CATENA-X
STANDARD

CX – 0029 PRODUCT CARBON FOOTPRINT RULEBOOK

BUSINESS DOMAIN: SUSTAINABILITY

USE CASE: SUSTAINABILITY

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Note: Please specify the platform capability in the subject line

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RELEASE HISTORY

Version	Release Date	Description
1.0.0	30. November 2022	Initial version by Catena – X Association

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Glossary

Term	Definition	Source
Allocation	Partitioning the input or output flows of a process or a product system between the product system under study or more other product systems	DIN EN ISO 14040, Feb. 2021, S. 12
Attributable process	Those processes that consists of all service, material and energy flows that become, make and carry a product throughout its life cycle.	Pathfinder
Biogenic carbon	Carbon derived from biomass	DIN EN ISO 14067, Feb. 2019, S.29
Carbon dioxide compensation	Investments outside the relevant product system, e.g. in renewable energy technologies, energy efficiency measures, afforestation/reforestation; According to DIN EN 14067 not to consider product carbon footprinting.	
Carbon offsetting	Mechanism for compensating for all or a part of the PCF or the partial PCF through the prevention of the release of, reduction in, or removal of an amount of GHG emissions in a process outside the product system under study. Carbon dioxide compensation must be reported separately.	DIN EN ISO 14067, Feb. 2019, S.18
Closed-loop recycling	In a closed loop, the secondary material from one product system is either reused in the same product system (real closed-loop) or used in another product system without changing the inherent properties of the material (quasi closed-loop).	
CO_2e (carbon dioxide equivalent)	Unit for comparing the radiative forcing of a greenhouse gas to that of carbon dioxide.	DIN EN ISO 14067, Feb. 2019, S. 20
Co-product	Any of two or more products coming from the same unit process or product system.	DIN EN ISO 14067, Feb. 2019, S.22
Cradle-to-gate PCF	Part of a product's full life cycle, covering all emissions allocated to a product upstream of a company plus all emissions resulting from processes within the company until the product leaves the suppliers' gate.	Pathfinder
Cut-off criteria	Specification of the amount of material or energy flow or the level of significance of GHG emissions associated with unit process or the product system, to be excluded from a PCF study	DIN EN ISO 14067, Feb. 2019, S.24
Declared unit	Quantity of a product for use as a reference unit in the quantification of a partial PCF. Alternative: Unit of analysis chosen for PCF, which serves as the reference to which the inputs (materials and energy) and	

Term	Definition	Source
	outputs (such as products, by-products, waste) are quantified.	
Direct emissions	GHG emissions from the processes that are owned or controlled by the reporting company.	Pathfinder
Downstream emissions	Indirect GHG emissions that occur in the value chain following the processes owned or controlled by the reporting company.	Pathfinder
End-of-waste	The end-of-waste state for waste in Europe is reached when the material is no longer considered a waste under the national implementation of the Waste Framework Directive.	EN 15804
Functional unit	Quantified benefit of a product system for use as a comparison unit.	
Global warming potential (GWP)	Index, based on radiative properties of GHGs, measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO2)	DIN EN ISO 14067, Feb. 2019, S.21
Greenhouse gases (GHGs)	Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds.	DIN EN ISO 14067, Feb. 2019, S. 19
ILCD Format	International Life Cycle Data Format	
Input	Product, material or energy flow that enters a unit process.	Pathfinder
Land use	Human use or management of land within the relevant boundary	DIN EN ISO 14067, Feb. 2019, S.30
Life cycle	Consecutive and interlinked stages related to a product, from raw material acquisition or generation from natural resources to end-of-life treatment.	DIN EN ISO 14067, Feb. 2019, S. 25
Life cycle assessment (LCA)	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.	DIN EN ISO 14067, Feb. 2019, S. 25
Life cycle emissions	The sum of GHG emissions resulting from all stages of the life cycle of a product and within the specified boundaries of the product.	Pathfinder
Life cycle inventory (LCI)	The phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle (such as a product's GHG emissions and sources).	DIN EN ISO 14067, Feb. 2019, S.25
Life cycle inventory results	GHG impact of the studied product per unit of analysis.	Pathfinder

Term	Definition	Source
Material	Physical products supplied from a supplier upstream, used as input for production processes of products.	Pathfinder
Multi-input-output unit process	Operation or process with multiple inputs, such as materials and energy, and multiple outputs, such as co-products and waste.	Pathfinder
Negative emissions	Removal of greenhouse gases (GHGs) from the atmosphere by deliberate human activities, i.e. in addition to the removal that would occur via natural carbon cycle processes.	IPCC glossary
Net negative emissions	A situation of net negative emissions is achieved when, as result of human activities, more greenhouse gases are removed from the atmosphere than are emitted into it. Where multiple greenhouse gases are involved, the quantification of negative emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).	IPCC glossary
Net zero CO2 emissions	Net zero carbon dioxide (CO_2) emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period. Net zero CO_2 emissions are also referred to as carbon neutrality.	IPCC glossary
Net zero emissions	Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).	IPCC glossary
Open-loop recycling	In open-loop recycling, the material is reused in other product systems and its inherent properties are changed (e.g. recycled material may have a different chemical composition, a different structure or a higher concentration of dissolved impurities compared to primary material).	
Output	Product, material or energy that leaves a unit process.	Pathfinder
Paris Agreement	The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is “Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels”, recognizing that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the	IPCC Glossary

Term	Definition	Source
	ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020.	
Partial PCF	Sum of GHG emissions and GHG removals of one nor more selected process(es) in a product system, expressed as carbon dioxide equivalents and based on the selected stages or processes within the life cycle.	DIN EN ISO 14067, Feb. 2019, S.16
Primary data	Quantified value of a process or activity resulting from a direct measurement or a calculation based on direct measurements. Primary data may include GHG emission factors and/or GHG-related activity data. Alternative: Data pertaining to a specific product or activity within a company's value chain. Such data may take the form of activity data, emissions or emission factors. Primary data is site-specific, company-specific (if there are multiple sites for the same product) or supply chain–specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material or product balances, stoichiometry or other methods for obtaining data from specific processes in the value chain of the company. A single calculation might include both primary and secondary data. For example, calculating emissions from the consumption of electricity could involve primary activity data, such as data on consumption in kWh, multiplied by a secondary emission factor provided by national GHG inventories representing GHG emission intensity (CO_2e per kWh).	Pathfinder
Process	Set of interrelated or interacting activities that transforms inputs into outputs	DIN EN ISO 14067, Feb. 2019, S.23
Product	Any good (tangible product, such as material) or service (intangible product).	Pathfinder
Product carbon footprint (PCF)	Total GHG emissions generated during the life cycle of a product, measured in CO_2e. Within the boundary of the CX PCF Rulebook, emissions related to the product use and end-of-life stages are excluded from the PCF.	Pathfinder
Product category	Group of products that can fulfill equivalent functions.	Pathfinder
Product category rules (PCR)	A set of specific rules, requirements and guidelines for calculating PCFs (among other things) and developing environmental declarations for one or more product categories according to EN ISO 14040:2006.	Pathfinder
Product system	Collection of unit processes with elementary flows, performing one or more defined functions and which models the life cycle of a product	DIN EN ISO 14067, Feb. 2019, S.22
Raw materials	Primary or secondary material used to produce a product.	Pathfinder

Term	Definition	Source
Reference flow	Measure of the inputs to or outputs from processes in a given product system required to fulfil the function expressed by the functional unit.	DIN EN ISO 14067, Feb. 2019, S.24
Representative product	Definition necessary because cut-off screening is performed on it as an example.	
Risk management	Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences.	IPCC Glossary, S. 45
Secondary data	Secondary data can include data from databases and published literature, default emission factors from national inventories, calculated data estimates or other representative data, validated by competent authorities.	DIN EN ISO 14067, Feb. 2019, S.28
Supplier gate	Supplier's production site or supplier's distribution site, as the case may be.	
Supply chain	Those involved, through upstream and downstream linkages, in process and activities relating to the provision of products to the user.	DIN EN ISO 14067, Feb. 2019, S.28
Sustainability	A dynamic process that guarantees the persistence of natural and human systems in an equitable manner.	IPCC Glossary, S. 49
System boundary	Boundary based on a set of criteria representing which unit processes are a part of the system under study	DIN EN ISO 14040, Feb. 2021, S. 13
Unit process	Smallest element considered in the life cycle inventory analysis for which input and output data are quantified	DIN EN ISO 14067, Feb. 2019, S.23
Upstream emissions	Indirect GHG emissions that occur in the value chain prior to the processes owned or controlled by the reporting company. All upstream transportation emissions are also included as part of upstream emissions.	Pathfinder
Use phase	That part of the life cycle of a product that occurs between the transfer of the product to the consumer and the end-of-life of the product.	Pathfinder
Value chain	All the upstream and downstream activities associated with the operations of a company.	Pathfinder
Waste	Materials, co-products, products, or emissions without economic value that the holder intends or is required to dispose of.	DIN EN ISO 14067, Feb. 2019, S.26; Pathfinder

1 INTRODUCTION

1.1. AUTOMOTIVE INDUSTRY AND THE CLIMATE CRISIS

The automotive industry is a customer-facing industry with high visibility and at the cutting-edge of climate action and is a solution-provider to the current climate crisis driving the transition towards low-emission mobility. Nevertheless, the global challenge to reduce GHG emissions also requires the automotive industry to measure its GHG emissions as well as any emissions reductions. Measuring GHG emissions for vehicles is a challenge, due to the enormous complexity of the internationally operating automotive supply chain. For vehicles a vast number of materials and parts are used. Even identical materials and parts are usually produced by different companies in different locations to ensure supply chain resilience and risk management.

1.2. THE CHALLENGE

For many years, the automotive industry and suppliers have already applied well established methods to calculate product carbon footprint and report the results in line with international standards such as the ISO standards 14040, 14044 and 14067 or the GHG Protocol Product Standard.

For today's portfolio mix with 80% - 90% of product carbon footprint resulting from the use phase and 10 - 20% from supply chain, the state-of-the-art is a sufficient combination between efforts and benefits. However, future electrification of the portfolio will radically reduce the overall GHG emissions of vehicles but also shift some of the emissions from the use phase to the production. Hence, the majority of GHG emissions in the life cycle of vehicles will occur during the production phase and will be needed to be reduced to reach climate goals.

Product specific GHG accounting standards and methods exist in the ISO standards 14040, 14044 and 14067 as well as the GHG protocol Product Standard, the Pathfinder Framework and sector specific guidelines such as Product Category Rules. However, these standards and methods are not sufficiently prescriptive and thus, leave room for interpretation regarding the accounting scope. Therefore, companies are not consistently applying these standards and methods. Consequently, reporting among companies are inconsistent and incomparable for companies, regulators, investors and consumers. In addition, the current application of well-established methods are mostly based on industry averaged data. Hence, the emissions of the status-quo are not specific to a supply chain and deviations between different supply chains remain unrecognized.

In the past, these deviations during the production did not lead to significant deviations over the entire life cycle due to the high contribution of the use phase. In the future, the majority of GHG emissions over the life cycle of vehicles will stem from the production. Hence, GHG emissions specific to a supply chain are required to accurately measure the status-quo and any GHG emission reductions.

Supplier-specific GHG emissions based on real data can be obtained by measuring and reporting at a product level at each part of the supply chain, i.e., a company. For this purpose, Catena-X provides an environment to exchange GHG emissions on a product level (also referred to as product carbon footprint, PCF) between companies. These data-driven values chains allow companies full data sovereignty keeping any sensitive information within the respective company.

However, the problem of not sufficiently prescriptive standards remains and thus, reported PCFs may differ significantly between companies even though identical parts with identical processes are applied. These differences would not origin from factual differences but are related to different application of GHG accounting. Due to the climate goals of companies, product carbon footprints will become a critical KPI in the purchase of parts and materials and thus PCFs need to provide a robust basis for decision making, i.e. differences in PCFs should only be related factual changes in emissions. Consequently, a more detailed view on the accounting methods for PCFs in the automotive supply chain is necessary for the PCF exchange network Catena-X.

1.3. THE PURPOSE OF THIS DOCUMENT

To reduce the room for interpretation, Catena-X developed this product carbon footprint rulebook with a focus on the exchange of production carbon footprint from tier to tier with increased consistency for PCF accounting. This increased consistency will ensure comparability for the PCFs of parts and components and allows for part and material selection. Consequently, the Catena-X rulebook focusses on the production phase of vehicles.

At the same time, accounting for product carbon footprints is currently mostly applied in large companies and smaller companies lack the knowledge and resources to account for the emissions of their products. Hence, this rulebook needs to carefully balance out applicability and comparability of product carbon footprint accounting to ensure that rules are scalable along the entire supply chain. For this purpose, the Catena-X rulebook foresees the application of some rules after a transition period to allow companies to adopt more complex rules. Additionally, guidance materials will be developed and cooperation with stakeholders representing small-medium enterprises will be strengthened in the near future.

As data sovereignty prohibits the full disclosure of information needed for the PCF accounting, the Catena-X PCF rulebook defines indicators for data quality and the amount of primary data used for PCF accounting to increase trust along the value chain.

The automotive supply chain has an enormous complexity using materials produced by various industry sectors including steel making, chemical production and electronics. Therefore, the Catena-X PCF rulebook recognizes and allows the applications of existing sectoral and product category rules if necessary. For this purpose, Catena-seeks close alignment with other initiatives such as the Together for Sustainability representing the chemical industry and the industry agnostic overarching Pathfinder Initiative and will engage with other relevant stakeholders in the future.

To ensure public acceptance of the reported PCFs along the Catena-X network, stakeholders are invited to provide comments during a thorough consultation process which takes place together with the A-PACT guidance.

2. SETUP OF THE FRAMEWORK

2.1. PRELIMINARY CONTENTS OF THE RULEBOOK

Preliminary contents of the rulebook are marked in blue. These contents are drafts and will be finalized following the external stakeholder consultation process. The limited audience that is allowed to read the current rulebook is welcomed to comment on these contents and provide productive feedback.

2.2. VERSION

This is version 1.0 of the Catena-X product carbon footprint rulebook released in October 2022. This rulebook will be updated and thus, PCF calculation shall be done according to the latest version available of this rulebook.

2.3. TERMINOLOGY: SHALL, SHOULD, MAY, CAN

Clarification on ISO expressions used in the rulebook

The following definitions apply in understanding how to implement an ISO International Standard and other normative ISO deliverables

- The term “shall” indicates what is required for a CX PCF to be compliant with this rulebook.
- The term “should” indicates a recommendation rather than a requirement. Any deviation from a “should” recommendation must be justified by the party conducting the study and made transparent.
- The term “may” indicates an option that is permissible
- The term "can" is used to indicate that something is possible, for example, that an organization or individual is able to do something.

Additional definitions of frequently used terms throughout the rulebook can be found in Glossary (see page A).

2.4. ELEMENTS OUT OF SCOPE OF THIS DOCUMENT

The Catena-X rulebook focused on the production of vehicles and thus, the PCF accounting spans from cradle-to-(factory)gate. Therefore, the assessment of recycling is currently limited to the provision of secondary materials. To holistically account for recycling, other methods are required but currently out of scope. For the same reason, the re-use and re-manufacturing of parts and vehicles is currently not included but will likely be added in the future.

2.5. TRANSITION PERIOD

After the official start of the PCF exchange in the Catena-X network a transition period is foreseen to allow companies to adopt more complex topics. The Catena-X association will decide on additional rules after the transition period and steer the process.

3. EXISTING METHODS AND STANDARDS

3.1. RELATIONSHIP

The Catena-X Product Carbon Footprint Rulebook (CX-PCF rules) is based on the product carbon footprint standard ISO 14067 and the life cycle assessment standards ISO 14040 and 14044 (Fig. 1).

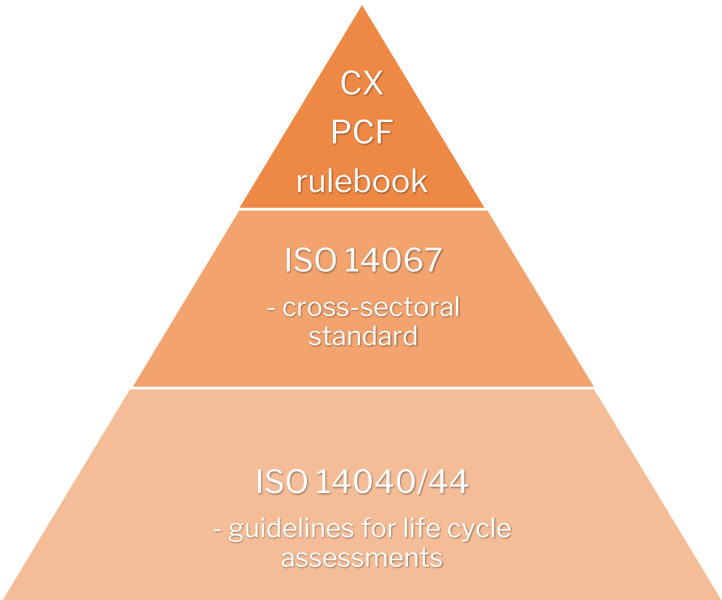


FIGURE 1: Relationship of standards.

The CX-PCF rules further specify existing standards and, if applicable, refers to sectoral guidance and product category rules for Product Carbon Footprints in Automotive Supply Chains.

If necessary additional sector-specific and product category rules are prescribed and are referenced within the rulebook.

The CX-PCF is closely aligned with WBCSD pathfinder framework. Further alignment with sector initiatives is planned in the future.

3.2. HIERARCHY OF APPLICATION

Application of existing rules shall follow the below hierarchy:

1. The product carbon footprints shall be in accordance with ISO 14067.
2. Automotive supply chain specific requirements shall be applied as defined in this document.
3. Sectoral-specific and product-specific rules should be used if prescribed within this rulebook.

Additional sector-specific or product-specific guidance will be added if necessary, during future revisions of this document.

Information on the applied methods or standards shall be shared downstream as part of the elements for data exchange (Section 7.1) to create greater transparency and enable comparability.

4. SCOPE AND BOUNDARY

4.1. LCA APPROACH

The CX-PCF rules are based on the attributional LCA approach. This approach seeks to determine the environmental impacts associated with a product's life cycle. The global warming potential (GWP) expressed in CO_2-equivalents is attributed to a specific unit of a product by adding up the CO_2-equivalents of all attributable processes along its life cycle.

4.2. FOCUS ON CARBON FOOTPRINT

The CX-PCF-Rulebook provide the methodological framework for assessing the product carbon footprint.

The GHGs that shall be accounted for are identified within the GHG Protocol titled "Required Greenhouse Gases in Inventories: Accounting and Reporting Standard Amendment". The list includes Carbon dioxide (CO_2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorinated compounds, Sulphur hexafluoride (SF_6), Nitrogentriflouride (NF3), Perfluorocarbons (PFCs), Fluorinated ethers (HFEs), Perfluoropolyethers (e.g., PFPEs), Chlorofluorocarbon (CFCs) and Hydrochlorofluorocarbon (HCFCs).

The 100-year GWP characterization factors (GWP_{100y}) according to the Intergovernmental Panel on Climate Change (IPCC) shall be used in the PCF calculations, based on the IPCC's Sixth Assessment Report (AR6). These factors include Climate carbon response for non-CO_2 gases, i.e., carbon feedbacks and chemical effects.

The AR 6 characterization factors shall be extracted in priority from the Table 7.15 of Chapter 7 of the IPCC AR6 Climate Change 2021 Physical Science Basis. This table includes the chemical effects of CH4 and N2O:

https://www.ipcc.ch/report/sixth-assessment-report-cycle/

The AR 6 characterization factors for the substances that are not listed in the table 7.15 shall be extracted from the Table 7.SM.7 in the Chapter 7 Supplementary Materials of the AR6 Climate Change 2021 Physical Science Basis.

https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07_Supplementary_Material.pdf.

In addition to the total PCF (including biogenic), the following contribution to the PCF shall be reported:

1) Net fossil GHG emissions and removals
2) Net biogenic GHG emissions and removals (if applicable)
3) GHG emissions and removals from direct land use change (if applicable)
4) GHG emissions resulting from aircraft transportation (if applicable).

Removals in the PCF shall not include any measures not related to the production system usually referred to as compensation and offsets (see Section 7.2.7).

In addition, the biogenic carbon content and total carbon content of products shall be reported separately.

If mass-balanced materials are used in the supply, both a physical and an attributed biogenic carbon content shall be reported to accurately account for emissions from combustion of these materials.

4.2.1. Accounting for carbon uptake (biogenic or fossil)

Uptake of atmospheric CO_2 as carbon uptake shall be assigned with a characterization factor of -1 kg CO_2 eq per kg CO_2 the emission of CO_2 shall be assigned with a factor of 1 kg CO_2 eq per kg CO_2.

4.3. SYSTEM BOUNDARIES

The life cycle of a product in general is composed of five stages: (1) resource extraction, raw material sourcing, (2) production, (3) distribution and storage, (4) product use and (5) end-of-life (Figure 2). The CX-PCF scope represents a reduced subset of these stages, excluding product use and end-of-life. This partial PCF, exchanged by a company (supplier), can then be used for calculating the PCF e.g., of a vehicle over the complete lifecycle by the customer (e.g., OEM).

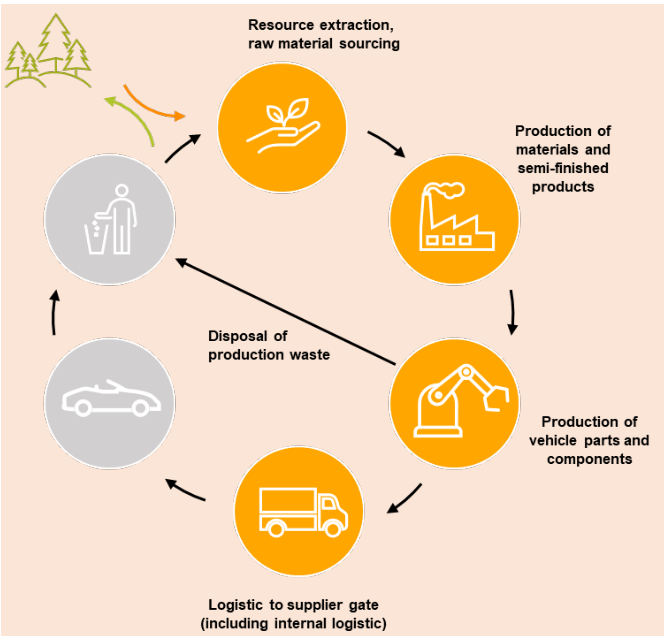


FIGURE 2: SYSTEM BOUNDARIES FOR CATENA-X PCF

The cradle-to–gate PCF of the CX-PCF rulebook includes all attributable upstream and direct emissions of producing a product, including all upstream transportation activities but excluding transportation from supplier to customer (cf. Section **Error! Reference source not found.**). The life cycle emissions that shall be accounted for in this cradle-to-gate PCF exclude downstream emissions related to the product use and end-of-life stages.

When accounting for emissions, companies shall further define their cradle-to-gate boundary by listing all the attributable processes of their studied product.

The CX PCF rules system boundaries therefore are:

- resource extraction, raw material sourcing,
- production of materials, semi-finished products,
- production of vehicle parts and components,
- packaging of vehicle parts and components,
- disposal of production waste,
- logistic to supplier gate (including internal logistic) (section 5.2.1)

In general, development / administration expenses and emissions from employee commuting are excluded from the system boundaries.

4.3.1. Cut off rules

In general, all processes and flows that are attributable to the analyzed system shall be included. If based on the results of a screening study, individual material or energy flows are found to be insignificant for the carbon footprint, these may be excluded for practical reasons (see DIN ISO 14067, PEF method).

For the CX cradle-to-gate PCF a completeness of 99% shall be achieved. Process modules, inputs and outputs may be neglected after reaching a completeness of 99% of the product carbon footprint.

Screening study:

An initial screening of the LCI of a representative product shall be performed by the supplier, referred to as the screening step. The screening focusses data collection activities and data quality priorities. A screening shall include the LCIA phase and allow to further refine the life cycle model of the product in scope in an iterative way, as more information becomes available. Within screening no cut-off is allowed, and readily available primary or secondary data may be used, fulfilling the data quality requirements to the extent possible. Once the screening is performed, the initial scope settings may be refined.

The screening study has to be updated at the end of the validity period of the CX PCF (see Section 7.2.1), so that possible changes of significant activities can be taken into account.

An exception for the chemical industry is to be revised in conversation with Together for Sustainability.

4.3. DECLARED UNIT

The carbon footprint shall be assessed for a declared unit. A functional equivalent is established by the data recipient and lies beyond the Catena-X PCF rulebook.

For **countable products**, i.e., a component or part, the declared unit shall be 1 piece as described in the part description including a defined weight and the part-ID

For **materials**, i.e., mass products or commodities, the declared unit shall be 1 kg of products.

5. GUIDANCE FOR PRODUCT CARBON FOOTPRINTING

5.1. ACCOUNTING FOR PRODUCT GHG EMISSIONS

System boundaries shall include all attributable processes that comply with the cut-off criteria (see Section 4.3 System Boundary).

5.1.1. Calculation

To be included in supplementary guidance.

5.1.2. Allocation

Allocation shall be avoided whenever possible by using process subdivision, system expansion or redefining the unit of analysis.

Subdivision refers to disaggregation of multifunctional processes or facilities to isolate the input flows directly associated with each process or facility output.

If subdivision cannot be applied, expanding the product system to include the additional functions related to the coproducts shall be applied. System expansion via substitution shall only be used if the following applies:

- The co-product for which substitution is applied is produced additionally to a main product and is not the main product of the process, i.e., the main product has significantly higher economic values than the co-product.
- There is a dominant, identifiable displaced product, and there is a dominant, identifiable production path for the displaced product, i.e., the co-product directly replaces a dedicated production process. No market-mediated effects shall be applied.
- Data on the GHG emissions of the replaced dedicated process is available.

For the identifiable production path only residual substitution processes shall be used. Double counting shall be avoided.

If subdivision and system expansion cannot solve the problem of multifunctionality, the inputs and outputs should be partitioned between different products or functions in a way that reflects the underlying physical relationship between them, i.e., the relationship should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.

If such an underlying physical relationship is not applicable, the inputs and outputs may be partitioned between different production or function that reflect other relationships between them:

- Pieces
- Mass
- Exergy
- Energy
- Economic value

For the use of economic values, prices shall be averaged over the last 5 years to smoothen fluctuations.

A sectoral approval for the chemical industry (Together for Sustainability) needs to be decided in near future.

5.2. ADDITIONAL GUIDANCE

5.2.1. Emissions from transportation

Additionally, to emissions from production and manufacturing, there are also emission from transportation of products. All upstream transportation processes shall be included in the product carbon footprint, i.e., included in the cradle-to-gate system boundaries. The same applies to inhouse logistics unless cut-off-rules apply (4.3 System Boundary). This section deals with the transportation from a supplier to its customer.

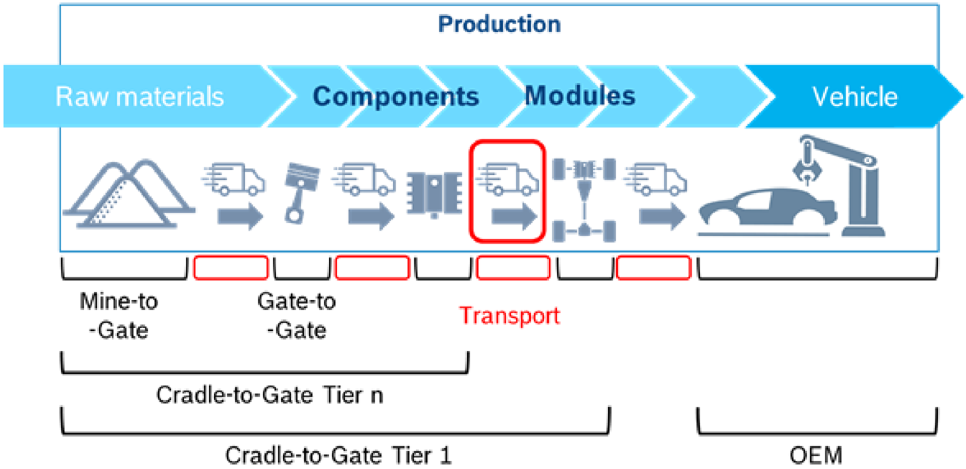


FIGURE 3: DEFINITION OF SCOPES

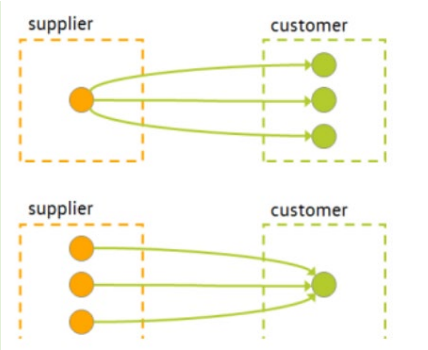
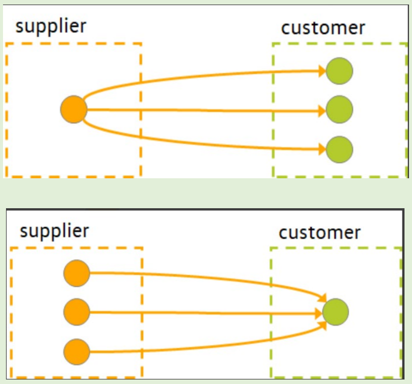
As for the product carbon footprint, the cradle-to-gate boundaries end at the suppliers' gates (cf. Section 4.3 System Boundary). This boundary applies independently from the responsibilities in economic or operative terms for transportation processes.

Nonetheless, if a supplier is responsible in economic or operative terms for the outbound logistics (i.e., the transport from the supplier to its customer), the supplier shall report the product carbon footprint from this transport in addition to and separately from the product carbon footprint (Table 1). Otherwise, the customer shall account for the transport between the supplier's and its own shipping site (factory gate and distribution center, see Figure 4 and Figure 5).

The table below describes different cases of responsibility and accountability for transport from supplier to customer:

TABLE 1: Transportation between supplier and customer. The responsibility to account for GHG emissions from transport depends which party is responsible in economic or operative terms.

Case	Description	Economic / operative responsibility for transport from supplier to customer	Accounting for transport emissions
1	multiple shipping sites, and/or multiple unloading sites	inbound transport contracted or operated by customer	customer responsible for quantification of transport emissions. as for multiple transport relations: emissions shall be weighted by received product quantities

			
2	multiple shipping sites, and/or multiple unloading sites 	outbound transport contracted or operated by supplier	transport emissions to be reported separately by supplier to the customer (additionally to supplier's PCF) as for multiple transport relations: emissions shall be weighted by shipped product quantities

Transports from production sites to **suppliers' distribution centers** are deemed as suppliers' inhouse logistics, i.e. the distribution center is regarded as shipping point (see Figure 4).

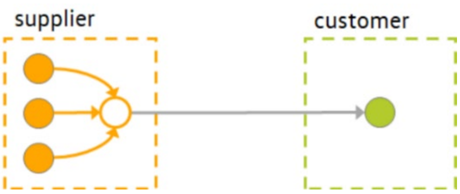


FIGURE 4: DISTRIBUTION CENTER ON SUPPLIER SIDE

Transports from **customers' distribution centers** to production sites are deemed as customers' inhouse logistics, i.e., the distribution center is regarded as unloading point (see Figure 5)

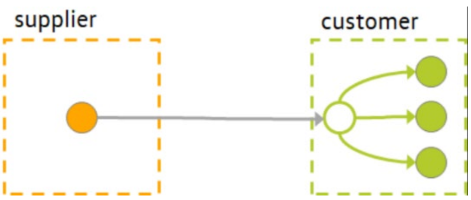


FIGURE 5: DISTRIBUTION CENTER ON CUSTOMER SIDE

Regardless of whether the transport emissions are quantified by a supplier or a customer, they shall be consolidated within the customers' PCFs.

Accounting for transport emissions

Emissions from transport shall cover emissions from well-to-wheel, i.e., the system boundaries span from energy provision, production and distribution ending at the transport operation itself. Emissions from the production of the transport means and infrastructure, e.g., roads, vehicles, ships and railways, shall not be included.

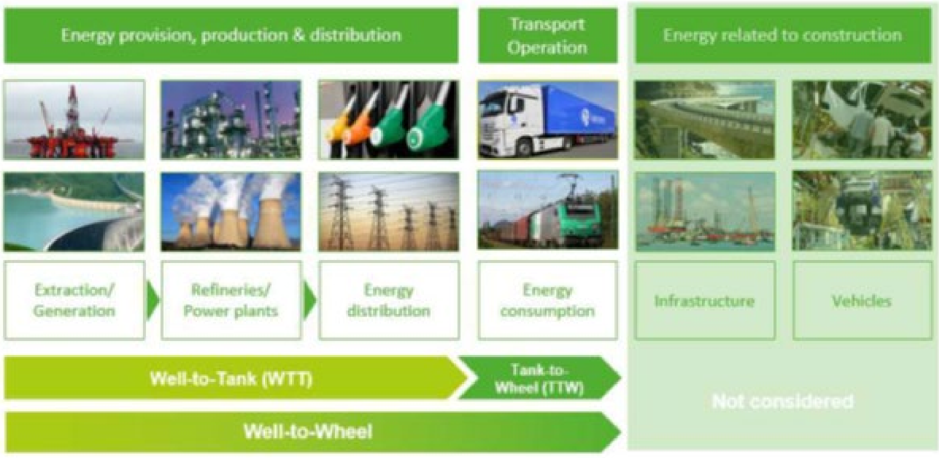


FIGURE 6: System boundaries for transportation

Transport emissions shall be quantified specific to transported products. In case, more than one product takes part in one transport operation emissions shall be attributed by mass. In case of distributed transport operations (e.g., same product on various transports with different routes), the allocation shall be done by distance and weight. If a transport from departure to destination point requires different transport modes (e.g., ship and truck or rail and truck) these shall be considered individually and thereafter be reported as one emission sum.

Consistent with the Catena-X target to base PCF quantification on primary data the ultimate approach of quantifying transport emissions shall be based on measuring fuel and energy consumption of a trip and multiply with the emission factor of the fuel/energy that covers all upstream emissions of the fuel/energy. An increasing number of logistic fleet operators equip their vehicles with onboard data collection systems and can provide fuel/energy consumption data on a highly resolved level. Only the measurement of fuel and energy consumption shall be considered as primary data.

Direct measurement of fuel/energy may however not always be possible. Therefore, the following hierarchy of quantification approaches shall be followed:

- Measure the fuel and energy use
- Modeling fuel and energy use using real trip routing and vehicle specific efficiencies and emissions
- Modeling fuel and energy use via route provided by planning tools and vehicle specific efficiencies and emissions
- Calculation based on geographical distance, total loading and default load and emissions intensity factors

If fuel/energy consumption cannot be measured, it shall be modelled with vehicle specific fuel/efficiency data and the real trip routing.

If the trip has multiple loading or unloading points the allocation shall consider the total trip length including eventual empty run. If recorded real load factors of the respective trip shall be applied. If no individual trip can be identified - as it is for transport networks - empty runs shall be covered by averaged load factors.

To calculate fuel/energy consumption on the basis vehicle efficiencies and a real route an assumption on the vehicle speed is required, which is usually the maximum allowed speed or fuel consumption/cost optimized speed for the respective vehicle. This however does not reflect typical traffic impediments like traffic jams, handling times etc. To ensure a conservative emission modelling network resistances shall be applied according to the respective transport mode, which either imply a speed reduction or distance elevation. Resistance factors are documented in the annex.

In case the real route is not known/available, route planning tools for the respective transport vehicle shall be applied using the minimum trip time and/or cost as optimization criterion. If no route based on road, rail or other transport network is possible, the geographical distance between departure location and destination shall be used with a distance supplement of 50%.

Vehicle efficiency data – if needed – shall be chosen for the specific transport vehicle. For details to determine efficiencies based on vehicle type and load factors reference may be taken to Vecto in case of heavy-duty road transport and/or EcoTransitIT also in case of other transport vehicles or modes.

As minimum requirements calculation of the transport emissions shall be based on geographical distance plus 50% distance supplement, transport tonnage and default load and emissions intensity factors differentiated by mode, fuel and distance as stated in Annex 8.1.

Emission reduction from the use of low carbon fuels may be claimed given that a statement of sustainability (origin and emission reduction) for the fuel is provided as issued by a bonded warehouse.

5.2.2. Accounting for waste treatment

For each product that generates waste, companies need to determine whether such waste will be recycled and turned into products or discarded as waste. Only the latter is considered as waste in this section. Any GHG emissions arising from the treatment of waste during the production process shall be included in the total PCF (reference to ICLD and PEF). Since the Catena-X boundaries span from cradle-to-gate, waste treatment covers any waste that occurs during production and does not include the end-of-life stage of vehicles.

Waste can be generated during different stages of a product's life cycle (cradle-to-gate), including (see Figure 7):

- Resource extraction, raw material sourcing,
- Production of materials, semi-finished products
- Production of vehicle parts and components
- Logistic to supplier gate (including internal logistic)

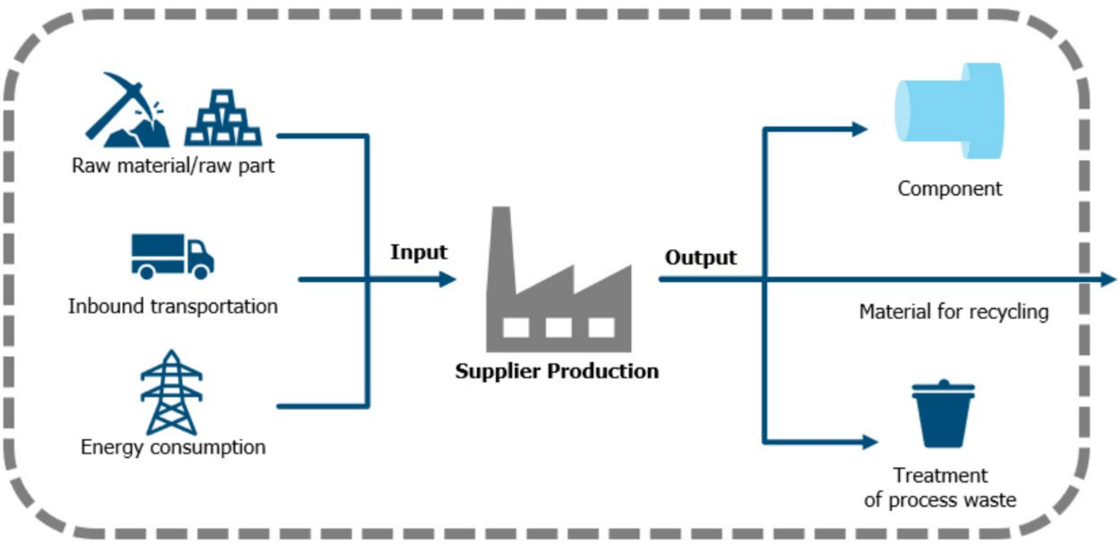


FIGURE 7: Waste generation during different stages of a product's life cycle

All auxiliaries and energy inputs and waste outputs shall be completely considered to calculate the product carbon footprint. Cut-off criteria apply.

The company generating waste is responsible for the treatment, until final disposal (for example, incineration or landfill). This is also referred to as the "Polluter pays principle". If additional processes follow the end-of-waste state, then these are attributed to the company who is using the recycled or reused material flow as a secondary material.

Production processes may also generate material scrap that is recycled. In this case, please see recycling chapter.

Calculation

GHG Emissions shall be calculated using primary data regarding the type of waste, its composition and type of waste treatment activity. Depending on the type of waste treatment (for example, landfill or incineration), companies may use waste treatment emission factors calculated based on internal primary data. If no primary emission factors are available, emission factors derived from accepted secondary databases can be employed (Section 6.2).

If companies do not have access to primary data from third-party waste treatment facilities, they shall estimate waste treatment emissions based on primary data on the waste type and composition and specific emission factors according to the quantity and type of waste treatment and final disposal (landfill, incineration).

5.2.3. Accounting for recycling

Accounting for recycling (within transition period)

Recycling plays a crucial role to enable a circular economy and reach climate protection goals. In particular, recycling of currently unused or inefficiently used secondary material streams are key to reduce primary material use as well as environmental burdens related to current waste treatment. The environmental burdens of the recycling process need to be distributed between the secondary material receiving and the providing system.

Shifting the distribution, i.e., the allocation, of the environmental burdens of the recycling process has an environmental steering effect on the supply chain, i.e., increasing the demand for recycled material leading to higher recycling rates or increasing the amount of material available for recycling. These steering effects can lead to technology shifts enabling emission reductions and/or increased material efficiency of the industry.

The allocation hierarchy in ISO 14044 does not account for the steering effects and no specific allocation hierarchy for recycling is provided. In principle, ISO 14044 applies the same allocation hierarchy for multi-output systems. However, specific allocation approaches for recycling are described in ISO 14044: Avoided burden for the primary production route and cut-off. Avoided burden of the primary production route usually incentivizes the provision of material for recycling at the end-of-life and, thus should only be applied if these incentives lead to overall emission reductions. However, if environmental incentives can lead to overall emission reductions, highly depends on the market situation and requires a detailed analysis. Consequently, without such an analysis, as a default, the cut-off approach shall be applied due to the following reasons:

- Ease of use in a CX network,
- Avoiding double counting and
- Comparability of data within CX

Accounting for recycling (after transition period)

Catena-X acknowledges the environmental steering effects of selecting allocation approaches and hence, may prescribe other allocation approaches to specific materials and regions in the future.

The allocation methods described in more sector-specific guidelines, e.g., Together for Sustainability, may serve as the basis to decide if other allocation methods shall be prescribed.

5.2.4. Accounting for GHG emissions from electricity

For each process step within the Catena-X boundaries that requires electrical energy, companies must determine which GHGs were emitted by this specific energy use. All GHG emissions resulting from the use of the required electrical energy during the production process (cradle-to-gate) must be included in the Product Carbon Footprint.

To calculate the share of electricity consumption in the Product Carbon Footprint, generator-specific emission factors must be used. Depending on the type of electricity generation, different amounts of greenhouse gases are emitted. The factors used shall take into account upstream emissions (e.g., the mining and transport of fuel to the electricity plant or the growing and processing of biomass for use as a energy source), emissions during the generation of electricity (e.g. combustion of fossil fuels) and downstream emissions (e.g. the treatment of waste arising from the electricity plants).

Electricity from directly and dedicated connected generator

In the case of on-site produced electricity with a direct connection to the power generator (e.g., photovoltaic plant on the roof, wind park beside the production facility, own fossil power plant) or a direct connection to a power generator operated by a power supplier, the amount of consumed electricity from this power generator and the related emission factor shall be used if no contractual instruments have been sold to a third party. Otherwise, the *country-specific residual grid mix* shall be used.

As verification of using electricity from the company's own facilities, proof of installation of the company's own generation technology as well as a meter reading shall be available. The amount of electricity and the period of the meter reading shall be equal to the amount of electricity required and the respective period. In addition, the meter reading should be confirmed by a third party to prove that the specified generation technology, the respective period and the amount of electricity generated are as stated.

Electricity (from a power supplier or) via contractual instruments

In the case electricity is accessed via contractual instrument the following electricity mix shall be used in hierarchical order:

- Supplier-specific electricity product shall be used if
  - a tracking system is installed in the country and
  - the set of minimum criteria to ensure the contractual instruments are reliable is met, i.e., no double counting and no exclusions.
- Total Supplier-specific electricity mix, i.e., the share of electricity supply specific to the supplier, shall be used if
  - the set of minimum criteria to ensure the contractual instruments are reliable is met.
- The country-specific residual grid mix (consumption mix) shall be used (such as AIB[1] for Europe) Country-specific means the country in which the activity occurs.
- The regional residual grid mix (consumption mix), e.g., EU+EFTA, or region representative residual grid mix, consumption mix, shall be used.

If residual grid mixes are not. available, grid specific consumption mixes may be used.

In general, three different reference types can be defined for contractual instruments:

- Utility Tariffs
  When using an electricity supply contract, electricity is purchased from a supplier via the public grid.

[1] :Available at https://www.aib-net.org/facts/european-residual-mix

- Energy Attribute Certificates (EACs)
  EACs should enable renewable energy to be tradable. An EAC is a certificate that proves that one Megawatt hour of electricity was generated from renewable energy and transferred into the electricity grid. EACs can be separated from the physical quantity of electricity and therefore traded independently. Depending on the region, different systems are in place for trading Energy Attribute Certificates (EACs). For example, International Renewable Energy Certificates (iRECs) are traded through an international registry as a renewable energy instrument. In contrast, Renewable Energy Certificates (RECs) or Guarantees of Origin (GoOs) are examples of verification instruments in specific regions.
- Power Purchase Agreements (PPAs)
  A PPA is an electricity supply contract concluded directly between an electricity producer (plant operator) and an electricity consumer. The contract specifies the delivery of a certain amount of electricity over a particular period at an agreed price. In general, different types of PPAs can be differentiated. There are physical PPAs, which can be further subdivided into on-site and off-site, and virtual PPAs.

The contractual instrument used to calculate the related emission factor shall meet the following minimum criteria:

- It shall convey the information associated with the unit of electricity delivered together with the characteristics of the generator.
- It shall be assured with a unique claim and therefore be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.
- It shall 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).
- It shall refer to the same year to which the contractual instrument is applied.
- The attribute tracking instrument shall refer to an electricity production asset located in the same regional market (within which a synchronous interconnection can be proven).

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. In case a *certificate of origin* covers only a part of the consumed electricity, the residual grid mix shall be used for the uncovered amount.

Additional to the emission factors as shown in the contractual instrument of the electricity, the following GHG emission shall be taken into account:

- upstream emissions (e.g., the mining and transport of fuel to the electricity plant, the growing and processing of biomass for use as an energy source or construction and maintenance),
- and downstream emissions (e.g., the treatment of waste arising from the electricity plants or demolishing).

5.2.5. Homologue parts

While many parts in the automotive supply chain are considered identical and require sampling strategies there is also the related issue: Products are nearly identical but differ systematically in a single (or very few) aspect(s). This very often brings about a product carbon footprint that is identical or differs systematically with that aspect. If this applies products are called homogeneous parts out of a homogenous product family.

PCF results obtained for homogeneous parts may be used to interpolated regarding the differentiating aspect for further parts of that product family.

To belong to a homogenous product family, the products shall have the following characteristics:

- same main function,
- same product standards,
- same manufacturing technology, processes, and materials,
- same supply routes.

A homogenous product family can be substantiated if a

- Product parameter (physical characteristic) can be identified that differentiates otherwise identical parts systematically with respect to PCF and proven by a sensitivity analysis.
- PCF results for homogeneous parts allow for a linear regression with respect to the differentiating parameter that renders a coefficient of determination $R^2 > 95\%$. Cut-off rules apply for the calculated PCF.
- The sample size to proof interpolation quality shall be $n > 20$.

A PCF for a part out of homogeneous product family shall be calculated by interpolation only. A homogeneous product family can be defined on the basis of an intermediate product, if the final product to market is produced by varying add-on parts to the intermediate product or additional process steps, e.g., specific paintings, additional leak tests or washing processes. For the additions in parts or processes to the intermediate product the respective CO_2 contribution shall be added to the final PCF.

The proof of a homogeneous product family shall be documented and provided to customers on request. A review of the proof shall be done latest after five years.

6. DATA SOURCES AND HIERARCHY

6.1. PRIMARY DATA

Primary data is a quantified value of a process, or an activity obtained from a direct measurement, or a calculation based on direct measurements. Primary data shall be used instead of secondary if available and meeting/complying the data quality requirements according to section 7.2.

TABLE 2: Definition for primary and secondary data

Direct Approach	**Direct Emission Measurement**			
Primary data	In-house/primary			
Indirect Approach	**Activity data source**		**Emission factor source**	
	Energy	**Material**	**Energy**	**Material**
Primary data	In-house/primary		For on-site production: In-house/primary For supplier-specific electricity: Primary / guarantee of origin	From supplier or via CX Network: primary
Secondary data	In-house/primary		Secondary Databases / data proxy	

Primary data need not necessarily originate from the product system under study because primary data might relate to a different but comparable product system to that being studied and shall include primary activity data, i.e., a technical flow, and GHG emission factor, i.e., the carbon footprint of the corresponding activity expressed in $kgCO_2e$ per unit (Table 2).

The data may need to be scaled, aggregated, or otherwise mathematically processed to relate it to the declared unit or the reference flow of the process (see allocation guidelines). Algorithms may be used to fill in the missing data, or data aggregation may be required to dampen the effect of revisions, turnarounds, or other untypical production conditions.

In case no product specific measurement or calculation of activity data or emission factors are available, or feasible site-specific or even company-specific data must be used, which might incorporate more than production related emissions, e.g., emissions related to research and development.

6.2. SECONDARY DATA

Catena-X follows the vision to calculate PCF based on primary data. This however will not be feasible from the onset of Catena-X but will require some transition time. At least during this transitional phase secondary data are required to ensure the information chain on PCF is not interrupted.

Ideally the use of secondary data has to warrant the following crucial requirements:

- When using secondary data, a conservative estimate shall be applied to avoid a lower PCF compared to a PCF based on respective primary data. With this the motivation to replace secondary by primary data shall be strengthened
- The use of secondary data shall avoid any competitive distortion due to ambiguous data for identical input information (if knowledge on a material is limited to virgin aluminum from Canada produced in 2020, this should result in an unequivocal CO_2eq-intensity for that material)
- The selection of secondary data shall be guided by the representativeness criteria (see Chapter 7.2.5) to limit errors introduced into the PCF calculation. The effort to search for data with the least error needs to be balanced with economic feasibility to the extent that misleading results are avoided.
- Secondary data shall be accessible to all Catena-X members, regardless of their size, economic power or experience in life cycle assessment.

For the use within the Catena-X there are three principal approaches to harmonize the use of secondary data with respect to the requirements mentioned above:

- Definition of CX-prescriptive secondary data,
- Definition of a whitelist of data sources, and
- Definition of hierarchy for secondary data sources.

Combinations of the approaches are also feasible.

With regard to the above-mentioned requirements the first option is clearly the superior approach. By prescribing the use of specific secondary data with adequate precision and following a conservative approach, comparability of results and avoiding underestimation of PCFs can be ensured. Harmonized and prescribed data sources ensure that unequivocal CO_2 eq-intensities are applied, and each CX-member has access to the same data. A fully harmonized prescribed set of data provided by Catena-X would also eliminate the need to define and do any data quality rating.

The obvious issue is the effort required to research and prepare the likely high number of data which is needed to cover the full supply chain and to keep such data up to date over the years to come. One has to keep in mind however, without a CX-prescriptive database the effort to define criteria for appropriate data does not disappear and the effort to identify and research appropriate and accepted data will be spent multiple times by every PCF/LCA-expert in each company in need of secondary PCF data. Most likely data quality checks and reviews will increase individual efforts further without a guarantee that competitive distortion can be avoided. The risk of a race to the lowest possible PCF results that can be argued with permissible creativity needs attention.

The actual drawback thus is not the high effort to provide CX-prescriptive data but the need to provide this effort upfront and centrally from CX side. A pragmatic solution with the support of various associations seems to be the most viable way forward.

For a web application that allow SMEs to calculate PCFs a CX-prescriptive database with overall no and moderate licensing fees seems to be the only solution.

Defining a hierarchical list of secondary data sources starting off with association data is already following the logic of a CX-prescriptive database. The shortcomings are possible multi references to the same material from different associations and the opening clause to universal data bases whenever one deems to find no appropriate datum in the associations data. This already indicates that avoiding arbitrary evasion to universal data bases will require a set of rules/criteria what approximations are permissible and CX-conform and which are not.

A non-hierarchical list or whitelist of data sources would require the set of rules/criteria which approximation of the real data by secondary ones is good enough to an even larger extent. To ensure a conservative data choice that does not undermine the use of sound primary data seems hardly possible. A whitelist of data sources would even require to review and approve the data content and ensure completeness.

As a bottom line, providing a harmonized set industry association data as prescriptive for CX is the superior approach. As of now these harmonized data do not yet exist and thus CX will require hierarchical use of secondary data sources in the following sequence:

1. industry association data,
2. general LCA data,
3. other documented references.

The particular value of association data is the higher certainty that the CO_2 intensities represent an industry/sector average and, in some cases, even indicate the dispersion of CO_2 intensities around the average value. CX will initiate the work on harmonized industry association data with the goal to prescribe those as only source in the long run.

6.3. ADDITIONAL QUALITY RULES FOR SECONDARY DATA USAGE

Secondary data that is used as emission factors shall be selected according to the following criteria:

- **Temporal representativeness:**
  The reference year for the secondary data shall correspond to the assessment period of the activity data. For instance, the electricity generation mix corresponding to the year of assessment, or the most representative year shall be employed for the calculations.
- **Geographical representativeness:**
  The geography of the data shall correspond to the activity data most geographically relevant to the process. For instance, the electricity generation mix corresponding to the geography of the product (country or state if available) shall be employed for the calculations.
- **Technological representativeness:**
  The secondary data source shall correspond to the activity data that is technologically representative of the process. For instance, the electricity or heating generation mix shall be representative of the source of energy used.

7. REQUIRED ELEMENTS FOR PCF DATA EXCHANGE

Standardized PCF accounting and data exchange constitutes an important step toward creating comparable and consistent emissions data. Another factor to enhance comparability and consistency is the standardized sharing of data elements relating to the PCF between stakeholders within the supply chain, as this is a pre-requisite for more granular and accurate calculations by each stakeholder.

Emissions data calculated in line with the CX Framework shall therefore be shared in accordance with the guidelines set out in this section.

7.1. DATA MODEL

The data model contains the information that companies shall include to report their PCF according to this Catena-X PCF Rulebook. A report on the full technical specification will be included in a separate document.

7.2. DETAILS ON THE REQUIRED DATA ELEMENTS

7.2.1. Time period

As default emissions shall be reported averaged over the period of one year (reporting or calendar year) to avoid seasonal fluctuations and reflect typical production conditions.

Shorter periods may be considered if data on a full year are not yet available. Longer averaging periods may be considered but shall not exceed three years. Any averaging period deviating from the default shall be flagged and justified.

7.2.2. Temporal validity

As default emissions shall be reported for the most recent year (reporting or calendar year). An annual check is mandatory to ensure actuality of data. An update of data is mandatory if the reported emission increases by 1% or more based on the screening study compared to the previous reporting period.

7.2.3. Geography

As default, emissions shall be reported on plant level. Averaging over a region or country may be considered but shall be flagged as such.

7.2.4. Primary data share

To create visibility on the share of primary data in PCF calculations, the primary data share (PDS) indicator in each data set shall be determined and shared. This can be done by calculating the proportion (percentage) of the total PCF in (kg CO_2e per declared unit) that is derived using primary data (as defined in Section 6.1):

$$PDS_{PCF} = \frac{Part\ of\ PCF\ based\ on\ primary\ data\ [kg\ CO_2\ e]}{Total\ PCF\ [kg\ CO_2\ e]}$$

$$PDS = \frac{\sum(|PCF_i| \cdot\ PDS)}{\sum|PCF_i|}$$

As an example, three suppliers, Company A, Company B and Company C, provide parts to Company D. Each part has a different primary data share and contribution to the PCF of the part of Company D (cf. Figure 8). According to formula above, the primary data share of the Company D's part is calculated from the primary data share and contribution to the PCF of the part of Company D (see Table 3).

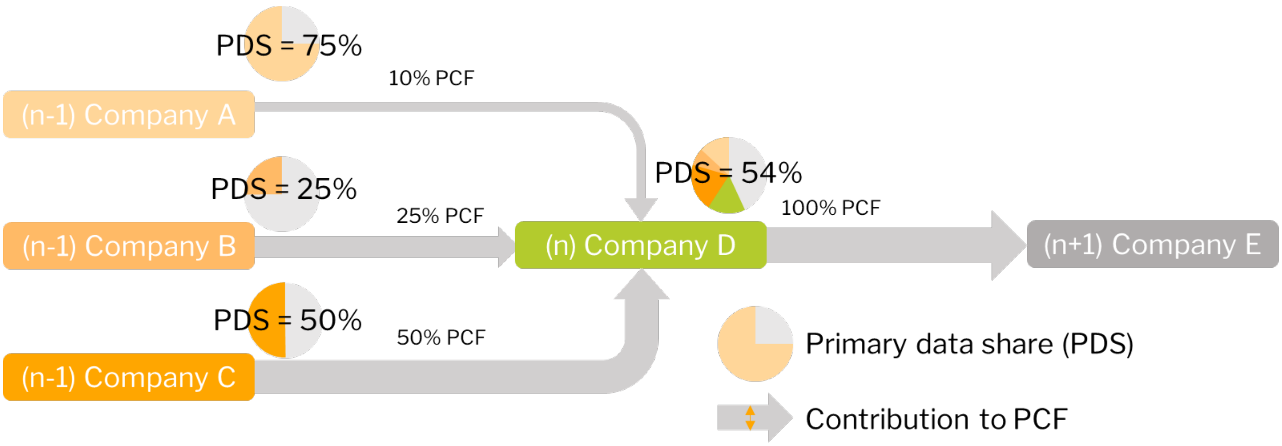


FIGURE 8: PCF cascade of primary data for an exemplary supply chain

TABLE 3: Primary data share of the example as in FIGURE 8.

	PDS input	PCFn Share	PDS output

Tier A	75%	10%	75 % * 10 % = 7.5%
Tier B	25%	25%	25 % * 25 % = 6.3%
Tier C	50%	50%	50% * 50% = 25%
Tier D	100%	15%	100% * 15% = 15%
Total		100%	7.5% + 6.3% + 25% + 15% ≈ 54%

To increase transparency on primary data use, the overarching PDS ($PDS_{PCF\ product}$) shall be shared downstream (Tier n+1), together with the PCF.

7.2.5. Data quality rating

In Catena-X, companies calculate the product carbon footprint of goods from (compare Figure 9):

1. Primary data owned by company calculating PCF, i.e., data on processes run by the company,
2. Primary data of third parties in the supply chain, i.e., data on processes not run by the company but the company receives data from its suppliers
3. Secondary data sources, i.e., the process is not run by the company and this company does not receive data from its suppliers.

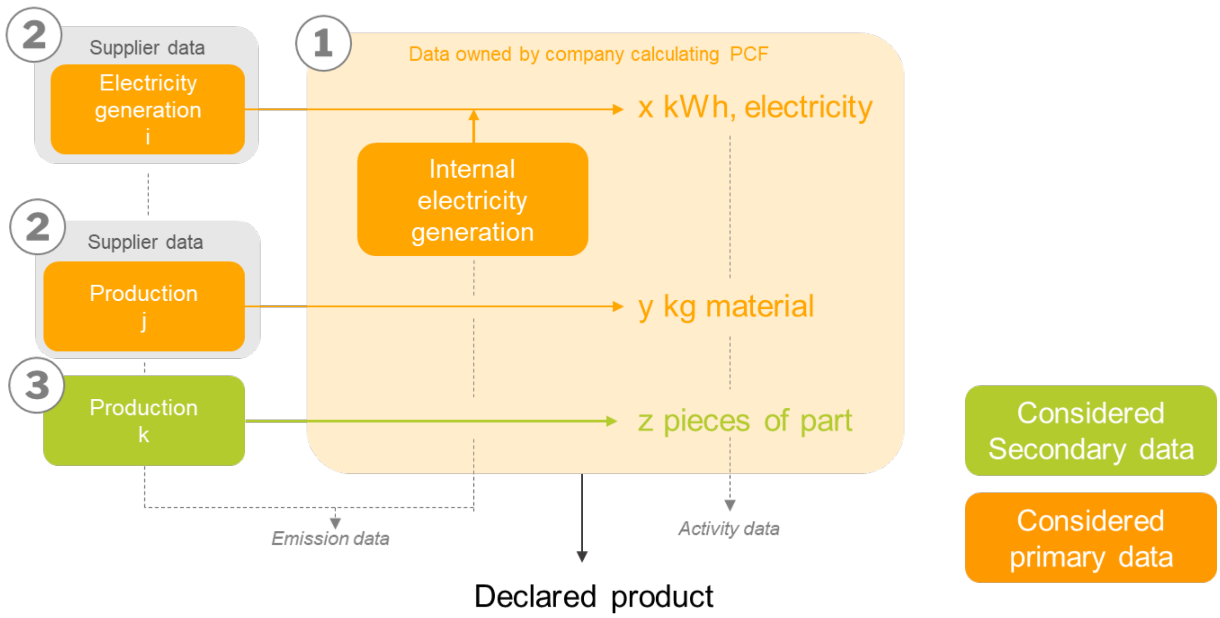


FIGURE 9:Data sources for PCF calculation

During the data collection, companies shall assess the data quality of direct emissions data, activity data and emissions factor used from secondary data sources for the data quality criteria described below.

As data quality assessment is currently not common practice Catena-X has decided to begin data collection with a single DQR for both primary and secondary data (Section **Error! Reference source not found.**).

After a transition period, Catena-X will require a more detailed assessment accounting for the different characteristics of primary and secondary data (Section **Error! Reference source not found.**). This detailed assessment will require a separate assessment of primary and secondary data as well as separate reporting of the data quality.

Data quality assessment within transition period

During the data collection process, companies shall assess the data quality of activity data, emission factors, and/ or direct emissions data by using the data quality ratings (DQR).

The standard defines five data quality indicators to use in assessing data quality. They are:

- Technological representativeness: the degree to which the data reflect the actual technology(ies) used in the process
- Geographical representativeness: the degree to which the data reflects actual geographic location of the processes within the inventory boundary (e.g., country or site)
- Temporal representativeness: the degree to which the data reflect the actual time (e.g., year) or age of the process
- Completeness: the degree to which the data are statistically representative of the process sites
- Reliability: the degree to which the sources, data collection methods, and verification procedures used to obtain the data are dependable

Assessing data quality during data collection allows companies to make data quality improvements more efficiently than when data quality is assessed after the collection is complete.

Data quality shall be assessed for both primary and secondary data in terms of how well they represent the actual for production for the product under study. In case of secondary data, the data quality rating reported for the original data taken from a database may not be directly used. Instead, the reported data quality rating should serve as the basis to assess the representativeness of the product under study, i.e., how well the secondary data represents the actual production in the supply chain.

The data quality of each PCF shall be calculated and reported. The DQR calculation shall be based on five data quality criteria where TeR is the Technological-Representativeness, TiR is the Time/Temporal Representativeness, GeR is the Geographical-Representativeness, C is completeness and R is reliability. Table 4 shall be used to determine a semi-quantitative data quality rating.

The quality levels are expressed in three categories from 1 Good, 2 Fair and 3 Poor. The representativeness (technological, geographical, and time-related) characterizes the degree to which the processes and products selected depict the system analyzed, while the completeness and reliability addresses the quality of the generated PCF result.

Note that, the data quality criteria, scoring and related definitions will be revised and aligned with WBCSD Pathfinder Framework.

TABLE 4: Sample scoring criteria for performing a qualitative data quality assessment

Data quality rating	1- Good	2- Fair	3- Poor
Technology (TeR)	Same or similar technology	Different technology	Unknown technology
Time (TiR)	Data less than 3 years old	Data less than 6 years old	Data more than 6 years old
Geography (GeR)	Same region or country	Same continent	Global or unknown

Completeness (C)	All processes run by the company within reporting period	<50% of processes run by the company within reporting period or >50% processes run by the company for shorter period	Less than 50% processes run by the company for shorter period or unknown
Reliability (R)	Measured data	Data partly based on assumptions	Non-qualified estimate

The data quality rating for an activity data or emissions factor shall then be calculated from the five data quality indicators as arithmetic mean.

$$DQR = \frac{TeR + GeR + TiR + C + R}{5}$$

For example:

	Product 1	Product 2
Technological representativeness (TeR):	2	3
Temporal representativeness (TiR):	1	3
Geographical representativeness (GeR):	2	2
Completeness (C):	3	4
Reliability (R):	2	3
Total	10	15
DQR total (Total / 5)	2	3

The data quality rating of the PCF shall be calculated as weighted mean with the product carbon contribution as weight:

$$DQR_{total} = \frac{\sum(DQR_i \cdot |PCF_i|)}{\sum|PCF_i|}$$

The data quality shall be propagated through the supply chain in the same manner as the primary data share (PDS).

Data quality assessment after transition period

During the data collection process, companies shall assess the data quality of activity data, emission factors, and/ or direct emissions data by using the data quality rating.

This standard defines five data quality indicators to use in assessing data quality:

- Technological representativeness (TeR): the degree to which the data reflect the actual technology(ies) used in the process
- Geographical representativeness (GeR): the degree to which the data reflects actual geographic location of the processes within the inventory boundary (e.g., country or site)
- Temporal representativeness (TiR): the degree to which the data reflect the actual time (e.g., year) or age of the process

- Completeness (C): the degree to which the data are statistically representative of the process sites
- Reliability (R): the degree to which the sources, data collection methods, and verification procedures used to obtain the data are dependable.

Assessing data quality during data collection allows companies to make data quality improvements more efficiently than when data quality is assessed after the collection is complete.

Data quality shall be assessed **separately** for primary and secondary data in terms of how well they represent the actual production of the product under study. In case of secondary data, the data quality rating reported for the original data taken from a database may not be directly used. Instead, the reported data quality rating shall serve as the basis to assess the representativeness of the data with respect to the product under study, i.e., how well the secondary data represents the actual production in the supply chain.

The quality levels are expressed in five categories from 1 'Excellent', 2 'Very good', 3 'Good', 4 'Fair', and 5 'Poor'.

Based on the criteria, data quality ratings (DQR) shall be assigned with scores between 1-5 based on a qualitative judgement. Scores shall be differently assigned to primary (Section 0) and secondary data (Section 0). Scores shall be aggregated towards a data quality rating according to the formulas below:

For primary data:

$$DQR_{Primary} = \frac{TeR + GeR + TiR + C + R}{5}$$

For secondary data:

$$DQR_{Secondary} = \frac{TeR + GeR + TiR + tbd + tbd}{3 + tbd + tbd}$$

TABLE 5: Overall data quality level, according to the achieved data quality rating

DQR of primary data

When determining the share of CX product carbon footprint based on primary data, the data quality of the primary activity data, e.g., the consumption of electricity, and the primary emission factor, e.g., supply of electricity from the power operator, shall be assessed separately. The DQR provided from supplier can directly be used.

The primary data DQR calculation shall be based on five data quality criteria where TeR is the Technological-Representativeness, TiR is the Time/Temporal Representativeness, GeR is the Geographical-Representativeness, C is completeness and R is reliability. Table 6Table 4 shall be used to determine a semi-quantitative data quality rating.

TABLE 6: Sample scoring criteria for performing a qualitative data quality assessment for primary data

Data quality rating	1 – Excellent	2 – Very good	3 – Good	4 - 5
Technology (TeR)	Data measured from the production	Data is measured from a similar production of the	Data is approximated from a similar production of the company under study	Not applicable

	technology under study	company under study		
Time **(TiR)**	The data of the most recent annual administration period.	The data refers to a maximum of 3 annual administration periods.	The data refers to a maximum of 5 annual administration periods.	Not applicable
Geography **(GeR)**	Production site specific	Same country or region	Same continent	Not applicable
Completeness **(C)**	All processes run by the company within reporting period	<50% of processes run by the company within reporting period or >50% processes run by the company for shorter period	Less than 50% processes run by the company for shorter period or unknown	Not applicable
Reliability **(R)**	Measurements specific to the product and the production process	Measurements specific to a production site and allocation to product	Data partly on assumptions or non-qualified estimate	Not applicable

DQR of secondary datasets used in Catena-X PCF

The procedure for calculating the DQR of secondary datasets used for CX-PCF is different to primary data. For secondary data, it shall be evaluated how well the secondary dataset represents the supply of goods and services accounted for the company's activities. Consequently, Table 7 shall be used for data quality evaluation of secondary data.

TABLE 7: Sample scoring criteria for performing a qualitative data quality assessment for secondary data

Data quality rating	1 – Excellent	2 – Very good	3 – Good	4 – Fair	5 – Poor
Technology **(TeR)**	Same production technology	Market mix including the production technology under study	Market mix excluding the production technology under study	Similar production technologies to those included in the scope of the PCF.	Production technologies are different
Time **(TiR)**	The publication date of the PCF is within the	The CX-PCF publication date is not later than 2 years after the time	The CX-PCF publication date is not later than 4 years after the	The CX-PCF publication date is not later than 6 years after the	The CX-PCF publication date is later 6 years after the

	validity of the dataset	validity of the dataset.	time validity of the dataset.	time validity of the dataset.	time validity of the dataset.
Geography (GeR)	The technology used in the CX-PCF is exactly the same as the one in scope of the dataset.	Same country or region	Same continent	Regions are different but based on expert judgement estimations are sufficiently similar	Regions are different or unknown
Completeness (C)	tbd	tbd	tbd	tbd	tbd
Reliability (R)	tbd	tbd	tbd	tbd	tbd

Aggregation of DQR

The DQR for primary and secondary data shall be assessed and reported separately to the customer in the CX data set (cf. Figure 10). The data quality rating for primary and secondary data of the PCF shall be calculated as weighted mean with the primary, respectively secondary data based, product carbon contribution as weight:

$$DQR_{primary} = \frac{\sum\left(DQR_{primary,i} \cdot |PCF_i \cdot PDS|\right)}{\sum|PCF_i \cdot PDS|}$$

$$DQR_{secondary} = \frac{\sum\left(DQR_{secondary,i} \cdot |PCF_i \cdot (1 - PDS)|\right)}{\sum|PCF_i \cdot (1 - PDS)|}$$

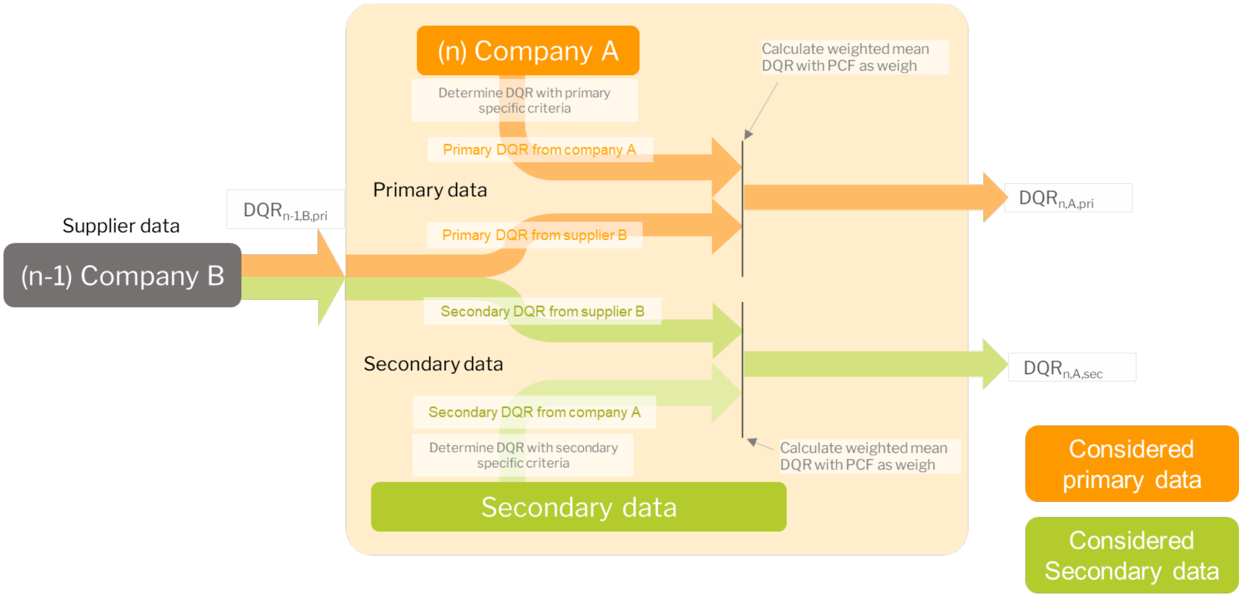


FIGURE 10: Aggregation of separate primary and secondary DGR

The data quality shall be propagated through the supply chain in the same manner as the primary data share (PDS).

For example:

TABLE 8: Example for data quality rating. Primary data

PRIMARY	*PCF*	*C*	*TiR*	*TeR*	*GeR*	*Total data quality rating*
Unit	kg CO_2 eq per declared unit					
Energy	0.5	2	1	2	1	
Waste	0.3	1	1	1	1	
Raw materials/semi-finished parts/parts	0.7	2	2	1	1	
Raw materials/semi-finished parts/parts	0.8	2	3	1	1	
Raw materials/semi-finished parts/parts	0.2	2	2	3	1	
		1.9	*2.0*	*1.4*	*1.0*	*1.56*

TABLE 9: Example for data quality rating. Secondary data

SECONDARY	*PCF*	*C*	*TiR*	*TeR*	*GeR*	*Total data quality rating*

Unit	kg CO_2 eq per declared unit	-	-	-	-	
Raw materials	0.9		3	3	3	
Raw materials	0.7		2	3	2	
Raw materials	0.5		4	5	4	
Raw materials	0.8		1	2	3	
			2.4	3.1	2.9	2.8

TABLE 10: Aggregated results

	PCF	*Primary data share*
Unit	kg CO2 eq per declared unit	%
Total	5.40	46

The total PCF is 5.4 kg CO_2eq per declared unit. The DQI of the primary data is 1.56 and of the secondary data is 2.8. The primary data share is 46%.

Improving data quality

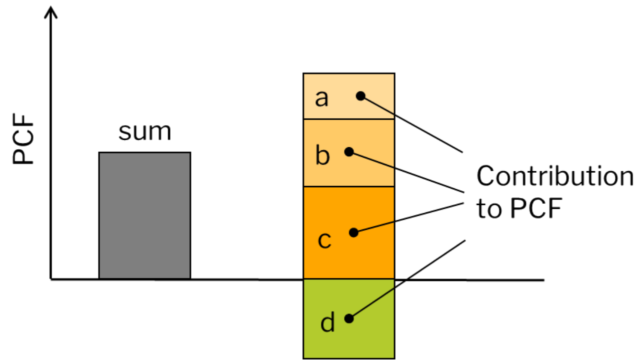
Collecting data and assessing its quality is an iterative process for improving the overall data quality of the product inventory. If data sources are identified as low quality using the data quality indicators, companies should re-collect data.

The following steps are useful when improving data quality:

1. Identify sources of low-quality data in the product inventory using the data quality assessment results. Sources with low quality data that have been identified as significant to the PCF results should be given priority.
2. Collect new data for the low-quality data sources as resources allow.
3. Evaluate the new data. If it is of higher quality than the original data, use in its place. If the data are not of higher quality, either use the existing data or collect new data.
4. Repeat as necessary and as resources allow. If companies change data sources in subsequent inventories, they should evaluate whether this change creates the need to update the base inventory.

7.2.6. Dealing with negative numbers

Accounting for uptake of biogenic or fossil emissions with a characterization factors of -1 kg CO_2eq per kg CO_2 will lead to negative PCF contributions. Thus, the sum of the PCF can be lower than the positive contributions to the PCF (Figure 11). When calculating the PDS or a DQR negative contributions would lead to erroneous calculation of the primary data share or data quality rating, e.g., the PDS can add up to more than 100%.



Contribution	PCF	DQR	PDS
a	1	1	0.9
b	1.5	2	0.7
c	2	2	0.8
d	-1.75	2.7	0.3
Results	w/o correction	1.2	1.1
	w/ correction	2	0.65

FIGURE 11: If negative PCF contributions occur, the PDS or DGR shall be calculated using absolute PCF contribution values

Hence, for the calculation of the PDS and DQR absolute values of the PCF, the following formula shall be used:

$$PDS = \frac{\sum(|PCF_i| \cdot PDS)}{\sum|PCF_i|}$$

$$DQR = \frac{\sum(|PCF_i| \cdot DQR)}{\sum|PCF_i|}$$

7.2.7. Reporting compensation and offsets separately

For the sharing of PCF data across the Catena-X network it is required that the full PCF (cradle-to-gate) is shared. Any GHG compensation and offsets shall be excluded from the reported PCF.

If applicable, the supplier delivering a PCF to a customer shall report any offsets separately from the PCF. This includes both offsets with certificates and without. If offsets have been purchased, they shall transparently mention the origin of reported offsets and reference to the original certificate.

For rules on taking into account renewable electricity certificate, refer to Chapter **Error! Reference source not found.**.

Any carbon-neutrality claims based on offsetting for parts and components are out of scope of this PCF rulebook and shall not be done.

8. ANNEX:

8.1. TRANSPORTATION

Network resistance:

Table x: Resistance of road categories

Road category	Resistance
Highway (Category 0)	1.0
Large country road (Category 1)	1.3
Small country road (Category 2)	1.5
Large urban road (Category 3)	1.67
Urban road (Category 4)	2.5
Small urban road (Category 5-7)	3.33

Table x+1: Resistance of ferries in road/railway networks

Attribute	Resistance
Freight corridor	1.0
Non-freight corridor	1.8
Diesel tracks at electrified calculation	4.0

Table x+2: Resistance of ferries in road/railway networks

Ferry handling Resistance	
Standard	5.0
Preferred	1.0
Avoid	100

Fuel Emission Factors: See GLEC 2018 , table 31 – 34

Default load and emission intensity: See GLEC, table 35 – 46; table 35 EN16258 data shall be used.

8.2. INVOLVED AUTHORS/COMPANIES AUTOREN/UNTERNEHMEN

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