Georgsmarienhütte
GMH GRUPPE

Manual

for the calculation of the Product Carbon Footprint for products of Georgmarienhütte GmbH

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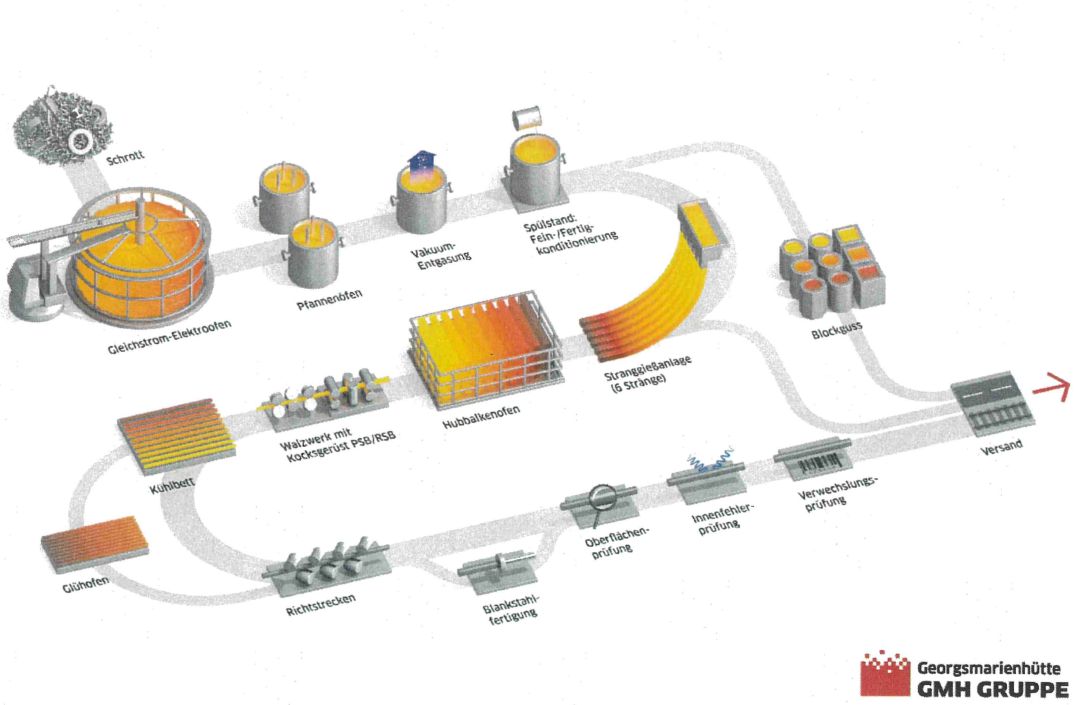
Content

1 Introduction

Georgsmarienhütte GmbH produces quality steel as semi-finished products in various steel grades with different rolling dimensions and heat treatment types. The company operates a modern electric arc furnace as the melting unit, which is followed by a secondary metallurgy of ladle furnaces and vacuum plant. Almost 100% steel scrap is used as the iron carrier, which is procured and processed by the company's own recycling plants.

In addition to physical-chemical material properties, customers are increasingly demanding information on the product carbon footprint of the products they order. Georgsmarien-hütte GmbH has therefore developed and implemented a methodology to calculate this information in accordance with ISO 14044 and ISO 14067. The aim is to be able to calculate a Product Carbon Footprint for the respective product that is as accurate as possible based on primary data. Clustering with product groups, as practised by other market competitors, is avoided in order to achieve a higher degree of accuracy.



After initial experience with an Excel-based, manually operated calculation model, Georgsmarienhütte GmbH has now developed an automated tool and implemented it in the company that accesses all process data and can thus calculate an exact PCF. This granularity allows the customer to make precise decisions regarding the selected material and, if necessary, to fall back on alternative materials from Georgsmarienhütte GmbH.

This manual describes and explains the normative references of the methodology and its implementation in the calculation tool and may also be used externally.
Information on the actual calculation steps and their implementation in the organisation's IT systems

can be found in the appendices of this documentation. This know-how may only be used internally, as it provides insight into business and trade secrets.

In order to ensure that the algorithms and data collection meet the requirements of the relevant ISO standards and thus a valid Product Carbon Footprint is calculated, Georgsmarienhütte GmbH regularly has the automated calculation model validated by independent experts.

2 Terms and abbreviations

2.1.1 Product Carbon Footprint

The Product Carbon Footprint (PCF) corresponds to the amount of greenhouse gases emitted in relation to the product under consideration, expressed as [t CO_2 e / product] or [kg CO_2 e / t product]. PCF corresponds to the CFP of ISO 14067.

2.1.2 Greenhouse gases

The PCF calculation includes the greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, NF_3 and SF_6 according to the Kyoto Protocol. The climate impact is assessed with the Global Warming Potential 100 according to IPCC AR6.

2.1.3 Organisation

The term "organisation" refers exclusively to Georgsmarienhütte GmbH at the location
Neue Hüttenstr. 1
49124 Georgsmarienhütte

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2.1.4 Emissions considered

The following GHG emissions are considered and calculated in the PCF calculations:

- Scope 1: direct GHG emissions
- Scope 2: Indirect GHG emissions from direct GHG emissions from purchased and self-consumed electricity.
- Scope 3: indirect GHG emissions of the upstream supply chain.
  Only the following Scope 3 emissions are considered according to the Greenhouse Gas Protocol are considered:
  - Scope 3 emissions for the provision of raw materials, consumables and supplies used (Scope 3.2)
  - energy-related Scope 3 emissions (Scope 3.3),
  - preliminary products including transport to GMH (Scope 3.4).

2.1.5 Declared unit

The input and output masses are always specified in the unit tonne [t], electricity as megawatt hour [MWh] and natural gas as standard cubic metre[1] [10^3 m^3].

[1] T = 273.15 K, p=1.01325 bar.

2.1.6 Waste

Waste is all substances that leave the system boundaries under consideration and correspond to the waste characteristics defined by the KrWG.

2.1.7 Supply chain

The supply chain under consideration corresponds to the upstream supply chain.

2.1.8 Calculation tool

The programmes developed by the organisation include a

- Calculation tool based on Excel with the three sub-programs for steelworks, rolling mill and final operation, as well as a
- automated programme based on a combination of an internal Oracle database and an in-house developed Qlik Sense evaluation.

For customer purposes, the automated programme is always used.

2.2 Abbreviations

BImSchG	Bundes-Immissionsschutzgesetz
DEHSt	German Emissions Trading Authority (Department of the German Federal Environment Agency in Dessau)
EEG	Renewable Energy Sources Act
EnWG	Energy Industry Act
KrWG	Closed Substance Cycle Waste Management Act
PCF	Product Carbon Footprint
GHG	Greenhouse gases
TSO	Transmission system operator

3 Target setting

3.1 Objective of the Life Cycle Inventory

3.1.1 Customer requirements

For some years now, the organisation has increasingly been confronted by customers with the question of how many emissions are associated with the production of a certain product. The companies either want to pass on these values or include them in their own PCF calculation.

In order to be able to guarantee the customer the highest possible accuracy of the PCF, the organisation has implemented a calculation model for the partial PCF calculation with an exact allocation of the input and output materials.

3.1.2 Own requirements

The GMH Group has developed its own roadmap, backed by strategic goals, for achieving climate neutrality by 2039. The effects of implemented operational goals in the area of process lines are digitally simulated and checked with the PCF calculation. With the detailed designation of the three

different scopes, interactions of the total emissions can be considered and undesirable developments can be avoided.

3.2 Limits of the life cycle inventory

Currently, various stakeholders are developing calculation rules for determining PCFs, some of which have conflicting requirements. As it is not reasonable to consider all of these requirements, the organisation will continue to calculate PCFs in accordance with this manual until further notice. Possible legal requirements will be implemented and included in the calculation according to the time frame of the entry into force of these requirements.

4 Life cycle inventory and application

4.1 Investigation framework of the PCF determination

4.1.1 Type of PCF calculation

The organisation does not deliver products to its customers that are directly ready for installation or already a final product for the consumer. The delivered product (see Chap. 4.1.34.1.3) is considered a semi-finished product. The company also does not know into which products the material will later be incorporated after further processing steps. Therefore, the information on the PCF is only a partial PCF.

4.1.2 System boundary

The PCF calculation considers the substances that are required and converted within the plant for the production of the products under consideration. The plant corresponds to the complete operating site of Georgsmarienhütte GmbH, Neue Hüttenstr. 1 49124 Georgsmarienhütte.

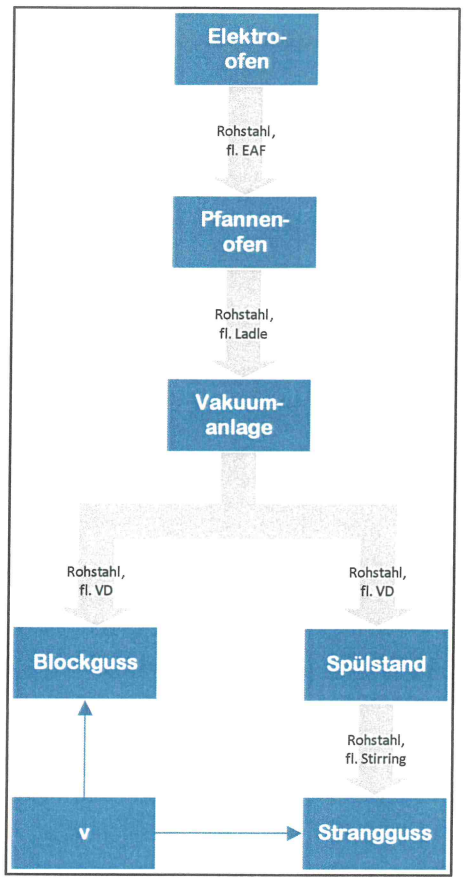
4.1.3 Products

With the calculation programme for PCF determination of the organisation, all steel qualities are considered which are produced within the plant boundaries of the company in 49124 Georgsmarienhütte. These are in particular

- Block casting
- Continuous casting
- Steel bars
- Heat treated bar steel
- Surface treated bar steel
- and combinations of these products.

4.1.4 Processes

The PCF determination records the operating units described below with individual process steps. Each operating unit leaves intermediate products that are further processed in subsequent operating units within the system boundaries, or final products. A PCF can be reported for each product.



Steelworks operating unit

4.1.4.1 Steelworks operating unit

The steelwork's operating unit has an operating permit in accordance with the Federal Immission Control Act (BImSchG). The sub-processes of the steelworks are described and defined in this permit. The actuality of the permit is checked and confirmed annually by the organisation's certified environmental management system according to DIN EN ISO 14001:2015. The process steps consist of

- Electric arc furnace, the melting unit.
- Ladle furnaces, metallurgical aggregates for the adjustment of chemical properties.
- Vacuum plant, metallurgical unit for degassing the liquid steel.
- Ingot casting plant, for casting the liquid steel into individual ingots or
- Rinse stand for setting the fine analysis in conjunction with the
- Continuous casting plant in which liquid steel is cast into endless strands.
- Infrastructure (summary of all material and energy flows that cannot be directly allocated).

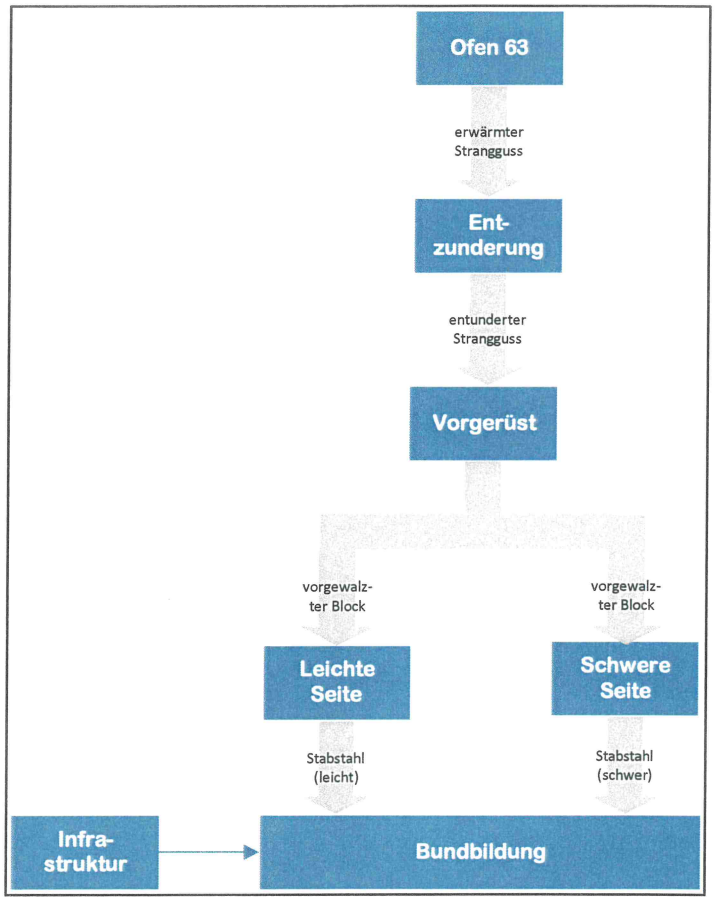
Leaving the steelworks:

- Block casting
  (leaving the system boundary as a product)
- Continuous casting
  - Internal further processing in rolling mill operating unit
    (leaving the operating unit as an intermediate product)
  - External processing
    (leaving the system boundary as a product)

4.1.4.2 Rolling mill operating unit

An operating permit in accordance with the Federal Immission Control Act (BImSchG) is available for the rolling mill operating unit. The sub-processes of the rolling mill are described and defined in this permit. The up-to-dateness of the permit is checked and confirmed annually by the organisation's certified environmental management system according to DIN EN ISO 14001:2015. The process steps consist of

- Furnace 63, the reheating furnace for the continuous cast ingots to be rolled.
- Descaling to remove oxide layers from the heated blocks.
- pre-strain to achieve initial cross-sectional deformation.



- Light side for rolling diameter

Rolling mill operating unit

- from 20 mm to 82 mm or
- Heavy side for roll diameters from 82 mm to 126 mm.
- Bundle formation, here the rolled bars are combined into bundles.
- Infrastructure (summary of all material and energy flows that cannot be directly allocated).

Leaving the rolling mill as a product

- Rolled steel
- Rolled steel for further processing in final and bright operations

Rolling mill operating unit

4.1.4.3 Final and blank operation

In the final and bright operations unit, the rolled steel produced in the rolling mill is heat-treated and/or surface-treated according to customer requirements. The rolling mill unit has an operating permit in accordance with the Federal Immission Control Act (BImSchG). The sub-processes of the final and bright operation are described and defined in this permit. The validity of the permit is checked and confirmed annually by the organisation's certified environmental management system according to DIN EN ISO 14001:2015. The process steps consist of

- Heat treatment
  - Heat treatment furnaces for adjusting mechanical properties.
- Blank operation
  - Line 1, peeling, grinding and cutting to length.
  - Line 2, peeling, grinding and cutting to length.
  - Tönsmeier Halle, cutting to length
- S lines

Final and blank operation leave as product

- Heat-treated bar steel.
- Surface-finished bright steel.

- Heat- and surface-treated bright steel.

4.1.5 Time validity range

The reporting of data on the PCF to third parties based on a change in the current, validated algorithms for calculating the PCF may in principle only take place after external validation by accredited auditors. Data such as emission factors are updated independently as described below.

4.1.5.1 Input materials

As far as possible, the emission factors of the Scope 1 values are taken from the current emission reports to the DEHSt. Other Scope 1 values are only re-determined on an ad hoc basis.

The emission factors of the Scope 2 value correspond to the last communication of the electricity supplier on the electricity mix, which is communicated by the TSO to the electricity supplier with a delay of almost two years due to the procedure.

The Scope 3 values are checked annually and updated if necessary. This is usually the case when EcoInvent's external databases are revised.

Energy consumption from the time before 2021 can be used in the form of interpolated values, which has no influence on their CO2 intensity within the scope of the validation. The decisive factors for the accuracy of the PCFs are the respective process starts and ends recorded to the second. All values from 2021 onwards are available as actual values.

4.1.5.2 Output materials

The temporal validity of the PCF for the product steel depends on the topicality of the Scope values of the input materials. The Scope 2 value has the greatest influence on the PCF value, so that the reported PCF is published with the note that it was calculated on the basis of the most current Scope 2 value.

5 Methodology

5.1 General

The greenhouse gas emissions are determined within the framework of a mass balance, which is described in the
ISO 14067. The requirements of ISO 14044 are observed accordingly. The following applies

$$GHG_{total} = \sum GHG_{Input} - \sum GHG_{Output}$$

GHG_{total} : total greenhouse gas emissions
GHG_{Input} : potential greenhouse gas emissions of the input substances considered
GHG_{Output}: potential greenhouse gas emissions of the output substances considered

The carbon contained in the material under consideration is converted into CO_2 using the factor: 3.664057947 [CO_2 /C].

5.2 Balance limits

The mass balance is carried out with a cradle-to-gate consideration, where cradle is the point of origin of the operating materials and energies used and gate is the point of departure (loading edge means of transport) from the system boundary of the organisation.

5.2.1 Dealing with GHG quantities

The emission values included in the PCF calculation comprise the greenhouse gases considered in the Kyoto Protocol (see chapter 2.1.2).

5.2.1.1 Scope 1

The legislator only requires the reporting of direct CO_2 emissions as part of the emissions reporting for the EU ETS, so that only CO_2 with the unit [t CO_2 e] is considered in the PCF calculation. Biogenic carbon is only reported as zero if it meets the sustainability criteria of RED II.

5.2.1.2 Scope 2

The emissions for the indirect emissions of the purchased electricity quantities are transmitted by the electricity supplier as CO_2 with the unit [g CO_2 /kWh]. Therefore, only this electricity mix with the unit [t CO_2 e/MWh] is considered in the PCF calculation.

Internally, electricity is generated in an ORC power plant from the plant's own waste heat. The amount generated is negligible and is charged with the respective electricity mix of the external electricity supplier instead of the actual, favorable value of 0 g CO_2/kWh.

5.2.1.3 Scope 3

Emissions to sourced precursors are based on primary data, but mainly on database values, which may include all six greenhouse gases. Here, the total greenhouse gas emission value is considered with the unit [t CO_2 e/t]. For the
following substance groups according to the Greenhouse
Gas Protocol, the Scope 3 upstream is considered in the PCF determination:

- Purchased goods and services, raw materials and supplies (Scope 3.1)
  such as scrap, coals, alloys, diesel.
- Energy-related upstream chain (Scope 3.3)
  such as electricity and natural gas
- Upstream deliveries (Scope 3.4)
  such as transports of scrap

5.2.2 Substances and energies considered

When calculating the PCF, only the substances and energies directly used in the production of the product are taken into account. The machinery and equipment of the operating units are not included in the calculation.

5.2.3 Data scope and data quality

5.2.3.1 Data scope

The claim of this partial PCF calculation is the almost complete recording of all substances and energies that are required for the direct production and processing of the product ordered by the customer. Since all mass flows and energy flows are digitally measured and recorded in the organisation, a high resolution of the data is guaranteed, so that only for a few substances, such as graphite electrodes and slags, average values have to be calculated.

5.2.3.2 Data origin

5.2.3.2.1 Own data

Input and output materials are recorded via various calibrated and tested measuring systems and digitally stored and retrieved in ERP systems. Measuring systems are in particular

- Calibrated truck scales
- Calibrated electricity meters
- Calibrated gas clocks
- Calibrated belt weighers
- Quality-assured steelworks laboratory with Leco, spectroscopy and other methods

Their functionality is regularly checked internally and externally.

5.2.3.2.2 Third party data

Third-party data comprehensive information from external laboratories on C-contents of input and output materials relevant for the Scope 1 calculation. Suppliers provide the organisation with corresponding quality certificates, which are also accepted by the German Emissions Trading Authority as part of the emissions reporting for the EU ETS.

Scope 2 information is submitted by the electricity supplier and recognised by the organisation. The calculation of the electricity mix by the TSO is based on the application guide "Leitfaden Stromkennzeichnung" of the BDEW of the respective reference year, which specifies the requirements §42 EnWG and §§78 and 79 EEG.

Information on Scope 3 comes from scientific databases (EcoInvent, GABi) or from government agencies such as the Federal Environment Agency. If a supplier reports its upstream scope 3 with individual primary data, the organisation requires a reliable certification by an accredited testing body.

EcoInvent currently uses version 3.9.1 with the allocation model "Allocation, cut-off by classification" and GWP100a according to IPCC 2021.

5.2.3.2.3 Data quality assessment

5.2.3.2.3.1 Representativeness of primary and secondary data

The calculation approach for the PCF calculation considers individual batches with identical material numbers and individual work orders and does not aggregate in the form of group formation. In order to present representative figures when considering batches of steelworks orders, the last 20 batches are considered. Since Scope 1 and Scope 2 values of the calculated PCF are mainly based on verified

primary data such as the emissions reporting to the DEHSt, these scopes are of high data quality. The quantity calculation is also based on weighted material flows, so that high quality can be assumed here as well. All emission-relevant substances such as coal, natural gas, alloys or electricity are recorded as primary data, so that their effects on the respective PCF are correctly shown.

Annual mean values are only used if it is not possible to weigh a batch. This applies to refractory, electrode burn-up, slag and bears. Electricity and natural gas consumptions that cannot be directly assigned to a batch are also recorded as annual averages and assigned to the batches. Since these substances have a minor influence on the PCF value due to their C content or quantity, the choice of annual mean values is justifiable.

The scope 2 value of the purchased electricity is published with a time delay by the transmission system operator, so that the actual current value can never be included in the calculation. The time delay is regulatory and cannot be influenced by GMH. This is a systematic deviation.

5.2.3.2.3.2 Error evaluation

Measurement errors are generally possible within specified tolerances, which is regularly checked by calibrations.

Potential inaccuracies due to measurement errors, disturbances of individual batches or atypical batches such as start-up batches in the steelworks are smoothed out by averaging 20 batches so that these deviations are irrelevant for the final data quality.

Due to the large amount of data and its collection systems, errors cannot be ruled out. Incorrect calculations based on such errors are counteracted by plausibility checks of the PCFs to be forwarded to the customer. In the operating areas, errors are excluded or minimised through preventive maintenance and digital monitoring of the processes.

5.2.4 Allocation

The CO_2 e emissions are generally only related to and calculated for the main product, steel. By-products and waste are not proportionally assigned emissions that arise within the system boundary and the upstream processes.

Credits from previous life cycle assessments (such as steel scrap) are not recognised and included in the calculation.

All GHG emissions of the partial PCF calculation refer to the physical unit 'tonne'.

5.2.5 Cut-off criterion

No cut-off criterion is set in this partial PCF calculation. All substances are considered that flow directly and specifically into the product and are therefore reported via ERP systems.

6 Report and impact assessment

6.1 General

The partial PCF applicable to the respective product is given in detail with Scope-1, Scope-2 and Scope-3 values with the physical units t CO_2 e/t product or kg CO_2 e/ t product in the factory test certificate.

6.2 Impact assessment of biogenic carbon

The PCF calculation does not show any credits for biogenic carbon. The use of sustainable biomass reduces the use of fossil carbon and thus minimises the scope 1 value of the product under consideration.
The use of biomass in the calculated order is indicated in the factory certificate.

6.3 Evaluation of the partial PCF

As a matter of principle, an evaluation and dedicated consideration of the PCF is only carried out at the customer's request, as the number of annual PCF calculations does not allow for this.

General statements on GHG reductions are only meaningful to a limited extent within the framework of the system boundary considered, as it is not possible to estimate what additional GHG emissions within the system boundary will enable in terms of savings outside the system boundary in the subsequent sub-steps of the life cycle analysis, in particular the use phase.

6.4 Written form

The customer receives written information about the PCF of his determined product, in which the Scope 1, 2 and 3 values are shown as kg CO_2 e/ t. The values are given as total values for the delivered product, not broken down into individual processes, as this would communicate process know-how. The values are given as total values for the delivered product and are not broken down into the individual processes, as this would communicate process know-how.

Assessments and justifications of the values can be carried out with the client on request.

7 Critical review

The scope and granularity of the partial PCF calculation is reviewed annually by Georgsmarienhütte Holding GmbH. Customer statements, industry opinions and political requirements are included in the assessment. Based on this review, the management of GMH Holding decides to what extent the PCF calculation is appropriate and may need to be revised.

8 Attachment

Documentation of the PCF calculation at Georgsmarienhütte GmbH

Status: 16.06.2023

This document is intended for internal use only and may not be passed on to third parties.