Catena-X and TFS
PCF Verification Framework

Version 1.0 open for public Consultation

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1. Glossary

Term	Definition	Source
Allocation	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.	DIN EN ISO 14040, Feb. 2021, p. 12
Carbon offsetting	Mechanism for compensating for a full PCF or a 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.	ISO 14067:2019
Certification	PCF Program Certification. 3rd party attestation related to a conformity assessment of an object. Here, the object is a client's PCF Program. For the sake of easy reading in this document this will be referenced as certification.	adapted from ISO 17000:2020
Client	Organization or person requesting a verification or validation for one or several PCF data sets or a certification for a PCF Program.	adapted from ISO 14064-1:2019, p. 22
Cradle-to-gate	System boundary that is applied for a partial PCF assessment that includes a part of the product's life cycle. Cradle-to-gate represents the GHG emissions and removals arising from all life cycle stages, up to the point where the product leaves the production site (the "gate"). This explicitly excludes the life cycle stages use and end-of-life.	adapted from TFS PCF Guideline 2022 and in reference to ISO 14067 6.3.4.2 System boundary options
Customer	Party that receives a product and the PCF dataset for this product or the receiver of the information that a supplier has a certified PCF program.	
Level of assurance	Degree of confidence in the PCF dataset verified through 3rd party verification, it can be either limited or reasonable.	adapted from DIN EN ISO 14064-1. June 2019. P. 23.
Materiality	Concept that individual misstatements or the aggregation of misstatements could change the overall PCF result and/or influence the intended users' decisions.	adapted from ISO 14064-3
Material misstatement	A difference between the reported amount, classification, presentation, or disclosure of a value and the amount, classification, presentation, or disclosure that is required for the item to be in accordance with the applicable framework. Misstatements can arise from error or fraud. Misstatements are material, if individually or in aggregation, it is reasonable to be expected that relevant decisions of a user taken on the basis of the statement are influenced.	

Party, first, second or third	Person, personnel or organization/company. 1st party: Personnel from the same, i.e. supplier organization/company. 2nd party: Personnel from an organization/company that is customer of the first party. 3rd party: Personnel from an organization/company that is neither supplier, customer nor competitor.	adapted from ISO 17029
PCF dataset	Full set of data attributes that is defined in the TFS Guideline and by the Catena-X PCF data model.	CX PCF data model & TFS Guideline https://github.com/eclipse-tractusx/sldt-semantic-models/tree/main/io.catenax.pcf
PCF documentation	Documents provided by the party seeking verification (client), presenting the PCF information package to be verified reflecting all details to be evaluated.	
PCF Program	System governing how a company generates and manages product carbon footprints	
PCF Program Certification	See Certification.	
PCF system model	Mathematical representation of a physical system and the incorporated processes to calculate a PCF (covering both simple or complex/automated calculations).	
PCF result	Total PCF excluding biogenic CO_2 expressed in CO_2eq per declared unit of product during the transition period set in the rulebooks/guideline or full set of required PCF values to comply with ISO 14067.	CX-PCF-Rulebook and TFS Guideline
PCF review	General term used in this document when all types of increasing trust into PCF dataset generation are addressed, therefore reflecting PCF dataset verification, PCF dataset validation, and PCF program certification conducted by a reviewing party.	
Primary data	Quantified value of a unit process or an activity obtained from a direct measurement, or a calculation based on direct measurements at its original source. Note 1 to entry: Primary data need not necessarily originate from the product system under study because primary data may relate to a different but comparable product system to that being assessed. Note 2 to entry: Primary data may include GHG emission factors and/or GHG activity data (defined in ISO 14064-1:2006, 2.11).	ISO 14067:2019
Risk Control Matrix (RCM)	A risk and control matrix serves as a comprehensive tool that outlines an organization's risk landscape. It encompasses potential risk events, corresponding risk control strategies, and the anticipated results of implementing these controls.	
Reviewing party	General term in this document for a party conducting a verification, certification or validation. See also more specifically “verifier” or “validator”.	

Rulebooks	Refers in this document to CX-PCF-Rulebook and TFS PCF Guideline in most recent published versions.	
Sample check	Form of an inspection in which only a selection of objects (samples) from the full population of objects is inspected. Also known as spot check.	
Screening analysis	Documents and describes the decision for the initial inclusions of inputs and outputs and the assumptions on which the cut-off thresholds required by the rulebooks are reached.	
Self-similarity	A self-similar object is exactly or approximately similar to a part of itself i.e., the whole has the same shape as one or more of the parts.	
Secondary data	Data obtained from sources other than primary data. Secondary data can include data from databases and published literature, default emission factors from national inventories, calculated data estimates or other representative data.	adapted from ISO 14067:2019
Targeted testing	Targeted testing involves selecting items to be tested based on some characteristic. It is the preferred approach for tests of details as it provides the opportunity to exercise significant judgment over what items are to be tested.	
Trust technology	Technology that enhances and propagates trust across supply chains.	
Validation	Environmental information validation: Process for evaluating the plausibility of assumptions, limitations and methods that support an environmental information statement about the outcome of future activities. The term “environmental information validation” is shortened to “validation” in this document to reduce sentence complexity and aid understanding.	
Validator	Competent and impartial person(s) with responsibility for performing an and reporting on a validation process.	adapted from DIN EN ISO 14064-1. June 2019. P. 23.
Value stream	All processes oriented at customer demand, that are in particular product and information flows.	ISO 22468:2020(en)
Verification	Environmental information verification: Process for evaluating an environmental information statement based on historical data and information to determine whether the statement conforms with the relevant criteria. The term “environmental information verification” is shortened to “verification” in this document to reduce sentence complexity and aid understanding.	based on ISO 14065:2020, 3.3.15 and ISO 14066:2023(en), 3.4.5
Verifier	Competent and impartial person(s) with responsibility for performing and reporting on a verification process.	adapted from DIN EN ISO 14064-1. June 2019. P. 22.

Verification report	Document created by the verifier documenting all relevant steps along the verification process, which is shared with the client.	
Verification result	Judgement of the verifier derived based on the evaluation of the PCF report and assessed evidence, that can be either positive or negative.	
Verification statement	Declaration by the verifier of the outcome of the verification process, which the client can share with its customer receiving the PCF dataset.	adapted from ISO/IEC 17029:2019(en), 3.7

2. Introduction

Various Stakeholders, including customers, investors, and regulators, rely on Product Carbon Footprint (PCF) data to make informed decisions about sustainability and climate action. Without trust in the reported PCF results, stakeholders may be skeptical of the claims made by companies and may question the effectiveness of sustainability efforts. Thus, building trust in PCF results is essential for ensuring that sustainability efforts are credible and effective. Sharing of PCF results across supply chains via interoperable ecosystems is enabled through a common PCF data model and PCF data exchange format. In case this PCF data model is filled in with a PCF result and additional attributes providing context this is referred to as PCF dataset. While there is the understanding that 3rd party verified PCF results are giving the highest level of trust, an immediately scalable approach with a PCF program certification is described. With a 3rd party certified PCF program an organization can create trust in its capability to generate PCF results in line with recognized standards. Beyond 3rd party verification and PCF program certification 1st and 2nd party verification are introduced as verification options that fall short of 3rd party verification in terms of level of trust.

Catena-X (CX) and Together for Sustainability (TFS) have jointly developed this PCF Verification Framework for verifying Product Carbon Footprint (PCF) results and datasets shared across the automotive and chemical supply chains. The Catena-X-PCF-Rulebook applies for Catena-X members calculating PCF results and sharing them as PCF datasets, while for TFS members the TFS PCF Guideline applies. Therefore, when mentioning 'rulebooks' in this document the latest published version of both is referred to. For normative references refer to chapter 4.

In the glossary (see chapter 1), this framework establishes definitions of key terms and concepts related to PCF result and PCF dataset verification or validation and to PCF Program certification.

This framework complements the requirements for PCF calculation in the rulebooks providing clarity and guidance for the verification of PCFs. Further, this guideline provides requirements for PCF Program certification through 3rd party certification.

This document addresses companies preparing for a verification or certification and also addresses verifying and certifying parties.

For this framework, three levels of trust have been defined, each with specific underlying procedures, purposes, and scopes. Figure 1 illustrates the trust levels and related review approaches, reflecting the PCF dataset check, certification and verification / respectively validation addressed within this framework. For detailed guidance on all review approaches related to each trust level refer to chapter 6.

PCF dataset check, PCF verification and PCF validation are conducted in reference to a single or multiple specific PCF dataset. PCF Program Certification, on the other hand, is carried out in reference to processes, management approaches and tools to calculate PCFs, where applicable. In the case of certification, only sample PCF data sets are assessed.

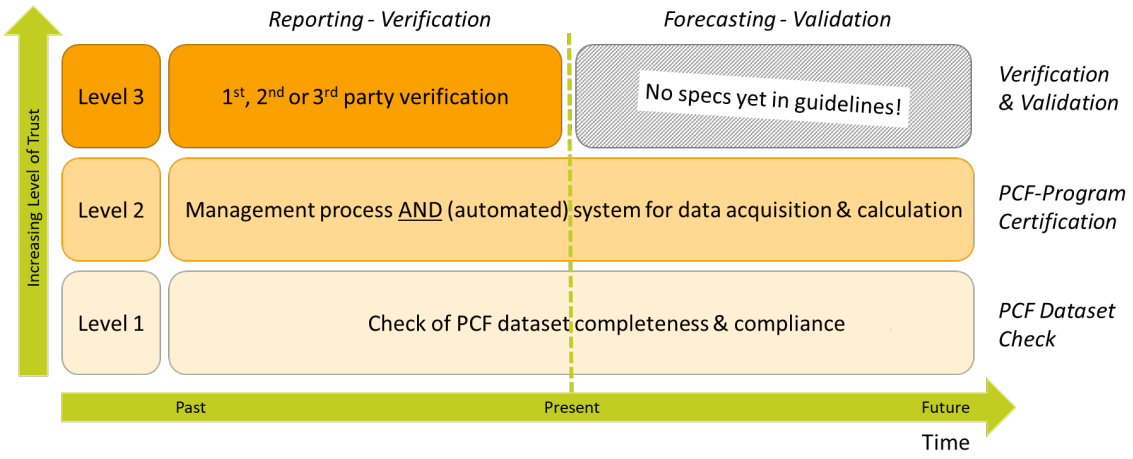

Figure 1: Levels of trust and related review approaches

Trust Level 1 is the entry level and applies to the use of (automated) solutions to perform PCF dataset completeness checks, including conformity with the PCF data models, transferred through data exchange platforms and connected solutions. This level of trust does not constitute any type of verification or certification. For detailed guidance refer to chapter 6.1.

Trust Level 2 refers to the certification of PCF programs operated by companies against requirements described in chapter 6.2. The certificate of an independent third party demonstrates that a company operating a PCF program is able to organize and to run PCF calculations in line with the requirements of the respective rulebook. PCF calculation solutions, automated and/or manual tools, operated by the respective company shall be included in the PCF program certification under Level 2.

Trust level 3 refers to the verification of specific PCF datasets by an independent party. A 3rd party verification gives the recipient of the PCF dataset the highest level of trust. Refer to chapter 6.3 for detailed guidance. A verification of specific PCF datasets can also be conducted by a 1st party or by a 2nd party, both with the precondition of the existence of a PCF program certification. The trust level associated to a 1st party or a 2nd party verification ranges below a 3rd party verification.

Despite the fact that a PCF dataset can be verified, the included PCF result cannot be understood as being the true absolute PCF value. A verification tells the receiver, that the PCF dataset has been generated following the requirements of the respective rulebook with a certain confidence level, see chapter 6.3.3.1.

The PCF program certification can be used by companies to qualify their management processes and procedures for the PCF calculation. Specific PCF datasets exchanged may not have been evaluated during a certification as described in chapter 6.2. However, the existence of a 3rd party certified PCF Program provides trust into the organization's capability of generating PCF datasets according to the respective rulebook.

Via the Catena-X and TFS ecosystems PCF datasets will be shared throughout supply chains from tier to tier to be aggregated up to the final PCF provider and recipient. Each supplier of a PCF dataset takes responsibility for the accurate and trustworthy application of the rulebooks and integrates PCF data from its suppliers.

As the PCF data aggregation is executed as a self-similar process in each tier level, verification of PCF data is executed in the same way. Each company in the supply chain will request verification of their PCF data relying on the PCF verification status achieved by its suppliers or utility providers. With each tier seeking and obtaining verification of its own operations (gate-to-gate), the entire chain (cradle-to-gate) can eventually be verified (see chapter 6.3.4.12).

Figure 2 illustrates the scope of a verification or certification engagement. The green dotted frame gives the scope considering a case where company B seeks e.g. verification for PCF datasets from production B1. Company B uses only production B1 to produce one or several products in the scope of a related verification engagement. While production B2 and B3 belong to company B as well and may be at the same or different production sites, the products

or components produced in these plants are out of scope for the respective verification engagement. They do not supply parts or materials to the products in scope of a verification engagement. The green dotted frame can also reflect the scope for a PCF program certification engagement.

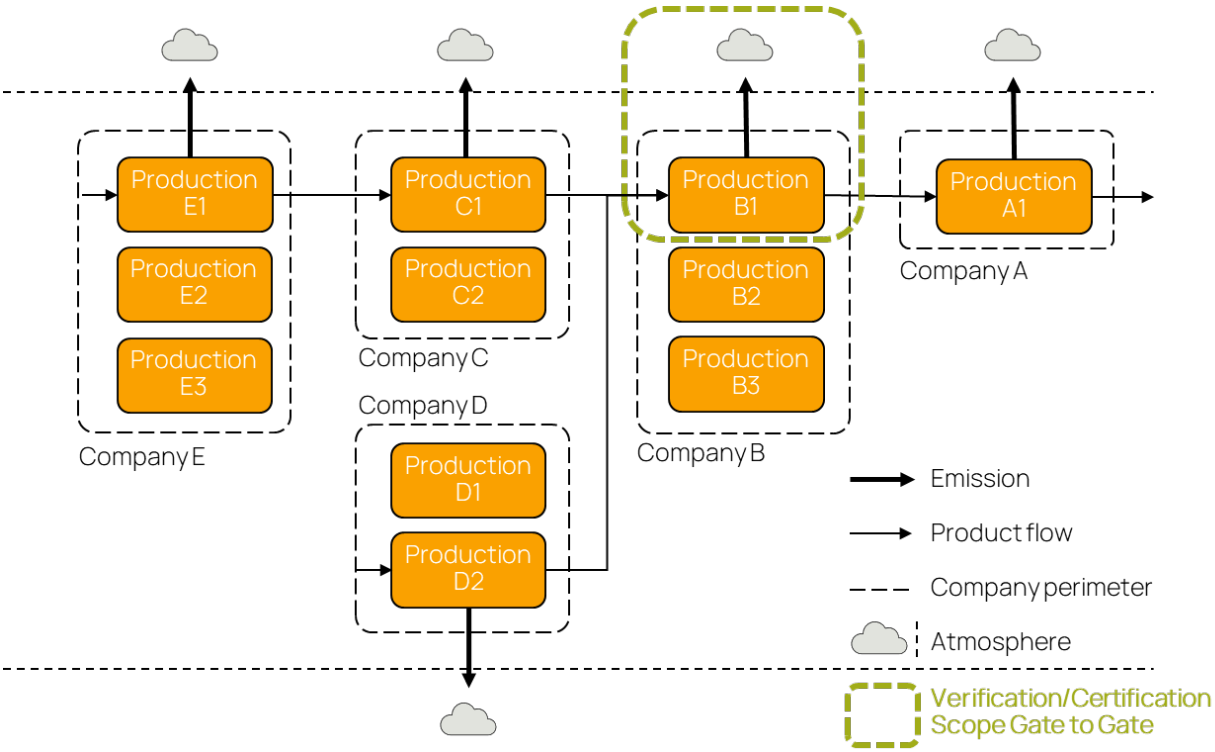

Figure 2: Scope of a certification or verification engagement

The engagement for PCF dataset verification or PCF program certification with a 3rd party is described in chapters 6.1ff and 6.2ff. In the course of a certification engagement, the certifier receives the client´s PCF program documentation and the corresponding evidence to certify that the PCF program has all elements described in chapter 6.2.1, which are the bases for a certification of the client's capability to generate PCF datasets in accordance with the respective rulebook. In the course of a verification engagement, the verifier receives in addition the client´s PCF dataset(s) and the corresponding evidence to verify if this or these PCF dataset(s) have been generated in accordance with the criteria and scope that are defined as pre-engagement activities following chapter 6.3.3.

Both rulebooks provide guidance and requirements to establish and calculate a Primary Data Share and a Data Quality Rating, which are both reflected as attributes in the PCF dataset and are intended to be cascaded from tier to tier enabling the final recipient of the PCF dataset to understand which share of the PCF result is calculated based on primary data and which overall data quality rating the PCF result has. This PCF Verification Framework does not prescribe any minimum value for the primary data share to achieve verification. Nevertheless, it has to be stated, that secondary data do not represent the actual supply chain, but reflect an average mix of technologies, regions, and/or are using estimated information to calculate PCFs.

In addition to Data Quality Rate (DQR) and Primary Data Share (PDS) information, this framework introduces new indicators to reflect and propagate the verification and/or certification status of a PCF data set (Chapters 6.3.5 and 6.2.3).

This PCF Verification Framework does not prescribe any minimum requirement for a Data Quality Rating for PCF datasets, either.

The PCF Verification Framework also does not prescribe any mandatory or minimum level of trust, but rather describes PCF review options to choose from.

It is subject to decisions taken within an industry initiative, an ecosystem or by the actors in a business-to-business relationship to create incentives or requirements related to indicators like Primary Data Share (PDS) or Data Quality Rating (DQR).

Finally, this PCF Verification Framework will be made available to the public for feedback to improve the verification and certification framework for Product Carbon Footprinting in the automotive and chemical supply chains.

3. Scope

The scope of this document is to provide guidelines for the verification of the product carbon footprint according to the PCF rulebooks. The document is applicable to all companies and suppliers in the automotive and chemical supply chains or all those outside the aforementioned industries who opt to report according to those PCF rulebooks. The framework covers the entire certification process for PCF programs and the verification process of PCF datasets, including the planning, execution, and creation of the verification report and the verification statement.

The scope of the described review approaches and achievable trust levels is gate-to-gate from the perspective of the client, illustrated as Company B in Figure 2. Thus, each tier in the supply chain takes responsibility for reaching a certain trust level of the PCF contribution under its control.

Cradle-to-gate is applied as system boundary in the rulebooks for calculating PCFs and the PCF result is subject to a review approach that reflects this system boundary.

In order to complete a verification of the cradle-to-gate PCF dataset, which is then passed on to the customer, data of upstream stages are included in the evaluation. This evaluation should use verified PCFs of suppliers and covers the accurate use of supplier PCF data in the PCF calculation. Chapter 6.3.4.12 and Chapter 6.3.5 provide details how to deal with verified or unverified upstream PCF datasets. Each tier is responsible for its share of the PCF (gate-to-gate) and its verification, so that aggregated the cradle-to-gate scope can be covered by verification. Therefore, the verified PCF result reflects cradle-to-gate emissions, even if the individual scope of verification engagement is limited to gate-to-gate.

Whenever ensuring plausibility of future-oriented/predicted PCFs the expression ‘validation’ is used. The current versions of the rulebooks do not provide any requirements or guidance on predicted PCFs therefore the current version of this PCF Verification Framework focuses on verification, certification and PCF dataset checks. In order to address the validation of projected PCF results, it is first necessary to expand the rulebooks. In this current version more specific guidance on validation is out of scope. More guidance on validation may be added, once there are clear requirements established in the rulebooks on the calculation of predicted PCFs.

The document does not cover specific methodologies for calculating product carbon footprints. Verification of carbon offsets are out of scope of this document. Other environmental impact categories or sustainability indicators to assess product sustainability in a wider scope have not been explicitly addressed by the document, transferability may be evaluated case by case.

4. Normative Reference

Catena-X Product Carbon Footprint Rulebook[1] (CX-PCF Rules) or TFS PCF Guideline[2], both in the latest published version and the standards these documents are referencing to. All requirements of the rulebooks shall be checked if accurately applied.

[1] https://catena-x.net/fileadmin/user_upload/Standard-Bibliothek/Update_September23/CX-0029-ProductCarbonFootprintRulebook-v2.0.0.pdf
[2] https://www.tfs-initiative.com/how-we-do-it/scope-3-ghg-emissions

5. Requirements

5.1 Objectiveness

Refers to the ability to perceive or represent something as it is, without being influenced by personal feelings, interpretations, or prejudices. Therefore, the verifier or certifier shall not be involved in setting up a company's PCF program or PCF calculation. This applies regardless of the party the verifier is associated with.

5.2 Relevance

Refers to the extent to which the PCF result and documentation is pertinent and applicable to the specific purpose of the PCF dataset verification or PCF Program Certification. The certification or verification shall ensure that the management processes, PCF data and related information is relevant to the specific purpose and context of the verification or certification engagement, and that any limitations or uncertainties are clearly communicated. This requirement is important to ensure that the verification or certification results are useful and meaningful to the intended users and stakeholders.

5.3 Transparency

Refers to the details and clarity of the documentation and the certification/verification process. The verification or certification process shall be transparent to the client and documented by the reviewing party. The documentation provided by the client seeking a certification or verification is clear and addresses the relevant topics of the PCF dataset generation, the calculation approaches, the impact assessment, the interpretation, and reporting.

5.4 Confidentiality

Emphasizes the importance of protecting sensitive information related to the generation of PCF datasets. The reviewing party must ensure that the information is only shared with authorized parties and that the appropriate measures are in place to maintain confidentiality throughout the review process.

6. Review Approaches

Referring to Figure 1 three levels of trust are differentiated in this document. In this chapter the approaches to reach the respective level of trust are described.

6.1 PCF Dataset Check

Considering the use case of sharing PCF datasets via digital ecosystems, the first level of trust for a PCF is reached if the PCF dataset passed a completeness and conformity check with the selected rulebook and the latest version of the respective PCF data model (see ANNEX A 1 for an example excerpt of the data model). The PCF Dataset check does not address any aspect of the underlying PCF calculation.

A PCF dataset shall be provided in the respective PCF data exchange format. This format includes mandatory, optional and default attributes, with a prescribed data type per attribute.

The completeness check of PCF dataset against the selected data model ensures that all mandatory fields are filled in. The conformity check ensures that all attributes are filled in using the respective required data type. The mandatory attributes and their data type are aligned between different initiatives aiming to share PCFs along supply chains. Various attributes only allow entries from a predefined selection list. The conformity check shall ensure that data entries comply with the respective selection list.

Default values refer to data attributes that allow only a specific entry to comply with a rulebook, e.g. the attribute #coveragepercent# can only have a '100' if reporting according to Catena-X PCF or TFS rulebook. The conformity check shall ensure that the only possible entry is set.

The PCF dataset check shall be performed by the reviewing party manually or via a certified software solution ensuring that the data is in accordance with the requirements of the respective rulebook.

Conformity checks can be combined with additional plausibility checks ensuring that values for a certain attribute meet further requirements, e.g. a #GeographyCountrySubdivision# should be in line within the corresponding attribute #GeographyCountry#.

6.2 PCF Program Certification

This chapter describes the certification process necessary to achieve level 2 of trust into PCF datasets, as outlined in the introduction (chapter 2) and illustrated in Figure 1.

The process in scope aims at certifying that the company calculating PCFs has established a PCF program in line with the respective rulebook. The PCF program shall include a description of the methodology used by the company to calculate PCFs. If applicable, the deployment of any automated PCF calculation solution (tool and integrated data sources and IT management) is also subject to certification. An automated PCF calculation solution is defined as a digital tool enabling mass calculations of PCFs in an automated manner.

The rulebooks do not mandate any PCF program or an automated PCF calculation solution. It is in the interest of the individual companies to adopt a company-specific approach, which is in line with the calculation rules in the respective rulebook and the following chapters.

The certification can only be done through a 3rd party appointed by the Catena-X Association or Together for Sustainability for their respective rulebook. Appointment process and criteria will be defined by the associations.

The scope of the certification shall be clearly defined (e.g. organizational units, products, product groups, sites, etc.).

The PCF program certification shall ensure that the methodological requirements set out in the respective rulebook are followed, including the respective mandatory attributes in the respective PCF data model. Certified PCF programs and automated PCF calculation systems shall include a process for the PCF dataset check. In addition, the elements of the PCF program described in 6.2.1 shall be ensured.

The PCF program certification shall only be used for systems, processes and calculation solutions deployed within a given company and reflecting this company's unique situation. Unlike the PCF verification described in chapter 6.3

this certification does not certify any specific PCF dataset for a product, nor does it claim any output (e.g., a specific PCF result or dataset) of a tool or program as certified, verified or in any other way assessed.

Calculations and data issued from certified PCF programs may be used as inputs to PCF verification and validation activities (see chapter 6.3 & 6.4). If the PCF program or automated calculation solutions are already certified and therefore known and trusted, individual PCF verification activities may build on this and therefore be simplified.

A PCF program certification is mandatory to obtain a 1st or 2nd party verification. However, a PCF program certification is not mandatory to obtain a 3rd party verification of a specific PCF dataset.

PCF program certifications cannot be substituted by existing certification schemes like ISO 9001 or ISO 14001.

6.2.1 Elements of a PCF program

The PCF program refers to the system governing how a company generates and manages product carbon footprints. The described system shall have the goal to allow streamlined, efficient PCF generation with a constantly maintained quality level. The PCF program requires the following elements:

- **Definition of set-up:** Identify and document company-internal stakeholders, production sites and parts of a company contributing to the PCF calculation process through data collection, processing, and transmission. The scope description of the calculation system shall also detail which products are covered under this PCF program, as well as how and which software solutions and databases are used. It shall cover a description of the expertise of PCF program responsible persons in the company.
- **Data Management:** Description of the primary and secondary data collection process, data quality assurance, application of the cut-off rule, procedures for data consolidation, processing, aggregation, calculation, and data transmission using the PCF data model. In case of estimate on activity or emission factor data, their use shall be documented with a description of the rationale of application. Furthermore, the system of archiving of data and data models shall be described. Documentation of software used, of their intervals for update and the documentation of secondary databases used.
- **Roles & Responsibilities:** Structuring the tasks, roles, and responsibilities within the organization, establishing reporting relationships, and allocating resources effectively. Training procedures as well as competency management shall be included.
- **Methodology implementation:** Documentation on systematic and coherent rulebook implementation (e.g., multi-output processes and allocation, integration of supplier data, justification for use of certain product category rules (PCRs), selection of secondary databases, etc.). In case decisions on options are to be made these shall be justified and documented.
- **Governance:** Documentation of internal procedures for PCF calculations, including processes for updating calculations and databases, responding to methodological changes, time validity of calculations, and the quality assessment of both primary and secondary data, among others. Risks (e.g. selecting wrong data, many manual data transfers, etc.) shall be evaluated, and those risks shall be addressed and mitigated.
- **Establishing internal controls:** Establishing controls can include activities like quality assurance processes (monitoring and evaluating compliance with the rulebooks), supporting analytics (4-eyes principle, automated plausibility checks, etc.), sample calculations, etc.. The effectiveness of controls regarding the calculation process shall be regularly evaluated. A continuous monitoring for the internal control shall be put in place.
- **PCF Dataset Sharing:** Procedures may be established for the sharing of calculated PCFs both internally and externally. This step shall include definition of criteria (e.g. data quality thresholds, geographical scope, etc.) to determine suitability for external publication of PCFs calculated via the calculation process.

6.2.2 Certification process

The following flow chart provides an overview on the certification process in total.

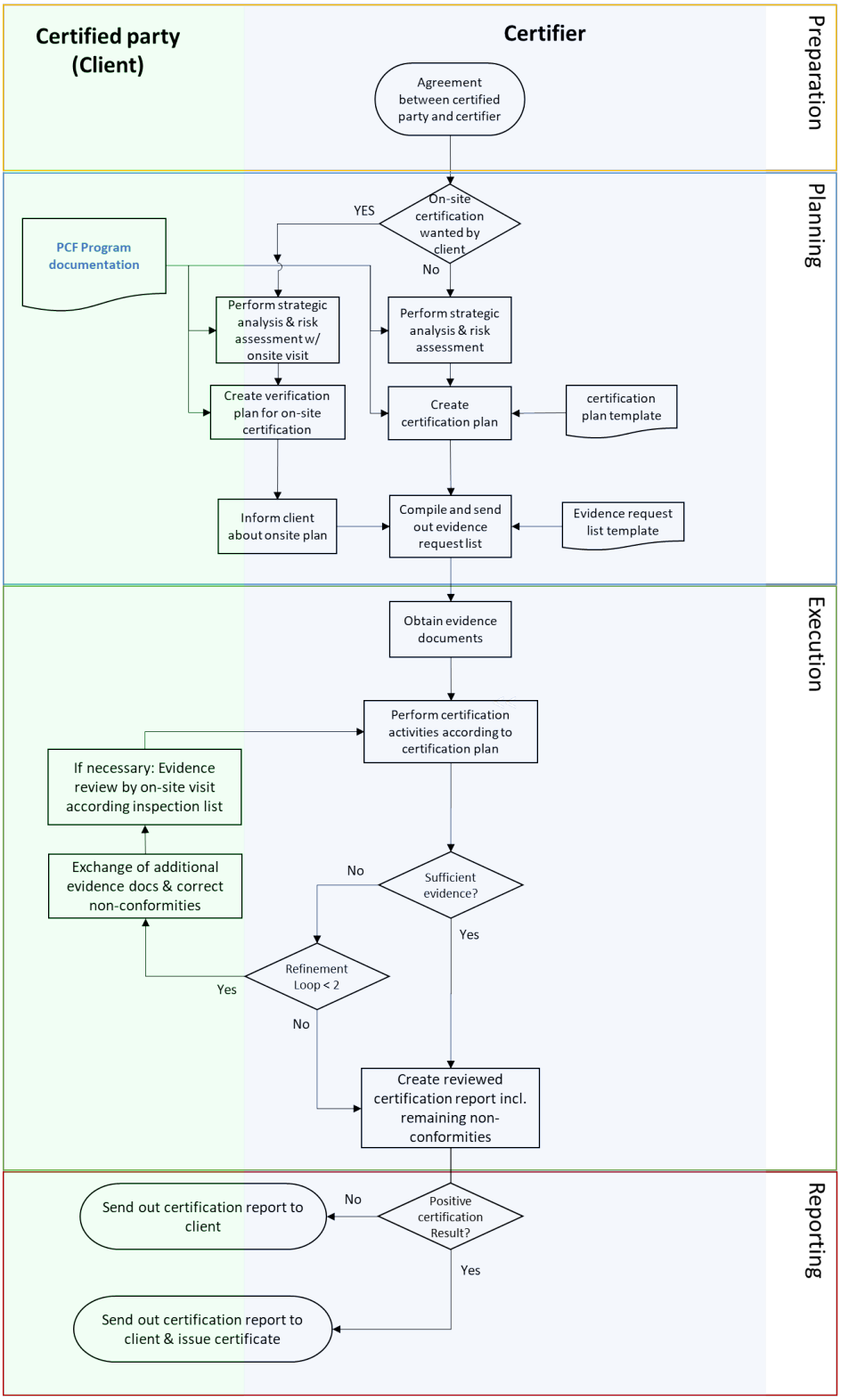

Figure 3: Certification process flow chart

The certification process procedure is similar to the verification process procedure and described step by step in 6.3. Certifying a PCF program (and automated PCF calculation solution if applicable) involves a comprehensive evaluation process to ensure its accuracy, reliability, and adherence to the rulebooks. The following activities are included:

1. **Select an independent certification body**: The client selects an appointed certification body.
2. **Application and documentation**: The client shall submit the PCF Program documentation (and automated PCF calculation solution if applicable) for certification, providing detailed documentation on technical specifications, methodologies, data sources, and any other relevant information required for evaluation.
3. **Conformity Assessment of the required PCF Program Element according to 6.2.1**: The certification body will thoroughly evaluate the PCF program (and automated PCF calculation solution if applicable) by checking their documentation and implementation. This includes sample and targeted checks. Recalculation and/or retracing of sample PCFs datasets shall be done in case of multiple products for at least 3 representative products. Data sources, data collection processes, and calculation methodologies will be analyzed to ensure they are robust, transparent, and aligned with the respective rulebook. In case of insufficient evidence, feedback loops to clarify open points can be used. It is recommended that a senior representative from the client's PCF team is involved to facilitate efficient execution by providing additional explanations or justification.
4. **Issuance of certificate**: Based on the evaluation and certification process, the certification body will issue a detailed report highlighting the PCF programs compliance and any areas for improvement. If the PCF program (and automated PCF calculation solution if applicable) meets the certification criteria, a certificate will be issued.

In the event of the certificate issuance being denied, meaning a negative certification result, re-application is possible after correction of any deviations.

6.2.3 Reporting

To promote the trust into PCF datasets being shared across the supply chain a performance indicator is defined that allows the recipient of the PCF dataset to recognize what share of the PCF result was calculated by PCF program certified suppliers. This indicator is named PCF-**P**rogram **C**ertification **S**hare (PCS) and is propagated and reported with the PCF result analogue to the product verification shares that are introduced in chapter 6.3.5.

$$PCS_{PCF} = \frac{|Part\ of\ PCF\ calculated\ within\ a\ certified\ program\ [kg\ CO_2\ e]|}{PCF_{as}\ [kg\ CO_2\ e]}$$

$$PCS_{aggregated} = \frac{\sum_i \left(\left|PCF_{total,i}\right| \cdot PCS_i\right)}{\sum_i PCF_{as,i}}$$

Annex A 3 provides an example of the PCS calculation.

The certification statement shall include:

- certification statement identifier,
- certifier identification,
- name of certifying person,
- definition of scope,
- issue date,
- certifier's digital signature.

The certification statement can be shared with client and customer in the way as the verification statement described on chapter 6.3.8.2.

6.2.4 Validity, surveillance, and re-certification

The certificate shall be valid for a maximum of three years after initial certification. The certificate will only be valid as long as the assessed PCF program (and if applicable, the automated PCF calculation solution) does not undergo changes. If there are changes in any way which may impact the certification decision, including methodology changes (e.g., new version of the respective rulebook), the certificate holder shall notify the certification body about the changes. The certification body shall evaluate if the certificate is still valid, if and which evaluation techniques need to be applied to re-certify the conformance of the PCF program, or if the certificate must be withdrawn.

The PCF program (and if applicable, the automated PCF calculation solution) shall be subject to periodic, at least one annual internal review to ensure that changes do not go unnoticed, and the program continues to meet the required standards.

Re-certification shall be carried out well in advance of certificate expiry to maintain the certification. Re-certification shall be necessary after not more than three years after issuance of the certificate. The scope of the re-certification should be focused on major changes. In addition, re-certification will also address changes to rulebooks which require process or other alterations.

Irrespective of the expiry of a certification program, the link between a PCF data set and a 3rd party certification valid at the time of issuance of the PCF will persist and retain its validity as long as the PCF data set is valid.

6.2.4.1 Internal review

An internal review performed by a competent reviewer shall ensure and document that the internal processes adhere to the certified quality requirements. An internal review shall be done on an annual basis or as soon as changes to the assessed PCF program (and if applicable, the automated PCF calculation solution) were made which may impact the certification decision. The internal reviews shall be documented for re-certification.

The reviewer can be affiliated with the same company it is reviewing as long as the reviewer can prove the independence from the PCF program. The reviewer shall be knowledgeable in the field of PCF and the related rulebooks.

6.2.5 Competence requirements for a certifier

The competence criteria for a verifier described in chapter 6.3.10 shall be met by the certifier.

Additionally, the certifier shall have knowledge about:

- The essential PCF program elements listed in 6.2.1.
- The certification process of the PCF program listed in 6.2.2.
- Reporting and communication requirements of a PCF according to the rulebooks.
- Quality management systems, approaches, and best-practices
- (e.g., ISO 9001, ISO 14001, ISO 14067 Annex C).
- Implementation of automated PCF calculation solution, maintenance, quality assurance, and best-practices.

6.3 Verification

6.3.1 Verifier Affiliation

In the most common case, a 3rd party, fully independent from the client, acts as verifier. However, verification by a 1st or 2nd party is also possible. With the choice of a 1st, 2nd or 3rd party verifier the achievable degree of trust is defined as well as the admissible degree of insight to background data that can be given to the verifier. Aside from these differences the same procedures shall be followed no matter whether 1st, 2nd or 3rd party verification is envisaged. The following chapters describe a 3rd party verification without limitation of applicability to a 1st and 2nd party verification (this explicitly applies also to the competence requirements for a verifier as described in chapter 6.3.10). Otherwise, the differences are clearly marked.

In the case of a 2nd party verification, the 2nd party (i.e., the customer) would request and be granted access to additional data on top of the regular PCF data-model from the supplier to enable an expert judgement on the plausibility of the exchanged PCF.

A necessary pre-condition of a 2nd party verification is a valid PCF program certification of the supplier (i.e. trust level 2). Moreover, the parties may sign a non-disclosure agreement about the additional data exchange. With such condition fulfilled, the 2nd party shall request confidential access to the following additional data (as a minimum requirement):

- Location of production,
- declaration of supplier type (e.g. manufacturer or distributor),
- adoption of specific PCRs in the PCF calculation,
- other data which are included in the PCF data model but have not yet been provided, because declared as “optional” or not yet “mandatory” at the time of the PCF exchange,
- manufacturing technology employed. The 2nd party and the supplier shall mutually agree on adequate data disclosure.

The additional data may be exchanged electronically by leveraging digital data exchange platform functionalities provided in Catena-X or TFS networks.

The 2nd party shall review the exchanged data and assess the plausibility of the PCF value. As an example, the 2nd party may compare the PCF with other available data in the lifecycle data inventory (e.g. other primary data from other suppliers of analogous or similar products and/or secondary data references) and request explanation on any peculiarities from the supplier. Such assessment shall be conducted by a LCA practitioner with the qualification defined in chapter 6.3.10..

The 2nd party verification assessment shall be conducted in reasonable time, not exceeding 3 months. In case of a positive verification, a verification statement will be issued. In the specific case of a 2nd party verification the identity of the verifying party shall not be disclosed.

In case of a failed verification, no verification statement shall be issued, however re-application is possible.

6.3.2 Verification process

The following flow chart provides an overview on the verification process in total.

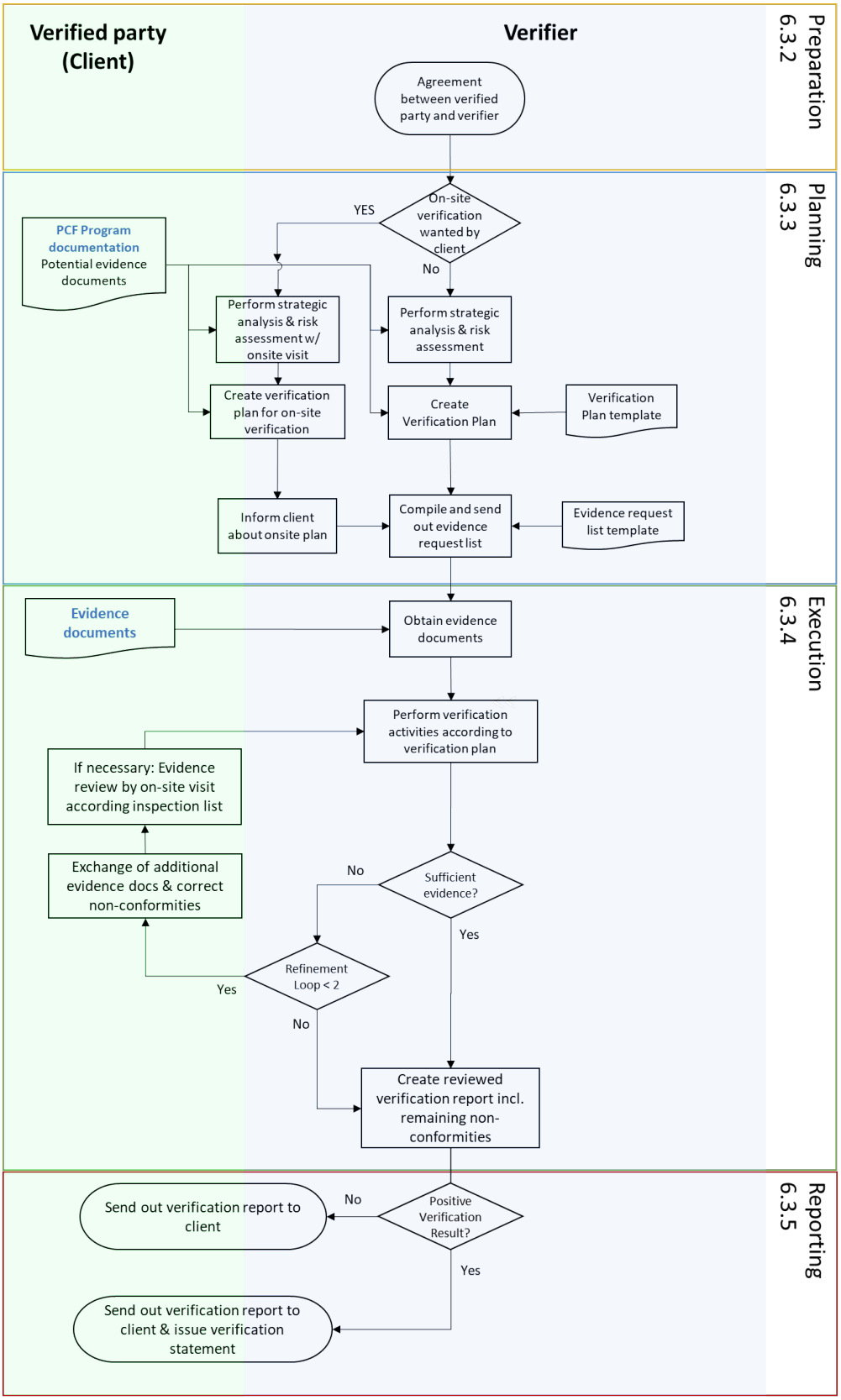

Figure 4: Verification process flow chart

6.3.3 Preparation

Before the start of the verification activity, the client shall define the product and agree with the verifier on the content of the activity according to process illustrated in Figure 4. The parties should agree on the specific verification process based on this framework to be performed.

Essential parts of the agreement are type of verification, objectives, criteria, timeline and scope. The client can request an on-site visit to perform the verification. Signing an agreement ends the preparation phase.

6.3.3.1 Types of verification

The targeted level of assurance shall be defined considering the situation and goals of the client and the needs of the intended use. The level of assurance describes the verifier's level of confidence in the PCF dataset and underlying information. A distinction is made between a regular and an in-depth verification. In case of a 3rd party verification these alternatives are referred to as reasonable assurance and limited assurance.

Limited assurance means that the PCF dataset is supported by information that allows the verifier to form an opinion that the statement is generally conformant with the evidence checked. Nothing came to the attention of the verifier that the PCF dataset is misstated by the client.

In-depth verification provides a higher level of confidence in a PCF dataset for the intended use. For in-depth verification, a verifier will use control testing (design and effectiveness) and enhanced sample testing to form a positive statement that this PCF dataset is correct. (see 6.3.4.3 ff)

An overview of the two confidence levels (regular/limited assurance and in-depth/reasonable assurance) is given in Table 1.

Detection of material misstatements is more likely for an in-depth verification compared to a regular verification due to a higher number of tests. Coverage of PCF of higher than 80% in this verification context means, that the evidence documents checked during the verification process cover sufficient items which represent at least 80% of the PCF value.

Table 1: Types of verification

	Regular	**In-Depth**
Assurance level (3rd party only)	limited assurance	reasonable assurance
Control tests	low, test of 1 per control	high
PCF model check	yes	yes
Sample testing of evidence	> 80% coverage of PCF	> 95% coverage of PCF

It shall be possible to switch from in-depth to regular during the verification process.

6.3.3.2 Criteria

The client shall create PCFs and report in accordance with the respective rulebook.

6.3.3.3 Objectives

The objective of the verification is to reach a conclusion about the accuracy, correctness, and completeness of the PCF dataset in accordance with the above defined criteria.

The subject matter of the PCF dataset shall be clearly defined:

- An individual product such as a single reference number.
- A homogenous product group corresponding to the definition of homogenous products according to the respective rulebook.

- A product group consisting of individual products.
- A group of similar or individual products out of a specific production site or part of a production site.

6.3.3.4 Scope of the verification

The scope for the verification shall be clearly defined and includes:

- Subject matter,
- Functional or declared unit,
- System boundaries,
- Production process/technology/facilities,
- Life cycle inventories
- GHG sources, removals, sinks and reservoirs,
- Impact assessment,
- Reference time period (recommended baseline for the historical data is one year, as stated in the rulebooks to rule out seasonal fluctuations).

Verification of carbon offsets are out of scope of this document.

As the PCF's reporting scope is always cradle-to-gate, it is the client's responsibility to report cradle-to-gate PCF values to the customer. In case the client organization is in charge of its own outbound logistic, it shall also take care of the calculation and verification of the emissions for this relation. For details refer to Annex A 2.

6.3.4 Planning

6.3.4.1 Strategic analysis and risk assessment

Before starting the verification, the verifier shall perform an assessment of the risk of material misstatement (inherent risk, control risk and detection risk) of the PCF. Therefore, the verifier needs to understand the complexity of the production steps for the product(s), complexity of quantification methods, the control environment and mindset regarding controls, if estimates are used for significant parts of the PCF as well as experience and skills of the personnel for the PCF value to be verified. The verifier shall use the results of the risk assessment to develop the verification plan and document request list. In case of increased risk additional documents and samples might be needed. A visualization of the verification scope, the system boundaries and the relevant flows as shown in Figure 5 shall be provided by the verified party.

Figure 5 shows a generic situation. To make the verification planning more tangible an example is given in the box below. All text in grey color and highlighted through boxes throughout the document is for illustration using a practical example only.

> The example concerns a production site for Diesel Rails. A Diesel Rail is a component of a Diesel injection system for internal combustion engines. Diesel from the vehicle fuel tank is delivered and compressed to high pressures by a Diesel pump and delivered to the Diesel rail. The rail serves as intermediate storage for the Diesel injectors which meter the fuel with multiple injections for single combustion stroke. Each engine cylinder is equipped with an injector, and these are connected via high pressure hydraulic lines with the Diesel rail.
>
> The rail production is located in one specific building at the production site, so that all GHG emissions associated with the final production of the rail can be recorded by a physical system boundary comprising that building.

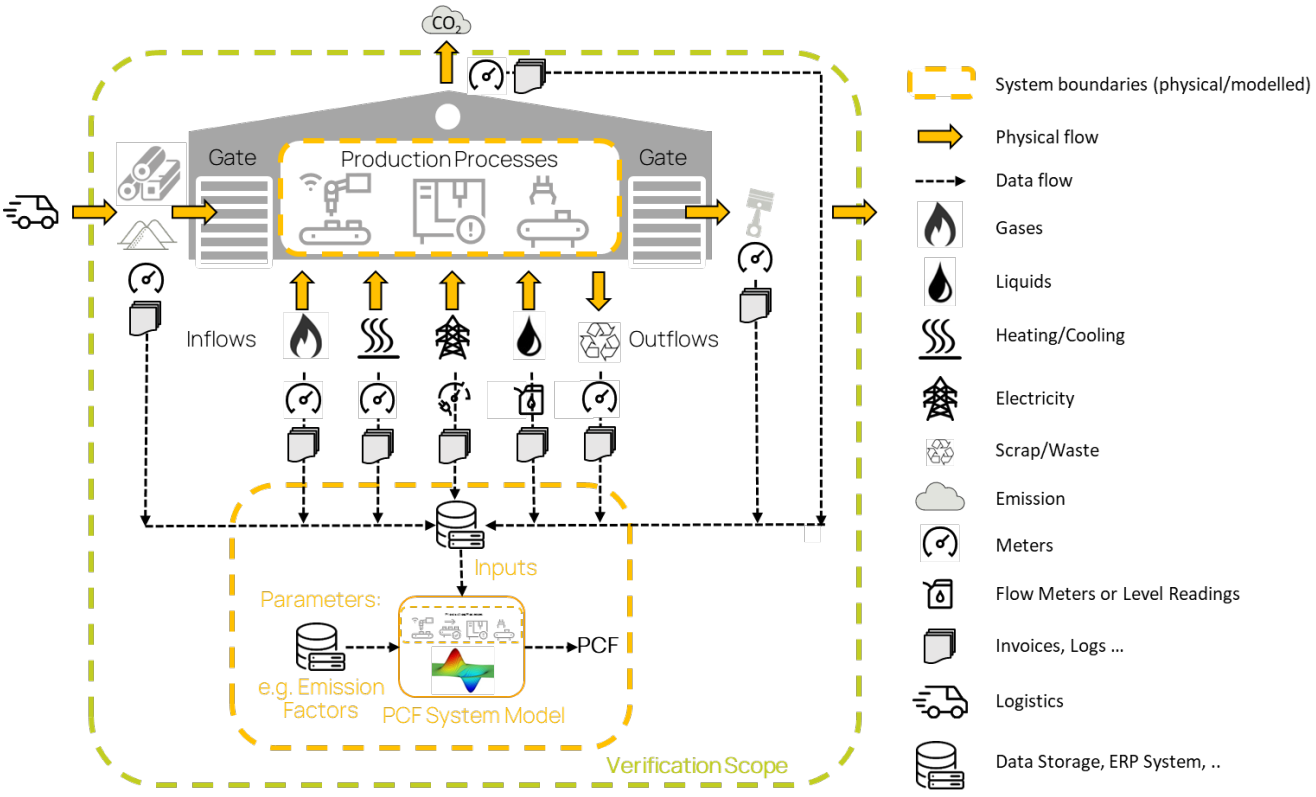

Figure 5: Verification scope, system boundaries, physical and data flows

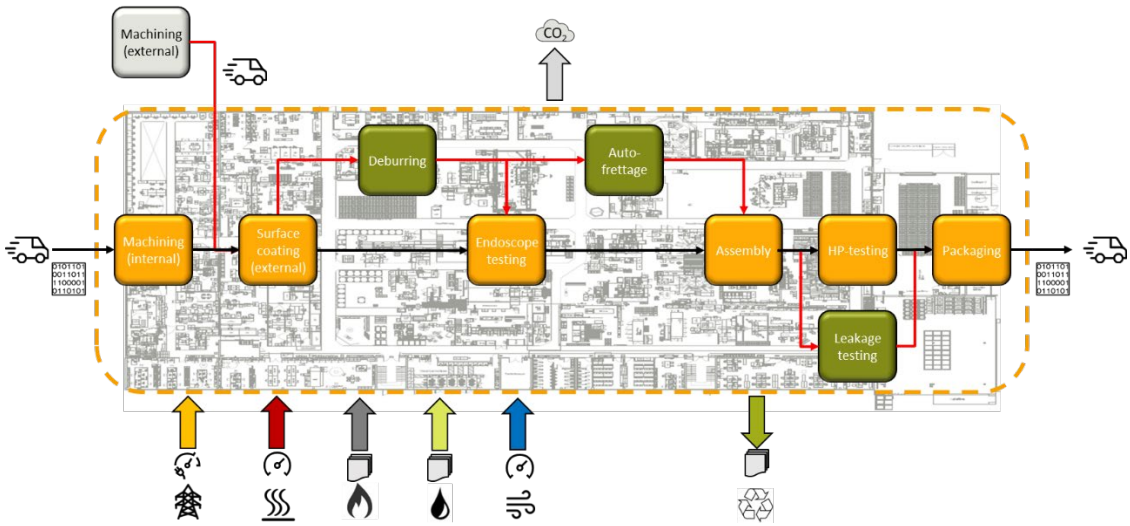

Figure 6: Floor plan of the rail production with main production processes

Figure 6 depicts the floor plan of the building. The starting point for the inhouse production is forged parts which are either externally or internally machined. Some production steps are specific to certain rail types only.

The PCF of forged parts and all other supplied parts assembled to the final rail is provided by the respective suppliers including the contribution of inbound logistics.

Electricity consumption of the building is recorded electronically on a quarter-hourly base. The same applies to hot / cold water and compressed air as supplied by the plant's central energy facility. The process gas for leakage testing is recorded by weekly pressure readings. Detergents and lubricants are recorded by the monthly refill quantities and documented by the plant logistics. Machining chips constitutes the production waste that is collected and weighed on a monthly base. The number of supplied parts and final rails is tracked by the plants ERP system.

Within this step the level of data availability and the management controls in place for data input and calculation model and tool (including allocation) for the PCF calculation are to be assessed. Therefore, the verifier shall collect the following information (ideally from the PCF program documentation) and assess the risk and strategy through an interview.

- Type of verification (see Table 1),
- Overview of the complexity of the verified system and calculation model(s),
- Reference time period and consistent availability of evidence for the period under consideration,
- Experience, skill level and training of personnel,
- Risk of misstatement (e.g. degree of automated vs. manual data collection),
- Level of detail of the available documentation,
- Management controls for data input and PCF calculation (e.g. down times in data processing or controls),
- Likelihood of omission of significant emission sources and possible data gaps (e.g. see screening analysis in accordance with cut off limit as defined in the rulebooks),
- Documentation and results of the previous verification, if applicable.

6.3.4.1.1 Review of the screening analysis

A screening analysis is an approach applied by the verified party to assess the general data used in the PCF calculation. It shows which types of data were used in general, if the sources are trustful and how significant the data are influencing the overall PCF result. In some cases, scenarios can be done by replacing datasets with others to decide which data are used in the final PCF calculation. The results of the screening analysis, which may be part of a background report and may be related to multiple datasets, shall be reviewed by the verifier. The verifier shall select one random sample of the values that are excluded in the PCF calculation as insignificant according to the cut-off-rule specified in the respective rulebook. For this sample it shall be reviewed if it can be proven that the value has an immaterial impact on the PCF value.

Misstatements, including omissions, are material if they, individually or aggregated, can influence relevant decisions of a user taken on the basis of the PCF calculation. An example is shown in Table 2. It shows, that the railbody has the most significant impact to the PCF.

A screening analysis for the Diesel rail production yields the following result:

Table 2: Screening analysis

Flow	Name	Amount	Unit	PCF	Unit	GHG	Unit	PCF Share	PCF [kgCO_2eq/pcs]
Inflows									
	electricity	3512	Mwh	50	kg CO_2eq/Mwh	175600	kg CO_2eq	2,1%	
	hot water @ 65°	2000	m^3	201	kg CO_2eq/Mwh	211964	kg CO_2eq	2,5%	
	cold water @ 5°C	3000	m^3	350	kg CO_2eq/Mwh	12180	kg CO_2eq	0,1%	
	compressed air @ 10 bar	15000	Nm^3	350	kg CO_2eq/Mwh	609	kg CO_2eq	0,007%	
	lubricant refill	50	m^3	1,2	kg CO_2eq/kg	905	kg CO_2eq	0,01%	
	water refill	1000	m^3	0,0003	kg CO_2eq/kg	1	kg CO_2eq	0,00001%	
	detergent refill	10	m^3	1,1	kg CO_2eq/kg	3005	kg CO_2eq	0,04%	
	process gas	1,6	m^3	24300	kg CO_2eq/kg	257774	kg CO_2eq	3,10%	
						662038	kg CO_2eq	8,0%	0,4
	supplied parts								
	railbody	1290000	pcs	3,1	kg CO_2eq/pcs	4029960	kg CO_2eq	48,5%	
	railbody machined	210000	pcs	3,2	kg CO_2eq/pcs	682282	kg CO_2eq	8,2%	
	pressure reg. valve	1500000	pcs	1,3	kg CO_2eq/pcs	1875000	kg CO_2eq	22,6%	
	high pressure sensor	1500000	pcs	0,3	kg CO_2eq/pcs	450000	kg CO_2eq	5,4%	
	fitting	1500000	pcs	0,008	kg CO_2eq/pcs	12600	kg CO_2eq	0,2%	
	sticker	1500000	pcs	0,005	kg CO_2eq/pcs	7500	kg CO_2eq	0,1%	
	protective caps	9750000	pcs	0,06	kg CO_2eq/pcs	594750	kg CO_2eq	7,2%	
						7652092	kg CO_2eq	92,0%	5,1
Outlows									
	waste (machining chips)	56115	kg						
	rail	1500000	pcs			8314130	kg CO_2eq		5,54

From the PCF Share it is obvious that the contribution of cooling water, compressed air, water, lubricant and detergent falls under the cut-off of 1% defined as an example. The contribution from fittings and product stickers is very low, so that these as well can be neglected.

In case of the rail production the verifier would for example refer to data inflow “cooling water”, “compressed air”, “lubricant, water or detergent refill” or the supplier information on the PCF of stickers and fittings to verify with evidence that its contribution is immaterial (see dotted square in Table 2).

6.3.4.2 Verification plan

The verifier shall develop a plan that describes the verification activities and schedule. The verification plan should include the following verification steps: Testing of design and effectiveness of controls, substantial/sample testing of the data sources, verification of PCF system model(s), testing of IT-controls (if tools are used), estimate testing and analytical testing (if applicable).

During the strategic analysis and risk assessment the relevant data inflows are identified. The verifier shall test samples for all relevant data inflows identified. Table 3 gives an overview on verification techniques with related verification activities.

Table 3: Verification techniques

Verification step	Verification activities	Number of samples
1. Testing of control design	▪ Review process description for PCF creation or risk control matrix (RCM, if available) and evaluate whether control design is appropriate (controls like 4-eyes-principle are in place to assure that PCF data is correct). ▪ Interviews with control owners	n/a, Process description or RCM
2. Testing of effectiveness	▪ Review of effectiveness of controls over the reference time period under review.	see table controls testing (Table 5)
3. Substantive testing of data sources	▪ Testing of samples for all relevant data inflows	see table substantive testing (Table 6) for each relevant data source
4. Testing of PCF system model	▪ Testing of calculation logic / rules / results ▪ Connection with emission factors, ▪ Review of emission factors (source).	
5. Testing of IT-Controls (if tools are used)	▪ Testing of IT controls to assure reliability and security of the data.	1 for each IT control 1 for major data inflow
6. Estimation testing (if applicable)	▪ Review of estimation methods.	1 sample for each relevant data inflow

In the following the example of an in-depth (reasonable assurance) testing for the Diesel Rail production is shown, where 95% coverage of the PCF is required. The verifier shall randomly select inflows to reach a coverage of 95% and define the number of samples for the selected inflows (Table 4).

Table 4: Examples of randomly selected inflows to meet 95% PCF coverage.

A

Flow	Name	PCF Share	cummulated PCF share
Infows			
	supplied parts		
	railbody	48,5%	48,5%
	pressure regulating valve	22,6%	71,0%
	railbody machined	8,2%	79,2%
	protective caps	7,2%	86,4%
	high pressure sensor	5,4%	91,8%
	process gas	3,1%	94,9%
	hot water @ 65°	2,5%	97,4%

or

B

Flow	Name	PCF Share	cummulated PCF share
Infows			
	supplied parts		
	railbody	48,5%	48,5%
	pressure regulating valve	22,6%	71,0%
	railbody machined	8,2%	79,2%
	protective caps	7,2%	86,4%
	high pressure sensor	5,4%	91,8%
	hot water @ 65°	2,5%	94,3%
	electricity	2,1%	96,5%

6.3.4.3 Testing of Design & Effectiveness of controls

The verification shall include the evaluation of the control design for the PCF calculation. In addition, the verifier shall test the effectiveness of these controls. From the description of controls (e.g. **R**isk **C**ontrol **M**atrix, RCM) the verifier shall derive testing steps to verify the operating effectiveness of controls. If controls are not performed as expected and deviations are detected, the verifier shall assess the impact on the PCF result and assess if additional verification steps are required and additional evidence needs to be evaluated. If automated controls are in place one sample (test of one) is sufficient. For regular (limited assurance) verification test of one is sufficient.

For in-depth (reasonable assurance) verification the number of samples shall be defined according to the following Table 5 and the samples shall be tested against the control description.

Table 5: Number of samples for control testing per year

Frequency of performance of control	Regular Number of Items to Test	In-depth Number of Items to Test
Multiple times per day	1	60
Daily	1	40
Weekly	1	15
Monthly	1	2
Quarterly	1	2
Annually	1	1

In the above example of a Diesel rail production and the selected inflows according to Table 4 A all supplied parts come with a verified PCF statement from the supplier in an automated manner. A test of one is sufficient for each of the supplied parts. Process gases are recorded manually on a weekly basis and crosschecked once per month. According to these controls two monthly records are randomly chosen and checked.

6.3.4.4 Substantive testing

In the next step the verifier analyses data and other evidence used in the PCF system model. Typical evidence to be gathered are the Bill of Material (BOM), invoices of energy used, auxiliary materials, and raw parts, as well as measured primary data and the measurement techniques behind it. Out of the population of evidence (e.g. list of meter readings) the verifier shall select random samples based on the following table (Table 6):

Table 6: Number of samples for substantive testing

Population	Regular		In-depth	
	Number of Items to test (0 Errors accepted)	Number of Items to test (1 Error accepted)	Number of Items to test (0 Errors accepted)	Number of Items to test (1 Error accepted)
>200 items in the population	40	70	55	85
Between 100 and 199 items	20	-	30	-
Between 50 and 99 items	10	-	15	-
Between 20 and 49 items	3	-	5	-
Fewer than 20 items	1	-	2	-

In the above example of a Diesel rail production the electronical recording of hot water provides 35040 data points per year. According to Table 6, for an in-depth verification, 55 items shall be tested with no error or alternatively 85 tests with one error.

6.3.4.5 Testing of PCF system model

The system model documentation will be checked for compliance with the framework. In case of flexible system models the application to the respective production is part of the testing. Besides the calculation rules and allocation logic the correct linking of input values on activity data to the respective electronic data acquisition or data storage is checked. The correct choice of emission data for the respective flows concludes the PCF system model testing. To test if the calculation is performed in the software in line with the rulebooks the verifier shall trace the calculation process.

6.3.4.6 Testing of IT controls

If a software is used by the client to calculate PCFs, the software should be part of the verifier´s evaluation. Testing the software once, enables future verifications to be processed significantly faster. Testing of IT Controls shall include review of the following:

- Data Center and network operations (Business Continuity, Back-ups)
- System software acquisition, change, maintenance
- Program change (Control over changes)
- Access security (Access controls)
- Application system acquisition, development, maintenance

An extensive guidance for the testing of IT Controls is provided in Appendix 6 of ISA 315:2019.

6.3.4.7 Estimation testing

If in the risk assessment it was evaluated that estimated values have a relevant impact on the PCF result the verifier shall evaluate if the estimation methodologies are appropriate, assumptions are applicable, and the quality of the data used in the estimation is sufficient. The verifier shall further assess whether the methods for making estimations have been applied consistently from prior reference periods or have been changed, if applicable.

6.3.4.8 Analytical testing

Analytical procedures may be used at all stages of the verification. They may include checks on mass/energy balance, number of parts, benchmark checks and checks of the cut-off sensitivity analysis. If fluctuations or relationships that are inconsistent with other relevant information are identified or that differ significantly from expectations, the verifier shall obtain additional evidence or clarification.

6.3.4.9 Testing for secondary data

The verifier shall check if the secondary data used is taken from secondary databases whitelisted in the respective rulebooks. The verifier shall also assess whether the appropriate dataset in the whitelisted secondary database has been selected (e.g., taking into account representativeness of geography and technology). The appropriate selection of secondary data can only be verified if the scope is controlled and well defined. In case that for the dataset under question also a primary supplier-provided dataset is available, the selection of a secondary dataset shall be justified, shall be in line with the respective rulebook and shall be subject to the assessment of the verifier.

6.3.4.10 Site visits

The verification is performed remotely. Under the following circumstances on-site visits are recommended:

- Major misstatements are identified during the verification that can be clarified through a visit of the site/-s or facility/-ies,
- Transparency of the documentation on either value stream or data management is insufficient and can be clarified through a visit of the site/-s or facility/-ies.

When performing a site visit the verifier should share an inspection list before the visit.

6.3.4.11 Document request list

Based on the information obtained in the initial interview(s) as well as the results of the strategic analysis and the risk assessment the verifier will create the document request list for the verification of the PCF dataset(s).

As guidance Table 7 can be used and adapted based on the specific situation and input factors for the PCF datasets(s), which will be verified.

Table 7: Items for documentation and corresponding evidence

Items for documentation	**Evidence documents**
Description of production process	Floor plan, value stream chart, chemical reaction sheet, process flow diagram, utility summary, mass balance sheet
System boundaries	Floor plan, process sheet, chemical reactions overview
Control system	Process description of controls, (control points, 4-eyes-principle, RCM (Risk Control Matrix))
Logistic process	Invoice, delivery note, allocation
Inflows: e.g. ▪ Electricity, ▪ Gas, ▪ Fuel, ▪ Materials, ▪ ...	 ▪ Meter readings, invoices, allocation plan, overview of consumption, invoices, PPA, EACs, VPPA, Green Tarif Agreements, ▪ Overview of consumption, meter readings, invoices, ... ▪ Overview of consumption, meter readings, invoices, ... ▪ Bill of materials, ▪ …
Outflows	Meter readings, invoices, allotment plan
Meter points/sampling rates	Installation plan
PCF system model	Description of calculation logic, Description and documentation of IT controls of the software
Data traces	Data flow chart, including a list of requested and received PCF datasets from suppliers
Parameters	Data table, e.g. emission factors etc.

The above evidence documents shall correspond to the physical system boundary. In case the inflows / outflows cannot be derived directly from bill of materials, meters or other evidence documents the applied allotment shall be documented and justified.

The verifier shall announce the start of the verification at least two weeks in advance and provide the verification plan and document request list to the client. According to the list the client will prepare the required documents.

6.3.4.12 Verified upstream PCF datasets

There is no need to perform repeated verification activities on upstream PCF datasets that are already 3rd party verified according to rulebook requirements. The PCF results shall be used as input in a clients' cradle-to-gate PCF calculation without additional checks on their confidence level.

6.3.5 Cascading verification

In Figure 2 the self-similar character of verification was briefly discussed, where verification is requested by a company A for its operations, the full verification coverage of PCF data can only be achieved, if verification is also provided for all the tier levels upstream of company A.

It cannot be assumed that the first companies upstream in a supply chain are the first ones to have their operations verified. Consequently, companies will face a situation, where verification is sought on the basis of partially unverified input data.

In the interest of widely verified PCF data verification should be possible without the prerequisite of a fully verified upstream supply chain. As such the situation is similar to the goal of primary data based PCFs even if primary data will not be available in the short term from all companies in the supply chain. The concept to address partially unverified upstream data follows the concept of the primary data share (see CX-PCF Rulebook V3). The **3**rd party **P**roduct **V**erification **S**hare (3PVS) is introduced as the share of PCF that can be attested by verified data.

$$3PVS_{PCF} = \frac{|Part\ of\ PCF\ based\ on\ verified\ data\ [kg\ CO_2\ e]|}{PCF_{as}\ [kg\ CO_2\ e]}$$

$$3PVS_{aggregated} = \frac{\sum_i \left(\left|PCF_{total,i}\right| \cdot 3PVS_i\right)}{\sum_i PCF_{as,i}}$$

The concept is illustrated in Figure 7 and the calculations is summarized in Table 8.

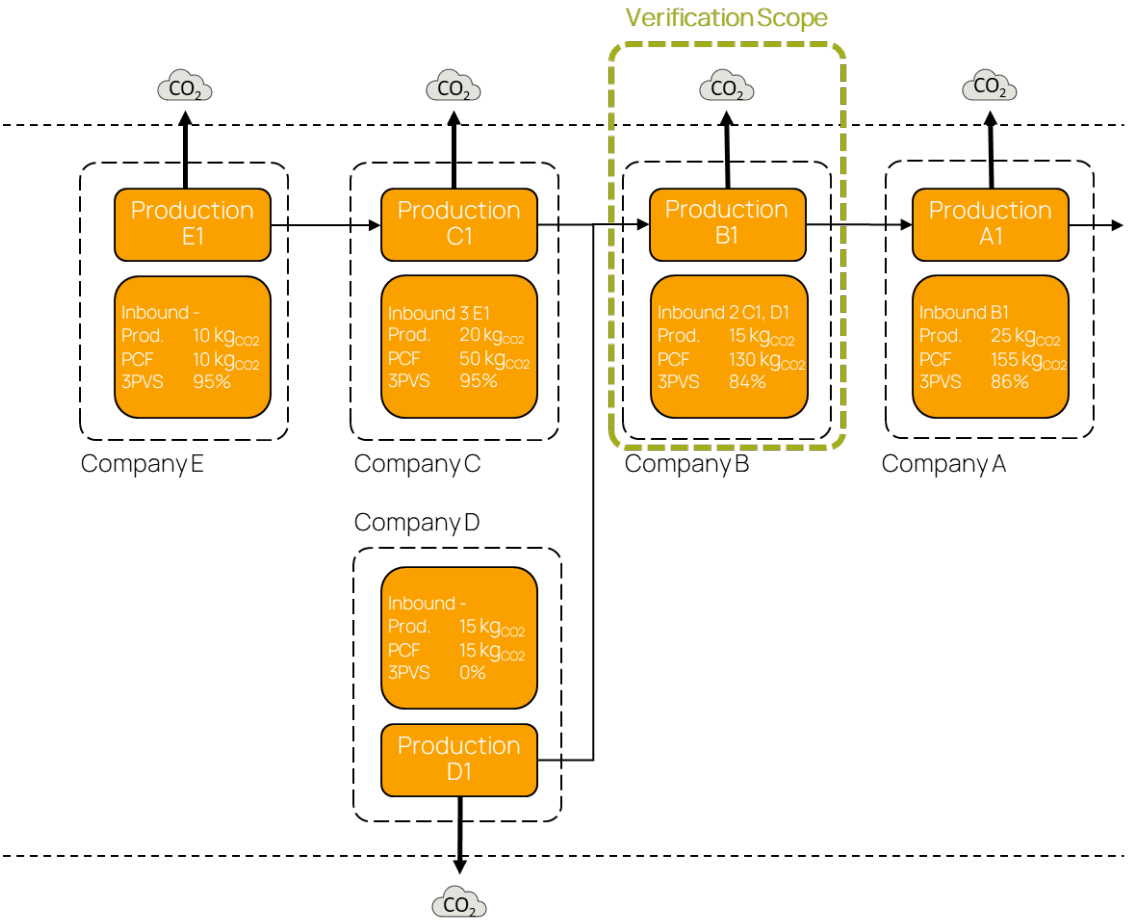

Figure 7: Concept of Product Verification Share

The supply chain of product A1 is depicted. Transport emissions are neglected for simplicity. The products E1 and C1 are verified in depth thus the 3PVS is 95%. With product B1 the situation is different. In B1 supplied parts C1 (two parts) and part D1 are assembled. For B1 100 kgCO_2eq stemming from C1 and 15kg CO_2eq due to the own operations are verified in depth. The D1 contribution comes unverified. Thus 109,25 out of 130 kg CO_2eq or 84% of the upstream emissions are verified. For company A 109,25 kgCO_2eq or 84% of the upstream emissions are verified. 25kg from their own operations are also verified in depth. In total 132,95 out of 155 kgCO_2eq (i.e. 86%) are verified. Note that the 3PVS can also increase from Tier n-1 to Tier n.

For Company A and B a regular verification can be achieved, an in-depth verification is not possible as in both cases the product verification share is less than 95%.

A high verification share will not guarantee that the true carbon emissions associated with the product are quantified within specified, narrow error margin. Even if evidence on all input data for a PCF result is available, a guaranteed error margin could only be assured if a complete check of all data would be performed.

Table 8: Calculation scheme for Figure 7

Production	Inbound parts	Inbound-PCF	Own Operations	Outbound-PCF	Verification G2G	3PVS
	[-]	kg_{CO2}	kg_{CO2}	kg_{CO2}	[-]	[%]
E1	-	-	10	10	in depth	95
C1	3 E1	3x10=30	20	50	in depth	95
D1	-	-	15	15	none	0
B1	2 C1 & D1	2x50+15=115	15	130	in depth	(2*50*95+15*0+15*95)/130 = 84,04 -> 84
A1	B1	130	25	155	in depth	(130*84+25*95)/155 = 85,77 -> 86

Table 9 shows the impact of a different verification type at company C. With C1 entering at 85% 3PVS into the calculation the verification share for A1 drops to 79%. This would not allow for a limited assurance as defined in 6.3.3.1. Still the 3PVS indicates that a high level of trust is justified in the PCF of product A1. From this example the conclusion can be drawn that for company A it would be more effective to motivate company C for an in depth verification than persuade company D into any verification. Please be aware that cascading 3rd party verification requires an unbroken chain of verification. A verifier of company A in our example from Figure 7 will not issue a positive verification statement including the PCF contributions from company B, if company B has not provided a 3rd party verified PCF dataset. The 3PVS shall be set to zero in that case.

Table 9: Exemplary calculation for C1 with “regular” verification

Production	Inbound parts	Inbound-PCF	Own Operations	Outbound-PCF	Verification G2G	3PVS
	[-]	kg_{CO2}	kg_{CO2}	kg_{CO2}	[-]	[%]
E1	-	-	10	10	in depth	95
C1	3 E1	3x10=30	20	50	**regular**	**85**
D1	-	-	15	15	none	0
B1	2 C1 & D1	2x50+15=115	15	130	in depth	(2*50*85+15*0+15*95)/130 = 76,34 -> 76
A1	B1	130	25	155	in depth	(130*76+25*95)/155 = 79,06 -> 79

Verification thus provides a statement on the probability that a PCF can be considered correct, but not on the magnitude of a possible error. Obviously, verification puts a focus on inputs of highest impact on the PCF result. The error for an ‘in depth’-verification is likely smaller than in a ‘regular’-verification.

Since verification is based on sample checks rather than full data checks, it does not make a difference if the origin of not checked data is located within the company’s own operations or somewhere in the upstream supply chain. The relevant information is what portion of the PCF result was or can be subject to verification. This is precisely the meaning of the 3PVS.

As for the PDS the 3PVS results from the multiplication of the verification status of activity data and emission factors. The following example illustrates the situation.

Table 10: Example for the multiplicative nature of 3PVS

		Activity	Activity Unit	Primary/Secondary	Verified	EF	EF Unit	EF origin	Primary/Secondary	3PVS	Emissions	Emission Unit	Primary/Secondary	3PVS$_i$
Tier n														
Inflow	Excavation	2000	kg	1	1	0	kg CO2 eq/ kg	Tier n	1	1	0	kg CO2 eq	1	1
	Electricity	500	kWh	1	1	0,8	kg CO2 eq/ kWh	Service Provider	1	1	400	kg CO2 eq	1	1
	Fuel (Diesel)	100	ltr	1	1	2,63	kg CO2 eq/ ltr	SD Whitelist	0	1	263	kg CO2 eq	0	1
Product	Ore	1000												
PCF	Ore	0,663	kg CO2 eq/ kg											
PDS	Ore	60%	-											
3PVS	Ore	100%	-											
Tier n-1														
Inflow	Ore	1000	kg	1	1	0,663	kg CO2 eq/ kg	Tier n	1	1	663	kg CO2 eq	1	1
	Electricity	500	kWh	1	1	0,8	kg CO2 eq/ kWh	Guess	0	0	400	kg CO2 eq	0	0
	Coal	500	kg	1	1	3,1	kg CO2 eq/ kg	SD Whitelist	0	1	1550	kg CO2 eq	0	1
	Limestone	1000	kg	1	1	0,6	kg CO2 eq/ kg	Guess	0	0	600	kg CO2 eq	0	0
	Scrap	300	kg	1	1	0,5	kg CO2 eq/ kg	Recycler	1	0,5	150	kg CO2 eq	1	0,5
Product	Iron-Billets	1300												
PCF	Iron-Billets	2,59	kg CO2 eq/ kg											
PDS	Iron-Billets	24%	-											
3PVS	Iron-Billets	68%	-											

One precondition to verify PCF results partially based on secondary data is, that secondary data can be traced to a whitelisted data source. In addition, the verifier shall assess the appropriate secondary data set selection. It is not necessary to differentiate between the verification of primary and secondary data.

In case no 3PVS is provided with a PCF data set, the company making use of that PCF data set has to account a 3PVS with the default value “0” for that PCF data set. A 3PVS value of “0” can therefore mean that a PCF verification was not successful, that information on any verification of the 3PCF data set is missing or that no verification was undertaken.

The description of cascading verification in the preceding section deals exclusively with 3rd party verification the concept however is fully transferable to 1st and 2nd party verification as introduced in section 6.3.3.1. These verification types are non-interchangeable, i.e. a 1st party verified PCF shall not count into a 3rd party verification. Besides the product verification share 3PVS for 3rd party verification therefore a **1**st **P**arty **V**erification **S**hare (1PVS) and a **2**nd **P**arty **V**erification **S**hare (2PVS) is introduced to allow the cascading of these verification types. 1PVS and 2PVS are calculated and handled in full analogy to the 3PVS, except for the need of an unbroken chain of verification. Find the respective definitions for 1PVS and 2PVS in Annex A 3.

6.3.6 Execution

6.3.6.1 Performing the verification plan

During the verification process, the verifier shall follow the defined verification plan. The verifier shall collect evidence according to the techniques described in Table 3.

If the confidence level is downgraded during execution, the verification plan shall be modified.

After the evidence is collected, the verifier shall evaluate and document:

1. Any material misstatement of the original content as well as of any changes made to the PCF program documentation during the verification,
2. whether the evidence is complete, consistent, accurate, comparable, and transparent, and assess any nonconformity with the defined criteria.

The verification process shall be documented in such a way that a competent verifier who has not been involved in the verification can form an opinion on the conduct of the verification within a reasonable period of time. To this end, the verifier shall document the planning, the verification procedures, the non-conformities, and the derivation of the opinion in the working papers. The working papers shall be archived.

6.3.6.2 Feedback loops

If the verifier is not in the position to form a final opinion on the verification result, he will create an updated, written document request list of missing documentation and/or a list of non-conformities identified. Depending on the complexity of the verification, the verifier will set a deadline to provide the missing documents and/or correct/clarify the open issues. The document request or non-conformity list and corrected documents shall be retained and documented by the verifier. If the requested evidence is inconclusive, the verifier may initiate an on-site verification.

This standard allows two feedback loops to correct open issues. If both feedback loops do not succeed in correcting all non-conformities, the verifier has the right to issue a negative opinion. In this case there is no verification statement issued.

A feedback loop is defined as asking formally via a request list for corrections of non-conformities after a sunset date. Continued communication between verifier and client is not considered a feedback loop.

6.3.7 Documentation

It is required to keep the following documents:

- verification report,
- verification statement.

It is recommended to keep the following documents:

- contract incl. agreed-upon terms, scope and criteria of verification,
- verification plan,
- evidence request list,
- evaluated evidence,
- list with found and corrected non-conformities.

6.3.8 Reporting

6.3.8.1 Drafting the Verification report

The verifier shall draft the verification report including an opinion, which serves as documented proof of the PCF verification process. The use-case for the verification report is to inform the client about the verification outcomes. The verifier shall document all performed verification activities (e.g. sample selection, recalculation, sampling techniques, analytical procedures). The documentation shall be archived for at least 10 years.

The verification report shall contain the following minimum information:

- The subject matter,
- a client identification,
- a verifier identification,
- type of verification (limited assurance and reasonable assurance, see 6.3.3.1),
- the verification procedures to assess the PCF program documentation of the subject matter,
- the verification results either in a:
  - Positive opinion, this means that the evidence collected is sufficient and the criteria are applied appropriately,
  - negative opinion, this means that the verifier was not able to obtain sufficient evidence,
- supplementary remarks to explain the verification results,
- the date of the report,
- the verifier’s signature.

An independent internal quality review at the verifier shall be completed before the verification report is sent to the client. The quality review should ensure a consistent verification result. The independent quality reviewer checks the verification draft report and supporting documents (e.g. completed verification plan, documentation of the tested samples). Once the quality review is complete and positive, the verification report is released, and the verification statement will be issued.

6.3.8.2 Verification Statement

The verification statement constitutes the link between the PCF dataset and the completed verification process. It indicates that the PCF dataset attributes have been verified according to a specific verification type. The verifier issues the verification statement to the client. The client can present the verification statement to the receiver of the PCF dataset (customer) with the intention to create trust in the PCF dataset. Hence, the verification statement can complement the exchange of PCF datasets.

To foster wide adoption of verification practice in industry the issuance of verification statements shall fulfill the main principles of trustworthiness:

- Assignment of the verification statement to the PCF dataset must be unique.
- Verification type covers all attributes of the exchanged PCF dataset, except for customer-specific information which is not required to be verified and therefore not disclosed in the verification statement (e.g. specific product IDs of different customers).
- Manipulation of any further PCF dataset content after verification shall be impossible.
- Independent assessment of the verification statement by the customer shall be possible.
- Trust technologies shall be in place allowing the customer
  1. to technically verify the validity of the verification statement (i.e. statement has not been revoked by verifier),
  2. to technically verify the unique assignment of the verification statement to the received PCF dataset (i.e. content of the statement matches the PCF information).

Exchange of verification statements at large scale should be enabled by suitable 'digital'/machine-readable solutions.

It is outside the scope of this document to prescribe a specific trust technology for the management of verification statements. Generally, trust technologies shall fulfill the guiding principles above, thereby enabling independent assessment of the verification statement by the customer. For illustration, a possible (conventional) mechanism for exchanging verification statements between verifier, client and customer including an optional storage functionality is depicted in Figure 8.

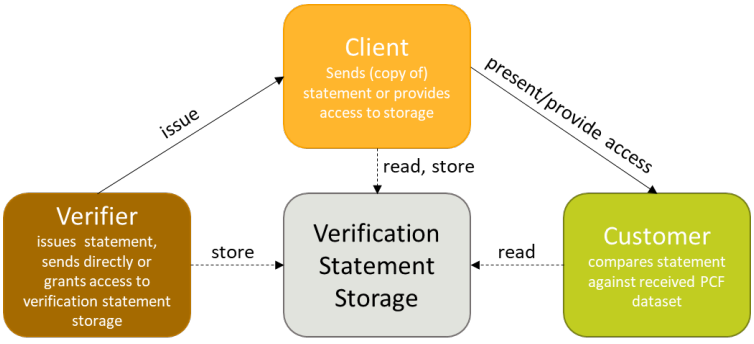

Figure 8: Exchange of verification statement using direct routes or indirect routes (via access to storage)

An example for a trust technology enabling a digitally signed verification statement with revocation functionality by the verifier is the 'verifiable credential' mechanism (see adapted schema in Figure 9). Here, the verifier uses a software to issue the verification statement as credential to the client. At the same time a key for identifying the authenticity of the credential is stored in a public registry. The client remains the holder of the digital credential. The verifier has the ability to revoke the credential. The client presents proofs of the credential to any customer (proofs

meaning digital copies, not the original credential, which is uniquely held by the client). To ensure that the presented proof is valid, the customer uses software to verify the proof against information stored in the public registry. In contrast to managing verification statements separately from the PCF dataset, verifiable credentials allow for combining both parts into one digitally signed dataset, meaning when exchanging a PCF with a customer, it is already combined with statement, i.e. the credential is dataset and verification statement at the same time.

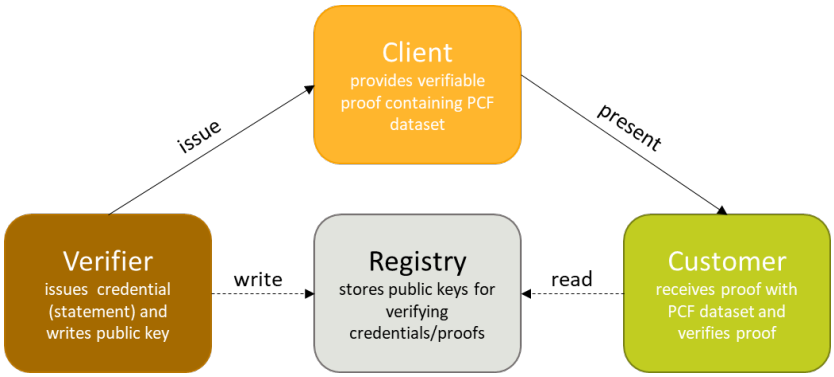

Figure 9: Mechanism of verifiable credentials used for PCF exchange (adapted from W3C Recommendation 2022)

The verification statement shall include:

- verification statement identifier,
- verifier identification,
- name of verifying person,
- PCF dataset,
- issue date,
- verifier's digital signature,

The PCF dataset does not need to provide the full content of the verification statement but shall provide:

- verification statement identifier,
- certification statement identifier (see chapter 6.2.3),
- PCF program certification share (PCS, see chapter 6.2.3),
- product verification shares (1PVS, 2PVS & 3PVS, see chapter 6.3.4.12),
- verification type (see chapter 6.3.3.1)

In case of a 2nd party verification verifier identification and the name of the verifying person shall be anonymized or blacked out for the customer.

In the PCF Data Model currently published such verification related attributes are not included yet, but the PCF-Verification working group will suggest amendments for the PCF Data Model after the consultation of this document.

6.3.9 Re-Verification

In case of a re-verification three spot checks shall provide evidence that no changes relative to the PCF program documentation need to be considered. Analogue to the initial verification a new set of samples shall be drawn and evaluated. This process could be supported by automated sampling and checks.

6.3.10 Competence requirements for a verifier

The competence requirements shall be fulfilled by one verifier or by a verifier team. These competences shall be documented and be proven through education, training, or work experience. The appointment process will be handled by Catena-X and TFS outside of this document.

First, second, and third-party verifiers need to fulfill the competence requirements below.

The competence requirements of ISO 14066:2023 chapter 4-7 shall be adhered to. Additionally, the verifier shall have knowledge about and experience with:

- PCF calculation processes according to the rulebooks and underlying standards,
- The assurance levels (regular & in-depth) as defined in this framework,
- GHG emission factor sources,
- Life Cycle Assessment (LCA) and/or Product Carbon Footprinting (PCF),
- PCF verification processes according to this rulebook containing but not limited to: Strategy analysis, Risk assessment, verification planning and documentation, review procedures to ensure quality,
- Concept of materiality,
- Sector/industry/product specifics like typical production processes, monitoring techniques, typical internal control systems, applicable assumptions, best practice, GHG emissions,
- Modelling software or automated calculation solutions.

6.4 Validation

Beside reporting PFC datasets for products that were already produced, product carbon footprints are also relevant for products still in development or not yet produced. In both situations PCF target values are defined and an estimate of the future PCF based upon the current design or sample stage is an important KPI to monitor and manage target achievement. Consequently, the estimated or predicted PCF of supplied parts is important during the acquisition process and for purchase decisions.

There can be no proof of a PCF result of parts not yet produced, but still trust in the communicated predicted PCF can be promoted by a 3rd party validation.

In a validation – contrary to a verification – the reviewing party shall check assumptions based on which the PCF was quantified.

Assumptions refer to data such as future residual grid mixes or future technology implications and may be included in the projection of a PCF. Assumptions shall be documented for a validation process. Two situations for future-oriented PCFs are to be distinguished:

- Projection of PCFs for existing products into the future: Reflecting changes in material source, sourcing of purchased parts, technology, tooling, energy mix etc..
- Prediction of PCFs for new product developments not in serial production yet: On top of the above aspects reflecting on preliminary sample stage (build and buy decisions) and/or production planning (production processes, volumes, locations).

Validation guidelines will be added to this document as soon as requirements on future-oriented (predicted) PCF calculations are defined in future versions of the rulebooks.

7. Annexes

A 1. PCF Data Model (excerpt)

Catena-X PCF Data model: https://github.com/eclipse-tractusx/sldt-semantic-models/blob/main/io.catenax.pcf/4.0.1/gen/Pcf.html

TFS data model: https://www.tfs-initiative.com/app/uploads/2024/02/TfS-Data-Model-February-2024.pdf

Please check for potentially newer version of PCF data models published by Catena-X or TFS.

For TFS available at https://www.tfs-initiative.com/how-we-do-it/scope-3-ghg-emissions

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PCF (Product Carbon Footprint) Entity

Entity for defining a PCF (Product Carbon Footprint) as specified in the Catena-X PCF Rulebook in accordance with the technical specifications for PCF Data Exchange (Version 2.0.0) from the WBCSD (World Business Council for Sustainable Development)/ PACT initiative. Optional in Catena-X for example, can be calculated by application.

Reference: https://wbcsd.github.io/tr/2023/data-exchange-protocol-20230221/

Properties

Unit of measurement

Unit of analysis of a product in context of the PCF (product carbon footprint) as specified in the Catena-X PCF Rulebook in accordance with the technical specifications for PCF Data Exchange (Version 2.0.0) from the WBCSD (World Business Council for Sustainable Development)/ PACT initiative. In Catena-X for example list of valid units includes "piece".

Name	declaredUnit
Characteristic	Enumeration
Value	liter kilogram cubic meter kilowatt hour megajoule ton kilometer square meter piece
Reference	https://wbcsd.github.io/tr/2023/data-exchange-protocol-20230221/
Typ	http://www.w3.org/2001/XMLSchema#string
Example	kilogram
Optional	No
In Payload	Yes
Payload key	declaredUnit
Reference	https://wbcsd.github.io/tr/2023/data-exchange-protocol-20230221/

A 2. Scope of Verification for Logistics (Normative Annex)

A special case regarding system boundaries can be logistics as the rulebooks state inbound logistics as part of the PCF and outbound logistics have to be reported separately but are also subject to verification. There are several possible cases, illustrated in Figure 10, to verify logistics as part of a PCF:

1. In the simplest scenario no additional verification shall be done as the client is not responsible for contracting the inbound or outbound logistics. The verified value for the inbound logistics shall be provided by the supplier.
2. The client as company seeking verification for the PCF of its products is also contracting the inbound logistics and therefore is responsible to provide evidence for the verification.
3. The client as company seeking verification for the PCF of its products is only contracting the outbound logistics and therefore is responsible to provide evidence for the verification.
4. The client as company seeking verification for the PCF of its products is contracting both inbound and outbound logistics and therefore is responsible to provide evidence for the verification of both parts.

Case	Transport contracting	Responsibilities (to provide)	Accounting of PCF
1	supplier → inbound → client → outbound → customer	Supplier: inbound transport PCF (incl. verification) Client: - Customer: outbound transport PCF (incl. verification)	Supplier: - Client: inbound transport PCF Customer: outbound transport PCF
2	supplier → inbound → client → outbound → customer	Supplier: - Client: inbound transport PCF (incl. verification) Customer: outbound transport PCF (incl. verification)	Supplier: - Client: inbound transport PCF Customer: outbound transport PCF
3	supplier → inbound → client → outbound → customer	Supplier: inbound transport PCF (incl. verification) Client: outbound transport PCF (incl. verification) Customer: -	Supplier: - Client: inbound transport PCF Customer: outbound transport PCF
4	supplier → inbound → client → outbound → customer	Supplier: - Client: in- & outbound transport PCF (incl. verification) Customer: -	Supplier: - Client: inbound transport PCF Customer: outbound transport PCF

Figure 10: In- & outbound transport PCFs including verification

In case the incoterm agreed by the parties reflect a shared responsibility for the transport, the verification of the transport may also be split according to the responsibility of the different parties, if contracted separately. If, however, only one party organizes and contracts the transport with such incoterm with a transport provider, the responsibility to provide the transport PCF including verification rests with the contracting party as only this party has an agreement with the transport provider and can request and receive such data. A common example is the agreement of an incoterm such as FOB (***F**ree **O**n **B**oard*) or CIF (***C**ost **I**nsurance **F**reight*) with the supplier organizing and contracting the full transport with a transport provider and charging the client its part of the transport cost.

Also, special cases (see Figure 11) as described in the rulebooks for cases such as distribution centers or (external) warehouses have to be considered for responsibility of PCF verification.

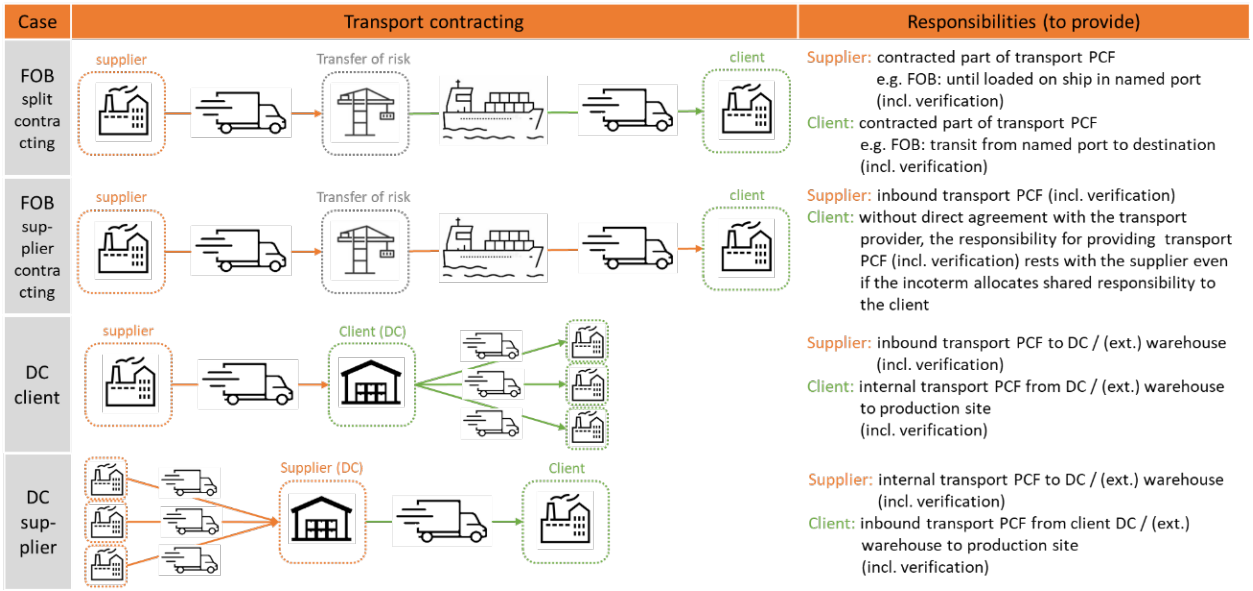

Figure 11: Examples for special logistics cases

A 3. Calculation example of PCS

Note, the PCS_i can only assume the value of 0% or 100%:
Either the PCF was calculated using a certified program or not.

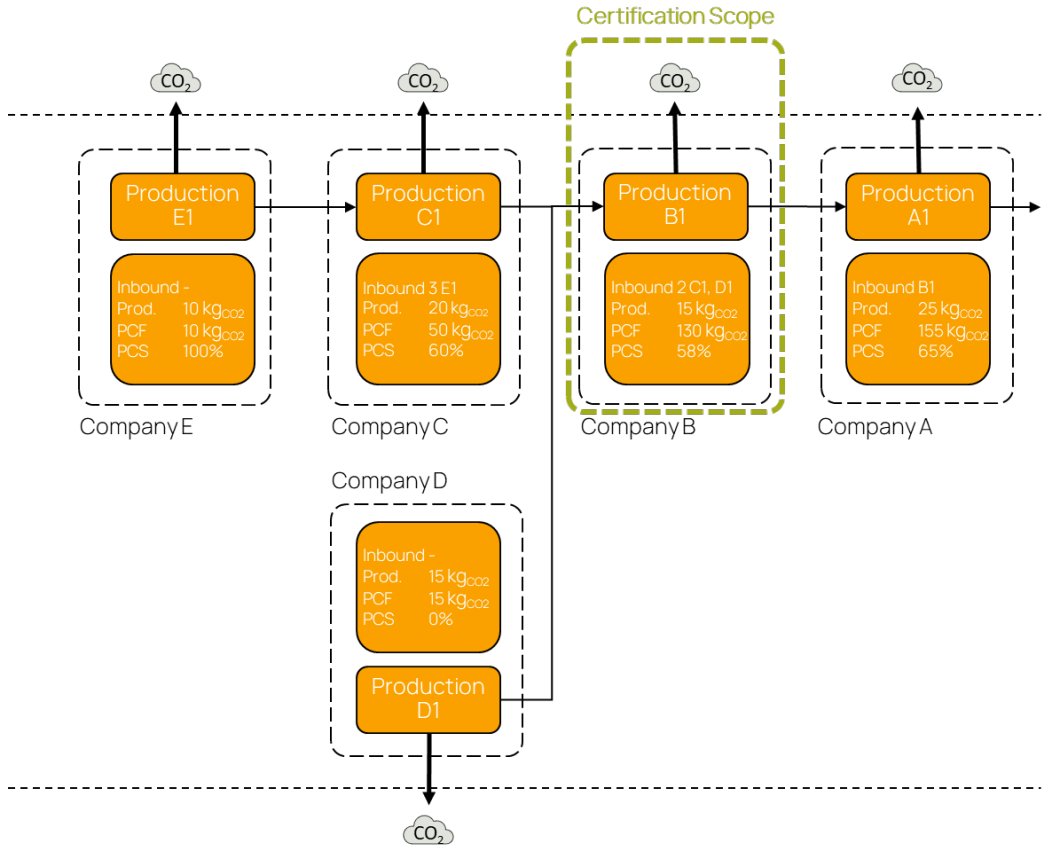

Figure 12: Concept of Program Certification Share

Table 11: Calculation scheme for Figure 12

Production	PCF-Program certified	Inbound parts	Inbound-PCF	Own Operations	Outbound-PCF	PCS
	[%]	[-]	kg_{CO2}	kg_{CO2}	kg_{CO2}	[%]
E1	100	-	-	10	10	100
C1	0	3 E1	3x10=30	20	50	(3*10*100+0*20)/50 = 60 -> 60
D1	0	-	-	15	15	0
B1	100	2 C1 & D1	2x50+15=115	15	130	(2*50*60+15*0+15*100)/130 = 57,69 -> 58
A1	100	B1	130	25	155	(130*58+25*100)/155 = 64,77 -> 65

Production E1, at the beginning of the supply-chain has an active certificate for its PCF program, the PCS is 100%. Production E1 is used as an input for production C1, which does not have an active certificate of its PCF program, meaning the PCS for C1 drops to 60%. At production B1, with an active certificate for 15 $kgCO_2eq$ of their own operations, 100 $kgCO_2eq$ from a partially certified supply and 15kg from an again uncertified supplier, the resulting PCS amounts to 58%. This is taken as the only input of production A1 which adds 25 $kgCO_2eq$ from their production which is covered in a certified program. Thus, the total PCS increases to 65%.

A 4. Definition formula for 1PVS and 2PVS

1PVS:

$$1PVS_{PCF} = \frac{|Part\ of\ PCF\ based\ on\ verified\ data\ [kg\ CO_2\ e]|}{PCF_{as}\ [kg\ CO_2\ e]}$$

$$1PVS_{aggregated} = \frac{\sum_i \left(\left|PCF_{total,i}\right| \cdot 1PVS_i\right)}{\sum_i PCF_{as,i}}$$

2PVS:

$$2PVS_{PCF} = \frac{|Part\ of\ PCF\ based\ on\ verified\ data\ [kg\ CO_2\ e]|}{PCF_{as}\ [kg\ CO_2\ e]}$$

$$2PVS_{aggregated} = \frac{\sum_i \left(\left|PCF_{total,i}\right| \cdot 2PVS_i\right)}{\sum_i PCF_{as,i}}$$

A 5. Main contributing companies from Catena-X and Together for Sustainability

- BASF SE
- BMW Group AG
- Deloitte Deutschland GmbH
- DENSO Automotive Deutschland GmbHs
- Evonik Industries AG
- Henkel AG & Co. KGaA
- PwC GmbH WPG
- Renault Group
- Robert Bosch GmbH
- Siemens AG
- Sika Technology AG
- Thyssenkrupp Materials Services GmbH
- TÜV SÜD Auto Service GmbH
- Valeo S.A.