METHODOLOGY FOR PRODUCT CARBON FOOTPRINT CALCULATION

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Corporate FUCHS Document

CORPORATE FUCHS STANDARD

CF-S SUS 1.1 Methodology for Product Carbon Footprint Calculation

	Department / Organization / Name	Date	Signature
Issued	SUS / FPSE / M. Garb	27.01.2023	i.V.
Reviewed SUS	SUS / FPSE / T. Deffner	30.01.2023	i.A. Thomas Deffner
Reviewed QM	GQM / FPSE / C. Winkelmann	30.01.2023	i.A.
Approved	Member of the Executive Board (CTO) / FPSE / Dr. S. Heiner	31.01.2023	Heiner

CF-S SUS 1.1 Methodology for Product Carbon Footprint Calculation

Content

CF-S SUS 1.1 Methodology for Product Carbon Footprint Calculation

1 Purpose

This document is meant as technical instruction to help suppliers and LCA practitioners use, calculate or supply product carbon footprints from or to FUCHS. It is based on FUCHS' own methodology to calculate cradle-to-gate product carbon footprints according to ISO 14067:2018 and the GHG Protocol Product Standard and aims to ensure that only PCF data for raw materials are used, which are generated/calculated on a comparable basis. We ask our suppliers to adhere to the requirements given in this document.

2 Scope / Validity

This document is mandatory for **all** organizational units of FUCHS PETROLUB SE and FUCHS affiliates where FUCHS is the controlling shareholder (e.g., > 50%). For Joint Ventures and associated companies, where FUCHS owns ≤ 50%, the implementation of the Documentation Policy is recommended. Furthermore, the document is shared with customers and suppliers as a reference on the methodology applied to calculate the Product Carbon Footprint of FUCHS products and to outline the requirements to our suppliers for submitting raw materials' product carbon footprint ("RMCF") data for raw materials supplied to FUCHS.

This Document shall be considered and transposed into the local Management System ***with immediate effect.***

3 Terms and Abbreviations

Terms

Allocation	Practice of partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems.
Carbon Dioxide Equivalent	For easier assessment on the global warming effect of different Greenhouse Gases resulting from a process, GHG are often converted into CO_{2e}
Cradle-to-gate	Assessment scope which includes part of the product's life cycle, including material acquisition through the production of the studied product and excluding the use or end-of-life stages.
Cut-off	Omission of non-relevant life cycle stages, activity types, specific processes, products, and elementary flows from the system model (ILCD Handbook)
Functional Unit	Quantified performance of a product system for use as a reference unit (ISO14040:2006)
Gate-to-Gate	Assessment scope which includes part of the product's life cycle limited to the production of the studied product and excluding the acquisition of materials, the use or end-of-life stages. (WBCSD)
Greenhouse gas	Gases that contribute to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and chlorofluorocarbons are examples of greenhouse gases.
GHG emissions	Emissions from a process or system which release GHG into the atmosphere
GHG Protocol Product Standard	The Greenhouse Gas Protocol. Product Life Cycle Accounting and Reporting Standard
ISO 14067	Principles, requirements, and guidelines for the quantification and reporting of the carbon footprint of a product

Life Cycle Assessment	Compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle (ISO14040:2006)
Life Cycle Inventory	Compilation and quantification of inputs and outputs for a product throughout its life cycle (ISO14040:2006)
Life Cycle Impact Assessment	Evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (ISO14040:2006)
Product Carbon Footprint	Method for determining the climate impact of a product, considering the total GHG emissions and GHG removals caused to produce a product, expressed as carbon dioxide equivalent
(partial) PCF	Method for determining the climate impact of a product, considering the GHG emissions and GHG removals caused in selected stages or processes of the entire life cycle of a product, expressed as carbon dioxide equivalent. Selection of stages is expressed by describing the phases of the life cycle considered in the calculation (such as Cradle-to-Gate, Gate-to-Gate, etc.)
Reference flow	Measure of the outputs from processes in a given product system required to fulfill the function expressed by the functional unit (ISO14040:2006)
Scope 1 emissions	Direct GHG emissions or -equivalents (CO_{2e}) by FUCHS (e.g., process emissions, heat production, GHG leakages, …) acc. to GHG-Protocol
Scope 2 emissions	Indirect GHG emissions or -equivalents (CO_{2e}) resulting from the generation of energy purchased by FUCHS (e.g., electricity, steam) acc. to GHG-Protocol.
Scope 3 emissions	Indirect GHG emissions which originate upstream due to use of raw materials purchased from suppliers as well as indirect GHG emissions due to generation or extraction of fuels but also other non-energy-related indirect GHG emissions caused by the operation such as Waste Generation, Water Consumption, Business Travel etc.).
WBCSD chemical guidance	Guidance for Accounting & Reporting Corporate GHG Emissions in the Chemical Sector Value Chain

<u>Abbreviations</u>

API	American Petroleum Institute
CCF	Corporate Carbon Footprint
CO_2	Carbon Dioxide
CO_{2e}	Carbon Dioxide Equivalents
FPSE	FUCHS PETROLUB SE
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
ILCD	International Reference Life Cycle Data System
ISO	International Organization for Standardization
LCA	Life-Cycle Assessment
PCF	Product Carbon Footprint
RMCF	Raw Material (Product) Carbon Footprint for product supplied to FUCHS
WBCSD	World Business Council for Sustainable Development

Please see the “List of Terms and Abbreviations to be used in FUCHS Documents” on the SP_Global_myFUCHS (Corporate Documentation) for further terms and abbreviations.

4 Responsibilities

Document Responsible	Chief Sustainability Officer/FPSE

5 Content

5.1 Intention and Introduction

FUCHS is a supplier to many different industries. With increasing requirements on sustainability assured as a guiding principle in their supply chain, our customers expect transparency of Product Carbon Footprints of the FUCHS Portfolio. Different methodologies and assumptions in calculating product carbon footprints can lead to very different results, and, therefore, consistency and comparability of data provided to FUCHS are needed.
A high share of FUCHS’ Scope 3 emissions is GHG emissions related to the raw materials purchased from FUCHS’ suppliers.
Providing our customers with transparent and coherent PCF for products purchased from FUCHS (representing part of our customer’s Scope 3 emissions) is a decisive basis to identify and ultimately reduce GHG emissions alongside our shared supply chain. In order to achieve this, carbon footprint data are needed for the complete supply chain based on a consistent methodology.

5.2 Goal for PCF-Calculation

The application of this framework is to enable product carbon footprint calculation of all FUCHS products. The reason for providing this document is to achieve transparency about product carbon footprints of FUCHS’ products to support environmental decisions. The intended audience are both FUCHS suppliers and customers. Comparative assertions can be supported, but neither the methodology alone, nor the calculated PCFs are a suitable basis for comprehensive comparative assertions. Moreover, results should not be disclosed to the broader public. The above goal definition applies both to FUCHS and its suppliers.

5.3 FUCHS Methodology for PCF calculation

FUCHS has developed a methodology to calculate PCFs for its products based on ISO 14067:2018 and the GHG Protocol Product Standard.

5.3.1 Functional Unit

The functional unit is defined as the production and storage of 1 kg of a certain FUCHS Product with a specific set of properties, e.g., density or composition at the FUCHS outbound gate, excluding any packaging. Additional functions can be reported in the documentation but do not need to be considered for PCF calculation.

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5.3.2 Reference Flow / Declared Unit Definition

The declared unit for which FUCHS calculates the (partial) PCF of its own products is 1 kg of the finished unpackaged product. Accordingly, the reference flow of the respective production system is also 1 kg of the finished unpackaged product.

5.3.3 Product System and Scope of FUCHS PCF

The scope for FUCHS PCF calculation is Cradle-to-Gate, whereas "Gate" means FUCHS outbound gate in this context. The related product system includes all product-related GHG emissions from exploration of raw materials up to production and internal storage of the FUCHS product defined as Scopes 1, 2, and 3 by GHG-Protocol.

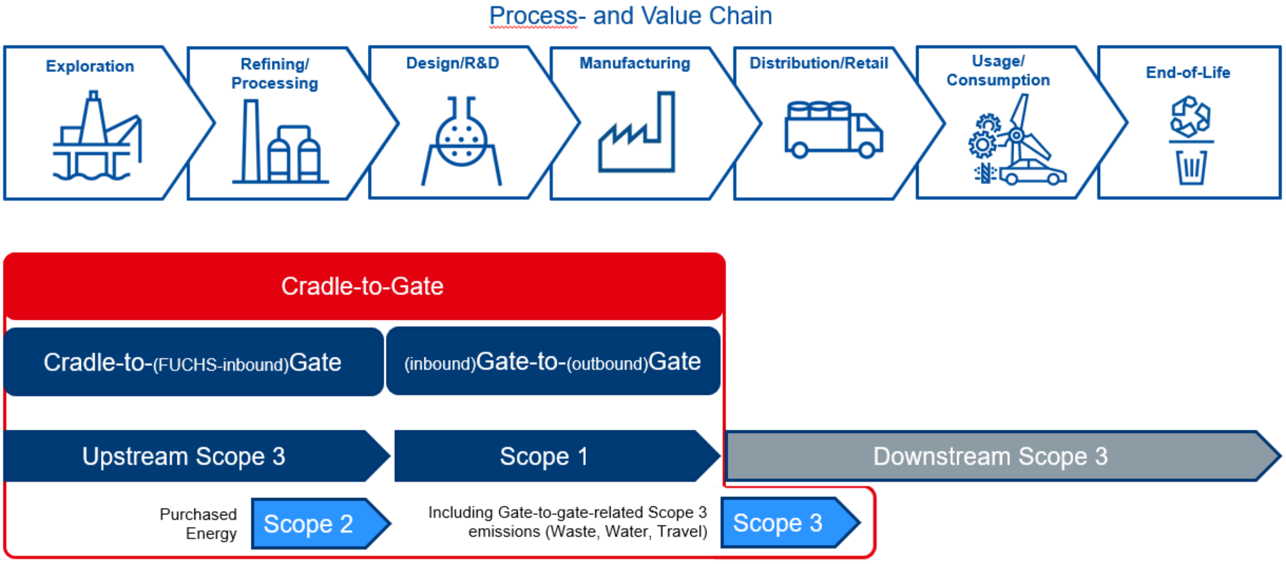

Figure 1: Scope of FUCHS PCF

The cradle-to-gate FUCHS PCF is calculated based on two main emission sources:

- Upstream scope 3 within the Cradle-to-(FUCHS-inbound-) Gate: summarizing all upstream GHG emissions resulting from the use of purchased raw materials needed to meet the defined reference flow of the product. These summarized GHG emissions also include average transportation-related emissions of raw materials in the upstream supply chain and to FUCHS.
- For the assessment of the emissions resulting from (inbound)Gate-to-(outbound)Gate activities, FUCHS collects internally related KPIs individually for each FUCHS-site and calculates the Gate-to-Gate-CCF based on these data:
  - Scope 1 within the (inbound) Gate-to-(outbound) Gate: summarizing all Gate-to-Gate GHG emissions originating from operations (production and storage) in the FUCHS-plants producing or storing the product. These data include direct emissions from combustion of fuels, process emissions and leakages, such as air-conditioning systems
  - Scope 2 directly related to (inbound) Gate-to-(outbound) Gate activities: summarizing all GHG emissions resulting from the production of energy purchased by FUCHS, such as steam and electricity.

- Scope 3 directly related to (inbound) Gate-to-(outbound) Gate activities, such as water consumption and wastewater treatment, waste generation in general, employee commuting, business travel and fuel-production related emissions for fuels used by FUCHS.

Based on the above product system and the related input data FUCHS calculates the following datasets based on ISO 14067:

- Sum of (partial) PCF: (partial) PCF_{fossil} + (partial) $PCF_{biogenic}$ + (partial) PCF_{dLUC}
  - (partial) PCF for FUCHS-Product including only fossil GHG emissions/removals in $kgCO_{2e}/kg$ product
  - (partial) PCF for FUCHS Product including only biogenic GHG emissions/removals in $kgCO_{2e}/kg$ product
  - (partial) PCF for FUCHS Product including only GHG emissions/removals occurring as a result of direct land use change (dLUC) in $kgCO_{2e}/kg$ product
- Biogenic carbon content in kgC/kg product

GHG emissions/removals occurring as a result of aircraft transportation do not need to be reported separately, as the relevance of the aircraft GHG emissions/removals in comparison to the total GHG emissions/removals is expected to be low, due to the low amount of air transportation for inputs and produced products.

5.3.4 System Boundaries FUCHS PCF

Included in FUCHS PCF	Excluded from FUCHS PCF
Raw Materials purchased	Packaging
Energy and Fuel Consumption	Outbound Transport
Waste Generation	Capital Goods and Infrastructure
Water Consumption and Wastewater	
Inbound Transportation	
General FUCHS Overhead (e.g. employee commuting / business travel)	

In the system boundaries used to calculate FUCHS PCFs, some parts of the system are excluded: First, the packaging of the finalized product is neglected because many products are sold in different packaging sizes or even bulk, resulting in different carbon footprints for the packaging. Additionally, outbound transport is excluded from the system boundaries, as FUCHS delivers their products to different costumers in different locations in the world, leading to different transportation distances and thus, different carbon footprints for the outbound transportation. Therefore, a case-by-case assessment would be necessary for a particular costumer of FUCHS. Moreover, emissions stemming from capital goods and infrastructure are usually not considered to be significant for the overall PCF by life cycle assessment experts. For this reason, the capital goods and infrastructure are neglected in the system boundaries to calculate FUCHS PCFs. An exception to this is the general overhead: As FUCHS collects data on general overheads (e.g. scope 3 commuting, business travel), FUCHS includes the general overhead in the system boundaries for the sake of transparency, even if the relevance for the total GHG emissions/removals might be below the cut-off threshold.

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If data are available for excluded parts of the system, these parts can optionally be included in the system boundaries to make the assessment more comprehensive. In this case, it must be reported in detail, which parts have additionally been included in the system boundaries.

5.3.5 Other Reporting

For customer information, FUCHS also calculates the remaining product related GHG emissions after deducting any reported compensation or neutralization measures in the upstream supply chain and at FUCHS. Considering compensation or neutralization effects is explicitly outside the ISO 14067 but necessary to offer transparency to our customers who eventually strive to compensate for their product-related emissions and want to avoid double compensation:

- “Remaining GHG emissions” comprising the above sum of product-related GHG-emissions/removals in kgCO_{2e}/kg product but DEDUCTING compensation or neutralization measures in the upstream supply chain or at FUCHS

5.4 Resulting Requirements for submission of Raw Material’s (Product) Carbon Footprint by suppliers

5.4.1 Functional Unit

The functional unit is defined as the production of 1 kg of a certain raw material with a specific set of properties, e.g. density or composition, excluding any packaging, delivered at FUCHS inbound gate (including average transport GHG emissions to FUCHS).
Example: 1kg of Baseoil, API Group III, with a kinematic viscosity of 4cSt at 100°C“

Additional functions should be reported in the material documentation but do not need to be considered for PCF calculation.

5.4.2 Reference Flow/ Declared Unit Definition

The declared unit for which the PCF of raw materials shall be determined is 1 kg of unpackaged raw material purchased by FUCHS. Accordingly, the reference flow of the respective production system is also 1 kg of unpackaged raw material purchased by FUCHS.

5.4.3 Product System (Raw Material)

The scope for raw material PCF calculation shall be Cradle-to-Gate, whereas “Gate” means FUCHS inbound gate (delivered) in this context. The related product system includes all product-related GHG emissions from exploration/extraction of raw materials, transportation in the raw materials upstream supply chain, refining up to the production of the purchased raw material, including storage and transportation to FUCHS-inbound Gate defined as Scopes 1, 2 and 3 by GHG-Protocol. The scope of the raw material product system is similar to the scope of the FUCHS product system (cf. Section 5.3.3), with the exception that the transport from the supplier's outbound gate to the FUCHS inbound gate is also taken into account in the raw material product system.

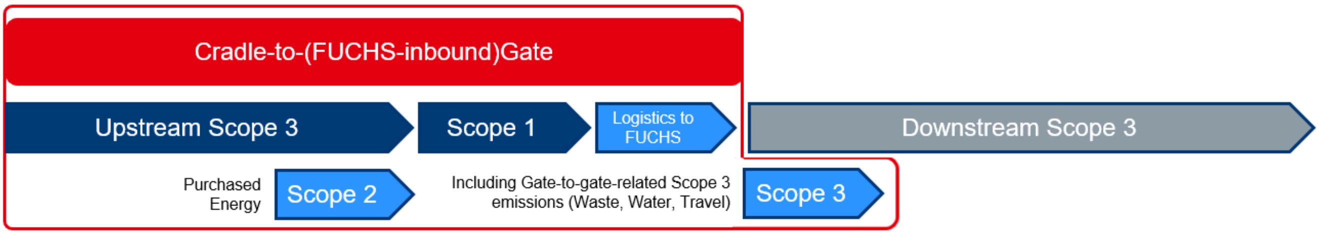

Figure 2:Scope of Supplier PCF

According to the current version of the ISO 14067, biogenic and direct land use change GHG emissions and/or removals should be reported separately in the product carbon footprint report.

FUCHS requests for each raw material, separately for each FUCHS-location supplied

- Sum of (partial) PCF: (partial) PCF_{fossil} + (partial) $PCF_{biogenic}$ + (partial) PCF_{dLUC}
  - (partial) PCF for raw material used by FUCHS including only fossil GHG emissions/removals in $kgCO_{2e}$/kg raw material
  - (partial) PCF for raw material used by FUCHS including only biogenic GHG emissions/removals in $kgCO_{2e}$/kg raw material
  - (partial) PCF for raw material used by FUCHS including only GHG emissions/removals occurring as a result of direct land use change (dLUC) in $kgCO_{2e}$/kg product
- Biogenic carbon content in kgC/kg raw material

GHG emissions/removals occurring as a result of aircraft transportation do not need to be reported separately, as the relevance of the aircraft GHG emissions/removals in comparison to the total GHG emissions/removals is expected to be low, due to the low amount of air transportation for inputs and produced products.

5.4.4 Other Reporting

FUCHS requests for each raw material

- “Remaining GHG emissions” comprising the above sum of product related GHG emissions/removals in $kgCO_{2e}$/kg but DEDUCTING compensation or neutralization measures which have been accounted for in the upstream supply chain prior to FUCHS in $kgCO_{2e}$/kg raw material. Compensation/neutralization shall only be considered if the evidence (decommissioned climate protection certificates, certification for climate protection projects, etc.) is available to the FUCHS Supplier and is based on primary data.
- Recycled Content of product from waste streams or used products in kg/kg raw material

5.4.5 System Boundaries

Included in Supplier PCF	Excluded from Supplier PCF
Raw Materials purchased	Packaging
Energy Consumption	Capital Goods and Infrastructure
Waste Generation	General Overhead (e.g. employee commuting / business travel)

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Water Consumption and Wastewater	
Inbound Transportation to FUCHS	
Transportation at and between Supplier and Pre-suppliers	

In the system boundaries used to calculate the raw material PCFs, some parts of the system are excluded: Firstly, the packaging of the raw materials delivered to FUCHS is neglected because many raw materials are sold in different packaging sizes or even bulk, resulting in different carbon footprints for the packaging. Therefore, a case-by-case assessment would be necessary for a particular delivery batch to FUCHS. Moreover, emissions stemming from capital goods and infrastructure are usually not considered to be significant for the overall PCF by life cycle assessment experts. For this reason, the capital goods and infrastructure are neglected in the system boundaries to calculate the raw material PCFs. Moreover, the general overhead (e.g. employee commuting, business travel) is excluded from the system boundaries because the relevance for the total GHG emissions/removals is expected to be low compared to the total GHG emissions and because the general overhead is not directly linked to the production activities of the product under study.

If data are available for excluded parts of the system, these parts can optionally be included in the system boundaries to make the assessment more comprehensive. In this case, it must be reported in detail, which parts have additionally been included in the system boundaries.

5.5 Cut-offs

FUCHS acknowledges that there is an unlimited number of processes linked to a product system, and therefore, it is difficult (or impossible) to gather process-specific data for all processes. The widely accepted method to mitigate this challenge is the cut-off of not relevant processes / raw material inputs.

Acceptable cut-off criteria are:

- Neglect flow contribution to less than
  - 1% of mass per single raw material but maximum of 5% cumulated
  - 1% of energy per single raw material but maximum of 5% cumulated

  of environmental relevance to the product system
- Where data are available, these should be included, even if a flow's contribution to the carbon footprint of a product is not relevant as per the above threshold.
- Consider expert guesses, the studied environmental impacts and the studied region of the LCA study to quantify the relevance of an environmental flow
- Production capital and overhead is typically neglected

5.6 Requirements on data generation and submission: Life Cycle Inventory

5.6.1 Data quality requirements

For data collection, there are different approaches for different types of data. FUCHS differentiates between primary and secondary data collection:

- Primary data: Data collected due to actual measurements or company own data must be minimum based on data acquired over the previous calendar year but also can be averaged over up to the last 5 years. Use of primary data is mandatory for in-house processes (under control or owned by the supplier).

- Secondary data: Data collected from secondary data sources, e.g., LCA databases. Use of secondary data is not allowed for in-house processes (under control or owned by the supplier).

All primary and secondary data should be specified according to their quality. FUCHS' suggestion for data quality indicators is listed in the table below:

Technological representativeness	Chemicals can often be produced by different production technologies using different reaction pathways and plant designs. Therefore, data from actual production plants that are relevant for the studied product should be used.
Geographical representativeness	Chemical production chains differ among regions. Datasets which reflect the true population of interest regarding geography should be used.
Time-related representativeness	Datasets should reflect the specific conditions of the system being considered regarding the time/age of the data. Therefore, the most recent data should be used and possibly not older than 3 years. Data should cover at least 12 months to avoid seasonal changes.
Completeness	Completeness indicates to which degree relevant flows are covered by a specific dataset. Completeness refers to both technical flows and elementary flows throughout the production chain. Completeness can be achieved by correct data collection and by following the recommendations for cut-offs.
Reliability	Data obtained from measurements of site-specific production data and detailed modeling lead to more reliable results. Simplified process calculations and assumptions lead to less reliable data sets.
Methodological Appropriateness and Consistency	Methodological consistency is crucial for comparable LCA results. Therefore, all datasets in a study should be compiled based on the same, consistent methodology described in this document if not stated otherwise.

The data quality matrix in the table below is a guidance for the determination of the data quality indicators and data quality levels:

Quality level	1 - Very good	2 - Good	3 - Fair	4 - Poor
Technological representativeness	Generated data corresponds to the same production technology as used in the actual production plant.	Generated data corresponds to a different, but similar, production technology than used in the actual production plant.	Generated data corresponds to a different production technology than used in the actual production plant.	Generated data corresponds to an unknown production technology.

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Geographical representativeness	Specific data from the same area,only state-specific or country-specific averages, but no region-specific averages such as European average.	Data from a similar area, or from the same area using a region-specific average such as European average.	Data from a different area.	Data from an unknown area.
Time-related representativeness	Representativeness has been checked and confirmed within the last 3 years.	Representativeness has been checked and confirmed within the last 6 years.	Representativeness has been checked and confirmed within the last 10 years.	Representativeness has been checked and confirmed more than 10 years ago, or the representativeness and age of data is unknown.
Completeness	All relevant processes have been measured or modeled at a high level of detail.	The majority of processes have been measured or modeled at a high level of detail.	Less than 50 percent of relevant processes have been measured or modeled at a medium level of detail. It is possible that some relevant flows are missing.	Less than 50 percent of relevant processes have been measured or modeled at a low or unknown level of detail. Relevant flows are missing.
Reliability	The dataset is fully based on measurements at all relevant production sites (primary data). The data have been verified.[1]	The dataset is based on detailed verified process simulations or non-verified measurements.	The dataset is based on simplified process calculations, non-verified assumptions or qualified estimates by experts.	The dataset is based on non-qualified estimates.
Methodological appropriateness and consistency	3rd party verification of the compliance with a defined methodology or standard based on (at least) spot checks.	Dataset is compliant with the methodology specified in this document.	Requirements specified in ISO 14067 and this document are mainly met.	Requirements specified in ISO 14067 and this document are only partly met.

[1] Verification can be carried out, e.g., by on-site checking, by additional modelling, through mass, energy, and elementary balances or by cross-checking with other sources.

5.6.2 Collection of primary data

For Scope 1 GHG emissions (GHG emissions due to processes run by the company itself), the company should collect company-specific primary data for each site. Collected primary data should be validated:

- Comparisons with other data sources
- Check against scientific laws (Conservation of mass, Conservation of energy, increasing entropy of interacting thermodynamic systems, stoichiometric relationships)
- Check against data requirements

Also Scope 1, 2 and 3-GHG emissions can be based on primary data if the supplier provides its product carbon footprints according to ISO 14067

5.6.3 Secondary data

For Scope 3 data, the following secondary data sources exist

- Databases: GaBi, ecoinvent, Carbon Minds, NREL, PlasticsEurope, etc.
- LCA studies and scientific literature

The source of secondary data must be reported. FUCHS requests the following data collection hierarchy (applicable for scope 1, 2, and 3) in order to calculate raw materials' PCF:

1. If available, use data from PCF-calculations of your suppliers (for raw materials). Data from suppliers can be checked and validated by several means, e.g. by on-site checking, by additional modelling, through mass, energy, and elementary balances, or by cross-checking with other sources. All PCF calculations from suppliers are subjected to a plausibility check by Fuchs. In addition, Fuchs plans to establish a standard process for checking PCF calculations from suppliers in the future.
2. If primary data are not available, use secondary data (as specific as possible): Use the best specific secondary data that are available on the market (most specific data for region, technology, and chemical) or even supplier-specific datasets based on secondary modeling.

5.6.4 Allocation

Allocation is accepted to solve multifunctionality problems (see Glossary for more info). Allocation significantly determines the result. Therefore, the strict allocation hierarchy specified by the ISO standards for LCA and PCFs as repeated below (always refer to the actual versions of ISO 14040 and 14067) should be adhered to:

1. <u>Subdivision</u>:
   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
2. <u>System Expansion:</u>
   Expanding the product system to include the additional functions related to the coproducts. A typical application for system expansion is energy recovery.
3. <u>Allocation according to other relationships:</u>
   Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions. This is typically allocation by energy (for products used as fuels), mass, or volume (for gases). In accordance with the WBCSD chemical guidance for accounting and reporting of corporate GHG emissions, allocation by economic value should only be performed if

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the unit price of the outputs diverges with more than 20%. Otherwise, allocation according to physical relationships by mass or energy should be performed.

Thus, we recommend the following allocation for plant-specific data at our suppliers (under control or owned by the supplier):

Intermediate flow	Allocation procedure
Energy	Allocation by mass
Raw materials	Allocation by physical relationships, e.g., formulations
Waste	Allocation by mass
Utilities	Allocation by physical relationships

Besides allocation for inputs and outputs, also an allocation for End-of-Life of production waste needs to be considered. For End-of-Life Allocation, there are 2 main methods commonly used in LCA for end-of-life recycling:

- **Cut-off approach:**
  Burdens/credits from recycled material are not considered, they are "cut-off". Input of recycled material into a production process is thus considered to be free of burdens.
  FUCHS uses cut-off approach for allocation of emissions on its own recycled flows and expects from its suppliers to apply the same principle. For the sake of clarification, the cut-off approach can only be applied to physical flows that are verifiably recycled.
- **Substitution approach:**
  Recycled material is considered as a substitute for an equivalent amount of virgin material. Thus a credit is given to a recycled material.

5.6.5 Modeling of waste and wastewater

The following hierarchy should be applied when modeling waste or wastewater. For determination of GHG emissions from waste treatment, FUCHS differentiates the following cases:

- Waste for material recovery: see chapter 5.7.4 (if the recommended cut-off approach is applied, no GHG emissions are to be allocated). For the avoidance of doubt, physical flows that are treated in a waste incinerator with energy recovery should be modeled acc. to substitution approach (see next bullet point).
- Waste for thermal energy and electricity recovery:
  - 100% conversion to CO_{2e} based on carbon content
  - CO_{2e} credit for thermal energy and electricity production may be considered
  - CO_{2e} from fuel needed for combustion process may be considered
- Waste to incineration:
  - 100% conversion to CO_{2e} based on carbon content
  - CO_{2e} from fuel needed for combustion process may be considered
- Waste to underground landfill: no GHG emissions to be allocated
- Waste to surface landfill: 100% conversion to CO_{2e} based on carbon content

For determination of GHG emissions from wastewater treatment:

- If the Total Organic Carbon load of the processes is known:
  - 100% conversion to CO_{2e} based on carbon content
  - Utilities for treatment of wastewater and sludge incineration to be included

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5.7 Life Cycle Impact Assessment

During the Life Cycle Impact Assessment (LCIA), all elementary flows are attributed with their specific influence on one particular environmental impact. By this means, the overall contribution of several elementary flows to one particular environmental impact can be calculated.

For product carbon footprint calculations, the latest IPCC method for climate change (indicator: GWP 100a) should be applied.

Climate Change (indicator: GWP 100a):

- Climate change takes into account relevant GHG emissions
- The resulting global warming impact is expressed in kg CO_2 equivalents
- The exact characterization factors quantifying the influence of each elementary flow to climate change according to the latest IPCC (indicator: GWP 100a) are listed in the Appendix A.
- Most relevant GHG emissions are:
  - CO_2 – carbon dioxide
  - CH_4 – methane
  - N_2O – nitrous oxide
  - HFCs – Hydrofluorocarbons
  - PFCs – Perfluorocarbons
  - SF_6 – Sulphur hexafluoride

Biogenic GHG emissions:
For product carbon footprint calculations, biogenic GHG emissions need to be reported specifically. In order to quantify biogenic GHG emissions, the biogenic and fossil carbon content within a chemical need to be tracked.

GHG emissions due to direct land use change:
For product carbon footprint calculations, GHG emissions due to direct land use change need to be reported specifically.

Similar to fossil GHG emissions, biogenic GHG emissions and GHG emissions due to direct land use change should be taken into account when calculating the global warming impact according to the IPCC method:

- For biogenic CO_2-uptake, -1 kg CO_{2e}/kg CO_2 is used as characterization factor
- For biogenic CO_2-emissions, +1 kg CO_{2e}/kg CO_2 is used as characterization factor
- For CO_2 stored in biomass stock or soil, -1 kg CO_{2e}/kg CO_2 is used as characterization factor
- For CO_2 taken from biomass stock or soil, +1 kg CO_{2e}/kg CO_2 is used as characterization factor

GHG emissions/removals occurring as a result of aircraft transportation do not need to be reported separately, as the relevance of the aircraft GHG emissions/removals in comparison to the total GHG emissions/removals is expected to be low, due to the low amount of air transportation for inputs and produced products.

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5.8 Sensitivity analysis, quality checks and interpretation

Important points for evaluation and interpretation of the results are:

Completeness check:

- All relevant data and information available and complete?
- Data collection in line with goal and scope?

Sensitivity analysis

- Identify effect on the result if one input parameter is changed in the modeling
- Parameters can be:
  - other dataset for raw material
  - other allocation rules applied
  - other cut-off criteria
  - other goal and scope definition: different boundaries and system definition
  - other assumptions concerning input data
  - other impact category selected

Quality check:

- Check the quality of the LCI and LCIA by checking:
  - Energy balances of single processes or overall production systems
  - Mass balances of single processes or overall production systems
  - Elementary balances by doing stoichiometric calculations
  - Direct process GHG emissions by checking e.g., carbon balance
  - Quality of secondary datasets by considering different data quality indicators (see Section 5.7.1)
  - Compare benchmark of LCIA results against own calculations and identify reasons for deviations between benchmark and own calculations

Interpretation:

- Based on analysis, quality check, and completeness check, generate conclusions, limitations and recommendations for product carbon footprint study or LCA study → full transparency

5.9 Reporting of a raw material's product carbon footprint to FUCHS

Important data that should be included in the report of the product carbon footprint or LCA are:

- Name of supplier
- Product name
- Facility of production including location
- Allocation procedure
- System boundaries
- Functional unit
- Raw Material Carbon Footprint (RMCF) data (separately for each FUCHS-location supplied)
    - Sum of (partial) PCF: (partial) PCF_{fossil} + (partial) $PCF_{biogenic}$ + (partial) PCF_{dLUC}
        - (partial) PCF for raw material used by FUCHS including only fossil GHG emissions/removals in $kgCO_{2e}$/kg raw material
        - (partial) PCF for raw material used by FUCHS including only biogenic GHG emissions/removals in $kgCO_{2e}$/kg raw material
        - (partial) PCF for raw material used by FUCHS including only GHG emissions/removals occurring as a result of direct land use change (dLUC) in $kgCO_{2e}$/kg product
    - Biogenic carbon content in kgC/kg raw material
    - Recycled Content of product [kg/kg raw material]
- "Remaining GHG emissions" comprising the above sum of product related GHG-emissions/removals in $kgCO_{2e}$/kg raw material but DEDUCTING
    - Compensation or neutralization measures which might have been evidently accounted for in the upstream supply chain prior to FUCHS in $kgCO_{2e}$/kg raw material. A corresponding proof of the compensation or neutralization measure must be disclosed.
    - Data quality for primary and secondary data (cf. Section 5.6.1):
    - Technological representativeness
    - Geographical representativeness
    - Time-related representativeness
    - Completeness
    - Reliability
    - Methodological Appropriateness and Consistency
        - Was a specific product category rule (PCR) applied to the study?
        - Who conducted the PCF study? Internal/external
- Is there an internal methodology document? If yes, please supply document
    - If external: Please provide PCF service
        - Have the methodology and/or datasets been reviewed or certified?
        - Data sources of primary and secondary data
        - Additional comments

CF-S SUS 1.1 Methodology for Product Carbon Footprint Calculation

5.10 Limitations and Assumptions

This document describes the Fuchs methodology to calculate cradle-to-gate product carbon footprints according to the ISO 14067:2018 and the GHG Protocol Product Standard. The methodological choices are described in detail in this document, and the corresponding assumptions and limitations are specified in the respective chapters of this document. Nevertheless, it should be noted that PCFs calculated according to this document are not a suitable basis for comprehensive comparative assertions on environmental impacts.

6 Other Valid Documentation

- Actual version of ISO 14067
- Greenhouse Gas Protocol Product Standard

7 Appendix

7.1 Appendix A: Characterization factors for climate change according to IPCC

See separate document CF-S_SUS_1.1_Methodology_for_PCF_Calculation_Annex A

8 Change History

Revision	Changes to previous version
0	Initial Release – no changes
1	Editing and Amendment acc. to TÜV Rheinland Review

The given methodology is subject to changes and updates as the expert discussion or standards evolve. The document will be monitored regularly to determine if any updates to the document are required. The document lifecycle as well as mandatory change management is defined in the FUCHS Corporate Policy CF-P GQM 0.1 Documentation Structure.