Kraft paper, uncoated {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying | production mix, at plant | <120 g/m2 | LCI result	Packaging EoL	8%	6%		7%	9%	3%	33%
Steel cold rolled coil {EU+EFTA+UK} | blast furnace route | single route, at plant | carbon steel | LCI result	Packaging EoL	3%	5%		5%			13%
Containerboard production, linerboard, testliner {EU+EFTA+UK} | technology mix | production mix, at plant | 1000 kg | LCI result	Packaging EoL		5%					5%
Tap water {EU+EFTA+UK} | average technology mix | consumption mix, at consumer | Technology mix for supply of drinking water to users | LCI result	Use						5%	5%
Treatment of residential wastewater, large plant {EU+EFTA+UK} | waste water treatment including sludge treatment | production mix, at plant | 1m3 of waste water treated | LCI result	Use						3%	3%
Total process contribution to each impact category (to reach minimal 80%)		**84%**	**86%**	**85%**	**81%**	**83%**	**84%**	

Table 15 List of the most relevant processes for dry cat food

Unit process	Life cycle stage	acidification	climate change	ecotoxicity	particulate matter	resource, fossils	water use	Total
Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result	Distribution		12%			17%		29%
Diesel mix at refinery {EU+EFTA+UK} | from crude oil | production mix, at refinery | 10 ppm sulphur, 7.23 wt.% bio components | LCI result	Distribution					15%		15%
Animal meal, poultry {EU+EFTA+UK} | from dry rendering | production mix | LCI result	Ingredients	16%	10%	5%	11%	5%		48%
Barge {EU+EFTA+UK} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result	Ingredients	7%	10%		18%	14%		48%
Beef cattle {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	14%	7%		14%			35%
Fat from animals, poultry {EU+EFTA+UK} | from dry rendering | production mix | LCI result	Ingredients	8%	5%		5%	3%		20%
Maize {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients	11%	5%	34%	8%		13%	71%
Maize starch, dried {GLO} | from wet milling (starch drying) | production mix | LCI result	Ingredients	6%	4%	14%	6%	3%	6%	39%
Wheat flour {GLO} | from dry milling | production mix | LCI result	Ingredients	7%	4%	7%	7%		21%	45%
Wheat grain, dried {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients	13%	6%	16%	11%	3%	49%	99%
Soybean meal (solvent) {GLO} | from crushing (solvent) | production mix | LCI result	Ingredients		15%	11%	5%			31%
Fish meal {GLO} | from fish meal and oil production | production mix | LCI result	Ingredients					4%		4%
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	Manufacturing		8%			10%		18%
Plastic bag, PE {EU+EFTA+UK} | raw material production, plastic extrusion | production mix, at plant | thickness: 0.03mm, grammage: 0.0283 kg/m2 | LCI result	Packaging					7%		7%
Plastic, shrink wrap {EU+EFTA+UK} | raw material production, plastic extrusion | production mix, at plant | thickness: 120 um, grammage: 0,11016 kg/m2 | LCI result	Packaging					5%		5%
Total process contribution to each impact category (to reach minimal 80%)		**82%**	**85%**	**89%**	**83%**	**86%**	**89%**	

Table 16 List of the most relevant processes for wet dog food

Unit process	Life cycle stage	acidification	climate change	ecotoxicity	particulate matter	resource, fossils	water use	Total
Aluminium tray {EU+EFTA+UK} | primary aluminium production, processing of foil/ tray | production mix, at plant | 2.7 g/cm3 | LCI result	Distribution	4%	5%		2%	5%		16%
Barge {EU+EFTA+UK} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result	Distribution	8%	7%	3%	13%	9%		40%
Diesel mix at refinery {EU+EFTA+UK} | from crude oil | production mix, at refinery | 10 ppm sulphur, 7.23 wt.% bio components | LCI result	Distribution			4%		12%		17%
Beef cattle {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	21%	7%	11%	13%			52%
Sheep {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	8%	9%					17%
Wheat flour {GLO} | from dry milling | production mix | LCI result	Ingredients	9%		26%	5%		58%	99%
Broiler {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg live-weight | LCI result	Ingredients		3%	13%	11%		3%	31%
Maize starch, dried {GLO} | from wet milling (starch drying) | production mix | LCI result	Ingredients			8%				8%
Starch potato {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients			9%				9%
Swine {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg live weight | LCI result	Ingredients			4%				4%
Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result	Manufacturing	4%	8%			10%	3%	25%
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	Manufacturing		7%			8%		15%
De-ionised water production {EU+EFTA+UK} | technology mix | production mix, at plant | 100% active substance | LCI result	Manufacturing						3%	3%
Treatment of residential wastewater, small plant {EU+EFTA+UK} | waste water treatment including sludge treatment | production mix, at plant | 1m3 of waste water treated	Manufacturing						3%	3%
Aluminium ingot (magnesium main solute) {EU+EFTA+UK} | primary production, aluminium casting and alloying | single route, at plant | 2.7 g/cm3 | LCI result	Packaging	2%	2%	6%	1%	3%		14%
Can food, body tin plated steel {EU+EFTA+UK} | tin- plated steel production, can forming, cleaning, drying, printing and varnishing, baking | production mix, at plant | body ti	Packaging	16%	23%		23%	19%	3%	84%
Cap, ECCS steel {EU+EFTA+UK} | metal production, cap manufacturing | production mix, at plant | ESSC steel | LCI result	Packaging	4%	6%		5%	4%		19%
Carton box {EU+EFTA+UK} | Kraft Pulping Process, pulp pressing and drying, box manufacturing | production mix, at plant | 280 g/m2, R1=47% | LCI result	Packaging		3%				6%	9%
Plastic, shrink wrap {EU+EFTA+UK} | raw material production, plastic extrusion | production mix, at plant | thickness: 120 um, grammage: 0,11016 kg/m2 | LCI result	Packaging					4%		4%
Steel cold rolled coil {EU+EFTA+UK} | blast furnace route | single route, at plant | carbon steel | LCI result	Packaging EoL	5%			8%	6%		19%
Tap water {EU+EFTA+UK} | average technology mix | consumption mix, at consumer | Technology mix for supply of drinking water to users | LCI result	Use						3%	3%
Total process contribution to each impact category (to reach minimal 80%)		**80%**	**80%**	**84%**	**82%**	**81%**	**83%**	

Table 17 List of the most relevant processes for dry dog food

Unit process	Life cycle stage	acidification	climate change	ecotoxicity	particulate matter	resource, fossils	water use	Total
Electricity grid mix 1kV-60kV {EU+EFTA+UK} | technology mix | consumption mix, to consumer | 1kV - 60kV | LCI result	Distribution		15%		5%	22%		42%
Diesel mix at refinery {EU+EFTA+UK} | from crude oil | production mix, at refinery | 10 ppm sulphur, 7.23 wt.% bio components | LCI result	Distribution					17%		17%
Animal meal, pig {EU+EFTA+UK} | from dry rendering | production mix | LCI result	Ingredients	5%						5%
Animal meal, poultry {EU+EFTA+UK} | from dry rendering | production mix | LCI result	Ingredients	10%	7%		7%	4%		29%
Barge {EU+EFTA+UK} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result	Ingredients	6%	10%		17%	15%		47%
Beef cattle {EU+EFTA+UK} | technology mix | production mix, at farm | 1 kg of live-weight | LCI result	Ingredients	18%	10%		19%			47%
Fat from animals, poultry {EU+EFTA+UK} | from dry rendering | production mix | LCI result	Ingredients	8%	5%		5%			18%
Maize {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients	8%	4%	29%	7%		9%	57%
Wheat flour {GLO} | from dry milling | production mix | LCI result	Ingredients	9%	5%	10%	9%	4%	23%	60%
Wheat grain, dried {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients	17%	10%	24%	16%	5%	55%	126%
Soybean meal (solvent) {GLO} | from crushing (solvent) | production mix | LCI result	Ingredients		8%	5%				13%
Maize starch, dried {GLO} | from wet milling (starch drying) | production mix | LCI result	Ingredients			10%				10%
Starch potato {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients			8%				8%
Rice {GLO} | at farm, crop cultivation | production mix | LCI result	Ingredients						6%	6%
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	Manufacturing		8%			11%		19%
Plastic bag, PE {EU+EFTA+UK} | raw material production, plastic extrusion | production mix, at plant | thickness: 0.03mm, grammage: 0.0283 kg/m2 | LCI result	Packaging					6%		6%
Total process contribution to each impact category (to reach minimal 80%)		**81%**	**82%**	**86%**	**84%**	**84%**	**92%**	

5. Life cycle inventory

5.1. List of mandatory company-specific data

The complete list of mandatory company-specific activity data and the processes to be modelled with company-specific data are listed in Table 18 below. Details for all company-specific data to be collected with the complete data quality ratings (DQRs) and the Universally Unique Identifier (UUIDs) are provided in Annex IV – LCI data.

Table 18 Mandatory company-specific data

Life cycle stages and processes	Activity data (amounts)
Ingredients	
Animal product production	% by weight for all unprocessed meat co-products, animal meals, animal oils and animal fats used per FU
Grain/vegetable product production	% by weight for all grains/vegetable products used per FU
Packaging	
Primary packaging	Weights or surface areas required per process for all metal, plastic and paper/board packaging materials per FU
Secondary packaging	Weights or surface areas required per process for all paper/board and plastic packaging materials per FU
Manufacturing	
Energy usage	Electricity, natural gas and fuel oil used at the plant
Distribution	
Transport from plant to the DC	Weight of product and total packaging Distance travelled locally, intra-continentally and internationally via truck, train and ship % of products distributed locally, intra-continentally and internationally

An example for wheat grain is provided in table 19 below. Wheat grains are used as an ingredient for many pet food products. The activity data required include the quantities of wheat grain used in the product studied and the country of origin, if known. For the representative product, the global average dataset was used but datasets for more specific geographies exist and shall be used when relevant.

Table 19 Data collection requirements for an example mandatory process

Requirements	Data type	Example
For data collection purposes	Activity data to be collected	Quantity of wheat grain
	Specific requirements (e.g., frequency, measurement standard, etc.)	Company-specific primary data on the percentage by weight required per FU that are no older than 2 years old
For modelling purposes	Unit of measure	g/FU
	Default dataset to be used	Wheat grain, dried {GLO} | at farm, crop cultivation | production mix | LCI result
	Dataset source (i.e., node)	FEFAC\Feed
	UUID	c178212c-0f62-4caf-8852-4cd29b4e7e2a 4b237fd3-7861-478d-86f4-00226abf96db
	TiR (average)	1.8
	TeR	1.5
	GR	1.8
	P	2.4
	DQR	1.9

* where TiR is time-representativeness, TeR is technological representativeness, GR is geographical representativeness, and P is precision/uncertainty

All newly created processes shall be EF-compliant. Note that sampling is not required per these PEFCRs.

5.2. List of processes expected to be run by the company

The processes that are expected to be run by the company (situation 1 as described in Section 5.5) applying the PEFCR are indicated in Table 20 below. Details are provided in Annex IV – LCI data.

Table 20 Processes expected to be run by the company

Life cycle stages and processes	Activity data (amounts)
Manufacturing	
Water usage	Volume of water used at the plant
Manufacturing losses	Loss rate at the manufacturing plant

The data collection efforts shall be focused on the most relevant life cycle stages and processes identified after the remodelling exercise. In order to classify the data as primary or secondary data, the following rules shall be considered:

- **Primary (or specific) data** refer 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 metre 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. In this PEFCR, primary data are synonymous with company-specific data or supply-chain-specific data.

- **Secondary (or generic) data** refer to data not from specific processes within the supply chain of the company applying the PEFCR. This refers to data that are 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.

Ideally, primary data should be used for all stages, but in practice, only secondary data may be available for some processes. Primary data shall be collected for the foreground system while secondary data may be used for the background system. Background/foreground systems shall be defined according to the goal of the study. In general, for all activities that are under the control or the direct influence of the commissioner of the PEF study, primary data should be collected and whenever primary and site-specific data are available, these data shall be used instead of secondary data.

Other stakeholders (i.e., all but pet food manufacturers) using the updated PEFCR may not have the same level of influence on each life cycle stage, and would therefore have different foreground and background systems. However, without the mandatory company-specific data listed in Section 5.1, a stakeholder is not allowed to carry out a PEF study in compliance with this updated PEFCR.

A complete list of processes to be included (primary or secondary) as well as associated data quality and review requirements is provided in Section 6 below per life cycle stage. Details on each flow considered per sub-category are included in Annex IV – LCI data indicating which data are required to be collected.

Geographical information is not required for any inventory flow other than water consumption. However, some flows such as particles or toxic emissions contain regionalized information using archetypes (e.g., urban, rural, etc.) which are recommended, but not required.

Secondary (or generic) data shall be replaced by primary (specific) data when available.

5.3. Data gaps

In this PEFCR, recommendations regarding default data to be used when no primary data are available are provided. According to European Commission (2021), "data gaps exist when there is no specific or generic dataset available that is sufficiently representative of the given process in the product's life cycle". Thus, few data gaps are foreseen:

- Lamb meal is modelled as beef meal
- Game co-products are modelled as broilers, for slaughter
- Fresh fish and seafood co-products are modelled as fish meal with a correction factor for moisture content based on 80% moisture content for fish co-products
- Other vegetable products are modelled as starch potatoes
- Flavouring is modelled as yeast
- Preservatives are modelled as ascorbic acid
- Gelling/thickening agents are modelled as maize starch
- Amino acids, taurine and colouring agents are modelled as naphthalene sulfonic acid
- The datasets used for container glass, testliners and tetrafluorethane are not EF-compliant but are ILCD entry-level datasets provided by the European Commission
- The dataset used for polypropylene recycling is not EF-compliant but it is a dataset provided by the European Commission
- Dishwashing detergent is modelled as soap
- The copper cathode dataset is used for dishwasher and fridge components and silver is used as a proxy for mercury in the fridge
- Incinerated waste without energy recovery (no EF-compliant dataset has no energy recovery) is modelled as landfilled municipal waste

5.4. Data quality requirements

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

$$DQR = \frac{TeR + GeR + TiR + }{4} \qquad \text{Equation 1}$$

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

The next sections provide tables with the criteria to be used for the semi-quantitative assessment of each criterion. If a dataset is constructed with company-specific activity data, company -specific emission data and secondary sub-processes, the DQR of each shall be assessed separately.

Company-specific datasets

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

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

2) Calculate the DQR criteria TeR, TiR, GeR and P for each most relevant activity data and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table 21.

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

    b. For each most relevant activity data, the 4 DQR criteria shall be evaluated (named T_eR_{-AD} TiR_{AD}, GeR_{-AD}, P_{AD})by the user of the PEFCR.

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

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

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

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

4) Calculate the TeR, TiR, GeR and P criteria of the newly developed dataset as the weighted average of each criteria of the most relevant activity data and direct elementary flows. The

weight is the relative contribution (in %) of each most relevant activity data and direct elementary flow calculated in step 3.

5) The user of the PEFCR shall calculate the total DQR of the newly developed dataset using Equation 1, where TeR, TiR, GeR and P are the weighted average calculated as specified in point (4).

Table 21 How to assess the value of the DQR criteria for datasets with company-specific.

Rating	PEF and PAD	TiR_{-EF} and TiR_{-AD}	TeR-EF and TeR-AD	GeR-EF and GeR-AD
1	Measured/calculated and externally verified	The data refers to the most recent annual administration period with respect to the EF report publication date	The elementary flows and the activity data 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

All processes required to model the product and outside the list of mandatory company-specific (listed in Section 5.1) shall be evaluated using the DNM (see Figure 5 below). The use of the PEFCR shall apply the DNM to evaluate which data is needed and shall be used within the modelling of its PEF, depending on the level of influence the applicant (company) has on the specific process. Note that the options

described in the DNM are not listed in order of preference. The following three cases are found in the DNM and are explained below:

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

		Most relevant process	Other process
Situation 1: process run by the company applying the PEFCR	**Option 1**	Provide company-specific data (as requested in the PEFCR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.5). Calculate the DQR values (for each criteria + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process not run by the company 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 partially disaggregated at least at level 1 (DQR ≤1.5). Calculate the DQR values (for each criteria + 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
Situation 3: process not run 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

Figure 5 Data needs matrix, to be applied in different cases as described above

Processes in situation 1

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

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

Situation 1/Option 1:

For all processes run by the company and where the 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 applicant decides to model the process without collecting company-specific data, then the applicant shall use the secondary dataset listed in the PEFCR together with its default DQR values listed here.

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

Processes in situation 2

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

1. The company applying the PEFCR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[6] (Option 1);
2. The company has some supplier-specific information and want to make some minimum changes;
3. 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 not run 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.

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

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 EF-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 applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating TeR and TiR. The criteria GR shall be lowered by 30%[7] and the criteria P shall keep the original value.

Situation 2/Option 3:

For the non-most relevant processes, the applicant may 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 applicant of the PEFCR shall take the DQR values from the original dataset.

Processes in situation 3

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

1. It is in the list of most relevant processes; or
2. It is not in the list of most relevant processes.

Situation 3/Option 1:

In this case, the applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating TeR, TiR and GR, using the tables provided. The criteria P shall keep the original value.

Situation 3/Option 2:

For the non-most relevant processes, the applicant 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 applicant of the PEFCR shall take the DQR values from the original dataset.

[7] In situation 2, option 2 it is proposed to lower the parameter GR 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.

The DQR criteria for secondary datasets are provided in Table 22 below.

Table 22 Data scoring criteria for all processes requiring secondary data

	TiR_{AD}	TiR_{SD}	TeR_{SD}	GR_{SD}	P_{AD}
1	The data (collection date) can be maximum 2 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset falls within the time validity of the secondary dataset	Technology aspects have been modelled exactly as described in the title and metadata, without any significant need for improvement	The processes included in the dataset are fully representative for the geography stated in the “location” indicated in the metadata	Measured/calculated and verified
2	The data (collection date) can be maximum 4 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 2 years beyond the time validity of the secondary dataset	Technology aspects are very similar to what described in the title and metadata with need for limited improvements. For example: use of generic technologies’ data instead of modelling all the single plants.	The processes included in the dataset are well representative for the geography stated in the “location” indicated in the metadata	Measured/calculated/ literature and plausibility checked by reviewer
3	The data (collection date) can be maximum 6 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 3 years beyond the time validity of the secondary dataset	Technology aspects are similar to what described in the title and metadata but merits improvements. Some of the relevant processes are not modelled with specific data but using proxies.	The processes included in the dataset are sufficiently representative for the geography stated in the ““location” indicated in the metadata. E.g. the represented country differs but has a very similar electricity grid mix profile.	Measured/ calculated/ literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer
4	The data (collection date) can be maximum 8 years old with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is maximum 4 years beyond the time validity of the secondary dataset	Technology aspects are different from what described in the title and metadata. Requires major improvements.	The processes included in the dataset are only partly representative for the geography stated in the “location” indicated in the metadata. E.g. the represented country differs and has a substantially different electricity grid mix profile	Qualified estimate based on calculations, plausibility not checked by reviewer
5	The data (collection date) is older than 8 years with respect to the "reference year" of the dataset.	The "reference year" of the tendered dataset is more than 4 years beyond the time validity of the secondary dataset	Technology aspects are completely different from what described in the title and metadata. Substantial improvement is necessary	The processes included in the dataset are not representative for the geography stated in the “location” indicated in the metadata.	Rough estimate with known deficits

5.6. Which datasets to use?

The secondary datasets to be used by the applicant are those listed in Annex IV – LCI data. Whenever a dataset needed to calculate the PEF profile is not among those listed in this PEFCR, then the applicant shall choose between the following options (in hierarchical order):

1. Use an EF-compliant dataset available on one of the following nodes:
    - http://eplca.jrc.ec.europa.eu/EF-node/
    - http://lcdn.blonkconsultants.nl
    - http://ecoinvent.lca-data.com
    - http://lcdn-cepe.org
    - http://lcdn.thinkstep.com/Node
2. Use an EF-compliant dataset available in a free or commercial source;
3. Use another EF-compliant dataset considered to be a good proxy. In this case, this information shall be included in the limitations section of the PEF report;
4. Use an ILCD-entry level-compliant dataset that has been modelled according to the modelling requirements included in the EF 2021 Recommendations. In this case, this information shall be included in the limitations section of the PEF report; and
5. Use an ILCD-entry level-compliant dataset. In this case, this information shall be included in the data gaps 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 applicant shall calculate separately the TeR, TiR, 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 (excluding the three toxicity-related ones). The calculation rules explained in Section 5.4 shall be used.

5.8. Allocation rules

The following decision hierarchy recommended by the PEF annex 2021 (European Commission, 2021) is in accordance with ISO 14044 (ISO 2006a), the international reference standard for LCA.

Step 1: Wherever possible, allocation should be avoided by either:

- Dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes; or
- Expanding the product system (known as system expansion) to include the additional functions related to the co-products.

Step 2: Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them.

Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.

Allocation rules for the parts of the life cycle involving multi-output processes are listed in Table 23 below.

Table 23 Allocation rules

Process	*Allocation rule*	*Modelling instructions*
Meat co-Products	Economic allocation	The economic allocation factors of the different outputs shall be used as described in Table 25 below in Section 6.1
Manufacturing	Mass allocation	See Section 6.3 for details
Distribution and retail storage	Allocation based on the storage capacity and type of representative products	See Section 6.4 for details
Transport from retailer to the consumer's home	Volume	See Section 6.4 for details
Material recycling, or incineration with energy recovery at the end-of-life	Allocation according to the Circular Footprint Formula (CFF)	See Section 6.6 for details

5.9. Electricity modelling

The following guidelines shall only be used for the processes where company-specific information is collected (situation 1 / option 1 and 2 / option 1of the DNM).

The following electricity mix shall be used in hierarchical order:

1. Supplier-specific electricity product shall be used if *there is a 100% tracking system in place or if*
    a. available, and
    b. the set of minimum criteria to ensure the contractual instruments are reliable is met.
2. The supplier-specific total electricity mix shall be used if:

a. available, and
b. the set of minimum criteria that to ensure the contractual instruments are reliable is met.

3. 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 occurs. This may be an EU country or non-EU country. The residual grid mix characterizes the unclaimed, untracked or publicly shared electricity. This prevents double-counting with the use of supplier-specific electricity mixes in cases 1 and 2 above.
4. 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.

The set of minimal criteria to ensure contractual instruments from suppliers is listed below:

A supplier-specific electricity product/mix may only be used when the applicant ensures that any contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then the "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.**

Information on modelling the "country-specific residual grid mix, consumption mix" is provided below:

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 5.6.

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

Determine the country consumption mix (e.g., X% produced with hydro energy, Y% produced with coal power plant) and combine them with LCI datasets per energy type and country/region (e.g., LCI dataset for the production of 1 kilowatt-hour (kWh) of 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; and
    - Type of fuel supply (share of resources used, by import and / or domestic supply).

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

- 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); and
    - Technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.

Allocation of electricity consumption shall be allocated as described in Table 24 below.

Table 24 Allocation rules for electricity

Process	*Allocation rule*	*Modelling instructions*
Pet food manufacturing	Mass	The electricity mix (i.e., national consumption) used shall be a production-weighted average when data from multiple sites are used.

Where such data are not available, the average EU mix (EU member states/EFTA countries), or region representative mix, shall be used.

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

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

- The production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site may be used.
- The production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product specific information (measure, record, bill) may be used.
- All the products produced in the specific plant are supplied with a public available PEF study. The company that 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

Information on on-site electricity generation is provided below:

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

1. No contractual instruments have been sold to a third party: the own electricity mix (combined with LCI datasets) shall be modelled.
2. 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 production 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 it exports 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted for in the PEF study).
- If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution.
- 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 climate change impact category 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 (carbon dioxide (CO_2), carbon monoxide and methane) 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 shall be modelled under sub-category 3 (including connected soil emissions, derived products, and residues). The emission flows ending with "(biogenic)" shall be used.

   A simplified modelling approach shall be used when modelling the foreground emissions. Only the emission "methane (biogenic)" is modelled, while no further biogenic emissions and uptakes from the atmosphere are included. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane.

3. **Climate change – land use and land transformation**: This sub-category accounts for carbon uptakes and emissions (CO_2, carbon monoxide and methane) originating from carbon stock changes caused by LUC and land use. This sub-category includes biogenic carbon exchanges from deforestation (and transformation from non-forest: annual crop, permanent crop), , road construction or other soil activities (including soil carbon emissions). For native forests, all

related CO_2 emissions are included and modelled under this sub-category (including connected soil emissions, products derived from native forest and residues), while their CO_2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.

For LUC, all carbon emissions and removals shall be modelled following the modelling guidelines of PAS 2050:2011 (British Standards Institution (BSI), 2011) and the supplementary document PAS2050-1:2012 (BSI, 2012) for horticultural products. PAS 2050:2011 (BSI, 2011): Large emissions of greenhouse gases (GHGs) can result as a consequence of LUC. Removals as a direct result of LUC (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 LUC are the conversion of land used for growing crops to industrial use or conversion from forestland to cropland. All forms of LUC that result in emissions or removals are to be included. Indirect LUC refers to such conversions of land use as a consequence of changes in land use elsewhere. While GHG emissions also arise from indirect LUC, the methods and data requirements for calculating these emissions are not fully developed. Therefore, the assessment of emissions arising from indirect LUC is not included.

The GHG emissions and removals arising from direct LUC 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 LUC values provided in PAS 2050:2011 Annex C, unless better data are available. For countries and LUC 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 LUC in accordance with the relevant sections of the IPCC (2006). The assessment of the impact of LUC shall include all direct LUC occurring not more than 20 years, or a single harvest period, prior to undertaking the assessment (whichever is the longer). The total GHG emissions and removals arising from direct LUC 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.

1. Where it can be demonstrated that the LUC occurred more than 20 years prior to the assessment being carried out, no emissions from LUC should be included in the assessment.
2. Where the timing of LUC 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 LUC occurred on January 1st of either:
    - the earliest year in which it can be demonstrated that the LUC had occurred; or
    - on January 1st 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 LUC occurring not more than 20 years or a single harvest period, prior to making the assessment (whichever is the longer):

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

The sum of the three sub-categories shall be reported and the sub-categories climate change-biogenic and climate change-land use and land transformation shall be reported separately.

5.11. Modelling of wastes and recycled content

The waste of products used during the manufacturing, distribution, use and packaging end-of-life stages shall be included in the overall modelling of the life cycle of the organisation. Overall, this should be modelled and reported at the life cycle stage where the waste occurs. Guidelines on how to model the end of life of products as well as the recycled content are provided below.

The Circular Footprint Formula (CFF) is used to model the end of life of products as well as the recycled content and is a combination of material, energy and disposal impacts as shown in Equation 2 below:

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

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

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

Equation 2

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.

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

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

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

$E_{SE,heat}$ 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.

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

$X_{ER,heat}$ 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.

The A values, default quality ratios, default R1 values for all default material datasets as well as default R2 values to be used in case no company-specific values are available are provided in Annex C of the EF Recommendations 2021. Default R1 values shall be set to 0% when no application-specific data are available.

The relevant definitions for pet food waste and pet food losses are based on Food and Agriculture Organisation of the United Nations (FAO) definitions (Parfitt et al., 2010) as follows:

- Pet food losses refer to the decrease in pet food mass throughout the part of the supply chain that specifically leads to food for pet consumption. Pet food losses are incurred at production and processing stages as well as in the pet food supply chain (distribution and retail)
- Pet food waste relates to consumer behaviour

Pet food waste and losses throughout the distribution chain are recognised as a potentially important issue because this pet food waste translates to an increase in pet food production to compensate for the actual amount of food that must be produced to achieve the functional unit. Losses occurring within and between the life cycle stages, from the manufacturing site to the retailer, and the waste occurring at the consumer's home, are however not clearly known.

The waste and loss rates shown below shall be considered when primary data are not available:

- At manufacturer: 2% (loss)
- At retailer: 0.5% (loss)
- At user: 1% (waste) per the Waste and Resources Action Programme (WRAP) report on pet food packaging (WRAP, 2009)

Loss at the retailer is assumed to include storage and transportation losses. Pet food waste and losses are treated in accordance with the following default assumptions based on secondary data (European Commission, 2021)

- 50% trashed (incinerated or landfilled based on the country-specific splits provided in Annex C of the EF Recommendations
- 25% composting
- 25% anaerobic digestion

6. Life cycle stages

6.1. Ingredients

The ingredients life cycle stage includes raw material acquisition and processing. The ingredients stage is considered to be most relevant for all four sub-categories of pet food considered for many impact categories and thus shall be included for all PEF studies. For detailed agricultural modelling requirements, section 4.4.1 can be consulted of Annex I of the PEF (European Commission, 2021).

Input and output data requirements for the ingredient life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data.

To ensure the pet food recipe (BOI) remains confidential, only the percentage for each ingredient type shall be displayed in the PEF report; however, for the analysis, a complete list of all ingredients required to produce 1 kg of pet food shall be included as well as ingredient processing. For example, the BOI might include chicken liver but considering no detailed dataset for chicken liver is available, the chicken liver would be modelled by the ingredient type, which in this case is poultry co-product. See Annex IV – LCI data for details on the specific ingredient types considered.

While all ingredients required to manufacture prepared pet foods are within the scope of this PEFCR, this PEFCR does not provide detailed guidance on how to model the upstream production of these ingredients.

For each ingredient used, use the datasets listed in Annex IV – LCI data for the benchmark calculations as guidance, and follow the procedure described in Section 5.6 to select the appropriate dataset. In all cases, the dataset used shall be clearly indicated in the PEF report.

Regionalized data refer to secondary datasets specific for the region in which the ingredients are produced, but for the products where the electricity or transport are dominating the overall impact, a regional secondary dataset should be approximated by default secondary data where the electricity and transport could be adapted to the local context.

It is important to regionalize by country where possible. For example, the impacts for Brazilian and American soybeans may be quite different for certain impact categories. If the ingredients come from multiple sources, a weighted average of the different sources may be used to properly represent the variability of the sources.

When published data representative of national averages for other EU countries are available, these may also be used providing they comply with the PEF requirements.

For background EF-compliant datasets, it will be clearly indicated if LUC emissions are included or not. For non-compliant datasets from another database or that were created for the specific PEF, LUC must be modelled as described in the EF 2021 Recommendations (European Commission, 2021).

Meat co-product allocation

Modelling of beef co-products shall be aligned with the recommendations described in the Animal Husbandry section 4.5.1 in the EF 2021 Recommendations (European Commission, 2021). For all meat products, the following co-products are considered:

- Fresh meat and edible offal
- Food-grade co-products (fat and bones)
- Category 3 slaughter by-products (food-grade co-products not intended for human consumption)
- Other (hides, skins, category 1 and 2 material and waste)

According to the CMWG on the basis of the legal definition as laid down in Regulation (EC) No 1069/2009, the by-products from slaughterhouse and rendering are classified in three categories:

- **Category 1**: Risk materials, e.g., infected/contaminated animals or animal by-products
    - Disposal and use: incineration, co-incineration, landfill, used as biofuel for combustion, manufacture of derived products
- **Category 2**: Manure and digestive tract content, products of animal origin unfit for human consumption
    - Disposal and use: incineration, co-incineration, landfill, fertilisers, compost, biofuels, combustion, manufacture of derived products
- **Category 3**: Carcases and parts of animals slaughtered and which are fit for human consumption but are not intended for human consumption for commercial reasons, include skins and hides going for leather industry (note that hides and skins can also belong to other categories depending on the use)
    - Disposal and use: incineration, co-incineration, landfill, feed, pet food, fertilisers, compost, biofuels, combustion, manufacture of derived products (e.g., leather), oleochemicals and chemicals

In accordance with the outcome of the CMWG's technical report (European Commission, 2021), upstream burdens and activities are allocated to raw milk and live animals based on the International Dairy Federation (IDF) biophysical allocation method (IDF, 2015) whereas downstream burdens and activities are allocated to slaughterhouse and rendering products based on economic allocation.

The environmental impact per mass unit of slaughterhouse output i (EI_i) is calculated according to Equation 3 below:

$$EIi = EIw\ x\ ARi \qquad \text{Equation 3}$$

where EI_w is the environmental impact of the whole animal divided by the live weight mass of the animal and AR_i is the allocation ratio for output i (calculated as the economic value of i divided by mass fraction of i).

The IDF 2015 allocation method between milk, cull cows and surplus calves is based on the physiological feed energy requirements of the dairy cow to produce milk and the meat. Allocation is used to split emissions that cannot be directly attributed to either milk or meat (e.g., energy use by milking equipment should be attributed entirely to milk). The allocation factor (AF) for raw milk is calculated according to Equation 4 below:

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

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) is calculated according to Equation 5 below:

$$FPCM\ \left(\frac{kg}{year}\right) = Production\ \left(\frac{kg}{year}\right) \times (0.1226 \times True\ Fat\% + 0.0776 \times True\ Protein\% + 0.2534)$$

Equation 5

The percentage of beef co-products coming from dairy cattle and beef cattle shall also be considered. This percentage may be customized to create a specific dataset.

The mass fractions and economic allocation percentages for meats are provided in Table 25 below.

Table 25 Mass fraction and economic allocation percentages for meats

Meat	Fresh meat and edible offal	Food-grade co-products	Category 3 slaughter by-products	Other	Source
Mass fraction (%)					
Beef	49%	15%	7%	29%	European Commission, 2021
Chicken	65.3%		34.6%	--	FEDIAF, 2014
Pork	67%	14%	19%	0%	European Commission, 2021
Lamb	44%	10%	13%	33%	European Commission, 2021
Fish	45%		55% (range: 40-70%)	--	Henriksson et al (2014)
Rabbit	65.3%		34.6%		Same as chicken
Economic allocation (%)					
Beef	92.9%	2.8%	0.8%	3.5%	European Commission, 2021
Chicken	96.6%		3.4%	--	FEDIAF, 2014
Pork	98.7%	0.58%	0.77%	--	European Commission, 2021
Lamb	97.8%	0.03%	0.6%	1.6%--	European Commission, 2021
Fish	96.6%		3.4%	--	Same as chicken
Rabbit	96.6%		3.4%	--	Same as chicken

The specific datasets used to model various animal co-products are available in Annex IV – LCI data but an overview of the processes used for modelling is shown in Table 26 below.

Table 26 Processes included in this PEFCR for animal co-products

Meat type	All other co-product processing	Meal processing	Oil extraction	Fat rendering
Beef (beef and dairy cattle)	☑	☑		
Chicken	☑	☑		☑
Pork	☑	☑		☑
Lamb	☑	☑		
Fish	☑	☑	☑	
Rabbit	☑			

Animal meal is assumed to have a dry matter content of 950 g/kg and animal oils and fats are assumed to have a dry matter content of 990 g/kg based on the Agri-Footprint dataset animal meal, from dry rendering (Agri-Footprint, 2015). It is also important to note that dry products such as meat meal are much more impacting per kg than wet co-products, and therefore moisture content plays an important role.

The moisture content for animal co-products shall be taken into consideration. Companies applying these PEFCRs shall determine the moisture content (and thus dry matter content) for all animal co-products used in each BOI and make necessary corrections based on mass ratios using the correction factor shown in Equation 6 below.

$$Correction\ factor = \frac{(1-M_{\ ingredient})}{(1-MC_{default})} \qquad \text{Equation 6}$$

where $MC_{ingredient}$ is the moisture content in percentage for the actual ingredient used and $MC_{default}$ is the moisture content in percentage for the default ingredient dataset.

For example, if the default dataset has a moisture content of 70% and the actual moisture content of the co-product is 80%, the dataset would be multiplied by 0.2 (the dry matter content for the actual ingredient used) and divided by 0.3 (dry matter content for the default dataset) in order to correct the impacts.

Additionally, all ingredient processing shall be included. Generally, ingredient processing is already included in the EF-compliant datasets but if it is not, it shall be included.

For each ingredient transported from a supplier to the manufacturing plant, data on the (i) mass transported, (ii) transport mode, (iii) distance per transport mode, (iv) utilisation ratio for truck transport and (v) empty return modelling for truck transport, are required. Truck transport is modelled per tonne kilometre (tkm) which expresses the environmental impact for 1 tonne (t) of product that is transported 1 kilometre (km) via truck with certain load.

The distance and transportation mode for each ingredient coming to the manufacturing plant may be based on primary data. Weight-limited transport is taken into account for all ingredients. For frozen ingredients, different default truck/van transport processes shall be used as detailed in Table 27 below as well as in Annex IV – LCI data. Note that no specific datasets for frozen transport via train or ship are currently available and therefore all transport via train and ship is modelled as ambient transport for the representative products.

Table 27 Default parameters for ingredient transport

Supply chain	Distance (km)	Utilisation rate	Provenance (% of total transport)	Transportation mode
Local (from field to processing plant)	200	64%	100%	Ambient: Articulated lorry transport, Euro 4, Total weight >32 t (without fuel)| diesel driven, Euro 4, cargo| consumption mix, to consumer| more than 32t gross weight / 24,7t payload capacity {EU-28+3}
European (from supplier to manufacturing plant)	130	64%	90% from Europe	Ambient: Articulated lorry transport, Euro 4, Total weight >32 t (without fuel)| diesel driven, Euro 4, cargo| consumption mix, to consumer| more than 32t gross weight / 24,7t payload capacity {EU-28+3} Frozen: Articulated lorry transport, Euro 5, Total weight 28-32 t, frozen diesel driven {EU+EFTA+UK} | diesel driven, Euro 5, frozen cargo | consumption mix, to consumer | 28 - 32t gross weight / 21,4t payload capacity
	240	n/a		Freight train, electricity traction {EU+EFTA+UK} | electricity driven, cargo | consumption mix, to consumer | average train, gross tonne weight 1000t / 726t payload capacity | LCI result
	270	n/a		Barge {EU+EFTA+UK} | technology mix, diesel driven, cargo | consumption mix, to consumer | 1500 t payload capacity | LCI result
Outside Europe (from supplier to manufacturing plant)	1'000	64%	10% from outside Europe	Ambient: Articulated lorry transport, Euro 4, Total weight >32 t (without fuel)| diesel driven, Euro 4, cargo| consumption mix, to consumer| more than 32t gross weight / 24,7t payload capacity {EU-28+3} Frozen: Articulated lorry transport, Euro 5, Total weight 28-32 t, frozen diesel driven {EU+EFTA+UK} | diesel driven, Euro 5, frozen cargo | consumption mix, to consumer | 28 - 32t gross weight / 21,4t payload capacity
	18'000	n/a		Ship

The utilisation ratio is calculated as the mass of the real load divided by the mass of the payload and shall be adjusted upon the use of the dataset. The default utilisation ratio to be used is 64%. For the EF-compliant datasets listed in Annex IV – LCI data, the empty returns are included. Therefore empty returns shall not be modelled separately. The utilisation rate shall be adapted in the EF-compliant datasets if situation 1 or 2 applies.

If the country of origin is known, the shipping distance for ship and plane transport should be determined using the following calculators:

- https://www.searates.com/services/distances-time/
- https://co2.myclimate.org/en/flight_calculators/newhttps://co2.myclimate.org/en/flight_calculators/new

6.2. Packaging production

The packaging production life cycle stage includes primary, secondary and tertiary packaging as well as packaging transport.

The following definitions apply and shall be used:

- **Primary packaging:** Material that immediately covers the product. For example, primary packaging can consist of a can, a lid and a label. Note that some consider the label to be secondary packaging but it is considered to be primary packaging in this PEFCR.
- **Secondary packaging:** Packaging or containment of a primary package. Packaging for multipacks and their labels are also considered to be secondary packaging.
- **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.

Input and output data requirements for the packaging life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data. Primary data shall be used to model primary packaging activity data (i.e., amounts), and secondary data may be used to model the upstream manufacturing of primary packaging materials and components. Secondary shall use primary data and tertiary packaging may be modelled using secondary data.

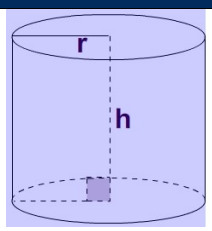
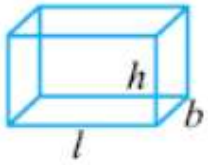
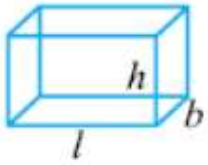
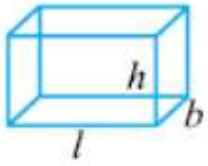
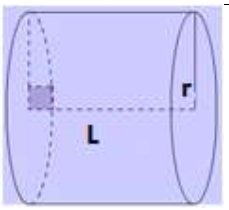
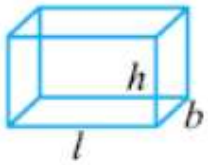
To model the plastic pouch for wet pet food representative product, the following dataset is used:

- Packaging film, High barrier {EU+EFTA+UK} | raw material production, lamination process | single route, at plant | thickness: 12 um PET, 12um alu, 75um PE; grammage 115 g/m2 | LCI result (UUID52ce6985-95af-47f4-87a5-d60ebcf3341e)

This dataset is to be used for a 3-layer pouch with a 12-micrometre (µm) polyethylene terephthalate (PET) layer, a 12-µm aluminium layer and a 75-µm PET layer. Should the applicant's pouch differ significantly from this, different processes shall be used for modelling or this process shall be scaled accordingly to account for the difference.

The dimensions of each pet food product and the quantity of pet food that each unit contains shall be documented. The volume and surface area calculations for each packaging type are provided in Table 28 below.

Table 28 Packaging dimension calculations

Packaging	Geometrical figures	Volume / Surface Area formula
Can		$V = \pi r^2 h$ $SA = 2\pi rh + 2\pi r^2$
Pouch		$V = lhb$ $SA = 2(hb + lh + bl)$
Bag		$V = lhb$ $SA = 2(hb + lh + bl)$
Tray		$V = lhb$ $SA = 2(hb + lh + bl)$
Sausage		$V = \pi r^2 h$ $SA = 2\pi rh + 2\pi r^2$
Carton box		$V = lhb$ $SA = 2(hb + lh + bl)$

*where V is volume, r is radius, h is height, l is length, b is base

Should any packaging materials contain recycled content, this shall be documented and modelled accordingly. The recycled content is modelled according to Equation 7 below:

$$(1 - R_1)E_V + R_1 \times \left(AE_{recycled} + (1 - A)E_V \times \frac{Q_{Sin}}{Q_p}\right) \quad \text{Equation 7}$$

The R1 values applied shall be supply-chain-specific or default values as provided in Annex IV – LCI data, in relation with the DNM. Material-specific values based on supply market statistics are not accepted as a proxy. The applied R1 values shall be subject to PEF study verification.

When using supply-chain-specific R1 values other than 0, traceability throughout the supply chain is necessary. The following general guidelines shall be followed when using supply-chain-specific R1 values:

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

Default parameters for A, Qs_{in}/Q_p and $E_{recycled}$ are provided in Annex C.

Finally, the distance and transportation mode for each packaging material coming to the manufacturing plant shall be considered. Packaging transport is assumed to be weight-limited for all packaging types with the exception of pre-fabricated metals cans and aluminium trays which may be volume-limited. Default parameters for packaging transport are provided in Table 29 below.

Table 29 Default parameters for packaging transport

Supply chain	Distance (km)	Utilisation rate	Provenance (% of total transport)	Transportation mode
European	230	64%	100% from Europe	Truck (>32 t, EURO4)
	280	n/a		Train
	360	n/a		Ship

6.3. Manufacturing

Primary data shall be used to model the energy during the manufacturing stage. If available, company data is preferred for water and waste production; otherwise, secondary data may be used. . Each pet food manufacturing plant typically produces a number of different pet foods. Details on how to address multi-functionality of the manufacturing processes are provided in Section 5.8.

Input and output data requirements for the manufacturing life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data.

Manufacturing allocation

Manufacturing plants usually produce more than one type of pet food. 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. Thus, the allocation of resources and emissions should be done by mass allocation.

The electricity mix (i.e., national consumption) used shall be a production-weighted average when data from multiple sites are used.

Manufacturing wastes may be divided into the following categories: materials that are recycled, materials that are put in a regular disposal facility, wastewater, hazardous waste, solvent waste and food waste (pet food that is not reworked).

Manufacturing losses are based on a mass balance using raw company data for the total input less the total output for the manufacturing plant. If no primary data are available, a default loss rate of 2% shall be used for the manufacturing stage, which is based on averaged primary data. Because manufacturing losses are not considered to be a most relevant process after the remodelling exercise, secondary data may be used. See Section 5.11 for details on how pet food loss/waste is treated.

6.4. Distribution

The distribution life cycle stage includes impacts related to transport of the pet food products from the manufacturing plant to the final client's home (which includes consumer transport), as well as the impacts related to storage at the DC and retailer, and distribution losses. The final client is defined as the purchaser of the pet food product.

Input and output data requirements for the distribution life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data.

For allocation of transport impacts, see Section 5.8. When available, primary data shall be collected for the distances and modes of transport for each transport step from the manufacturing plant to the

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

Weight-limited transport may be taken into account for all pet food products.

The default transport scenario shown in Table 30 below may be considered if no primary data are available for transport from distribution to retail and from retailer to consumer.

Table 30 Default parameters for distribution

Supply chain	Distance (km)	Utilisation ratio	Provenance (% of total transport)	Transportation mode
Local	1'200	64%	30% local	Truck (>32 t, EURO4)
Intra-continental	3'500	64%	60% intra-continental	Truck (>32 t, EURO4)
International	1'000	64%	10% international	Truck (>32 t, EURO4)
	18'000	n/a		Ship
Consumer	5	See below	62%	Passenger car
	5	20%	5%	Van (<7.5t, EURO 3), round trip
	n/a	n/a	33%	No impact because transport is via foot, bike or public transport

LCA datasets for consumer transport (typically, passenger car) are per kilometre. In the PEF context, the allocation of the car impacts shall be based on volume. The maximum volume to be considered for consumer transport is 0.2 m^3 (around 1/3 of a trunk of 0.6 m^3).

For products sold through supermarkets or shopping malls, the product volume (including packaging) shall be used to allocate the transport burdens over the product transported. The allocation factor shall be calculated as the volume of the product transported divided by 0.2 m^3.

Product volumes and product capacities (because the functional unit is in terms of kcal and thus less energy-dense pet food will be required per feeding) are needed to allocate storage impacts as well.

Storage at the distribution centre and retail place may be modelled according to the datasets provided in Annex IV – LCI data. The following elements are included in this dataset: electricity usage, energy consumption, water use and wastewater treatment.

See Section 5.9 for further details on electricity modelling. Default values for energy use are based on the EF 2021 Recommendations (European Commission, 2021). Ceiling heights of 5 m (at the distribution centre) and 2 m (for refrigerators) are considered to convert from surface to volume references. Capital goods may be neglected. Details are provided in Table 31 below.

Table 31 Energy and refrigerant consumption at DCs and at retail

Parameter	Per surface area (per m^2.year)	Per volume occupied (per m^3.year)
General electricity consumption at DC	30 kWh	6 kWh
General energy at DC (natural gas burned in boiler)	360 MJ	72 MJ
General electricity consumption at retail	400 kWh	200 kWh

Average storage times at the manufacturing plant, at the distribution centre and at the retailer should be based on primary data when available. Average default storage times for all representative products were calculated based on primary data:

- At plant: 5 days
- At DC: 20 days
- At retailer: 15 days

The average storage volume factor for ambient product storage (which takes into account the fact that more space than the actual volume of the product itself is needed) is 4 (European Commission, 2021). The ambient storage volume is calculated according to Equation 8 below:

$$Ambient\ storage\ volume = Product\ volume\ for\ primary\ packaging\ x\ 4 \qquad \text{Equation 8}$$

A default loss rate of 0.5% shall be used for the distribution stage, which is based on averaged primary data. The losses are modelled based on the total quantity of product that leaves the manufacturing plant compared to the quantity that arrives at the point of sale. See Section 5.11 for details on how pet food loss is treated.

Note that the distance from the DC to the point of sale includes the total distance the product has travelled from the first distribution centre to which it was sent to the final point of sale. When the product is sold on multiple markets, an average distance may be calculated based on sales.

6.5. Use

The use stage includes the impacts related to the dishwashing of the dishes and utensils used to serve pet food, the refrigeration of unused portions of the pet food as well as the waste of pet food.

Input and output data requirements for the use life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data.

For wet pet food, it was assumed that by default a small dish and fork are used for each meal and they are washed once per day. For dry pet food, it is assumed that by default the dish is washed once per week. For washing, it is assumed that 50% of the dishes are washed in a dishwasher and 50% are washed by hand.

Other default assumptions related to the dishes are listed below:

- Dish lifetime: 3650 uses
- Dish material: hard plastic
- Feedings per day: 2 (morning and evening)

Impacts related to dishwashing in a dishwasher based on the fraction of space that the dishes take up per dishwasher cycle include the following by default (European Commission, 2021):

- Dishwasher production, delivery and end-of-life
- Electricity necessary to operate the dishwasher
- Water usage and associated wastewater treatment
- Soap usage

Impacts related to hand washing include hot water and soap usage.

Refrigerated storage of unused portions of wet pet foods is also considered and it includes the energy necessary to operate the refrigerator as well as the refrigerator production, delivery and end-of-life.

The following default values were used:

- Energy (0.0037 kWh/litre-day for a fridge with a 210-litre internal storage capacity)
- Storage volume factor (which takes into account the fact that more space than the actual volume of the product itself is needed) in the fridge is 3
- The refrigerated storage volume is calculated according to Equation 9 below:

$$Refrigerated\ storage\ volume = Product\ volume\ for\ primary\ packaging\ \ x\ 3 \qquad \text{Equation 9}$$

- The whole package is put in the refrigerator and based on its storage volume, a fraction of the refrigerator is allocated to this package
- For both wet cat food and wet dog food, the average fridge storage time per day for the remaining pet food is 1 day because the 400-g products are never fully emptied (there is a variable amount of wet pet food always stored in the fridge in its 400-g packaging). Note that the fridge storage time should be updated based on the actual product size and the energy content of the product.

See Section 5.11 for details on how pet food loss is treated.

For the use stage the consumption grid mix shall be used. The electricity mix shall reflect the ratios of sales between EU countries/regions. The ratio will be based on the kcals sold. Where such data are not available, the average EU consumption mix (EU member states/EFTA countries), or region representative consumption mix, shall be used.

6.6. Packaging end-of-life

The packaging EOL stage includes the transport and treatment of the different packaging wastes (primary, secondary and tertiary packaging). Food waste is accounted for during the life cycle of the product in various stages and the wastage of product by the end user is included in the use stage.

Input and output data requirements for the packaging EOL life cycle stage are listed in Table 8, and data requirements and default data for these processes are detailed in Annex IV – LCI data.

The end of life shall be modelled using the formula and guidance provided in Section 5.11 together with the default parameters listed in the tables below.

Please note that the transport from collection place to EOL treatment is included in the landfill, incineration and recycling datasets tendered by the European Commission. However, there may be some cases where additional default transport data are needed and are included below.

Before selecting the appropriate R2 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.

Points 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.

Following the evaluation for recyclability, the appropriate R2 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 R2 value of 0% shall be applied.

Company-specific R2 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 R2 values shall be used as listed in Table 32 below:

- If an R2 value is not available for a specific country, then the European average shall be used.
- If an R2 value is not available for a specific application, the R2 values of the material shall be used (e.g., materials average).
- In case no R2 values are available, R2 shall be set equal to 0 or new statistics may be generated in order to assign an R2 value in the specific situation.

The applied R2 values shall be subject to the PEF study verification.

All packaging waste that is not recycled shall be assumed to be incinerated or landfilled according to the municipal solid waste treatment rates of the corresponding market. For EU member states/EFTA countries, 45% of municipal solid waste is incinerated and 55% is landfilled (Eurostat, 2013).

For the representative products, all secondary and tertiary packaging is assumed to be 100% recycled.

Default parameters for waste packaging collection and treatment after consumer use are provided in the tables below.

Table 32 Default parameters for waste collection and treatment

Transport	Distance (km)	Transportation mode	Reference
Consumer home to collection point	1	Passenger car	2021 Recommendations (75% of households do not need transport; 25% of households drive about 4 km to local collection point)
Collection point to anaerobic digestion	100	Truck (>32 t, EURO 4)	2021 Recommendations
Collection point to composting	30	Truck (<7.5t, EURO 3)	2021 Recommendations

Data used for end-of-life logistics and treatment are summarized Table 33 based on Eurostat statistics (European Commission, 2021). The lower heating values (LHVs) for each type of packaging material are also included in Table 33 below.

Table 33 End-of-life treatment of packaging materials based on average EU data

Packaging material	Recycling (R2)	Incineration	Landfill	LHV (MJ/kg)
Mixed plastics	29%	32%	39%	30.79
Polyethylene (PE)	0%	45%	55%	42.47
PET	0%	45%	55%	22.95
Cardboard	75%	11%	14%	15.92
Paper	75%	11%	14%	14.12
Aluminium	69%	14%	17%	30.8
Steel	74%	12%	14%	0
Wood	30%	32%	39%	14
Pouches/other	0%	45%	55%	30.79

The electricity mix (i.e., national consumption) used should be a sales-weighted average.

7. PEF results

According to ISO 14044, LCI flows of materials, energy, and emissions into and out of each product system are classified into impact categories by the type of impact their use or release has on the environment. Then, they are characterized by their contribution to an indicator representing the impact category. The category indicator can be located at any intermediate position between the LCI results and the resulting damage (where the environmental effect occurs) in the cause-and-effect

chain. The damage represents changes in environmental quality and a category indicator is a quantifiable representation of this change. The LCIA of environmental impacts is based on the methods described in Table 10.

7.1. Benchmark values

Within the EF pilot phase, normalisation and weighting were used for the remodelling exercise to identify the most relevant impact categories.

Per ISO 14044, normalisation is an optional step of LCIA that allows the practitioner to express characterized results using a common reference impact to support the comparison between alternatives using reference numerical scores. The normalisation factors express the total impact of a reference region (EU-27 in this case) for a certain impact category (e.g., climate change, eutrophication, etc.) in a reference year (2010 in this case). Per person normalisation factors were calculated and provided in the EF Recommendations (European Commission, 2021). The normalisation and weighting factors used in these PEFCRs are provided in Annex I – List of EF normalisation and weighting factors.

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 pet food products from the same sub-category. The PEF could be compared to the benchmark results for the representative products provided in this PEFCR to understand the main differences.

The range in which results could be seen as being significantly different in comparisons or comparative assertions should be determined in the PEF studies with a comparative Monte Carlo simulation.

The limitations of the PEF shall be clearly stated and described. Key limitations of this PEFCR are discussed in Section 3.6 above.

The benchmarks for the four representative products are presented in Table 34 through Table 37 below based on the reference flows provided in Table 7.

Table 34 Characterised, normalized and weighted benchmark values for wet cat food

Impact category	Units	Characterized results (see unit column)		Normalized results (no units)		Weighted results (Pt)	
		Life cycle excl. use	Use stage	Life cycle excl. use	Use stage	Life cycle excl. use	Use stage
Acidification	mol H+ eq	2.28E-03	1.05E-04	4.10E-05	1.89E-06	2.54E-06	1.17E-07
Climate change	kg CO2 eq	3.63E-01	3.46E-02	4.81E-05	4.58E-06	1.01E-05	9.64E-07
Climate change - Biogenic	kg CO2 eq	1.32E-02	1.58E-03	n/a	n/a	n/a	n/a
Climate change - Fossil	kg CO2 eq	3.18E-01	3.26E-02	n/a	n/a	n/a	n/a
Climate change - Land use and LU change	kg CO2 eq	3.21E-02	3.61E-04	n/a	n/a	n/a	n/a
Ecotoxicity, freshwater	CTUe	1.17E+01	3.67E-01	2.06E-04	6.46E-06	3.96E-06	1.24E-07
Particulate matter	disease inc.	3.22E-08	1.36E-09	5.41E-05	2.28E-06	4.85E-06	2.04E-07
Eutrophication, marine	kg N eq	1.09E-03	4.71E-05	5.59E-05	2.41E-06	1.65E-06	7.13E-08
Eutrophication, freshwater	kg P eq	1.15E-05	1.81E-07	7.14E-06	1.13E-07	2.00E-07	3.16E-09
Eutrophication, terrestrial	mol N eq	8.41E-03	2.89E-04	4.76E-05	1.63E-06	1.77E-06	6.06E-08
Human toxicity, cancer	CTUh	1.79E-10	1.61E-11	1.04E-05	9.36E-07	2.21E-07	1.99E-08
Human toxicity, non-cancer	CTUh	6.00E-09	3.22E-10	4.66E-05	2.50E-06	8.57E-07	4.60E-08
Ionising radiation	kBq U-235 eq	2.91E-02	7.46E-03	6.91E-06	1.77E-06	3.46E-07	8.86E-08
Land use	Pt	1.22E+01	-4.73E-01	1.49E-05	-5.77E-07	1.19E-06	-4.58E-08
Ozone depletion	kg CFC11 eq	-1.37E-09	2.30E-10	-2.62E-08	4.40E-09	-1.65E-09	2.77E-10
Photochemical ozone formation	kg NMVOC eq	1.08E-03	6.22E-05	2.63E-05	1.52E-06	1.26E-06	7.28E-08
Resource use, fossils	MJ	5.16E+00	5.29E-01	7.93E-05	8.13E-06	6.60E-06	6.77E-07
Resource use, minerals and metals	kg Sb eq	2.04E-06	5.19E-09	3.21E-05	8.15E-08	2.42E-06	6.15E-09
Water use	m3 depriv.	4.04E-01	1.98E-02	3.52E-05	1.72E-06	3.00E-06	1.47E-07
Total	Pt					**4.1E-05**	**2.56E-06**

Table 35 Characterised, normalized and weighted benchmark values for dry cat food

Impact category	Units	Characterized results (see unit column)		Normalized results (no units)		Weighted results (Pt)	
		Life cycle excl. use	Use stage	Life cycle excl. use	Use stage	Life cycle excl. use	Use stage
Acidification	mol H+ eq	8.94E-04	1.95E-05	1.61E-05	3.52E-07	9.97E-07	2.18E-08
Climate change	kg CO2 eq	9.85E-02	5.10E-03	1.30E-05	6.75E-07	2.75E-06	1.42E-07
Climate change - Biogenic	kg CO2 eq	4.39E-03	2.99E-04	n/a	n/a	n/a	n/a
Climate change - Fossil	kg CO2 eq	6.88E-02	4.54E-03	n/a	n/a	n/a	n/a
Climate change - Land use and LU change	kg CO2 eq	2.53E-02	2.58E-04	n/a	n/a	n/a	n/a
Ecotoxicity, freshwater	CTUe	1.25E+01	1.60E-01	2.21E-04	2.83E-06	4.24E-06	5.43E-08
Particulate matter	disease inc.	9.46E-09	2.33E-10	1.59E-05	3.91E-07	1.42E-06	3.50E-08
Eutrophication, marine	kg N eq	5.37E-04	9.95E-06	2.75E-05	5.09E-07	8.13E-07	1.51E-08
Eutrophication, freshwater	kg P eq	9.26E-06	-5.49E-08	5.76E-06	-3.41E-08	1.61E-07	-9.56E-10
Eutrophication, terrestrial	mol N eq	3.31E-03	6.10E-05	1.87E-05	3.45E-07	6.95E-07	1.28E-08
Human toxicity, cancer	CTUh	5.32E-11	2.55E-12	3.08E-06	1.48E-07	6.57E-08	3.15E-09
Human toxicity, non-cancer	CTUh	2.10E-09	5.61E-11	1.63E-05	4.36E-07	3.00E-07	8.02E-09
Ionising radiation	kBq U-235 eq	6.21E-03	8.91E-04	1.47E-06	2.11E-07	7.37E-08	1.06E-08
Land use	Pt	6.07E+00	-1.71E-02	7.41E-06	-2.09E-08	5.88E-07	-1.66E-09
Ozone depletion	kg CFC11 eq	4.19E-11	1.70E-11	8.00E-10	3.24E-10	5.05E-11	2.04E-11
Photochemical ozone formation	kg NMVOC eq	2.97E-04	1.02E-05	7.27E-06	2.49E-07	3.48E-07	1.19E-08
Resource use, fossils	MJ	1.15E+00	7.61E-02	1.77E-05	1.17E-06	1.47E-06	9.74E-08
Resource use, minerals and metals	kg Sb eq	2.30E-08	-2.55E-09	3.62E-07	-4.01E-08	2.73E-08	-3.03E-09
Water use	m3 depriv.	2.97E-01	4.92E-03	2.59E-05	4.29E-07	2.20E-06	3.65E-08
Total	Pt					1.62E-05	4.43E-07

Table 36 Characterised, normalized and weighted benchmark values for wet dog food

Impact category	Units	Characterized results (see unit column)		Normalized results (no units)		Weighted results (Pt)	
		Life cycle excl. use	Use stage	Life cycle excl. use	Use stage	Life cycle excl. use	Use stage
Acidification	mol H+ eq	7.90E-03	1.63E-04	1.42E-04	2.94E-06	8.81E-06	1.82E-07
Climate change	kg CO2 eq	1.19E+00	4.48E-02	1.57E-04	5.93E-06	3.32E-05	1.25E-06
Climate change - Biogenic	kg CO2 eq	4.29E-02	3.56E-03	n/a	n/a	n/a	n/a
Climate change - Fossil	kg CO2 eq	1.03E+00	4.01E-02	n/a	n/a	n/a	n/a
Climate change - Land use and LU change	kg CO2 eq	1.14E-01	1.18E-03	n/a	n/a	n/a	n/a
Ecotoxicity, freshwater	CTUe	4.06E+01	6.57E-01	7.16E-04	1.16E-05	1.38E-05	2.22E-07
Particulate matter	disease inc.	1.18E-07	2.23E-09	1.98E-04	3.74E-06	1.77E-05	3.35E-07
Eutrophication, marine	kg N eq	3.66E-03	6.71E-05	1.88E-04	3.44E-06	5.55E-06	1.02E-07
Eutrophication, freshwater	kg P eq	4.35E-05	-3.51E-06	2.71E-05	-2.19E-06	7.59E-07	-6.12E-08
Eutrophication, terrestrial	mol N eq	2.83E-02	4.93E-04	1.60E-04	2.79E-06	5.94E-06	1.03E-07
Human toxicity, cancer	CTUh	6.52E-10	2.09E-11	3.78E-05	1.21E-06	8.05E-07	2.58E-08
Human toxicity, non-cancer	CTUh	2.40E-08	5.10E-10	1.87E-04	3.97E-06	3.43E-06	7.30E-08
Ionising radiation	kBq U-235 eq	9.31E-02	8.29E-03	2.21E-05	1.96E-06	1.11E-06	9.84E-08
Land use	Pt	3.12E+01	-2.80E-01	3.81E-05	-3.42E-07	3.02E-06	-2.72E-08
Ozone depletion	kg CFC11 eq	-4.30E-10	2.87E-10	-8.21E-09	5.49E-09	-5.18E-10	3.46E-10
Photochemical ozone formation	kg NMVOC eq	3.63E-03	8.98E-05	8.88E-05	2.20E-06	4.25E-06	1.05E-07
Resource use, fossils	MJ	1.66E+01	6.45E-01	2.55E-04	9.93E-06	2.12E-05	8.26E-07
Resource use, minerals and metals	kg Sb eq	9.41E-06	8.03E-08	1.48E-04	1.26E-06	1.12E-05	9.52E-08
Water use	m3 depriv.	1.31E+00	2.92E-02	1.15E-04	2.55E-06	9.75E-06	2.17E-07
Total	Pt					1.40E-04	3.55E-06

Table 37 Characterised, normalized and weighted benchmark values for dry dog food

Impact category	Units	Characterized results (see unit column)		Normalized results (no units)		Weighted results (Pt)	
		Life cycle excl. use	Use stage	Life cycle excl. use	Use stage	Life cycle excl. use	Use stage
Acidification	mol H+ eq	3.27E-03	4.31E-05	5.88E-05	7.76E-07	3.65E-06	4.81E-08
Climate change	kg CO2 eq	3.25E-01	7.62E-03	4.30E-05	1.01E-06	9.06E-06	2.12E-07
Climate change - Biogenic	kg CO2 eq	2.43E-02	8.71E-04	n/a	n/a	n/a	n/a
Climate change - Fossil	kg CO2 eq	2.37E-01	6.10E-03	n/a	n/a	n/a	n/a
Climate change - Land use and LU change	kg CO2 eq	6.41E-02	6.46E-04	n/a	n/a	n/a	n/a
Ecotoxicity, freshwater	CTUe	4.28E+01	4.63E-01	7.55E-04	8.16E-06	1.45E-05	1.57E-07
Particulate matter	disease inc.	3.29E-08	4.65E-10	5.53E-05	7.81E-07	4.95E-06	6.99E-08
Eutrophication, marine	kg N eq	2.01E-03	2.33E-05	1.03E-04	1.19E-06	3.05E-06	3.53E-08
Eutrophication, freshwater	kg P eq	3.36E-05	-7.06E-07	2.09E-05	-4.39E-07	5.85E-07	-1.23E-08
Eutrophication, terrestrial	mol N eq	1.23E-02	1.51E-04	6.95E-05	8.54E-07	2.58E-06	3.17E-08
Human toxicity, cancer	CTUh	1.35E-10	3.35E-12	7.81E-06	1.94E-07	1.66E-07	4.14E-09
Human toxicity, non-cancer	CTUh	7.69E-09	1.13E-10	5.97E-05	8.78E-07	1.10E-06	1.62E-08
Ionising radiation	kBq U-235 eq	2.49E-02	1.05E-03	5.89E-06	2.48E-07	2.95E-07	1.24E-08
Land use	Pt	2.07E+01	1.29E-01	2.53E-05	1.58E-07	2.01E-06	1.25E-08
Ozone depletion	kg CFC11 eq	2.25E-10	1.88E-11	4.31E-09	3.58E-10	2.72E-10	2.26E-11
Photochemical ozone formation	kg NMVOC eq	9.38E-04	1.68E-05	2.29E-05	4.10E-07	1.10E-06	1.96E-08
Resource use, fossils	MJ	3.78E+00	9.99E-02	5.81E-05	1.54E-06	4.83E-06	1.28E-07
Resource use, minerals and metals	kg Sb eq	8.79E-08	-2.16E-09	1.38E-06	-3.39E-08	1.04E-07	-2.56E-09
Water use	m3 depriv.	1.30E+00	1.50E-02	1.14E-04	1.31E-06	9.68E-06	1.11E-07
Total	Pt					5.77E-05	8.44E-07

7.2. PEF profile

The user of the PEFCR shall calculated 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:

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

Together with the PEF report, the applicant shall develop an aggregated EF-compliant dataset of its product in scope. This dataset shall be made available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node). The disaggregated version may stay confidential.

7.3. Classes of performance

No additional technical information is required.

7.4. Additional environmental information

Practitioners should report additional environmental information as described in the European Commission (2021) PEF Guide. Additional environmental information should include the following (non-exhaustive list):

- Information on local/site-specific impacts on biodiversity. Biodiversity is relevant for pet food because animal, vegetable-based and fibre-based inputs are relevant. The PEFCR applicant shall report whether any of the ingredients are certified as organic and report the total mass percentage of the recipe that is certified organic;
- Information regarding the company work with social/environmental responsibility but also data about specific environmental characteristics of the product may be added; and
- Sustainability programs for pet food or ingredients/energy/packaging, etc., percentage that follows this sustainability program. (e.g., percentage of cardboard that is from a certified source or percentage of a fish ingredient that is from sustainable fisheries). In case the information is unknown, it shall be stated as such and considered as zero by default.

8. Verification

The verification of an EF study/report carried out in compliance with this PEFCR shall be done according to all the general requirements included in Section 8 of the PEF (2021)and the requirements listed below.

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

These requirements will remain valid until an EF verification scheme is adopted at the European level or alternative verification approaches applicable to EF studies/report are included in existing or new policies.

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:

- The verifier shall check if the correct version of all impact assessment methods was used. For each of the most relevant impact categories, at least 50% of the characterisation factors (for each of the most relevant EF impact categories) shall be verified, while all normalisation and weighting factors of all impact categories shall be verified. In particular, the verifier shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with.
- All the newly created datasets shall be checked for EF compliance (for the meaning of EF-compliant datasets refer to the PEF guidance, 2021). All the underlying data (elementary flows, activity data and sub-processes) shall be validated.
- The aggregated EF-compliant dataset of the product in scope (meaning, the EF study) is available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node/).
- For at least 70% of the most relevant processes in situation 2/option 2 of the DNM, 70% of the underlying data shall be validated. The 70% data shall including all energy and transport sub-processes if situation 2/option 2 applies.
- For at least 60% of the most relevant processes in situation 3 of the DNM, 60% of the underlying data shall be validated.
- For at least 50% of the other processes in situation 1, 2 and 3 of the DNM, 50% of the underlying data shall be validated.

In particular, it shall be verified for the selected processes if the DQR of the process satisfies the minimum DQR as specified in the DNM.

The selection of the processes to be verified for each situation shall be done by ordering them from the most contributing to the least contributing one and selecting those contributing up to the identified percentage starting from the most contributing ones. In case of non-integer numbers, one shall round up.

These data checks shall include, but should not be limited to, the activity data used, the selection of secondary sub-processes, 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 data type that could possibly be subject to the checks.

The verification of the EF report shall be carried out by randomly checking enough information to provide reasonable assurance that the EF report fulfils all the conditions listed in Section 8 of the PEF Guidance (2021).

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List of annexes

Annex I – 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 and are provided in Table 38 below.

The three classification levels are based on the ILCD Handbook "Recommendations for Life Cycle Impact Assessment in the European context" (JRC, 2011) and according to their quality:

- Level I: recommended and satisfactory
- Level II: recommended, but in need of some improvements
- Level III: recommended, but to be applied with caution
- The full list of characterization factors for EF 3.1 is available at this link: https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml
- Information on Normalization and Weighting factors available at this link:
- https://eplca.jrc.ec.europa.eu/permalink/EF3_1/Normalisation_Weighting_Factors_EF_3.1.xlsx

Table 38 Normalisation factors for EU-27 (2010) based on domestic inventory

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
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	II/III	III	III	
Human toxicity, non-cancer	CTUh	8.88E+05	1.29E-04	II/III	III	III	
Particulate matter	disease incidence	4.11E+06	5.95E-04	I	I/II	I/II	NF calculation takes into account the emission height both in the emission inventory and in the

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
							impact assessment
Ionising radiation, human health	kBq U235 eq	2.91E+13	4.22E+03	II	II	III	
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	
Freshwater ecotoxicity	CTUe	3.91E+14	5.67E+04	II/III	III	III	
Land use	Pt	5.65E+15	8.19E+05	III	II	II	The NF is built by means of regionalised CFs.
Water use	m3 world eq	7.91E+13	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
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			

*where CFs are characterization factors

Table 39 Weighting factors including toxicity impacts

With toxicity 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
Acidification	4.94	0.67	3.29	6.2
Climate change	12.9	0.87	11.18	21.06
Ecotoxicity, freshwater	6.12	0.17	1.02	1.92
EF-particulate matter	5.49	0.87	4.76	8.96
Eutrophication, freshwater	3.19	0.47	1.49	2.8
Eutrophication, marine	2.94	0.53	1.57	2.96
Eutrophication, terrestrial	2.95	0.67	1.97	3.71
Human toxicity, cancer	6.8	0.17	1.13	2.13
Human toxicity, non-cancer	5.88	0.17	0.98	1.84
Ionising radiation	5.7	0.47	2.66	5.01
Land use	9.04	0.47	4.22	7.94
Ozone depletion	5.58	0.6	3.35	6.31
Photochemical ozone formation	4.76	0.53	2.54	4.78
Resource depletion, fossils	7.37	0.6	4.42	8.32
Resource depletion, minerals and metals	6.68	0.6	4.01	7.55
Water use	9.69	0.47	4.52	8.51

Annex II – Checklist for the PEF study

Each PEF study shall include this Annex with Table 40 completed with all the requested information.

Table 40 PEF study checklist

Item	**Included in the study (Y/N)**	**Section**	**Page**
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			
List of secondary datasets used			

Item	Included in the study (Y/N)	Section	Page
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 III – Critical PEFCR Review Report

Annex III is provided as the following document which includes all findings of the review process and the actions taken by the TS to answer the reviewer comments:

- Pet Food PEFCR light update review comments overview Annex III.xlsx

Annex IV – LCI data

Annex IV is provided as the following document:

- PEFCR_PetFood_FinalPEFCRs_AnnexIV-LCI Data 25-07-2024

This Excel file includes the following:

- a comprehensive list of secondary datasets in the foreground and background systems to be used if applicable for the product in question;
- the generic data that shall be used for each process for each life cycle stage if no primary data are available;
- the DQR ratings for each dataset used as well as the DQRs calculated for the four benchmarks; and
- information on the nodes to access all EF-compliant datasets.

Annex V – PEFCR development steps

The main steps taken to develop this PEFCR are as follows which are detailed in the European Recommendation 2021:

- Define the PEF product category scope and the scope of the PEFCR (started in November 2014)
- Define the product "model" based on representative product(s)
- Perform the PEF screening study (completed in August 2015)
- Develop draft PEFCRs (completed in September 2015)
- Perform PEFCR supporting studies for each product sub-category (completed in March 2016)
- Confirm the benchmark(s) after the remodelling exercise (completed in January 2018)
- Publish the final PEFCR (completed in May 2018)
- Updated recommendation of PEF methods (December 2021)
- Update of PEFCR (November 2023)

During the pilot testing phase, the European Commission set up various working groups, including the CMWG, to address cross-cutting issues. Additionally, pertinent issue papers were prepared based on Technical Advisory Board (TAB)-level consensus.

The CMWG was set up in July 2014 and consisted of a transversal group of experts including two representatives from each of the dairy, meat, leather, feed and pet food PEF pilots; the EC/DG-ENV; the European Commission JRC; the FAO; and the European Food Sustainable Consumption and Production Roundtable. More details on the allocation procedure are provided in Section 5.8.

A total of four supporting studies were conducted in compliance with the latest version of the PEF guide and with the draft PEFCR dated 8 March 2016; one for each sub-category in this PEFCR. The studies were concluded in March 2016 and two reports, one confidential and one non-confidential, were prepared for each PEF supporting study that was carried out.

The supporting studies were based on existing, real products and they were performed under the assumption that the results would be used for a PEFCR that could support comparisons or comparative assertions intended to be disclosed to the public.

The supporting studies were performed to:

- Test the draft PEFCR;
- Check the relevance of the identified the most relevant environmental impacts; and
- Check the relevance of the environmental performance of the representative products.

A total of four supporting studies were conducted, one for each sub-category in this PEFCR, in compliance with the version of the draft PEFCR "PEFCRs: Prepared Pet Food for Cats and Dogs" (dated 8 March 2016) and the requirements regarding data collection and the data quality assessment procedure described in Annex E of the "Guidance for the implementation of the EU PEF during the EF Pilot Phase, version 5.2" (European Commission, 2016). The studies were concluded in March 2016 and two reports, one confidential and one non-confidential, were prepared for each PEF supporting study that was carried out.

The supporting studies were based on existing, real products and they were performed under the assumption that the results would be used for a PEFCR that could support comparisons or comparative assertions intended to be disclosed to the public.

Details for the four products that were studied in each study are described in **Error! Reference source not found.**Table 41 below.

Table 41 Supporting study details

Information	C&D Foods	Purina	Saturn	Mars
Product type	Wet cat food	Dry cat food	Wet dog food	Dry dog food
Packaging	Steel can	Plastic bag	Steel can	Plastic bag
Product size	400 g	1.5 kg	1.24 kg	10 kg
Reference year	2015	2015	2014/2015	2015
Place of manufacture	Netherlands	France	Germany	Germany
Market	UK	France	Mainly Germany	Germany

The functional units and system boundaries considered follow the requirements of the draft PEFCR and include the full life cycle (cradle to grave) divided into the following life cycle stages: ingredients, packaging production, pet food manufacturing, distribution, use and packaging end-of-life.

Primary data were used for the ingredients, packaging materials, manufacturing and distribution data. Secondary data were used for the use and EOL stages as well as for pet food losses at retail and at the consumer's home.

The most relevant life cycle impact categories determined in all four supporting studies support the findings in the draft PEFCR and are listed below:

- Climate change (total: sum of the three sub-categories)
- Freshwater eutrophication
- Marine eutrophication
- Terrestrial eutrophication
- Land use
- Water resource depletion
- Mineral and fossil resource depletion

The most relevant life cycle stages for each supporting study compared to the findings from the screening study for the corresponding representative products (RPs) are shown in Table 42 below.

Table 42 Most relevant life cycle stage comparing screening and supporting study results

	Cat				Dog			
Type:	Wet		Dry		Wet		Dry	
Product:	RP	C&D	RP	Purina	RP	Saturn	RP	Mars
Ingredients	✓	✓	✓	✓	✓	✓	✓	✓
Packaging production	✓	✓			✓	✓		
Manufacturing								
Distribution	✓	✓	✓	✓	✓	✓	✓	✓
Use								
Packaging EOL								

When comparing the results of the screening study to the supporting studies, the following differences can be noted:

Wet cat food: C&D Foods

- Although the overall contribution per life cycle stage is similar, C&D Foods' wet cat food product has lower impacts compared to the wet cat representative product for 4/7 impact categories (higher impact on climate change, water resource depletion and mineral and fossil resource depletion).
    - Climate change, water resource depletion and mineral and fossil resource depletion impacts are all driven by tin plating.

Dry cat food: Nestlé Purina PetCare Europe

- Nestlé Purina's dry cat food product has lower impacts compared to dry cat representative product for 5/7 of the most relevant impact categories (higher impact on mineral and fossil resource depletion and land use). The overall contribution per life cycle stage is similar.
    - Land use impacts are driven by grain production.
    - Mineral and fossil resource depletion impacts are driven by retail activity.

Wet dog food: saturn petcare gmbh

- Saturn's wet dog food product has lower impacts compared to the wet dog representative product for 6/7 of the most relevant impact categories with the exception of land use however the overall contribution per life cycle stage is similar.
    - Land use impacts are driven by wheat production.

Dry dog food: Mars Petcare

- Mars Petcare Europe's dry dog food product has lower impacts compared to the dry dog representative product for 6/7 of the most relevant impact categories with the exception of land use however the overall contribution per life cycle stage is similar.
    - Land use impacts are driven by wheat production.

All the differences mentioned above are expected due to the different energy content of the products, the different BOIs, the difference in packaging materials used, and the different packaging sizes for each real product compared to the representative product.

With regards to implementing the draft PEFCR, the following modifications are recommended based on the findings of the 4 supporting studies that were conducted:

- The energy contents for the representative products may be overestimated; the TS might consider reanalysing how it was calculated and perhaps review the current baseline approach.
- Clearly indicate how ingredients that are not specifically listed in the PEFCR should be modelled with specific details for animal co-products.
- Clearly indicate how to handle moisture content for animal co-products.
- Make users aware that regionalisation for some datasets may significantly affect results: for example, wheat from Switzerland compared to wheat from the US could be very different from certain perspectives.
- Provide clear guidance on how to calculate packaging dimensions.
- Provide clear guidance on how to model tin plating, especially given its important contribution to the PEF.
- Verify the relevance and accuracy of default pet food losses (at manufacturing, retail and use stages) and update the PEFCRs if necessary and determine if they should be correlated to packaging types and sizes (not currently correlated).
- Make it clear when specific (i.e., national consumption) electricity mix shall be used when a product is sold on numerous markets for the following cases: in storage at warehouse and retail, at the consumer home and for electricity generation from packaging EOL incineration.

The findings were then used to improve the PEFCRs and make them more user-friendly for non-experts. The supporting study verifications will be complete by end 2016 and findings from the verification will be included in this PEFCR at a later date.