BASF Global Supplier CO_2 Management Program -

TRAINING MODULES FOR SUPPLIERS

PCF INTRODUCTION SESSION WITH A DEEP DIVE ON BIOGENIC CARBON ACCOUNTING

NOVEMBER 2024

Sustainability is our business

Contents

Warm welcome & some housekeeping rules

Chatham House Rules: participants are free to use the insights that emerge from the session, **but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.**

The meeting is not being recorded. We will be capturing outputs from the session but no participant details will be shared with any party, at any time for any purpose.

Your **microphones** will be **on mute** during the entire training.

Use the Q&A function to raise questions.

Engage;
Be present;
Be open;
Be curious;

Poll function is also enabled **for exercises.**

Antitrust Disclaimer

All participants of the meeting wish to ensure compliance with applicable Competition Laws. In this regard, please find below some **key rules** which apply throughout the meeting - not only during its formal sessions but also while we get together informally.

1. **No** discussions about each other's cost of sales, sales plans, planned sales territories, cost of purchase, trade secrets, discounts, margins, rebates, credit terms, customer quotes, supplier relationships.
2. **No** discussions about pricing and other purchasing conditions in contracts.
3. **No** exchange of other commercially sensitive information.
4. **No** agreement not to compete.
5. **Stay within the limits of the agenda of the meeting**.

Looking forward to a productive meeting!

Today‘s objectives

The **main objectives** of the introduction sessions is to provide

TOGETHER FOR SUSTAINABILITY

Alignment between BASF’s program and the Together for Sustainability (TfS) Scope 3 GHG Emissions Program,

PCF

Product Carbon Footprint (PCF) calculation,

PCF

Biogenic GHG emissions accounting and modelling in PCF, and

PCF

Common PCF pitfalls & lessons learned.

Your hosts for today‘s session

Your ERM Speakers & Hosts

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Managing Consultant, ERM
Product Sustainability
Central & Eastern Europe

Dr. Michael Spielmann
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Product Sustainability
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BASF objectives & benefits to participating suppliers in the training program

What are the objectives for the Training Program?

- The objectives of this training program are to get first insights into the calculation of a PCF and provide some basic information on what is needed to calculate your own PCF

What benefits do suppliers get in participating in the following introduction session?

- Understanding the context of Product Carbon Footprinting: Standards, data requirements and accounting
- Enable all BASF suppliers to provide PCF values of their products
- Enable suppliers supplying bio-based materials to consider the biogenic carbon content in the PCF calculation
- Understand the requirements and what information and data is needed to carry out these assessments
- Learn from previous experiences from peers and avoid common PCF pitfalls
- Act on the principle “only what gets measured gets managed“

Setting the scene: PCF calculation standards

Detailed guidance for chemical products now available based on ISO 14067:2018:

TOGETHER FOR SUSTAINABILITY

- PCF Guideline for chemical products
- Based on ISO 14067:2018
- Developed by members of TfS
- Launched in Q4 2022 and available on this link in different languages: English, Chinese, Japanese and Spanish. Update to be published before the end of the year.
- BASF actively contributed to the development
- Most detailed guidance for PCF calculation of chemical products

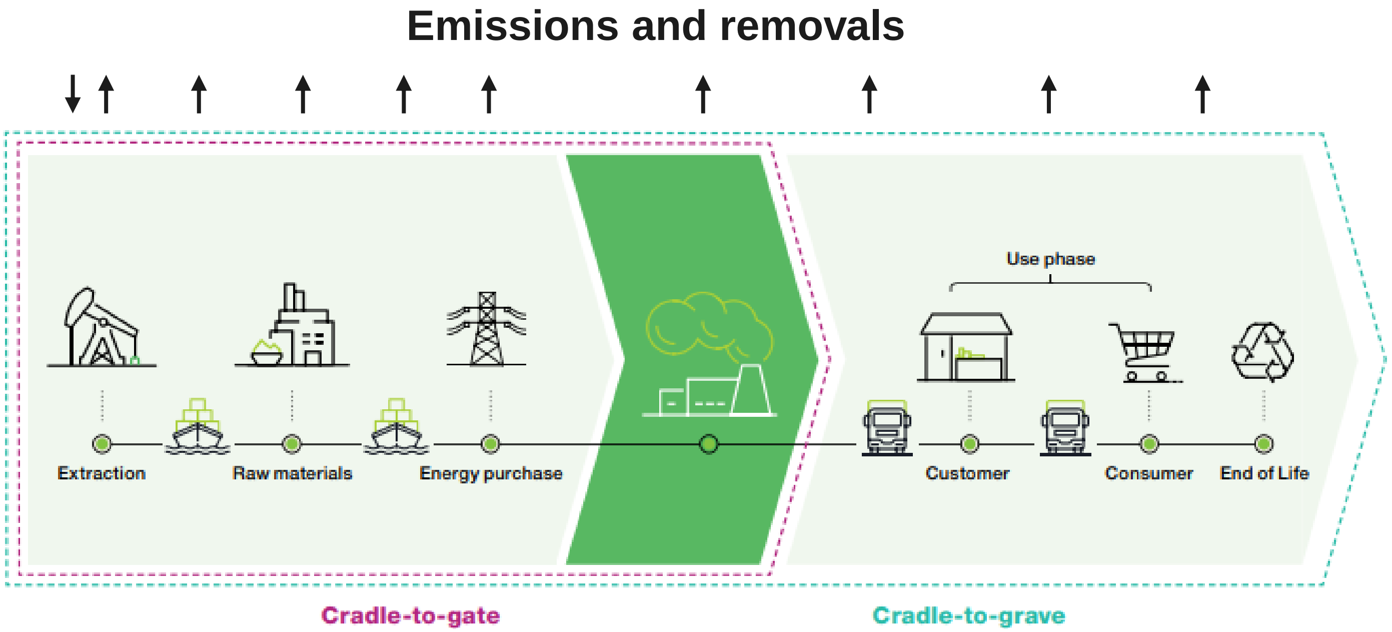
Other standards

- ISO 14067:2018
- ISO 14044:2006

- GHG Protocol Product Standard
- PAS 2050
- EPDs

What is Product Carbon Footprint (PCF)?

- ISO 14067 definition: The “sum of greenhouse gases emissions and removals in a product system, expressed as CO_2 equivalents and based on a life cycle assessment […]”
- From ‘cradle-to-grave’
- From ‘cradle-to-gate’
- Holistic



Exercise

Exercise 1: Carbon footprint of some raw materials

1. Can you guess which footprint belongs to which raw material numbers 1-3?

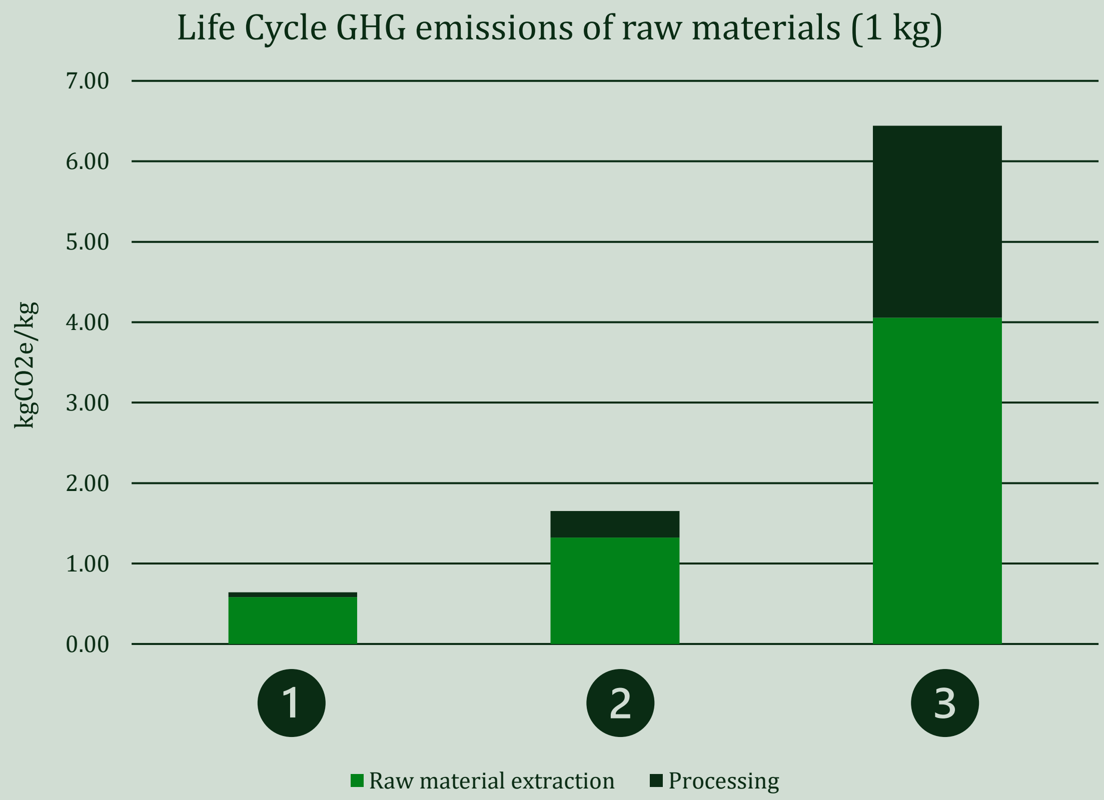
Benzene,

Naphtha,

Tin

2. What is the contribution of raw material extraction and of processing towards the footprint (bright green & dark green color)?

Type your answers in the Zoom chat.



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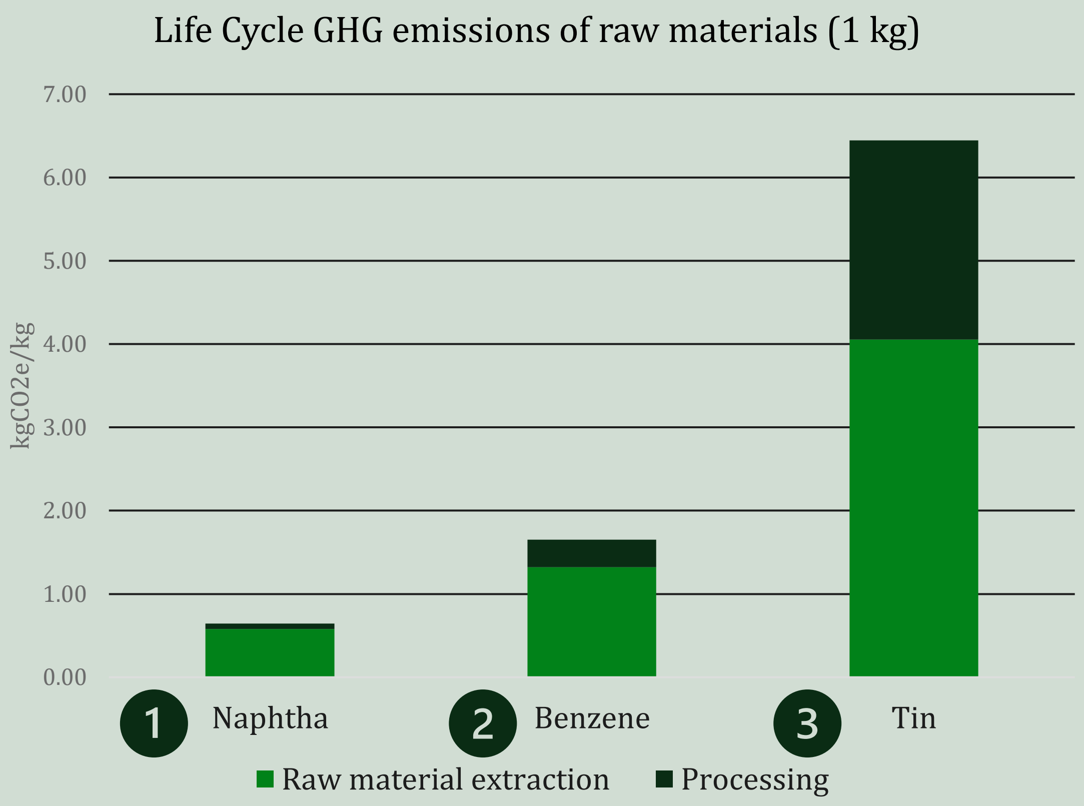

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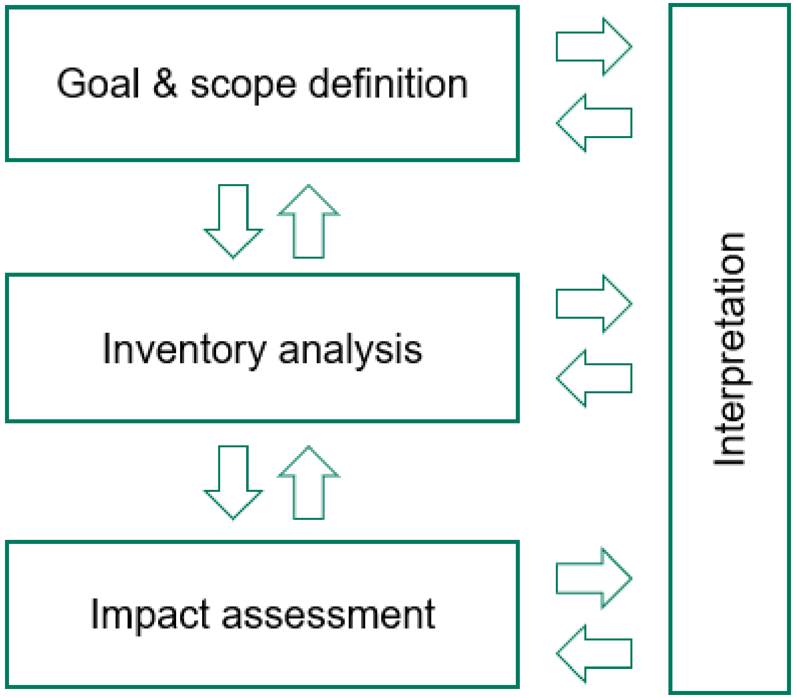
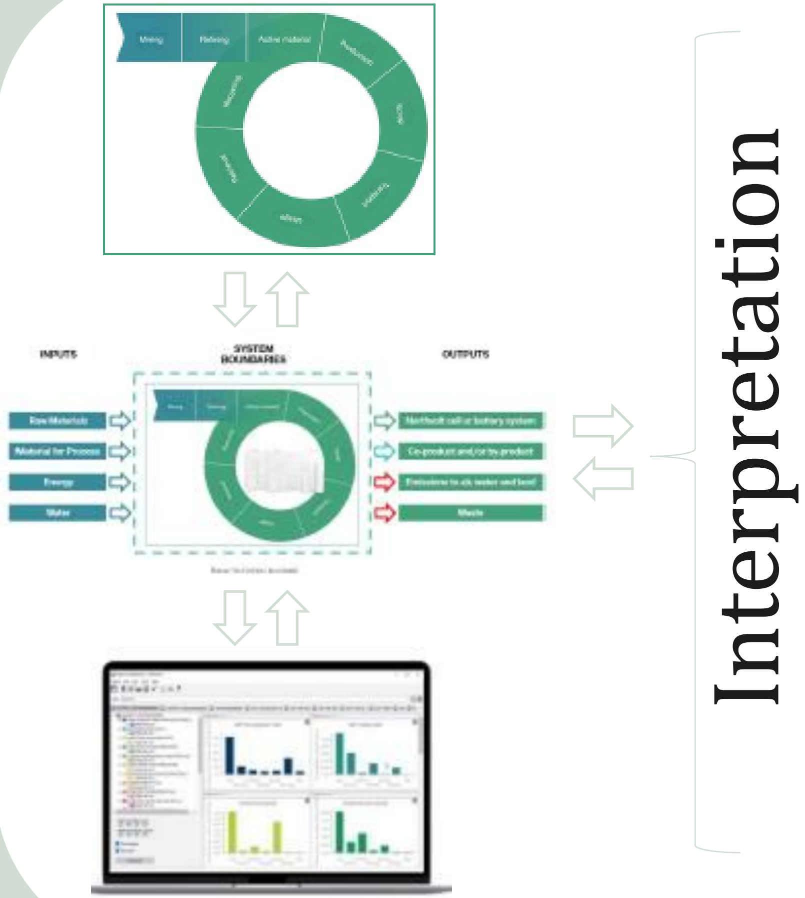
Conducting a PCF follows a clear structure of four key phases

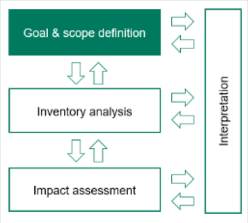
ISO-Approach



Illustrative example of practical implementation



Goal and scope



Potential goals of PCFs

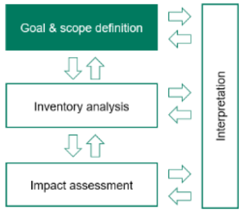
- Identify '**hot spots**'
- Guide **product development**
- **Benchmark**
- Compare **products alternatives**
- Product **certifications, labelling**, etc.
- **Transparent communication** with stakeholders
- Support **public policy decisions**
- **Reduce environmental impact**

Questions regarding PCF scope

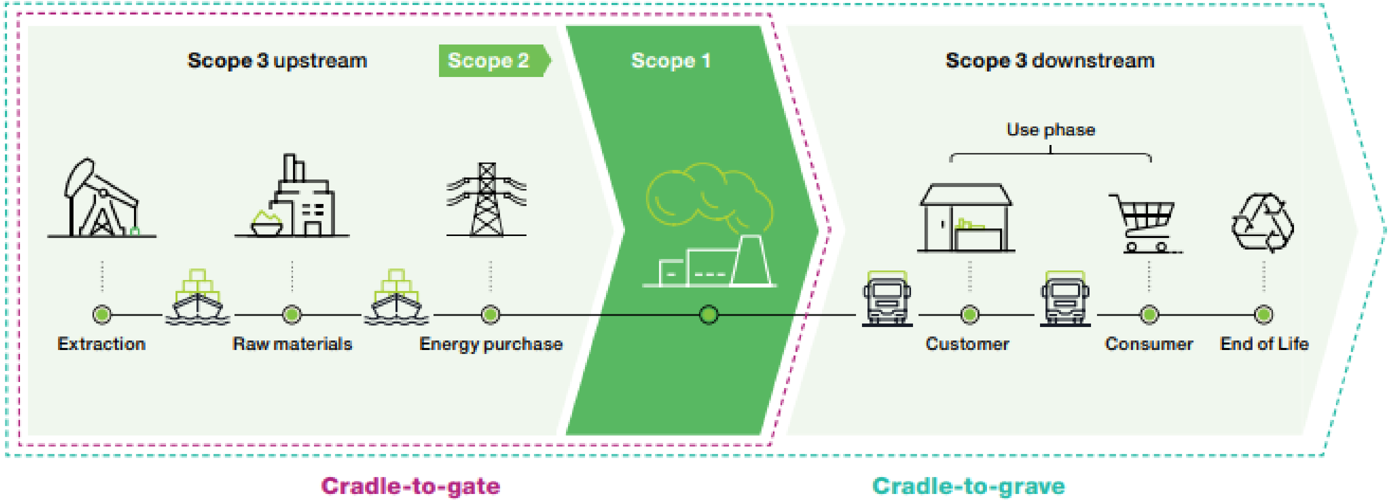
- What is being **assessed**?
- What is the **intended application**?
- What **process stages** are included?
- In what **detail**?
- **Data sources** and **methods**?
- How are results being **reported**?
- Who is the **audience**?

As PCF data collection continues, the scope may require modification to meet the original study's goal

BASF's scope definition



BASF system boundaries



Source: TfS

The **boundary** of the TfS guideline and this training is a **cradle-to-gate PCF.** This includes emissions from all processes and steps of **extraction, manufacturing, and transportation, until the product leaves the factory gate**.

Downstream emissions from product use & end-of-life are in general **excluded.**

The **Declared Unit** for which the PCF of a product system is calculated is **1 kg of unpackaged product at factory gate**, regardless of its state (solid, liquid, gas).

Include all product-related direct (Scope 1) and indirect (Scope 2) **GHG emissions** of the production process and related upstream activities:

- Production of related raw materials
- Consumption of utilities, energy and fuels
- Direct emissions from manufacturing and related on-site generation of utilities
- Transport of raw materials and site-to-site
- Treatment/disposal of process waste & wastewater

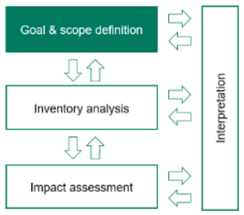
Exclude the following activities

- R&D activities, infrastructure services, other services such as engineering
- Business travel, employee commuting
- Capital and technical goods
- All downstream activities (i.e., use & EoL)

Optional (separately reported)

- Packaging and outbound logistics

BASF's data quality requirements follow industry standards & best-practice



Temporal

Most recent data (not older than 3 yrs) covering **12 calendar months**

Geographical

Production & emission data from **relevant locations**

Technological

Data from the production plant(s) with the **technology used to produce BASF's raw material**

Complete

Only **use cut-offs where necessary**

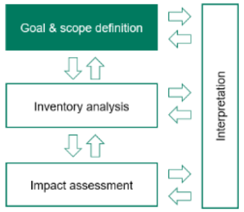
Consistent

Check for deviation with last year's data

Precise & Reliable

Measured/calculated data based on internal production data & verified by **(internal) reviewer**

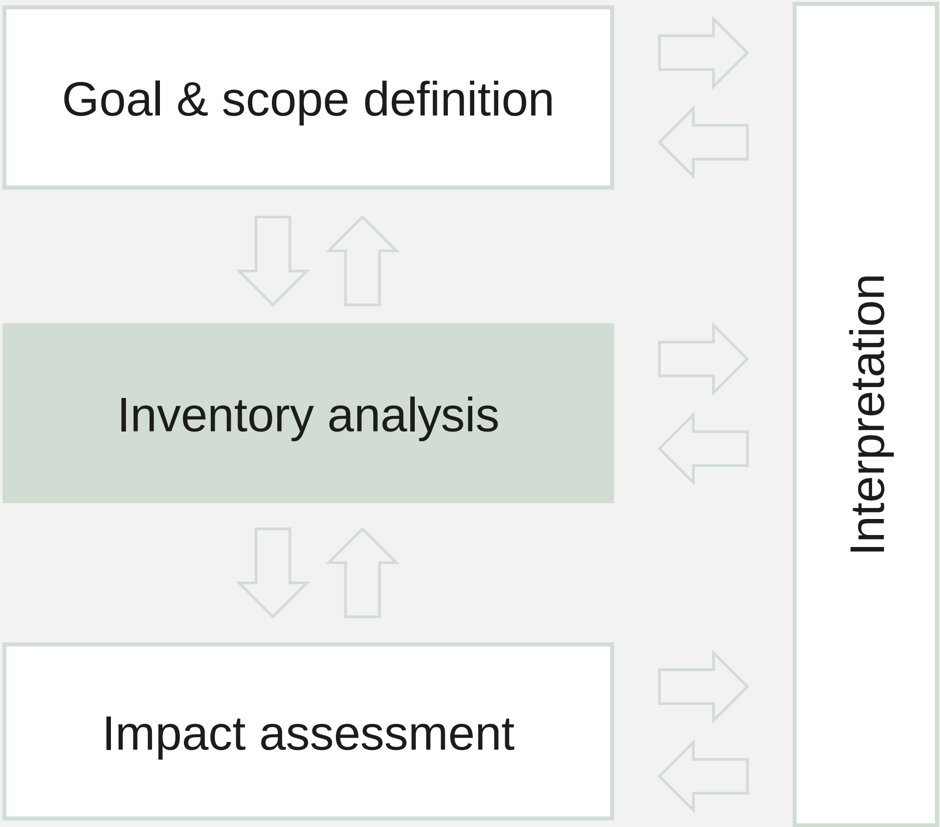
Lessons learned: Goal & scope definition

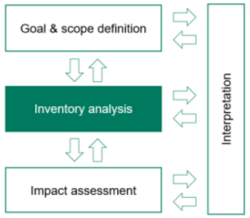


Based on the data received from suppliers so far, some common pitfalls for this first phase „goal & scope definition“ include:

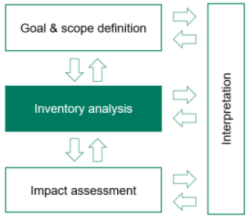
- **Standard to be used:** Follow TfS Guideline based on ISO standard 14067:2018
- **Scope:** Cover all product-related GHG emissions and removals from **cradle-to-gate** (not “gate-to-gate”)
- **Declared unit:** Refer to **1 kg of unpacked product**
- **Data quality:** Use data of **high quality** and **good representativeness** that is up-to-date and reflect the geography and the technology that is **specific to the product** that you supply to BASF

PCF Phase 2: Inventory Analysis



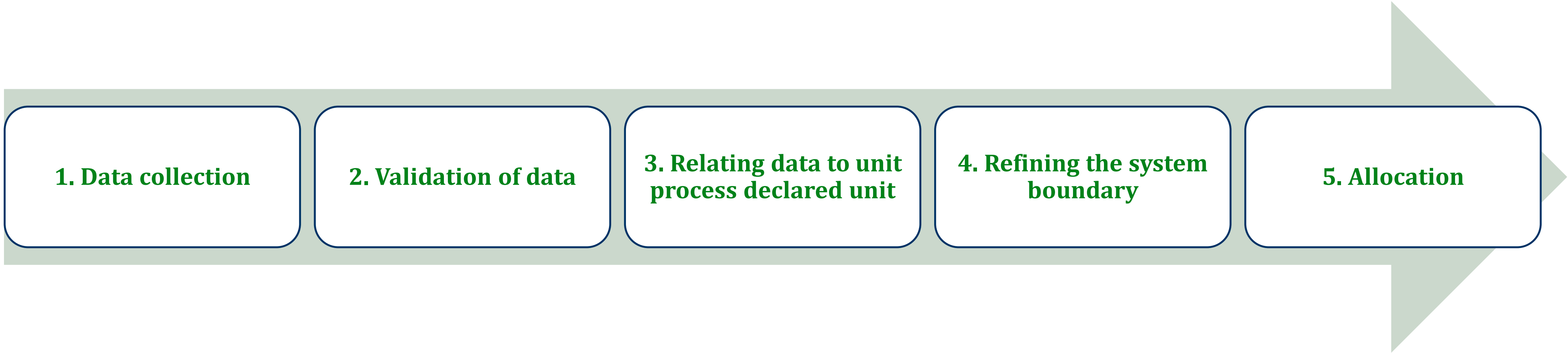


5 steps within the inventory analysis



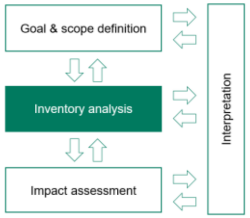
ISO 14067:2018 requirement

- Life cycle inventory (LCI) analysis is the phase of LCA involving the **compilation and quantification of inputs and outputs** for a product throughout its life cycle
- After the goal and scope definition phase, the LCI of a PCF study shall be conducted
- This consists of the following steps, adapted from ISO 14044, which shall apply when relevant:



Source: ISO 14067:2018

Data collection for the inventory analysis



Inputs

Outputs

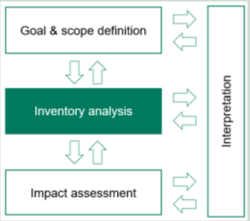
Products and co-products

Solid waste and treatment options

Effluents

Air emissions

Primary vs secondary data



Primary Data

Definition: **Primary data** are used to describe the **elements of a product system,** which are directly **under the decision-makers' control**

Sources - From process operators and drawn from:

- Production data
- Energy & raw material accounting
- Emissions and waste reporting
- Financial reporting
- Equipment specifications

Secondary Data

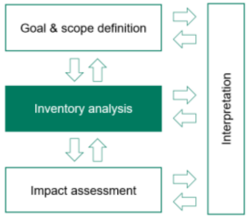
Definition: **Secondary data** are used to describe **elements of the life cycle** which **originate from the open market,** e.g., electricity, commodity materials and fuels etc.

Sources - External sources (*in order of preferred use*):

- **LCI databases** (e.g., ecoinvent, GaBi, US LCI Database, Product Environmental Footprint)
- **Industry associations** (e.g., PlasticsEurope, Worldsteel, International Aluminium Institute)
- **Scientific publications**

Primary data is preferred. Secondary data only if from external, trustworthy sources.

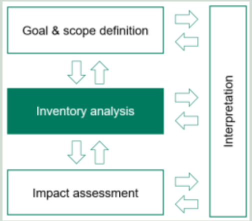
Commonly used (industry) databases & software



PCF Software	Databases	Industry data
SimaPro	ecoinvent	EUROFER The European Steel Association
openLCA	European Commission - Joint Research Centre LCA Tools, Services and Data	Zinc ...essential for life
umberto® know the flow.	sphera®	European Aluminium
sphera®	U.S. LIFE CYCLE INVENTORY DATABASE	INTERNATIONAL ALUMINIUM
		FEFCO Corrugated Packaging
		worldsteel ASSOCIATION
		PLASTICS EUROPE Enabling a sustainable future

...and more

Allocation hierarchy



1. Allocation methods in line with published & accepted **product category rules (PCR)**

2. Application of process subdivision

3. Application of **economic values of co-products** as criterion to decide between physical & economic allocation(*):

$$\frac{\text{Price Product 1 (max)}}{\text{Price Product 2 (min)}} > 5?$$

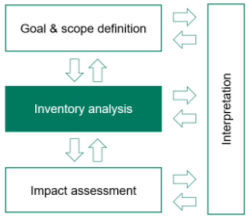
4. If the economic values ratio is higher than 5, the CO_2 eq impact shall be allocated with economic allocation approach.

5. If the economic values ratio is lower than 5, the CO_2 eq impact shall be allocated with the default allocation approach: physical allocation.

(*)Economic allocation factors should be calculated based on stable market prices, as yearly average or over multiple years in case of high fluctuation (e.g., >100%) of prices.

- The **correct application of allocation rules** is crucial for calculating a PCF
- The **allocation hierarchy** defined by TfS must be followed for PCF calculation
- **See decision-making tree** for allocation rules, TfS guideline, p.64
- **Examples are provided in the TfS guide.**

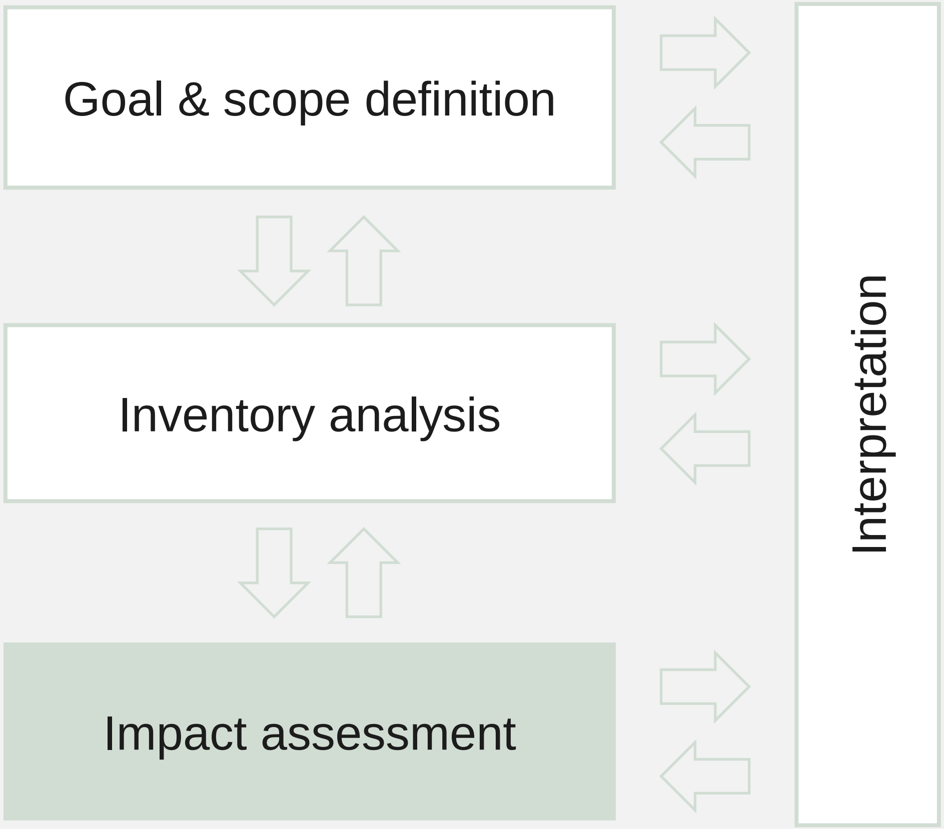
Lessons learned: Inventory analysis

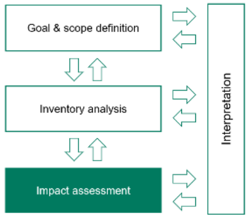


Based on the data received from suppliers so far, some **common pitfalls** for this second phase „inventory analysis“ include:

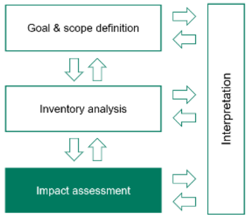
- **Questionable databases:**
  - PCF values of raw materials are taken from **non-acceptable data sources** (e.g., non-verified databases, the internet).
  - PCF values from LCA databases are only accepted for **purchased goods**, **not for own controlled processes.** This should be calculated based on own company data.
  - Data from **free databases** are **often insufficient**, as there are no data updates and the derivation of datasets is unclear
- **Proportion of supplier-specific data for raw materials:** It is often claimed that the data for raw materials are 100% supplier-specific. However, in many cases ecoinvent or Gabi values are then used for own purchased raw materials rather than real supplier-specific data. **For raw materials and utilities (Scope 3) consider either supplier-specific PCF data (preferably) or PCF data from LCA databases**.
- **Incorrect primary data:** Consider **primary data for all processes under your ownership** (Scope 1) and **market-based emission factors for purchased energy** (Scope 2).
- **Incorrect secondary data: Secondary data** used must at least have correct **geographical reference**, e.g., productions in China with an upstream chain from China should not/must not be calculated with LCI data from Europe, at least not if the contribution is >5%.

PCF Phase 3: Impact Assessment





Impact assessment



Life cycle inventory results, i.e. material and energy balance

Classify (by GHG)

GHG	Quantity
Carbon dioxide	10 kg
Methane	1 kg
Nitrous oxide	0.1 kg

Characterise

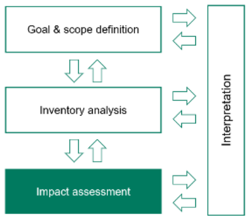
Compared to CO_2
1 kg = 1 kg CO_2
1 kg = 29.8 kg CO_2
1 kg = 273 kg CO_2

Impact potential

GWP, kg CO_2e
10 kg = 10 kg CO_2e
1 kg = 29.8 kg CO_2e
0.1 kg = 27.3 kg CO_2e
Total = 67.1 kg CO_2e

- **Impact assessment** follows a **three-step conversion** to **compare GHG emissions** and **impacts.**
- During the process, **all GHG emissions** are converted into a **single impact category result** in terms of **Global Warming Potential (GWP)** or 'Carbon Footprint' reported as **kg CO_2e** (CO_2-equivalents).
- **Assigning flows to impacts** is known as **classification**. **Software automatically** perform this exercise.

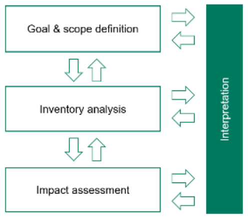
Lessons learned: Impact assessment

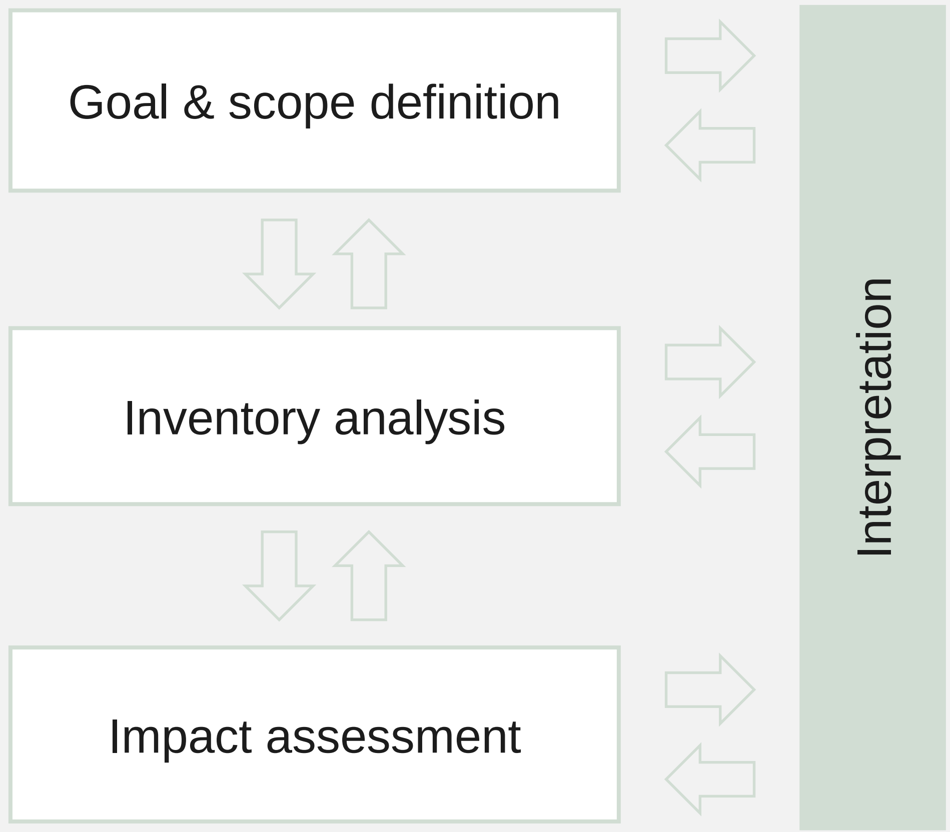


Based on the data received from suppliers so far, some common pitfalls for this third phase „impact assessment“ include:

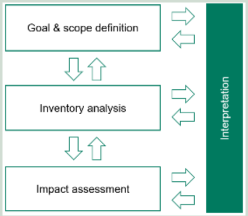
- **Submission of incorrect PCF values**: either very low or extremely high PCF values are being submitted, potentially due to using the wrong units (kg CO2e/t Product instead of kgCO2e/kg Product)
- **Application of incorrect CO2 emission factors for electricity and steam:** regarding the emission factors used, it is important to keep in mind that the upstream value chain must be included in those (instead of using only the market-based equivalent factors from the utility company)
- **Biogenic emissions:** further explanations are needed for calculating PCFs including / excluding biogenic CO2 emissions and removals. If your product is based on biomass, please separately report the PCF including biogenic emissions and removals, by considering the CO2 assimilation (CO2 removal) and any biogenic emissions.

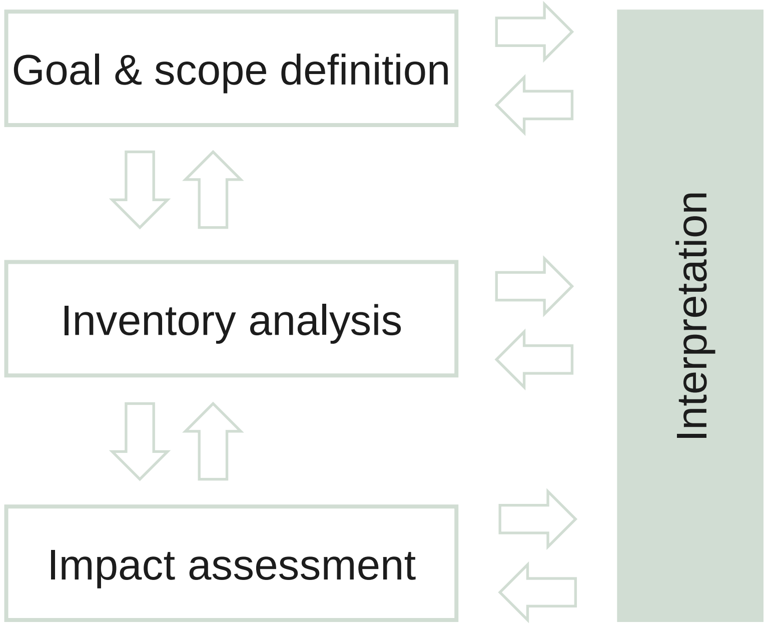
PCF Phase 4: Interpretation





Interpretation of the results as the final step of PCF



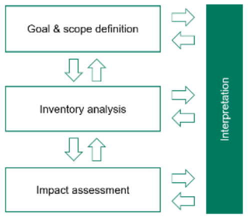


Interpretation includes:

- **Identification of the significant issues** based on the results of Inventory Analysis and the Impact Assessment phases
- An **evaluation** that considers **completeness, sensitivity** and **consistency checks**
- **Conclusions, limitations**, and **recommendations**

Interpretation may prompt iteration of the assessment

Lessons learned: Interpretation



Based on the data received from suppliers so far, some common pitfalls for this last phase „interpretation“ include:

Critical Review:

- It should become evident from the critical review statement that it refers to the product in question and it should refer to ISO 14067 or another **product-based calculation standard**, not a corporate standard.
- If suppliers have a critical review/PCF report, please upload them to the PCF data platform.
- **We recommend a critical review of your PCF calculation by a third party**.

Exercise

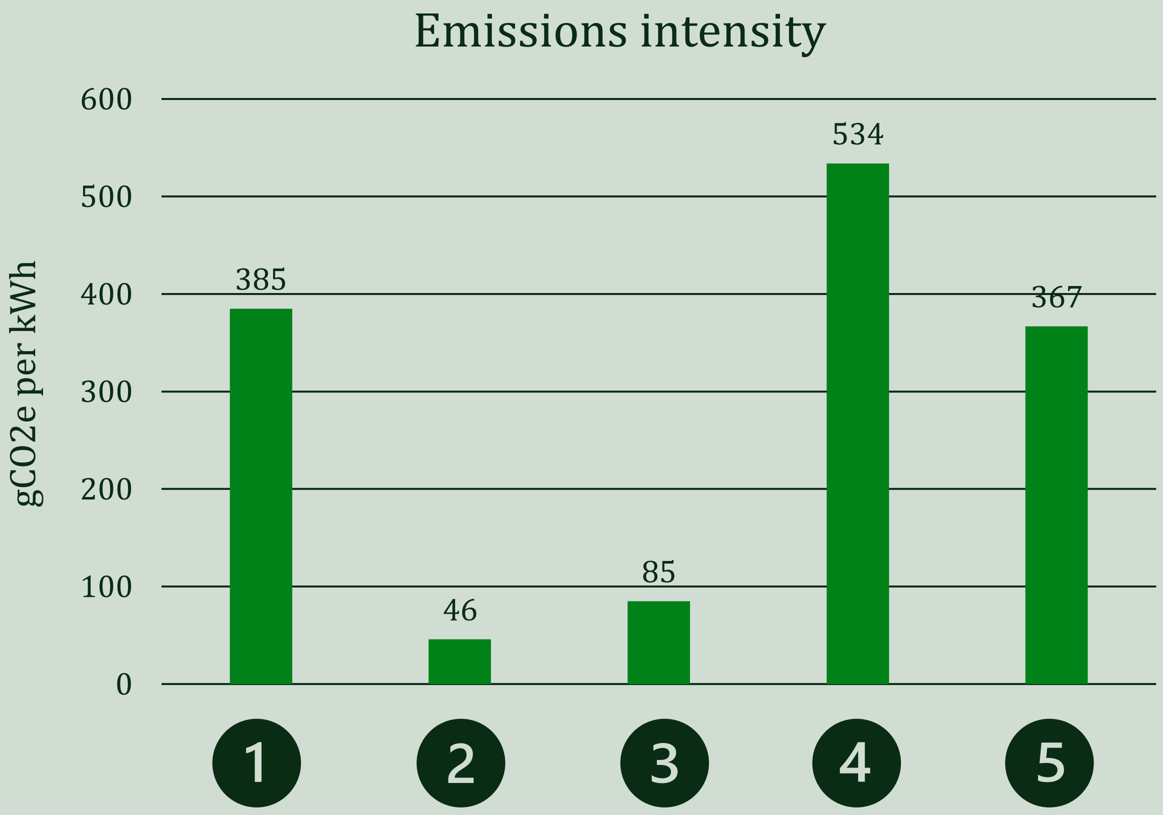
Exercise 2: Carbon footprint of national electric grids

Which of the bars (numbers 1-5) represents the power mix for the following countries:

- China
- Germany
- Switzerland
- US
- France

And why?

Type your answer in the Zoom chat.



Source: Ember

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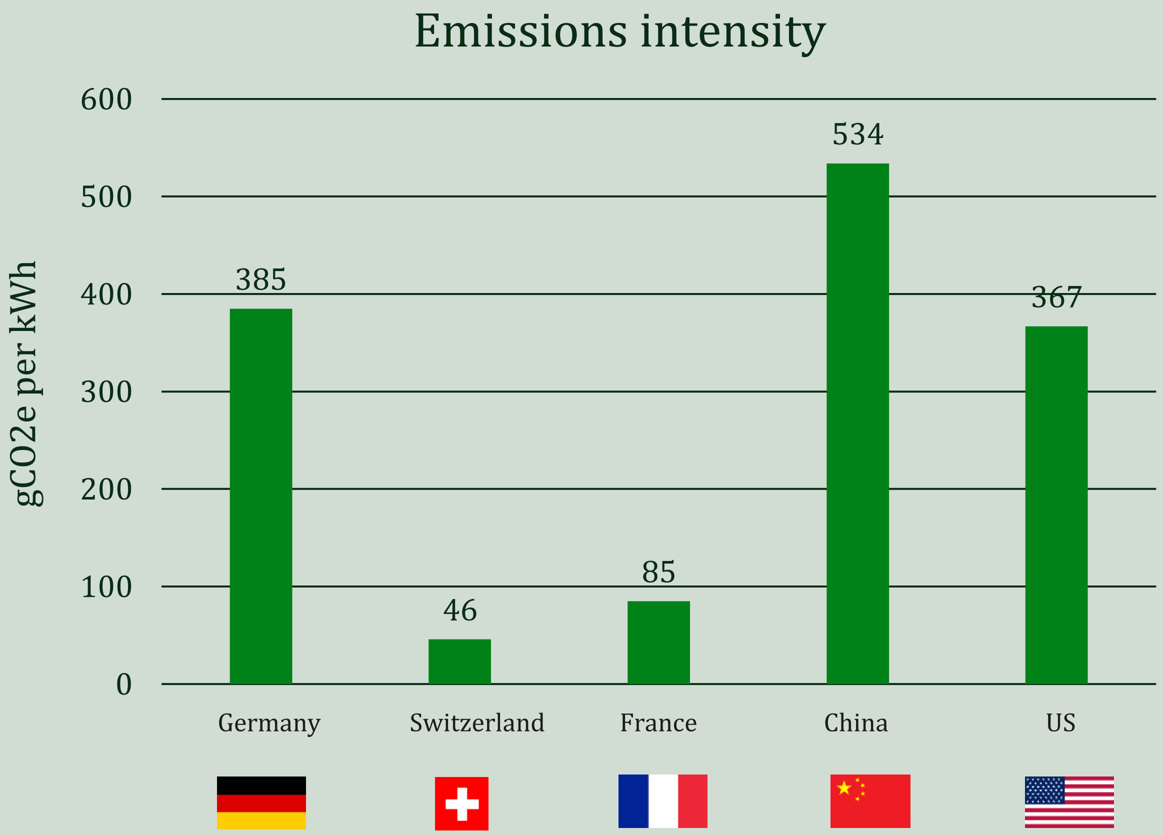

Source: Ember

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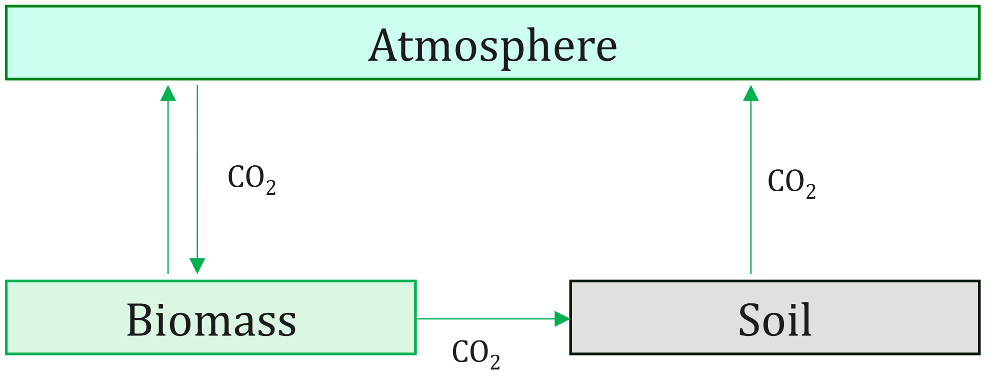
Background: Important Definitions & The Biogenic Carbon Cycle

Definitions

- **Biomass**: material of biological origin, e.g., trees, crops, grasses, tree litter, algae, animals, manure.
- **Biogenic carbon content**: Fraction of carbon derived from biomass in a product.
- **Biogenic emissions**: e.g., CO_2-emissions from combustion or biodegradation of biomass (other biogenic emissions include e.g. CH_4 from enteric fermentation or N_2O from bio-based fertilizers).
- **Biogenic sequestration**: Sequestration/removal/uptake of CO_2 from the atmosphere (i.e., CO_2 absorption by biogenic materials during photosynthesis).

Biogenic carbon cycle

- **CO_2 is absorbed** from the atmosphere during **photosynthesis** (plants use sunlight to convert CO_2 and water into carbohydrates and oxygen, **storing carbon** as carbo-hydrates). This is a **unique** feature of **biomass** and **reduces CO_2** in the atmosphere.
- Biomass, and embiodied **biogenic carbon**, can be **transformed into products**, representing a **CO_2 removal** as long as it is kept out of the atmosphere.
- **Biogenic carbon can be released** through cellular respiration, animal ventilation or burning of plants / bio-based products (e.g., as biogenic CO_2 or biogenic CH_4).
- Biogenic carbon is **stored over a shorter time** (<1-500 yrs) than fossil carbon (>10,000-millions of yrs), nevertheless **biogenic and fossil emissions** have the **same effect when released** to the atmosphere.



Use of biogenic carbon in the chemical industry & its accounting

Different PCF standards have different accounting requirements for biogenic carbon

Application in the chemical industry

- The chemical industry uses **biogenic carbon** from **bio-based materials** to reduce the Product Carbon Footprint of products.
- The benefit of products using bio-based materials is that they **contain biogenic carbon from CO_2 removed from the atmosphere** which is **stored in these products** until it is released back into the atmosphere (e.g., at end of life through incineration or biodegradation).
- **This benefit** of removing and keeping CO_2 from/out of the atmosphere **shall be considered in PCF** calculations.

Accounting of biogenic carbon (uptake and emissions) in PCF

ISO 14067 and Together for Sustainability (TfS)*

- **Consider biogenic CO_2 removals** when entering the product system as „negative emissions“ and **biogenic emissions** (e.g., if generated at the End of Life stage as „positive emissions“).
- This allows **accounting for the benefit of biogenic carbon** materials in the respective product lifecycle.

EC Product Enfironmental Footprint (PEF 2021)

- **Does not consider biogenic CO_2** emissions nor **CO_2 removals** but considers them as neutral.
- Does consider **biogenic CH_4** emissions.

* TfS requirements are aligned to ISO 14067. The GHG Protocol Product Standard, as ISO 14067, also considers biogenic CO_2 removals and emissions.

Accounting of biogenic CO_2 according to ISO 14067 and TfS

Counting both, biogenic CO_2 uptake and emissions using the -1/+1 method

Using the "-1/+1" method

- The following **emissions and removals shall be included** in the PCF
    - Biogenic **CO_2 uptake** during biomass growth (CO_2 removal)
    - All **biogenic emissions** (e.g., CH_4 from manure application)
    - **Further emissions** from relevant processes, such as cultivation, production and harvesting of biomass
- The following **indicators shall be reported / reflected**
    - **Total carbon content & biogenic carbon content*** in products
    - **Fossil and biogenic GHG emissions**
    - **Biogenic GHG removals** (CO_2 uptake during biomass growth)

Report two PCF values as required in ISO 14067

a) PCF (**including** biogenic CO_2 removal)

b) PCF (**excluding** biogenic CO_2 removal)

The **difference in emissions** between a) and b) is the **net carbon uptake** (carbon stored in the product given by the carbon content in the product's molecule).

*If the mass of biogenic carbon containing materials in the product is less than 5% of the mass of the product, the declaration of biogenic carbon content may be omitted

Global Warming Potential

Global Warming Potential of different Greenhous Gases

- All **Greenhouse Gases** (e.g., CO_2, CH_4 and N_2O) have **varying lifetimes and potencies** that define their impact on the climate beyond their pure "mass" (e.g., kg of CH_4 emitted into the atmosphere).
- Each GHG has a **global warming potential** (GWP) - its **relative potency as an agent of climate change** compared to CO_2 over a specified time interval.
- Non-CO_2 emissions or a sum of multiple GHG emissions are often expressed in **carbon dioxide equivalents (CO_2e),** which is calculated by multiplying the mass of a non-CO_2 GHG by its GWP (CO_2e expresses the **amount of carbon dioxide that would have the same climate impact** over a specified time horizon. If the time horizon is not specified, it is usually 100 years).
- This enables **comparison** of the climate impact of various greenhouse gases.

GWP values are provided by the **Intergovernmental Panel on Climate Change (IPCC).** The table below shows the 100-year values of the IPCC's Sixth Assessment Report (AR6; published in 2023). TfS advises to use these GWP values.

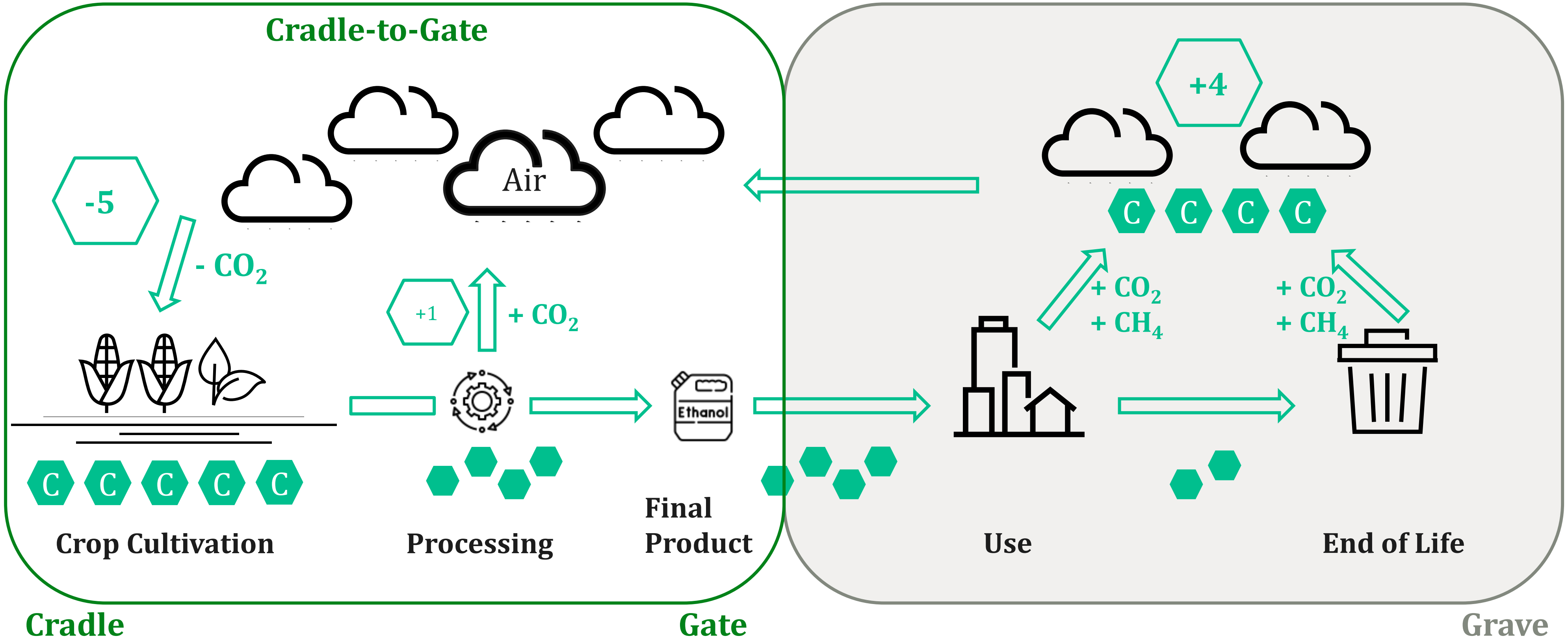
GHG	CO_2	CH_4 – non fossil	CH_4 – fossil	N_2O	NF_3	SF_6
GWP AR6	1	27	29.8	273	17,400	24,300

Source: IPCC - Chapter 7: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity | Climate Change: The Physical Science Basis (Section7.6.1.1, Table 7.15)

Accounting of biogenic CO_2 according to ISO 14067

Counting both, biogenic uptake and biogenic emissions using the -1/+1 method

-1/+1 approach of considering biogenic carbon



- BASF suppliers must deliver **cradle-to-gate PCFs** (left part of the figure).
- Where the emissions occur, and which ones, **depends on the type of bio-material and the market.**
- Right part of the figure (gate-to-grave) shows the **downstream life cycle stages** (no BASF suppliers' operations).
- The "**-1/+1-balance**" refers to the **carbon content.**

Cradle-to-Gate Biogenic Carbon Uptake: **-5+1 = -4**

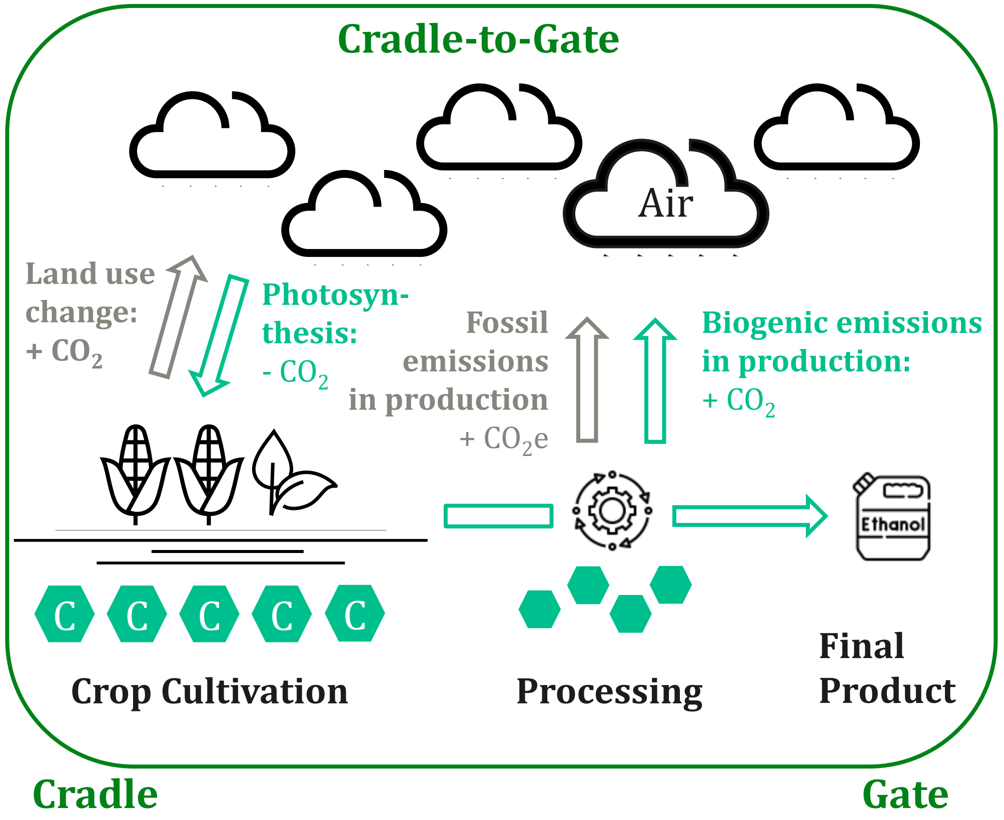
Gate-to-Grave Biogenic Carbon Release: **+4**

- e.g., if studying ethanol being used as a fuel, the emissions occur during combustion in the use phase
- e.g., if studying a bioplastic, the emissions will occur at EoL

Accounting of biogenic CO_2 according to ISO 14067

How biogenic uptake and emissions are accounted for in a cradle-to-gate PCF will be explained using the example of ethanol production

-1/+1 approach of considering biogenic CO_2



Crop cultivation:

- CO_2 is absorbed via **photosynthesis during crop growth** (e.g., starches such as corn and sugars such as sugar cane).
- Emissions occur due to land use and **land use change** (e.g., conversion of a forest into agricultural land).

Processing / production of ethanol

- **Biogenic CO_2 emissions** are released during the production (e.g., fermentation of starches and sugars)
- **Fossil emissions** are released, e.g., by consuming electricity and fuels

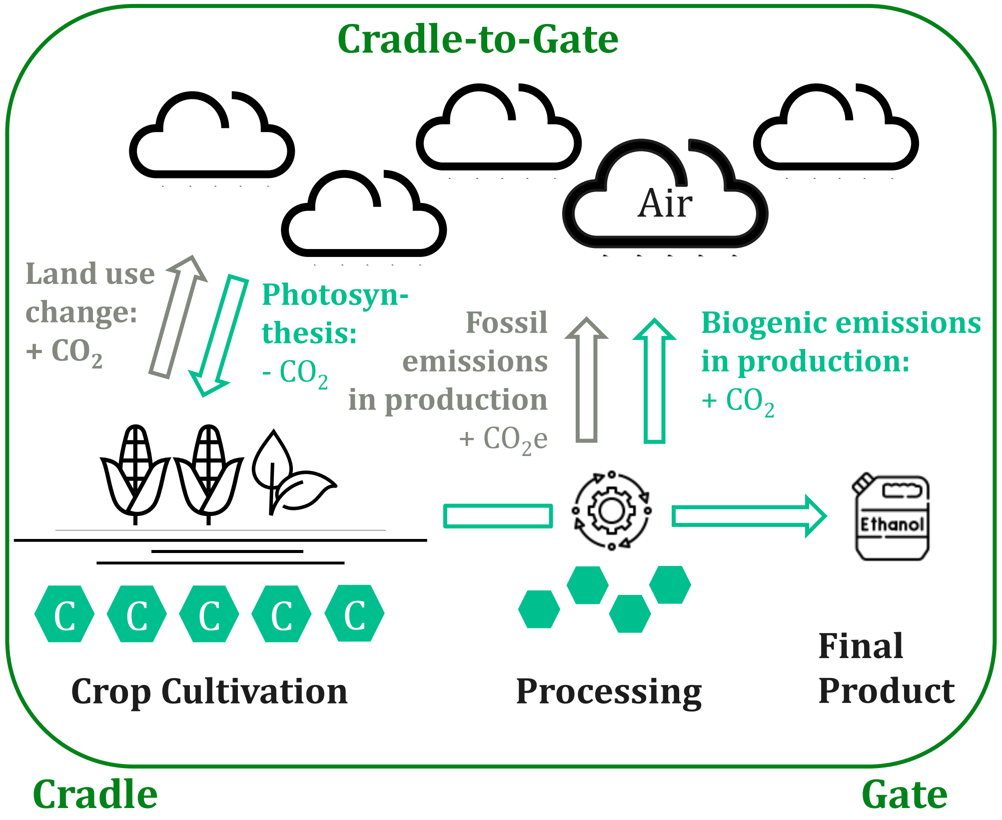
Final product: Ethanol (C_2H_6O)

- As an **organic substance**, ethanol (C_2H_6O) **stores carbon**, **two atoms** per molecule.
- The amount of the **initial carbon uptake must be corrected** as the carbon uptake must account for the **biogenic emissions released during production** of ethanol (e.g., carbon stored in the corn plant that is not transformed into ethanol).
- This "**carbon uptake correction**" must be done so that the **net carbon uptake** (difference betw. the PCF result incl. biogenic CO_2 removal & the one excl. biogenic CO_2 removal) **equals** the amount of **carbon stored in the product** given by the **carbon content** in the **product's molecule.**

Accounting of biogenic CO_2 according to ISO 14067 – Example (1/4)

How biogenic uptake and emissions are accounted for in a cradle-to-gate PCF will be explained using the simplified example of ethanol production

-1/+1 approach of considering biogenic CO_2



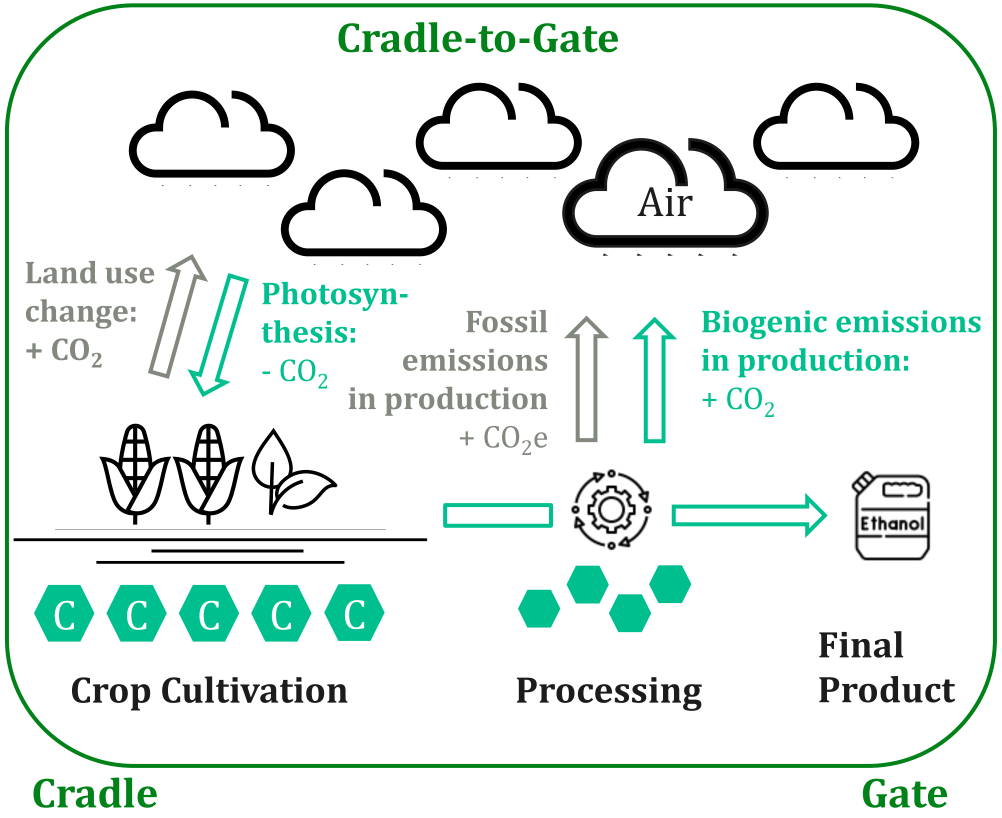
Reporting PCF results with biogenic materials per 1kg of ethanol (C_2H_6O)

Indicator	Unit per kg ethanol	ISO 14067, TfS	Calculation / Source
A) Biogenic carbon in products	kg biogenic C	0.522	Values are either calculated or retreived from a background LCI database (secondary data) Details will be explained on the following slides
B) Equivalent biogenic carbon removal in product	kg CO_2	-1.91	
C) Equivalent biogenic carbon overall removal	kg CO_2	-2.31	
D) Emissions, land use and direct land use change	kg CO_2e	0.2	
E) Of that is direct land use change	kg CO_2e	0.1	
F) Emissions, biogenic	kg CO_2e	0.4	
G) Emissions, fossil	kg CO_2e	2.0	
H) Cradle-to-gate emissions	kg CO_2e	= -2.31 + 0.2 + 0.4 + 2 = **0.29**	

Accounting of biogenic CO_2 according to ISO 14067 – Example (2/4)

A) Biogenic carbon content in ethanol and B) equivalent biogenic carbon removal

-1/+1 approach of considering biogenic CO_2



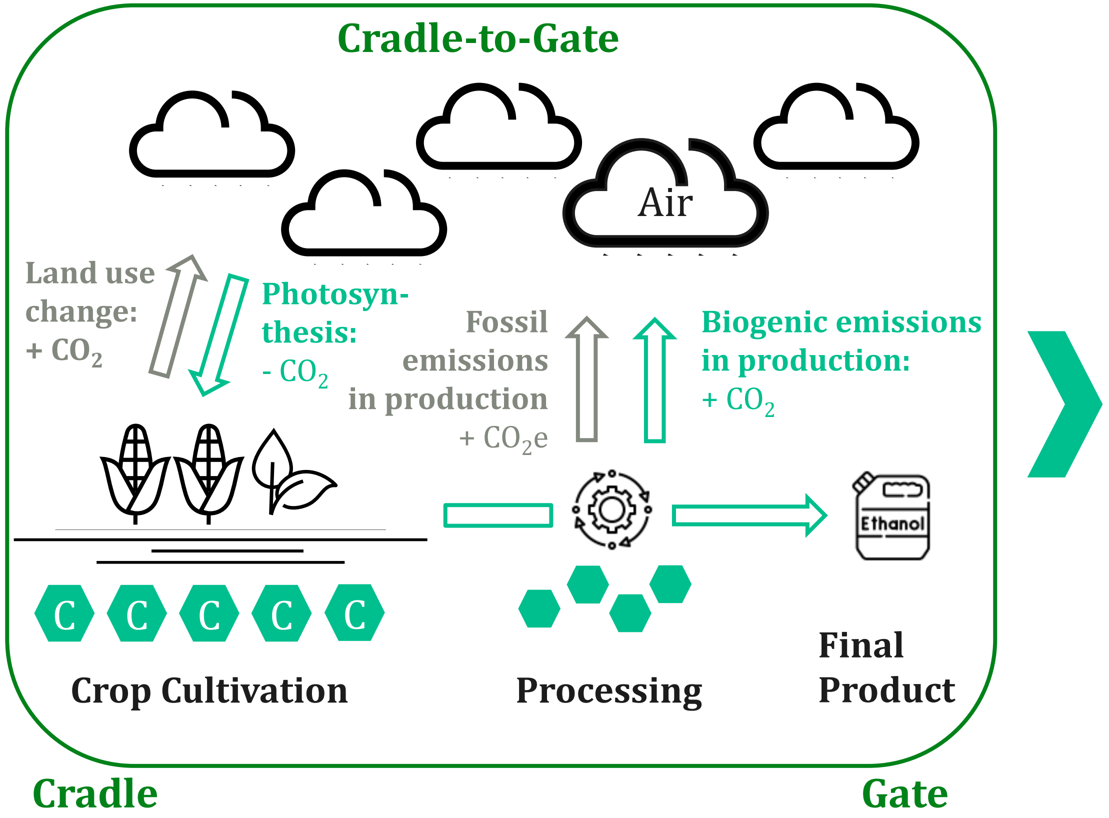
Reporting PCF results with biogenic materials per 1kg of ethanol (C_2H_6O)

Indicator	ISO 14067, TfS	Formula & Calculation
A) Biogenic carbon in product in *kg biogenic C (per kg of ethanol)*	0.522	Calculating the carbon content in ethanol using the number of C atoms in ethanol and molecular weights: $\frac{\text{(\# carbon atoms in ethanol} * \text{molecular weight of carbon)}}{\text{molecular weight of ethanol}} =$ $\frac{(2*12)}{46} = 52.17\%$ → 1kg ethanol contains **0.522 kg carbon** (100% of the carbon is biogenic)
B) Equiv. biogenic carbon removal in product in *kg CO_2 (per kg of ethanol)*	-1.91	Converting carbon from A) into CO_2 using atomic mass units: $\frac{amu_{CO2}}{amu_{carbon}} * 0.522kg = \frac{44}{12} * 0.521kg = 1.91kg\ CO_2$ → Per kg of ethanol, **1.91kg of biogenic CO_2** are removed from the atmosphere (removal is expressed as negative)

Accounting of biogenic CO_2 according to ISO 14067 – Example (3/4)

C) Equivalent biogenic carbon overall removal

-1/+1 approach of considering biogenic CO_2



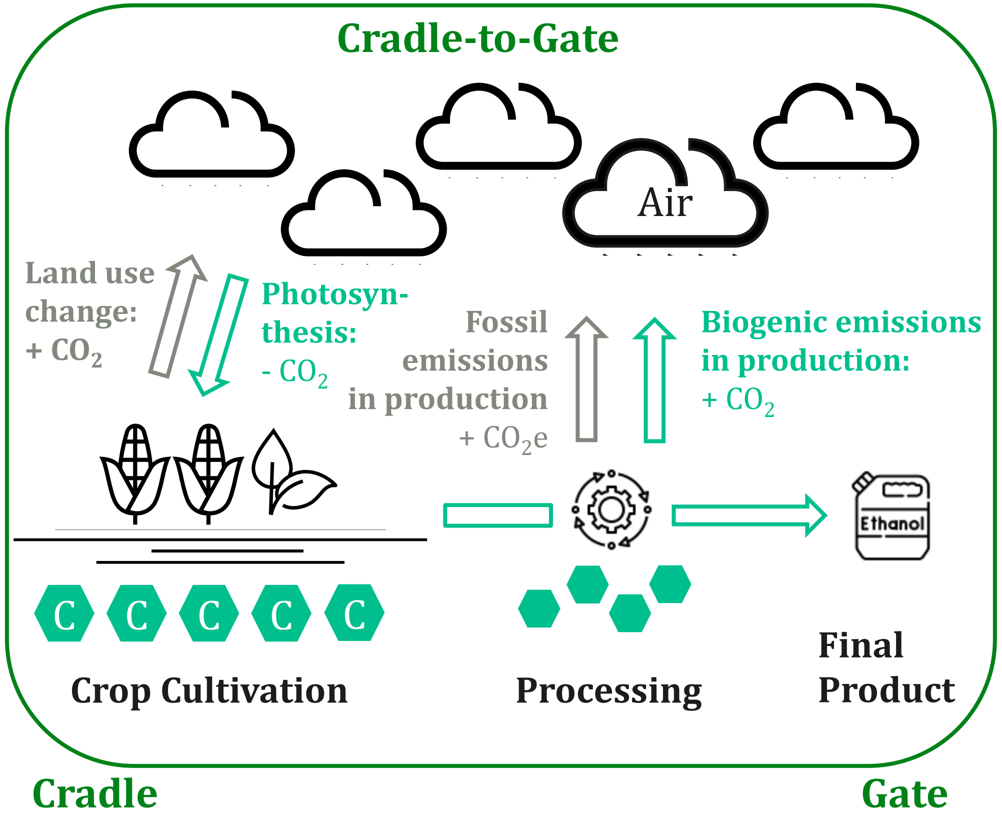
Reporting PCF results with biogenic materials per 1kg of ethanol (C_2H_6O)

Indicator	ISO 14067, TfS	Formula & Calculation
C) Equiv. biogenic carbon overall removal in *kg CO_2 (per kg of ethanol)*	-2.31	**Sum of B (-1.91kg) and additional CO_2 uptake** corresponding to biogenic CO_2 emissions released in production **("carbon correction"):** **Biogenic CO_2 emissions per kg ethanol: 0.4kg CO_2e** (retreived from a background database) → Per kg of ethanol, an additional **0.4kg of biogenic CO_2** are removed from the atmosphere In sum, that is a **total biogenic CO_2 uptake** of: B + C = -1.91 – 0.4 = **-2.31 kg CO_2**
D) Emissions, land use and direct land use change in *kg CO_2e (per kg of ethanol)*	0.2	Secondary data retreived from a background database

Accounting of biogenic CO_2 according to ISO 14067 – Example (4/4)

D & E) Land use (change) emissions, F) Biogenic emissions, G) Fossil Emissions and H) Overall Emissions

-1/+1 approach of considering biogenic CO_2



Reporting PCF results with biogenic materials per 1kg of ethanol (C_2H_6O)

Indicator	ISO 14067, TfS	Formula & Calculation
E) Of that is direct land use change in *kg CO_2e* *(per kg of ethanol)*	0.1	The fraction of emissions from D that are due to direct land use change. Secondary data retreived from a background database
F) Emissions, biogenic in *kg CO_2e* *(per kg of ethanol)*	0.4	Value of biogenic emissions in C: **0.4kg CO_2e** Secondary data retreived from a background database
G) Emissions, fossil in *kg CO_2e* *(per kg of ethanol)*	2.0	Secondary data retreived from a background database
H) Cradle-to-gate emissions in *kg CO_2e* *(per kg of ethanol)*	0.29	C + D + F + G = Overall biogenic CO_2 removal + LUC emissions + biogenic emissions + fossil emissions = -2.31 + 0.2 + 0.4 + 2 = **0.29kg CO_2e**

Accounting of biogenic CO_2 according to ISO 14067
Summary & Lessons Learned

- The **amount of CO_2-uptake stored in products** containing bio-based materials **shall be accounted for** in cradle-to-gate Product Carbon Fooprints, specifically as **„negative emissions“** as the CO_2-uptake **represents a removal of CO_2 from the atmosphere** (for as long as it is stored in the respective product). This is required **by ISO 14067** and by **TfS**, which is aligned to ISO 14067.
- The **total CO_2-uptake** from the atmosphere per kg of material is **calculated based on the sum** of:
  1. **CO_2 based on the amount of C-atoms** in the material (then deriving CO_2 based on molecular weights and atomic mass units)
  2. **CO_2 based on the biogenic CO_2 emissions during the production** of the material
- The **net CO_2-uptake*** is equal to the amount of carbon stored based on the # of C-atoms per molecule.
- **Other indicators** to be reported can be retreived from **background databases** used (e.g., land use and land use change emissions, fossil emissions)

*** Net CO_2-uptake:** The difference between the PCF result incl. biogenic CO_2 removal & the PCF result excl. biogenic CO_2 removal

Contents

Q&A and next steps

?

In case you have **questions before/during/after your PCF calculation**, please do not hesitate to get in touch with **supplier-carbon-footprint@basf.com**

Thank you

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