



Basics of CO₂eq calculation in *FRED: Footprint Reduction Tool*

Carbon footprint calculator generated in the NOCARBforging2050 project compliant with DIN EN ISO 14067 and 14064-1

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Foreword

FRED was developed as part of the NOCARBforging 2050 initiative of the German Forging Association (Industrieverband Massivumformung e.V.). It is a software tool that can be used for calculating product and corporate carbon footprints according to DIN EN ISO 14067, DIN EN ISO 14064-1 and the GHG protocol. Meanwhile the tool also enables calculations according to the Catena-X rulebook and CBAM. It was specifically designed for the member companies of the Association and created in such a way that even users without any detailed prior knowledge of carbon footprints can successfully perform a calculation.

This document sets out details of the method used for calculating product carbon footprints with FRED. The aim is to generate knowledge and understanding of the underlying assumptions, as well as to enable a comparison with external requirements (e.g. those of customers).

Furthermore, the document provides guidelines for interpreting and communicating the results..

1 Objective and Analysis Framework according to DIN EN ISO 14067

1.1 Objective of the carbon footprint study

Use case and reasons for the study: The product carbon footprint is calculated to gain knowledge about the impact which production of formed products has. This information is intended for use as an internal value as well as for customer communication. In addition, the aim is to quantify the effect of planned measures for mitigating greenhouse gas potential. The study is designed to indicate which processes and “scopes” make a significant contribution to the product carbon footprint.

Communication of the results: On the one hand, the results can be used by internal employees, such as process engineers, product developers, those in controlling or environmental/energy management, when initiating and assessing climate protection measures. On the other hand, the results can be shared with customers who request a carbon footprint assessment. Details of the analysis framework are not yet required by these customers.

1.2 Analysis framework of the carbon footprint study

1.2.1 Declared unit and reference flow

The declared unit defines the benefit or function that a product provides. In cradle-to-gate studies, this function is usually calculated for one unit of product (one piece), as is the case here. The reference flow corresponds to the weight (in kilograms) of the product.

1.2.2 Product system under consideration and system boundaries

- The product system considers the production of a variety of products with different characteristics.
- The analysis is in most cases limited to cradle-to-gate. Accordingly, raw material extraction, raw material processing, energy generation, production processes, and transport are taken into account.
- The use phase of the products and disposal or recycling at the end of the product life cycle are thus not taken into account in most cases. The same applies to the infrastructure and facilities used as well as to administrative activities, business trips, etc. Nevertheless a cradle-to-grave assessment is also possible.
- The production processes (all production and auxiliary processes, starting with the delivery of material and concluding with storage of the finished product) represent the “foreground system”.
- Raw material extraction and raw material processing for the provision of the material, as well as all intermediate products used during the production processes, represent the “background system”. For the provision of electricity, ISO explicitly stipulates that emissions from the combustion of energy sources, the extraction and processing of fossil fuels, as well as the cultivation and processing of bio mass, must be taken into account, including transmission losses in each case. The same principle (taking into account the entire life cycle up to supply) also applies to other intermediate products.
- Further information about the system boundaries of the individual data sets are found in the results layout.

1.2.3 Data quality

- The production processes are mapped with primary data from contributing companies. Specific data from measurements, calculations and expert estimates of the company carrying out the CO₂ evaluation should take precedence. Alternatively, sample data was collected for FRED and stored in the tool. As far as possible, the data used should cover the period, location and technology used when carrying out the CO₂ evaluation.
- Data (in the form of “CO₂ rucksacks”) is stored in FRED for the provision of intermediate products (material, energy sources, transport, packaging) and the disposal of waste. This data maps the entire life cycle up to the provision of the intermediate product. It is derived from databases, literature sources, and primary data from the consortium. In addition, primary data based on supplier information can be used. A list of the data sources in the background system can be found in section 3.5. As far as possible, the data used should cover the period, location and technology used when carrying out the CO₂ evaluation.
- In order to reduce bias and uncertainty as far as practical and use the best quality data available, a data quality assessment is applied following the criteria listed in Table 1.
- The data quality rating of the PCF is calculated as a weighted mean with the product carbon contribution as weight:

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

- The results of the data quality assessment are communicated in the GHG report.
- The publisher of the data has the responsibility of updating the data quality information. The publisher of the general data carries out an annual audit.

Table 1: Criteria for performing a data quality assessment

Data quality rating	1 - Very good	2 - Good	3 - Fair	4 - Poor	5 - Very poor
Technology Representativeness (TeR)	The dataset has been created based on data reflecting the exact technology employed	The dataset has been created based on data reflecting the company specific and same technology to the one employed for the actual manufacturing	The dataset has been created based on data reflecting an average for an equivalent technology to the one employed for the actual manufacturing	The dataset has been created based on data reflecting a technological proxy	The dataset has been created based on different or unknown technology vs technology actually employed
Time Representativeness (TiR)	The difference between “Reference Period End” of the dataset and “Date of Issue” of the PCF is ≤1 year	The difference between “Reference Period End” of the dataset and “Date of Issue” of the PCF is >1 year and ≤2 years	The difference between “Reference Period End” of the dataset and “Date of Issue” of the PCF >2 years and ≤3 years	The difference between “Reference Period End” of the dataset and “Date of Issue” of the PCF is >3 years and ≤4 years	The difference between “Reference Period End” of the dataset and “Date of Issue” of the PCF is >4 years
Geographical Representativeness (GeR)	The dataset has been created based on data reflecting the country subdivision in which the product has been manufactured	The dataset has been created based on data pertaining the country in which the product has been manufactured	The dataset has been created based on data pertaining the geographical region (e.g. Europe, Asia, N. America) in which the product has been manufactured	The dataset has been created based on global averages	The dataset has been created based on data with a geographical scope which is either unknown or pertaining a country or region not including the site in which the product has been manufactured

1.2.4 Allocation

- Multifunctionality (through the provision of by-products) is currently not taken into account in the foreground system (as no relevant by-products have been reported). Accordingly, all emissions generated are attributed 100% to the product undergoing the CO₂ evaluation (=the declared unit).
- For the background system, a system extension is preferred according to ISO 14067. If the data situation is not sufficient for this, allocation should be applied. The decision as to what form this allocation should take lies with the person carrying out the CO₂ evaluation, drawing on the methodological guidelines of the World Steel Association (2017). Whichever form of allocation is chosen, however, it should be appropriate and substantiated. More information on the allocation method of single datasets is communicated in the GHG report.

1.2.5 Cut-off criterion

- Certain material and energy flows are so negligible that they do not significantly affect the results. These flows are not taken into account in the CO₂ evaluation
- In general, all processes and flows that are attributable to the analyzed system shall be included. If based on the results of a screening study, individual material or energy flows are found to be insignificant for the carbon footprint, these may be excluded for practical reasons (see DIN ISO 14067, PEF method).
- For the cradle-to-gate PCF a completeness of 97% shall be achieved. Process modules, inputs and outputs may be neglected after reaching a completeness of 97% of the product carbon footprint.
- The initial LCI screening serves to ensure near-complete coverage by identifying significant processes and data gaps before any exclusions are considered. All available data must be included in the screening, with supplier PCFs and emission factors assumed to represent 100% coverage, allowing the company to justify and document any later scope refinements. This iterative screening helps demonstrate compliance with the cut-off requirement at a product, category, or sector level and ensures transparency through documentation and periodic updates.
- The cut-off percentage shall be specified in the general inputs of the PCF. This will then be part of the PCF report.

1.2.6 Handling biogenic emissions

- After an emissions calculation check for background and foreground processes of formed products and company members of the forging association, biogenic emissions were identified as non-essential.
- In case a data set does show biogenic carbon emissions and removals, these will be calculated in FRED and shown separately to the total emissions in the results and GHG report.

1.2.7 Further emissions and removals

FRED additionally enables the calculation of the following emissions and removals:

- Fossil emissions
- Biogenic emissions excluding CO₂
- Emissions from land-use change
- Emissions from land-use

- Aviation emissions
- CO₂ emissions from land-use
- Biogenic CO₂ removal
- Land-use CO₂ removal

The fossil and biogenic carbon content of products can also be specified and calculated.

1.2.8 Assumptions made

- Any material loss (e.g. due to scrap, flash, saw cuttings) that is recycled leads to a higher input of primary material in the upstream chain. Accordingly, a CO₂ credit is not to be applied. The underlying assumption is that material cycles are sufficiently closed, that sufficient recycling capacity exists, and that material of sufficient quality can be produced again from the material loss that occurs. The cut-off approach is thus applied for secondary materials.
- If primary data for direct emissions from natural gas combustion are not available, these emissions are calculated. Here, a CO₂eq emission of 202g CO₂eq /kWh (Quaschnig 2019) is assumed for combustion. This value refers to the calorific value and composition of H-gas. The slightly lower emission of L-gas is not taken into account in FRED.

1.2.9 Electricity

- The market-based approach should be used for determining the emissions of the electricity mix. This needs to be given by the user, based on information from the electricity supplier.
- If specific emission data is not available, data using the location-based approach from recognized databases are used.

1.2.10 Limitations

- The data sets used in the background system have not been checked for compliance with the cut-off criterion described here. Where knowledge of supplier data exists, the “individual” option should be used.

1.2.11 Methode zur Umweltwirkungsbewertung

- The assessment method influences which factors are used to convert the different emissions into CO₂ equivalents (CO₂eq). This tool calculates the GWP (Global Warming Potential) for 100 years (up-to-date data according to IPCC 2023).
- The GHGs that shall be accounted for are identified within the GHG Protocol entitled “Required Greenhouse Gases in Inventories: Accounting and Reporting Standard Amendment”. The list includes carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorinated compounds, sulfur hexafluoride (SF₆), nitrogen trifluoride (NF₃), perfluorocarbons (PFCs), fluorinated ethers (HFEs), perfluoropolyethers (e.g., PFPEs), chlorofluorocarbon (CFCs) and hydrochlorofluorocarbon (HCFCs).

2 Guidelines for Interpreting and Communication Results

The results are to be interpreted as follows: The calculated product carbon footprint indicates the greenhouse gas potential (relating to 100 years) of a product unit in CO₂ equivalents. The results are in line with the objective and analysis framework described in section 1. The guidelines on communicating the results should be observed.

The results of the process-specific hotspot analysis subdivide the overall result according to processes. This means that for each process, the carbon footprint is calculated based on the direct emissions in the process as well as the emissions from the provision of the intermediate products used in the process (with the exception of the incoming material). In addition, a comparison function in the tool allows users to perform a sensitivity analysis. Users can thereby compare PCF results and thus evaluate the effect of the selection of methods and data on the results.

The results of the scope analysis subdivide the overall result according to the following grouping:

- Scope 1 indicates the carbon footprint attributable to the direct emissions from the foreground system, e.g. from the combustion of natural gas
- Scope 2 indicates the carbon footprint attributable to emissions from the provision of electricity
- Scope 3 indicates the carbon footprint attributable to emissions from the provision of other intermediate products

The results may be used in the following way according to ISO 14067:

- Internal: The results are suitable for non-public communication. Possible applications include the reporting or the presentation of the product carbon footprint to customers (if no specific stipulations exist) and to other internal stakeholders. In addition, the overall results as well as the results of the process-based analysis (hotspot analysis) can be used for the assessment of internal measures.
- Public sustainability reporting: The use of the results for publically viewable sustainability reporting explicitly depends on the underlying stipulations of the report. If no specific stipulations are followed, additional documentation of the objective and analysis framework as well as the data used for the background system is recommended as part of the report. In the FRED tool it is possible to download a detailed GHG report of the PCF calculations. The GHG report provides a breakdown of the background system, with information regarding the data source, data quality as well as the scope specific to the individual datasets. This allows users to provide a detailed description of the objective and scope of the PCF. The user is required to be as transparent as possible here.
- Public: Additional, public communication (e.g. using the internal value for promotional purposes, product labelling, or for comparison with competitors) requires additional reporting and, if necessary, verification by an expert panel. Furthermore, the analysis framework also needs to be extended to cover the entire life cycle (cradle-to-grave). The tool does not currently map this analysis framework.

3 Implementation in the FRED Tool

3.1 Calculation logic

The calculation is performed analogously to a cost calculation. The CO₂ emissions generated beyond the production company (electricity, material, etc.) are defined as CO₂ rucksacks in the calculation. The direct and indirect CO₂ emissions are then calculated and added up for each individual value-adding process. Here, material inputs and outputs are calculated by specifying the percentage loss (flash, non-used sheet in blanking, test parts, rejects in quality assurance) in this value-adding step, so that the amount of processed material (and thus energy consumption, direct and indirect CO₂ emissions, etc.) can be calculated for each individual process step in relation to the final product.

The losses are calculated as follows:

- Delivery weight: 10 kg
 - Process 1: 30% loss
 - Process 2: 20% loss
- The calculation starts at Process 2: The CO₂ emissions are calculated as CO₂ emissions/kg*10 kg
- Process 1 operates with 10 kg/0.8, i.e., with 12.5 kg. Its CO₂ emissions are calculated as CO₂ emissions/kg*11.11 kg
- The material to be purchased amounts to 17.86 kg
- All specific CO₂ emissions of processes are thus related to the **finished mass** of the process (my process produced 450 to of finished material and, for that, the machine consumed 300 MWh. The specific CO₂ emissions therefore amount to 0.66 kWh/kg).

3.2 Notes for use

Things to consider during use:

- Green electricity: The Catena-X PCF Rulebook requires that green electricity with upstream chain is also specified. This is a better reflection of reality than the regulatory requirement of 0 g_{CO₂}/kWh. The realistic CO₂ emission data for different types of electricity can be read here <https://app.electricitymaps.com>. Click on a country and then move the mouse over a corresponding electricity type on the left-hand side.
- Transport of individual materials and products shall be included. The user should account for this transport process based on primary data in FRED. In a complete cradle-to-gate PCF (as expected by customers of supplier companies), the transport of the endproduct to the customer must then also be included as the last value-adding process.

3.3 Available data for foreground processes

The data for the foreground processes were collected from companies as part of the first phase of the NOCARBforging2050 project. The companies were asked about their measured energy consumption, which they have available in different granularity, depending on the evolutionary stage of the energy management system. The data was therefore recorded, for example, as electricity or gas consumption (or both) of a plant related to the production volume of the plant in the last year, for instance. The companies were also asked whether they agreed to the values they provided appearing in the calculation tool alongside their name, anonymously as an individual value, or whether they should only be included in the tool as part of an averaging

process. If “anonymous” was chosen, a designation such as “Company 3” is added to a value. Thus, if there is an entry such as “Company 1” behind a value, this means that it is a concrete value, supplied by an anonymous participant of the project. It should be noted, however, that if data is stored with the designation “Company 3” in one process, this may not necessarily be the same “Company 3” that appears in another process. In this way, the desired anonymity of the data suppliers is better guaranteed.

New consolidated data for starting materials and processes will be available from August 2022. This is based on the data supplied by the project participants during the first project phase as well as on newly recorded data. For reasons of clarity, the volume of centrally provided data has been reduced. This is because, from August 2022, companies can also enter company-specific data.

This consolidated central data usually provides a mean value and technically substantiated max and min values, which were determined on the basis of industrially reported values.

All data carries a timestamp (e.g. 22/08: August 2022). This makes it possible to deactivate central values and provide new central values (with a new date), while still allowing old PCF and CCF calculations to work. The publisher of the data has the responsibility of updating the datasets.

The consumption data collected in the tool is based on industrial values and can serve as well-founded reference points. However, it is important to always check whether different conditions prevail in your own production environment.

The following parameters influence the electricity, compressed air, ...consumption and material loss in the processes:

Sawing:

- Ratio of the billet length to the diameter
- Hardness of the material
- Thickness of the material
- Thickness of the blade
- Lubricant
- Sawing material
- (carbide, high-speed steel)

Shearing (cold and hot)

- Material hardness
- Shear design (mechanical, hydraulic)
- Design and quality / wear of the shear blades
- Round or square material
- For hot shearing: The energy required for preheating and heating has the greatest influence here and should be entered on a company-specific basis (induction or gas-based heating).

Heating gas furnace steel or aluminium

- Type of burner
- Recuperation or not
- Packing density

- Furnace insulation
- Tightness of the furnace
- And, of course, most importantly, the heating temperature. Typical temperatures are stored in the central data – in case of deviating temperatures, company-specific values should be used

Heating induction steel or aluminium

- Ratio of the diameter of the coil and the material to be heated
- Inverter efficiency
- Operating mode of the machine
- No values are currently available for aluminium

Heating conduction steel

- Transformer efficiency
- Contact resistance
- Length/diameter ratio (edges sometimes remain slightly colder)

Die preheating

- Type of heating (gas ring, electric cartridges)
- Size of the dies
- Does heating only take place before forging or also during the forging process?
- The specific energy is related to the quantity of the processed forging material – here, too, company-specific values are expressly recommended

Forging hammers

- Type of hammer (pneumatic, steam, servo, drop hammer)

Forging crank presses

- Type of forging (light calibration, hot forging or extrusion with a long stroke is the biggest influence and should therefore be set in a company-specific way)
- Efficiency of the inverter, friction conditions in mechanical and guiding systems

Forging spindle press

- Component family
- Processed material
- Losses, mainly due to friction

Forging horizontal presses

- Material processed (steel hot, steel cold, aluminium cold)
- Component family and type of forming associated with it
- Electric and mechanical systems

Surface treatment after forging: Blasting

- Type of forging (hot or warm forging)

Heat treatment steel and aluminium in gas furnace

- Type of burner
- Recuperation or not
- Packing density
- Furnace insulation
- Tightness of the furnace
- And of course the type of heat treatment, which involves different temperatures and sometimes multiple heating

QA+Packaging

- Overall, common consumption (heating, lighting) have turned out to be very marginal in the data collection. Influencing factors are the type of heating and lighting, insulation, gate strategy
- Material loss in QA operations is the main factor influencing the CO₂ evaluation here – and is mainly determined by the quality produced and the reliability of quality testing

Transport internal

- There is little data available here
- Influencing factors include the paths taken internally between the production steps

3.4 Available data for background processes

The data for background processes (e.g. transport) was partly collected from the participating companies and partly taken from databases or publicly searchable reports (e.g. from the German Environment Agency – UBA). The following databases were used for the background processes:

- ProBas: a German dataset library originally provided by the German Federal Environment Agency (impact assessment method: IPCC 5).
- UVEK: the UVEK LCI data DQRv2:2018 is based on ecoinvent 2.2 and was updated in relevant sections. The update was commissioned by the Swiss Federal Authority (impact assessment method: IPCC 5).
- BAFU2025: the UVEK LCI data DQRv2:2023 is based on ecoinvent 2.2 and was updated in relevant sections. The update was commissioned by the Swiss Federal Authority (impact assessment method: IPCC 6).

The publisher of the data has the responsibility of updating the datasets.

4 Corporate Carbon Footprint (CCF) calculations according to DIN EN ISO 14064-1

The preceding annotations for the emission calculations in FRED are largely applicable to the CCF calculations, However, several components are explicitly defined according to DIN EN ISO 14064-1:

- Objective: The corporate carbon footprint is calculated to gain knowledge about the impact which an organization has. This information is intended for use as an internal value as well as for customer communication. In addition, the aim is to quantify the effect of planned measures for mitigating greenhouse gas potential. The study is designed to indicate which processes and “scopes” make a significant contribution to the corporate carbon footprint.
- Scope: The CCF calculates CO₂eq at the organisational level. Both direct and indirect GHG emissions caused by an organization’s activities within a defined timeframe are considered. The boundaries, which defines organizational boundaries, locations, and timeframe, are defined individually by FRED users. Additionally, users can enter information on the data collection method in comment field.

Further specifications:

- The organisation shall quantify direct GHG emissions separation for CO₂, CH₄, N₂O, NF₃, SF₆ and other appropriate GHG groups in tonnes of CO₂e. For any exclusions, a justification must be provided in the GHG report.
- The organisation shall identify and document all relevant GHG sources and sinks included in its reporting boundaries. For this, a net balance of emissions resulting from the aggregation of GHG sources and sinks shall be listed for each position. The organization may exclude GHG sources or sinks for which the contribution to GHG emissions or removals is not relevant. In the GHG report, it shall identify and explain why the GHG sources or sinks are excluded in accordance with the categories and any categorical subdivisions included in the report.
- The organization should generate a GHG report in accordance with the intended use (e.g., for a verification, a GHG program, or to inform users). A GHG report can be generated in FRED with the required information.
- The organization shall establish and maintain a procedure for managing GHG information. The requirements of this information management system are described in detail in DIN EN ISO 14064-1.
- The organisation shall establish a historical base-year for GHG emissions for comparative purposes. In FRED, a CCF may be created and used as the base year balance. Any changes from the base year must be explained in the GHG report.

4.1 Differentiation from the GHG Protocol

There are differences in method between the standard used here (DIN EN ISO 14067) and the Greenhouse Gas Protocol Product Standard (GHG Protocol), for example with regard to the underlying system boundaries or cut-off criteria. The GHG Protocol always provides for CO₂ evaluation across all life cycle phases (cradle-to-grave), whereas here (in compliance with DIN EN ISO 14067) a cradle-to-gate CO₂ evaluation is carried out. In the tool, the classification of emissions into scopes and different categories corresponds to the requirements of the GHG Protocol. Scope 1 includes direct emissions caused by the company itself. Scope 2 includes

emissions that occur during the electricity generation by the power supplier. Scope 3 includes all other indirect emissions.

Scope 3 emissions are organized into 15 distinct categories. There are minimum requirements for each category. Companies may exclude scope 3 activities provided that any excluded is disclosed and justified. The categories and their minimum are listed below:

- Purchased goods and services: all upstream (cradle-to-gate) emissions of purchased goods and services.
- Capital goods: all upstream (cradle-to-gate) emissions of purchased capital goods.
- Fuel- and energy-related activities: all upstream emissions of purchased fuels, energy consumed, and energy purchased.
- Upstream transportation and distribution: scope 1 and scope 2 emissions of transportation and distribution providers that occur during use of vehicles and facilities.
- Waste generated in operations: the scope 1 and scope 2 emissions of waste management suppliers that occur during disposal or treatment.
- Business travel: the scope 1 and scope 2 emissions of transportation carriers that occur during use of vehicles.
- Employee commuting: the scope 1 and scope 2 emissions of employees and transportation providers that occur during use of vehicles.
- Upstream leased assets: the scope 1 and scope 2 emissions of lessors that occur during the reporting company's operation of leased assets.
- Downstream transportation and distribution: the scope 1 and scope 2 emissions of transportation providers, distribution, and retailers that occur during use of vehicles and facilities.
- Processing of sold products: the scope 1 and scope 2 emissions of downstream companies that occur during processing.
- Use of sold products: the direct use-phase emissions of sold products over their expected lifetime.
- End-of-life treatment of sold products: the scope 1 and scope 2 emissions of waste management companies that occur during disposal or treatment of sold products.
- Downstream leased assets: the scope 1 and scope 2 emissions of lessees that occur during the operation of leased assets.
- Franchises: the scope 1 and scope 2 emissions of franchises that occur during operation of franchises.
- Investments: please refer to the GHG protocol for guidance on the minimum requirements for investment scope 3 emissions.

5 Calculations according to the Catena-X rulebook

5.1 System boundaries

The Catena-X rulebook defines system boundaries to be included in the PCF calculation. These shall be considered by the FRED User. The system boundaries include:

- Resource extraction, raw material sourcing
- Production of materials, semi-finished products
- Production of vehicle parts and components
- Packaging of vehicle parts and components, including all operations required for performing

- packaging
- Disposal of production waste (including packaging waste)
- Logistics (including internal logistics and transport packaging)
- Quality control in production
- IT for process and manufacturing control

Regarding transportation, all upstream transportation and transshipment processes shall be included in the product carbon footprint, i.e., included in the cradle-to-gate system boundaries. Emissions from transportation shall cover emissions from well-to-wheel, i.e., the system boundaries span from energy provision, production and distribution ending at the transportation operation itself. Emissions from the production of the transportation means and infrastructure, e.g., roads, vehicles, ships and railways, shall not be included.

Despite being included in the system boundaries in principle, insignificant processes may be excluded based on the cut-off rules. In general, GHG emissions not connected directly to the production system relevant for the product shall be excluded from the system boundaries. These are among others:

- Employee commuting and work travel
- Research and development, administration, or sales processes
- Auxiliary inputs not directly related to the production process (such as heating and lighting of associated office rooms, secondary services like maintenance, sanitary facilities, canteen services, facility management e.g., plant security and fire safety and general IT)
- Auxiliary inputs to maintain the manufacturing equipment
- Emissions from construction or dismantling of capital goods (such as buildings, manufacturing equipment or any other infrastructure for transport, and media distribution, within or outside the control of the reporting company)

5.2 Calculating the primary data share

Primary data is a quantified value of a process, an activity obtained from a direct measurement, or a calculation based on direct measurements. In FRED primary data is marked with a checkbox. To create visibility on the share of primary data in PCF calculations, the primary data share (PDS) indicator in each data set shall be determined and shared. The Primary Data Share (PDS) is defined as the proportion (percentage) of a PCF that is derived from primary data. The aggregated primary data share for multiple PCF contributions is calculated and reported as follows:

$$PDS_{aggregated} = \frac{\sum_i (|PCF_i| * PDS_i)}{\sum_i |PCF_i|}$$

When calculating the primary data share, a contribution to the primary data share shall only be attributed, if both the activity data (e.g., amount in kWh) and the GHG emission factor (expressed in kgCO₂eq per unit) information is derived from primary (Table 5). Supplier data shall only be considered as primary data if declared as such in percentage of primary data share. Only product- or company-specific data may contribute to the primary data share.

6 CBAM calculations

The EU CBAM Regulation (Carbon Border Adjustment Mechanism) is an instrument of the European Union to prevent distortions of competition. It ensures that certain imported products

(steel, cement, aluminium, fertilizers, hydrogen) are subject to similar CO₂ taxes as those applied to goods manufactured within the EU that are subject to the EU Emissions Trading System. The basis is the calculation of the greenhouse gas emissions generated during production and supply chain per imported quantity. The amended CBAM rules in 2025 align system boundaries with the EU ETS, meaning that for certain aluminium and steel goods emissions from non-ETS finishing processes are excluded, making precursor emissions the main driver of embedded emissions in those cases.

On this basis, importers must purchase corresponding CBAM certificates starting in 2026, the price of which is based on the average CO₂ price of the EU Emissions Trading System. CO₂ taxes already paid in the country of origin can be credited. During the transitional period from October 2023 to the end of 2025, only reporting obligations apply before the financial obligation to surrender certificates takes effect. During the transitional period, it is permissible to use the EU's so-called "default values" for calculating emissions. These are fully available in FRED. With the amendment in 2025, default values can now always be used to calculate embedded emissions (with no verification required), but this choice limits carbon price deductions to Commission-set default carbon prices, not actually paid ones.

CBAM emission factors are essentially PCFs for selected CBAM goods with specified (reduced) system boundaries. Only input materials that also correspond to CBAM-listed goods are included. In connection with the specified goods, only the direct emissions generated in the process steps and the indirect emissions from electricity consumption are considered. The upstream chains of energy sources are not included. Emissions associated with e.g. transport, waste treatment, or packaging are also not included.

Existing PCFs in FRED can be converted into CBAM results. To do this, the relevant CBAM input materials must be marked in the data management system. Emission factors for direct and indirect emissions must be entered separately. Input materials and processes can then be regionalized in the CBAM calculator. Only CBAM-relevant input materials and processes are included in the emissions calculation. The resulting emission factors can then be transferred to the CBAM portal.

7 Disclaimer

FRED is provided in a carefully researched state. Many input variables are based on data made available by the participating companies. This data has been included in the database to the best of our knowledge and belief, and following careful technical consideration.

However, the German Forging Association (Industrieverband Massivumformung), GreenDelta, Herlanco, and prosimalys shall under no circumstances assume any liability for the calculation results.

8 Literature (only in their original language)

Catena-X (2025). Product Carbon Footprint Rulebook Version 4

DIN EN ISO 14040 Umweltmanagement - Ökobilanz - Grundsätze und Rahmenbedingungen (ISO 14040:2006); Deutsche und Englische Fassung EN ISO 14040:2006./German and English versions EN ISO 14040:2006.

DIN EN ISO 14044 Umweltmanagement - Ökobilanz - Anforderungen und Anleitungen (ISO 14044:2006 + Amd 1:2017 + Amd 2:2020); Deutsche Fassung EN ISO 14044:2006 + A1:2018 + A2:2020./German version EN ISO 14044:2006 + A1:2018 + A2:2020.

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9 Document status

This document is updated continuously. You are currently reading the version from February 26th 2026

10 Contact

Publisher

Industrieverband Massivumformung e.V. (German Forging Association)

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11 FRED version report

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Date: 18.02.2026

Version 2.7.0 – Release xx.xx.xxxx

- Transport per process and product
- New data quality matrix
- Primary data share calculation option
- Additional life cycle stages
- Cut-off specification
- Detailed emissions factors

Version 2.6.1 – Release 18.02.2026

- CBAM order option
- Chinese translation

Version 2.6.0 – Release 10/20/2025

- CBAM Calculation
- PCF/CCF Editor Lock/Prevention of Concurrent Editing
- Two-Factor Authentication at User Level
- Provider Data CSV Import
- Decimal Place Configuration
- Performance Improvements
- Bug Fixes

Version 2.5.0 – Release 06/18/2025

- New UI Design by Creativum including new certificate printing
- Exchanges in organizational data can be sorted by name
- Material loss can be specified as a ratio of input to output mass
- Specification of the container quantity for time-based processes
- Bug Fixes

Version 2.4.1 – Release 03/10/2025

- Improved notifications for registration and quotation requests
- Back to the login link
- Technologies such as PCF are being used Selected displayed
- Synchronize user count with Hubspot
- Improved CCF printing options
- Subsequent categorization of "Shared Materials" in 3 levels
- Reference to other scopes for multiscope CCF providers
- Optionally apply material loss to non-mass-related processes
- Independent provider units
- Conversion factor to mass for input materials
- Bug fixes and UI improvements

Version 2.4.0 – Release 04.12.2024

- Self-registration of organizations
- Request a quote and place an order
- Separate billing address for organizations
- Input materials in CCF Scope 3 possible
- Changes to processes/providers with warnings possible
- Processes in PCFs can be exchanged directly
- Optional compact process navigation
- Percentage change added for comparison
- Industry example PCFs
- Volume units cm³, mm³ Added
- Bug fixes and UI improvements

Version 2.3.1 – Release 08/26/2024

- Translations: Czech, Spanish, French, Italian, Polish, Turkish
- Warning when provider selection is missing
- Bug fixes and UI improvements

Version 2.3.0 – Release 07/29/2024

- Cross-industry calculation
- Find and replace process/provider usage in PCF/CCF
- Share PCF with other FRED organizations as input material
- Flexible unit selection for process inputs and PCF weight
- New units
- Mass translation for Central Admin
- Reverse industry-to-organization assignment
- Default weight for providers
- Custom print options
- Translations
- Bug fixes and UI improvements

Version 2.2.0 – Release March 12, 2024

- CCF calculation compliant with ISO 14064-1 and the GHG Protocol, including greenhouse gas reporting
 - Complete list of Scope 3 categories
 - Option to compare market-based and site-based electricity in the GHG report
 - Data quality for activity data in the CCF editor
 - New "Note" fields
 - Display of direct emissions in CCF results
 - Individual dataset selectable
 - Option to generate a detailed GHG report
- New and updated general data
 - Electricity mix
 - Additional greenhouse gases
 - Recycling metals
 - Fuel upstream chains
- Improved validation in the PCF/CCF editor
- Comparison of CCFs

- Option to exclude material product mass from the calculation
- Additional fields for organizational information
- Simplified exchange creation in data management
- Multiple scopes for providers
- "Material" fields moved to "Provider" and "Exchange"
- Option for organization-wide two-factor authentication
- Option to select the number format
- Bug fixes and UI improvements

Version 2.1.1 – Release 10/10/2023

- Correction of scaling of PCF results based on product weight

Version 2.1.0 – Release 30/08/2023

- Different data disclosure levels in the PDF report
- Emissions calculation by area, time, or piece
- Multiple input materials and materials
- Merging PCFs
- Differentiation of scopes for electricity, gas, and other inputs
- Ability to specify biogenic emissions
- Calculate overall quality
- Mass of individual process steps and materials in the results view

Version 2.0.1 – Release 14/03/2023

- New material types "Waste" and "Packaging"
- New fields "Data Source", "Data Quality", and "Validated by" for processes, providers, and electricity/gas/compressed air/primary material
- New "Comment" field for providers
- New "Lifecycle Phase" field for processes
- New providers can be added to existing processes in exchanges

Version 2.0.0 – Release November 22, 2022

- Additional "Industry" level including "Industry Data"
- Comment field for processes and electricity/gas/compressed air
- User limit for organizations
- Compare PCFs
- "No selection" option for electricity/gas/compressed air in the PCF
- Loss-based calculation option
- CCF creation/calculation
- Scope override in process inputs
- Translations adjusted
- Redesign

Version 1.0.0

Initial tool development with core functions such as user, organization, and PCF creation, multilingual support, and data management (initially Excel-based, then as input masks in the tool) including extension to organizational data)