Certification Scheme

Ammonia Origin &
Carbon Footprint Calculation

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History of Changes

Document Version	Date	Description of changes

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Ammonia Europe
Avenue des Nerviens 31
B-1040 Brussels | Belgium

Contact
info@ammoniaeurope.com
www.ammoniaeurope.com

Transparency Register
255318194242-02

Definition of Terms

Table 1: Definition of Terms

Term	Definition
(Production) Batch	Ammonia output from a production plant between two defined points in time
Carbon Footprint (CFP)	Sum of GHG emissions and GHG removals in a product system, expressed as CO2equivalents and based on a life cycle assessment using the single impact category of climate change
Carbon Capture and Storage (CCS)	Capture of carbon dioxide (CO2) from industrial installations, its transport to a storage site and its injection into a suitable underground geological formation for the purposes of permanent storage
Carbon Capture and Utilization (CCU)	Range of applications through which CO2 is captured and used either directly (i.e., not chemically altered) or indirectly (i.e., transformed) into various products
(Product) Certificates	Digital documents issued at time of production for each tonne of product having environmental attributes that are intended to be disclosed
Consignment	Lot of product in the supply chain having a given set of attributes
Core energy input	Energy input from which the energy content of the ammonia derives
Emission factor	Sum of GHG emissions and GHG removals, considering all the processes in the product system associated to the supply of the input from extraction of raw materials to delivery to the input gate of the hydrogen and / or ammonia production device, as well as oxidation of the carbon of which it is composed (if applicable), expressed in mass of CO2e per unit amount of input
Guarantee of Origin (GO)	Certificate issued to show to a final customer that a given share or quantity of energy was produced from a specified primary energy source
Origin	Primary energy source from which the energy content of the ammonia originates
Residual mix	The mix of primary energy sources and other attributes of the energy supplied in a Domain in a given period of time, excluding energy for which certificates were cancelled, and excluding energy covered by other means of explicit tracking
Well-to-gate CFP	Partial carbon footprint of a product considering all the processes in the product system from extraction of raw materials *until* the point where the product is made available for transport and supply to users
Well-to-supply-gate CFP	Partial carbon footprint of a product considering all the processes in the product system from extraction of raw materials to the transport to the user of ammonia up to the supply of ammonia to the user

1 Introduction

This Ammonia Europe Certification Scheme document provides requirements and specific guidance for determining the share of ammonia output from a specific energy origin and for quantifying its carbon footprint in line with ISO 14067.

2 Determination of the Origin of Ammonia

2.1 Core energy inputs

The origin of ammonia identifies the primary energy source from which energy content of the ammonia originates. Its identification is based on the concept of core energy input which is energy input in the production process that contributes to the energy content of the ammonia product as reflected by its lower heating value (LHV). Since hydrogen is the only core energy input in the synthesis of ammonia, the origin of ammonia is the origin of the hydrogen input to the ammonia production process. The origin of the hydrogen is the energy source of core energy input to the production process of the hydrogen used.

Energy consumption that does not contribute to the energy content of ammonia, such as for example energy used for compression, does not contribute to defining the origin of ammonia.

When ammonia is produced by co-processing hydrogen produced from more than one core energy input, a share of ammonia output is assigned to each corresponding primary energy source. The share of ammonia from a given energy source is considered to be the share of hydrogen from that energy source in total hydrogen input, as shown in Figure *1*.

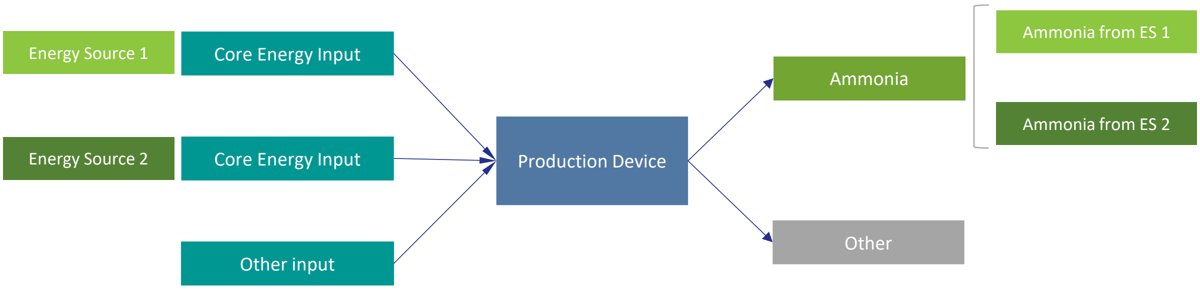


Figure 1: Origin based on primary energy source of core energy inputs

Other inputs are inputs not contributing to the energy content of the ammonia as reflected by its LHV, such as electricity for compression.

Ammonia is considered renewable if its assigned primary energy source is wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas.

Ammonia production using hydrogen from different energy sources within the timeframe defining a production batch results in that batch including a corresponding proportion of ammonia from each of these energy sources.

2.2 Claiming the renewable origin of core energy inputs

The renewable origin of grid electricity shall be established by cancelling Guarantees of Origin.

The renewable origin of gas from the grid, shall be established by cancelling Guarantees of Origin or alternatively based on a Declaration of Sustainability from the supplier under a certification scheme approved either by the European Commission or by an EU Member State.

The renewable origin of hydrogen shall be established by cancelling Guarantees of Origin, non-governmental product certificates in countries where guarantees of origin are not issued, or alternatively on the basis of a Declaration of Sustainability from the supplier under certification scheme approved either by the European Commission or an EU Member State.

3 Calculation of the Carbon Footprint of Ammonia

3.1 General calculation approach

The calculation of the Carbon Footprint of ammonia shall follow the methodology defined by standard ISO 14067 *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification*.

The carbon footprint is the sum of greenhouse gas (GHG) emissions and GHG removals across the considered lifecycle scope per unit amount of product, expressed as CO_2 equivalents (CO_2e).

It is calculated by dividing the net sum of GHG emissions across the considered lifecycle scope for the amount of ammonia produced in the assessed period by that amount of product.

$$CFP = \frac{E}{N}$$

CFP carbon footprint of ammonia (t CO_2e/t),

E lifecycle GHG emissions for the amount of ammonia produced in the assessed period (t CO_2e),

N amount of ammonia produced (t),

The greenhouse gas emissions to be considered are CO_2, as well as methane and nitrous oxide (N_2O), applying the following CO_2 equivalence factors for a 100-year time horizon:

Methane: 28,

Nitrous oxide: 265,

as established in the Sixth Assessment Report by the Intergovernmental Panel on Climate Change[1].

3.2 Carbon footprint scope

The Ammonia Production Certificate discloses the well-to-gate footprint of the ammonia, covering the emissions occurring from the extraction of the raw materials up to the ammonia production plant gate.

The Attribute Disclosure Statement provided with certified ammonia in the ammonia supply chain may optionally show the ammonia's footprint at the point at which it is supplied, i.e., the well-to-supply-gate footprint, adding estimated emissions from transport to the well-to-gate footprint (see scheme document on chain of custody requirements).

The above two scopes are depicted in Figure 2 below.

[1] Intergovernmental Panel on Climate Change: *Fifth Assessment Report*; 2014.

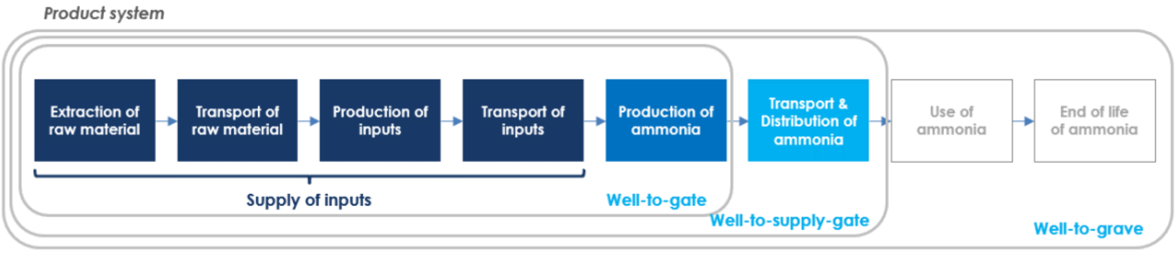


Figure 2: Scope of carbon footprint calculation

In the case of generation of waste, the emissions from its disposal, including processing and transport, must be included as well.

Emissions from the construction of assets in the product system are excluded.

3.3 Quantification of lifecycle emissions

The lifecycle emissions in the assessed period are quantified by adding up the emissions from the various segments of the supply chain:

$$E = e_{input} + e_{process} + e_{transport} - e_{CCS}$$

where

e_{input} emissions from supply of inputs (t CO_2e), i.e. the well to supply gate emissions related to the inputs

$e_{process}$ emissions from the production of ammonia from the above inputs (t CO_2e),

$e_{transport}$ emissions from transport and distribution (up to the production gate of ammonia) (t CO_2e),

e_{CCS} emission savings from carbon capture and long-term geological storage (t CO_2e).

Possible GHG emissions from use of the ammonia (such as emissions of nitrous oxide) are not included since these take place beyond the point of supply.

Since ammonia production requires the carbon contained in the inputs for ammonia production to be oxidized, emissions from supply of inputs and their processing may be quantified in a single step by considering the Emission Factor of the inputs multiplied by input quantity.

Non-CO_2 GHG emissions from the ammonia production process (such as methane emissions as a result of methane slip or methanation in the secondary reformer) need to be quantified (in CO_2 equivalent emissions) and added to the calculation.

The carbon footprint of the ammonia may be quantified applying either one of the following approaches, depending on the input considered:

1) Considering activity data over a period duration of one, two, or three consecutive calendar years, and applying the resulting footprint to all the ammonia produced in the subsequent calendar year. Shutdown period for plant turnaround may be excluded, considering the activity data over two (or three) consecutive calendar years if the shutdown duration exceeds 6 months.
2) Considering activity data and input data for an individual production batch for calculating the footprint of ammonia of that batch.

The second approach needs to be applied for inputs such as electricity and gas when the latter's assigned origin and footprint are dependent on the use of certificates, in order to be able create batches of product with a specific footprint in accordance with amount of input covered by certificates and the attributes assigned to this input. The second approach also needs to be applied when there is a factor generating variations in the footprint of the ammonia product over time (for instance in relation to CCS or CCU) so that the ammonia may be assigned the corresponding footprint.

Upon start-up of a new plant, or following a modification of the production process, a CFP may be assigned to the product based on initial operational data, in conjunction with an on-site audit. This CFP should be updated after 6 months based on data collected over the first months.

Both approaches above allow to assign a specific footprint based on energy origin (renewable, low carbon, other) as defined in section 2 to ammonia within a batch of any size. Product with a specific origin and footprint within a batch constitutes a consignment which remains identified as such in the supply chain thanks to mass balance.

3.4 CFP calculation in function of production configurations

Calculation methods are described below in function of increasing complexity in terms of number of co-products and energy sources of core energy inputs.

In all cases below, non-CO_2 GHG emissions from the ammonia production process (such as methane emissions as a result of methane slip or methanation in the secondary reformer) need to be quantified (in CO_2 equivalent emissions) and added to the calculation.

3.5 Ammonia from a single core energy source

When ammonia is produced as a single product (no plant by-products such as steam) with the hydrogen all produced from the same primary energy source the ammonia footprint can be calculated as indicated in Figure 3 below.

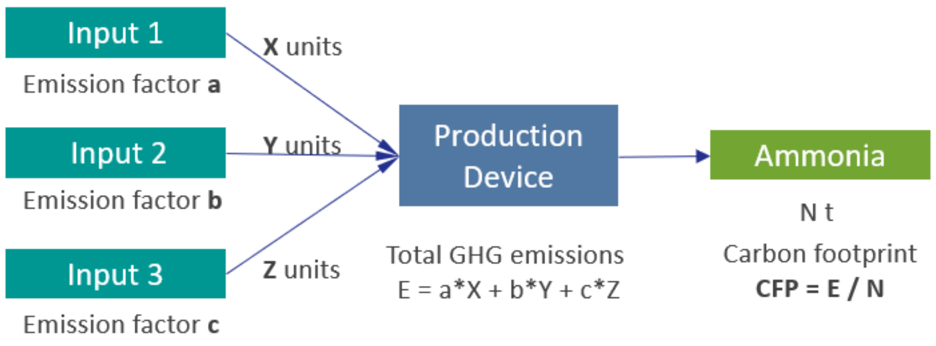
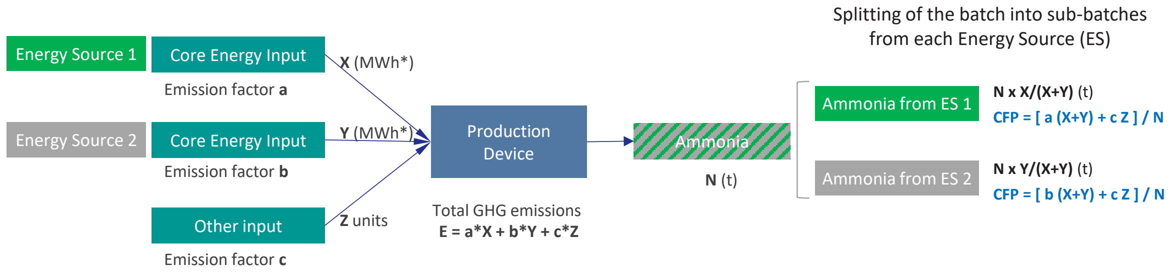


Figure 3: Calculation of the carbon footprint of ammonia from a single core energy source

3.6 Ammonia from multiple core energy sources

When ammonia is produced using hydrogen generated from multiple core energy sources, the quantity of ammonia considered to be produced from each core energy source and its corresponding carbon footprint shall be calculated as shown in Figure 4.



For this calculation the amount of core energy input needs to be expressed as an amount of energy, e.g. MWh

Figure 4: Quantity and carbon footprint of ammonia produced from multiple core energy sources

In above figure, amount of ammonia from energy source 1 (ES 1) is calculated as:

$$N_1 = N \times X/(X+Y)$$

Where:

N_1 amount of ammonia produced from ES 1
N total amount of ammonia produced
X amount of core energy input for ES 1
Y amount of core energy input for ES 2

Carbon footprint assigned to NH_3 from ES 1 is calculated as emissions assigned to ammonia from ES 1 divided by quantity of ammonia from ES 1:

$$CFP_1 = \left[a\,X + \frac{X}{X+Y} c\,Z\right] / N_1$$

$$CFP_1 = \left[a\,X + \frac{X}{X+Y}\, c\,Z\right] / [N\, \frac{X}{X+Y}]$$

$$CFP_1 = [a\,(X+Y) + c\,Z]\,/\,N$$

Amount of NH_3 from ES 2 is calculated by:

$$N_2 = N \times Y/(X+Y)$$

Where:

N_2 amount of ammonia produced from ES 2

Similarly, as for the carbon footprint assigned to ammonia from ES 1, the carbon footprint assigned to ammonia from ES 2 is:

$$CFP_2 = \left[b\,Y + \frac{Y}{(X+Y)}c\,Z\right]/N_2$$

$$CFP_2 = [b\,(X+Y) + c\,Z]/N$$

3.7 Allocation of emissions to multiple co-products

This section covers the case of co-production of multiple co-products of a production process. In the production of ammonia, this concerns production of ammonia along with at least one other co-product such as steam.

The share of emissions assigned to co-products is determined as described below, in application of ISO 14067[2].

First, the production process needs to be subdivided into sub-processes, to identify which inputs and intermediate products contribute to defining the attributes of co-products. Attributes of products must be determined in accordance with the attributes of relevant inputs. These sub-processes may have either single or multiple outputs.

After subdivision, relevant emissions related to the considered subprocess need to be divided between useful outputs of said subprocess, in a procedure called allocation. Relevant emissions are those of inputs at the input gate of the subprocess as well as the subprocess own process emissions. In the case of multiple subprocesses, allocation shall start with subprocesses that are most upstream.

Emissions shall be distributed between coproducts based on how the upstream and process emissions change when the quantity of just one product output is changed, i.e., keeping the quantities of all the other product outputs constant.

When steam generated from process heat is exported to another process, net steam enthalpy use shall be allocated a carbon footprint per MJ equal to:

[2] ISO 14067:2018(en), *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification*; August 2018.

- the footprint of steam from a natural gas fired boiler assuming 90% efficiency if the steam export avoids production of such steam
- the average emission factor of the feedstock and fuel gas (typically natural gas) used to produce the ammonia otherwise.

The emissions allocated to the ammonia are reduced by the emissions allocated to the exported steam.

3.8 Allocation of emissions to steam in hybrid ammonia plants

This section describes the case of hybrid ammonia plants which co-produce natural gas based and electrolytic ammonia from hydrogen produced by natural gas steam reforming (SMR) and hydrogen produced by water electrolysis in a single integrated plant. The guidelines provided for assigning a footprint to the steam used are also applicable other steam use configurations.

For compression of the ammonia syngas, made up of hydrogen from both sources and nitrogen generated in the secondary reformer following injection of compressed air, high grade steam is typically transferred from the SMR (frontend) to the ammonia synthesis unit (backend). Also, medium grade steam from heat generated by the ammonia synthesis reaction is returned to the SMR or exported. A simplified process scheme is shown in Figure 5.

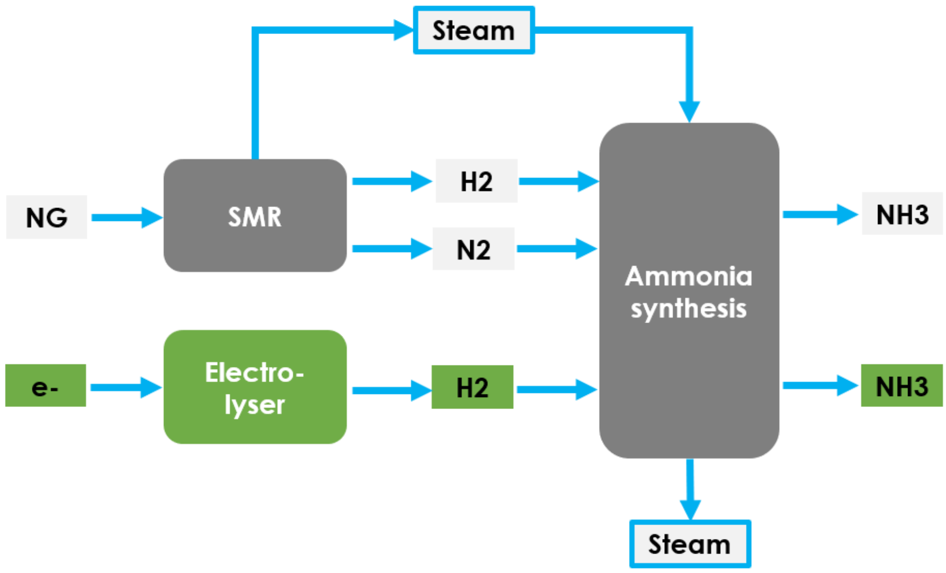


Figure 5: Simplified process scheme of a hybrid ammonia plant, highlighting steam energy flows

Regardless of the origin of the hydrogen, the footprint of the produced ammonia includes GHG emissions related to the energy used by the ammonia synthesis unit, of which net steam enthalpy consumed constitutes a major part.

The contribution of steam to the footprint of the ammonia produced, is determined (i) by the net consumption of steam enthalpy and (ii) the footprint assigned to steam energy entering and leaving the synthesis unit.

Quantification of the net consumption of steam enthalpy should, when possible, be performed by measuring overall steam input and output flows to and from the synthesis unit along with the relevant steam properties (pressure and temperature).

If this is too difficult or resource intensive the steam energy use may be calculated based on energy consumption measured directly or indirectly by other means.

A carbon footprint must be assigned to the steam supplied to and exported from the synthesis unit, as specified in section 3.7.

4 Carbon footprint of Inputs

4.1 Hydrogen

Hydrogen supplied from an external supplier must be certified and Hydrogen Production Certificates (similar to Guarantees of Origin) must be cancelled for the consumed quantity of hydrogen. The hydrogen production certificate specifies the carbon footprint of the hydrogen, which is to be applied in the calculation of the ammonia carbon footprint.

Hydrogen produced within an integrated production process in the ammonia production facility does not require the issuing of a hydrogen production certificate. In that case, a carbon footprint calculation methodology determined to be consistent with the methodology described in this document, such as the one put forward by Together for Sustainability or CertifHy[3] which addresses hydrogen specifically, should be applied to calculate the CFP of hydrogen.

4.2 Natural Gas and Biomethane

The carbon footprint of natural gas or biomethane shall be based on information from its supplier. If the supplier does not specify a Carbon footprint (CFP), economic operators may apply the applicable standard value listed in the Annex.

For claiming the renewable origin and low CFP of biomethane, a production certificate (e.g. GO) must be supplied equalling the consumed quantity of biomethane.

4.3 Electricity

The carbon footprint of electricity shall include lifecycle emissions from the electricity supply system and emissions occurring during generation, including any energy losses. If electricity is consumed through the grid, the use of renewable electricity and its corresponding low emission factor may be claimed through cancellation of electricity GOs, equivalent to the quantity of consumed electricity. The carbon footprint stated in the GO must be applied in the ammonia CFP calculation.

If GOs were issued for electricity consumed from power generation assets with which the production plant has a direct connection, these must be cancelled for the amount of electricity consumed.

Any electricity consumption that is not covered within the quantity of cancelled GO shall apply the Residual mix of the country for assigning of the CFP as well as for the determination of the origin.

4.4 Steam

The emissions assigned to steam used as an input should be consistent with allocation to the co-products of the process from which the steam originates, considering the steam as one of the co-products, see section 3.7.

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[3] CertifHy Scheme: *CertifHy-SD Hydrogen Criteria*; April 2022.

4.5 Other inputs

The carbon footprint of other inputs, that are not specifically mentioned above, shall be based on the CFP provided by the supplier of the product.

5 Carbon Capture Utilisation & Storage

This section describes how credit from the capture of carbon in ammonia production is assigned for utilization and storage of carbon. Additionally, the requirements for geological storage of carbon are laid out.

5.1 Allocation of credit for carbon capture and utilization

When CO_2 from the production of ammonia is captured for use in the production process of another product (CCU), the corresponding avoided CO_2 emissions in the ammonia production step may be assigned either to that other product (so called "-1/+1" allocation approach) or to the ammonia (so called "cut-off" allocation approach).

- In the "-1/+1" approach, the emissions avoidance is fully assigned to the used CO_2 , which is thus allocated a carbon footprint of -1 t CO_2e/t at the gate of the capture process; this offsets a later emission of that CO_2 (+1) when the CCU product is used.
- In the "cut-off" approach, the emissions avoidance is all assigned to the ammonia, and the CO_2 is as a result allocated a zero footprint at the gate of the capture process (as there is no impact of CCU on process emissions left to be allocated to the CO_2)

Further to the above allocation, the footprint assigned to the CO_2 also needs to account for the emissions from capturing (if not already part of the ammonia production process), conditioning, and transporting the CO_2.

In the case of ammonia production with CCU, the following provisions shall be applied:

- Product footprints shall be calculated according to both approaches;
- Ammonia product certificates shall indicate that the production process includes CCU and present the footprint values according to both methods, and indicate which approach was selected for assigning a footprint to the ammonia and its co-products, as detailed in the scheme document on handling of ammonia attributes in the supply chain;
- If the CO_2 is used within the same facility, the footprint of the product produced with the used CO_2 shall also be quantified under the facility's product footprint reporting system;
- The presentation of the calculations provided for certification shall include the reason for choosing the selected approach.

If the captured CO_2 is recombined with the ammonia from which it originates to produce a derivative such as urea, there is the option to consider that the latter is simply produced from the input used to produce the ammonia, e.g. natural gas, and that there is therefore no CCU.

5.2 Allocation of credit for full or partial carbon capture and storage

Carbon dioxide capture and geological storage (CCS) includes the capture of carbon dioxide from industrial installations, its transport to a storage site and its injection into a suitable underground geological formation for the purposes of permanent storage. Emissions related to these three steps of CCS must be accounted for when assigning a credit to co-products of a carbon capture process.

The credit for captured and stored carbon is assigned to the product(s) of the process at which carbon is captured. The captured carbon is credited to the product(s) by allocating a negative contribution to the CFP of the product(s) reflecting the quantity of permanently stored CO_2. Any emissions and losses occurring in the capture, conditioning, transport and storage of CO_2 must be taken into account for determining the net amount avoided GHG emissions from capture and storage. Furthermore, the requirements for geological storage of carbon dioxide, laid out in section 5.4, must be met.

Allocation of credit for CCS is illustrated with the example of ammonia from steam methane reforming (SMR) with CCS. Process CO_2 in the SMR step is captured and geologically stored. The CFP of ammonia receives a credit for net quantity of avoided GHG emissions from CO_2 capture and storage considering the amount of CO2 captured and injected into a CO2 transport infrastructure for geological storage, Q_{capt}, and the emissions from capture (if any beyond the capture process that is already part of ammonia production), conditioning, transport and storage of captured CO_2, E_{CCS} as shown in Figure 6.

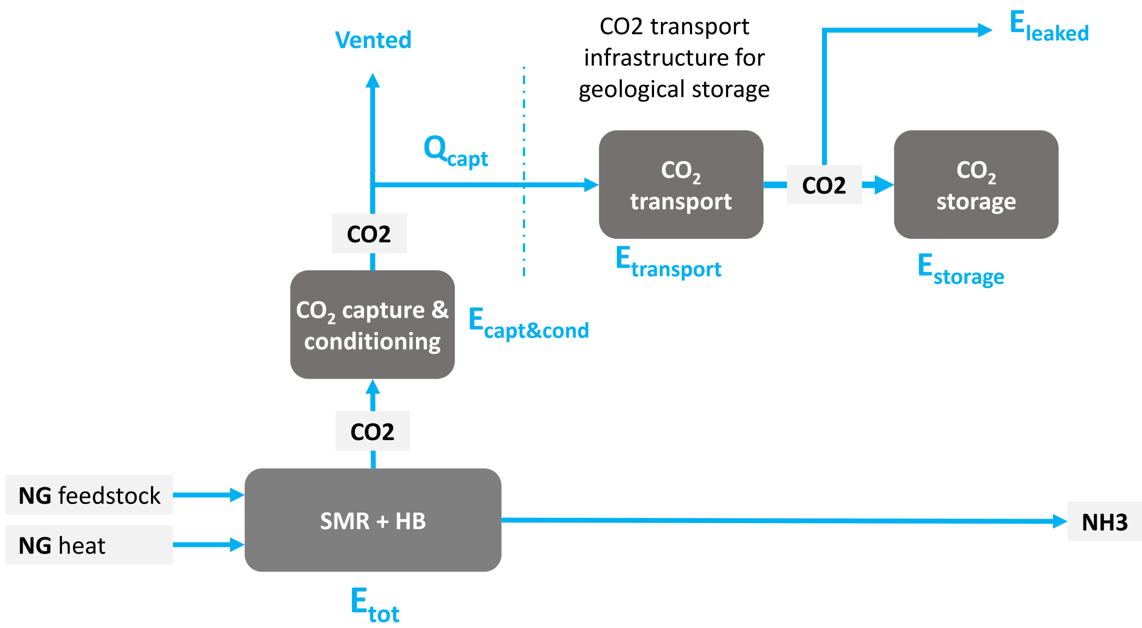

Figure 6: Net quantity of avoided GHG emissions from CCS

$$E_{CCS} = Q_{capt} - (E_{capt\&cond} + E_{transport} + E_{leaked} + E_{storage})$$

It should be noted that for most SMR plants the CO_2 capture process is embedded in the SMR, in which case $e_{capture}$ is zero.

The footprint of the produced ammonia can then be expresses as:

$$CFP_{RC\ NH3} = \frac{E_{tot} - E_{CCS}}{P_{NH3}}$$

Where:

E_{tot} lifecycle GHG emissions for the amount of ammonia produced in the assessed period *in absence of CO_2 capture and storage*

E_{CCS} net emissions avoidance from carbon capture and storage in the assessed period

P_{NH3} amount ammonia produced in the assessed period

In the case that only part of the carbon dioxide that could technically be captured with the capture technology applied is captured and stored, an approach of physical plant splitting may be applied. The plant is virtually split into sub-plant A, which includes the implemented capture solution, and sub-plant B, which does not apply CCS, as illustrated in Figure 7.

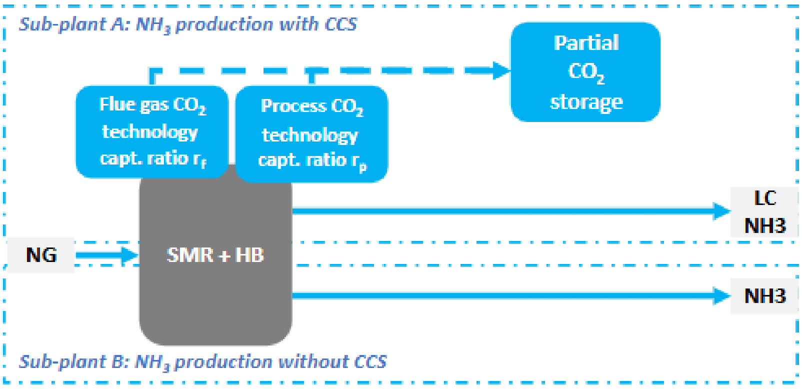

Figure 7: Allocation of carbon credit for partial CCS

Splitting of the plant allows to assign the emissions reduction from CCS to the production of sub-plant A, while the ammonia produced at sub-plant B does not receive a credit.

The carbon footprint of the "low carbon" ammonia, $CFP_{RC\ NH3}$, from virtual sub-plant A is calculated as:

$$CFP_{LC\ NH3} = \frac{E_{totnom} - E_{CCSmax}}{P_{NH3nom}}$$

where:

E_{totnom} lifecycle GHG emissions for the nominal amount of ammonia produced by the plant in absence of CO_2 storage

E_{CCSmax} maximum net GHG emissions avoidance from carbon capture and storage that would be achieved if the capture rate of the applied capture technology (e.g. allowing to capture 95% of the process CO_2) was fully applied to the nominal plant capacity

P_{NH3nom} plant nominal ammonia production capacity

The quantity of low carbon ammonia, $P_{LC\ NH3}$, is calculated as:

$$P_{LCNH3} = \frac{Q_{Capt}}{Q_{Captmax}} \cdot P_{NH3nom}$$

where:

Q_{Capt} quantity of CO_2 captured and injected into the CO_2 transport infrastructure for storage during the considered period

$Q_{Captmax}$ quantity of CO_2 that would be captured and injected into the CO_2 transport infrastructure for storage if the capture rate of the applied capture technology (e.g. allowing to capture 95% of the process CO_2) was applied to the nominal plant capacity

The quantity of "regular" ammonia, $P_{Reg\ NH3}$, is determined as:

$$P_{RegNH3} = P_{NH3} - P_{LCNH3}$$

The carbon footprint of this regular ammonia is calculated as:

$$CFP_{RegNH_3} = \frac{E_{tot} - E_{CCS} - CFP_{LC\ NH3}P_{LCNH3}}{P_{RegNH_3}}$$

which can be expressed as:

$$CFP_{RegNH_3} = \frac{E_{totnom}}{P_{NH3nom}} \frac{1 - \frac{Q_{Capt}}{Q_{Captmax}}}{1 - \frac{P_{NH3}}{P_{NH3nom}}}$$

In the case that multiple ammonia production plants with CCS capabilities are connected to the same CO_2 network, it must be specified to which ammonia production plant the stored CO_2 is assigned. The operator shall indicate the order of plants to which storage is assigned, which shall not be changed more often than once per year. The assigned CO_2 storage shall never exceed the quantity of CO_2 captured at the specified plant.

5.3 Allocation of credit for CCS in case of coproduction of urea

A credit for CCS may be assigned to the plant when the requirements for carbon storage as laid out in section 5.4 are fulfilled.

This section describes the allocation of credits for CCS in an ammonia plant where urea is also produced using the CO_2 that is not stored.

In such cases, the plant may be virtually split into two sub-plants, called A and B in the following, as shown in shown in Figure 8.

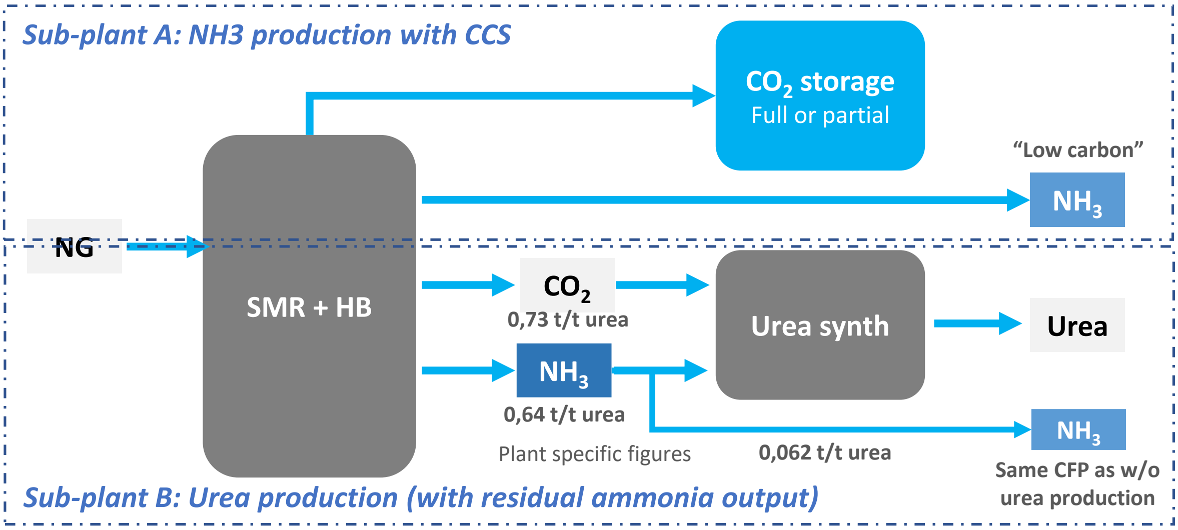

Figure 8: Allocation of credit for carbon capture and utilization

Sub-plant A includes the CCS technology and produces low-carbon ammonia as a result of the credit for carbon storage being fully assigned to the ammonia from this sub-plant.

Sub-plant B utilizes ammonia along with part of the captured carbon dioxide for urea production, with some residual conventional ammonia corresponding to ammonia co-produced with the used carbon dioxide but not used by urea production the process.

The CFP of ammonia with CCS from sub-plant A is determined in accordance with paragraph 5.2.

The CFP of the urea and ammonia from sub-plant B remains the same as in the case where there is no CCS.

5.4 Requirements for carbon storage

Requirements for the safe and long-term storage of carbon shall be adapted as set out in the EU Directive 2009/31/EC (so-called CCS Directive) on the geological storage of carbon dioxide[4]. The CCS Directive establishes a legal framework for the environmentally safe geological storage of carbon dioxide.

The CCS directive sets out extensive requirements for the selection of storage sites. A thorough analysis of a potential storage sites must establish that there are no significant risks of leakage or other dangers to health and environment when permanently storing CO_2 at the site. Operators must receive an exploration permit before exploring a potential storage site.

Once a storage site has been selected, a storage permit must be issued to the storage site. A storage permit may only then be issued when operators can show that they are financially stable and technically competent. Following the start of operation of the site, operators must continuously monitor the storage site. The CCS directive additionally sets out further

[4] Official Journal of the European Union, *Directive 2009/31/EC of the European Parliament and of the Council*; April 2009

requirements on the transport of carbon to the storage site, which are detailed in the CCS Directive.

6 Cut-off criteria

When evaluating the environmental performance of energy systems through LCA it is important to include a materiality threshold to avoid unjustified efforts in quantifying total emissions beyond the agreed level of accuracy.

A cut-off criterion specifies which elements of the carbon footprint assessment may be excluded from the total carbon footprint of the ammonia.

Generally, the carbon footprint of ammonia shall cover all processes and material flows within the system. Some elements contributing to the carbon footprint may, however, be excluded based on insignificant contributions in terms of material amount, energy flow or greenhouse gas emissions. This materiality can be set both as a percentage of the total ammonia CFP and as an absolute threshold.

The cut-off criterion permits the exclusion of elements from the CFP assessment if they are disproportionate to collect/calculate and contribute less than 3% to the total carbon footprint or to less than 0.03 tCO_2eq/tNH_3.

7 Data Quality Requirements

The data used for calculating the ammonia's CFP is subject to quality requirements to ensure adequate accuracy of the quantification, based on a Data Quality Rating (DQR) system. A higher quality rating is requested for data pertaining to the 'Most Relevant Processes' which are those that collectively contribute to at least 80% of the carbon footprint of ammonia.

DQR approaches are still under development and the level of complexity of those provided in existing documents such as Together for Sustainability (TfS) is still quite high. The approach to address data quality described below, which aims to be simpler, may be applied.

The DQR system evaluates separately the quality of primary data ($DQR_{Primary}$) and secondary data ($DQR_{Secondary}$). Primary data, also referred to as process-specific data, is data directly measured or collected at a specific facility. Secondary data is data from literature, scientific papers, industry average life cycle data, industry association reports, government statistics or other relevant sources.

The level of data quality required depends on whether the data pertains to the most relevant processes and whether the process is run by the company conducting the calculation as described in Table 2. The level of quality specified in this table shall be met as far as reasonably possible.

Table 2: Data Quality Requirements based on Data Access & Process Relevance

Access to data	Data pertaining to Most Relevant Processes	Data pertaining to other processes
Situation 1: The process is run by the company conducting the calculation.	Production Batch or process specific data rated as 'Good'	Process specific data rated as 'Fair' *OR* Secondary data rated as 'Good'.
Situation 2: The process is not run by the company conducting the calculation, but the company has access to process specific information.	Process specific data rated as 'Good'	Process specific data rated as 'Fair' OR Supply chain specific data for transport and electricity rated as 'Fair'
Situation 3: The process is not run by the company conducting the calculation and the company does not have access to process specific information.	Supply chain specific data for transport and electricity rated as 'Good' *OR* Secondary data rated as 'Good' Note: Process specific data is required for externally sourced hydrogen and biomethane	Supply chain specific data for transport and electricity rated as 'Fair' *OR* Secondary data rated as 'Fair

The criteria for rating the quality of primary data and secondary data as "Good" or "Fair" are described in sections 7.1 and 7.2, respectively.

7.1 Primary Data

For primary data, data quality is assessed with regards to the following two characteristics:

1. **Precision/Accuracy (PA)**: This is a measure of the accuracy and reliability of the data. PA assesses the extent to which the data points are measured or calculated with precision and verified, thus ensuring the accurate representation of the company's operations.
2. **Time-Related Representativeness ($TIR_{Primary}$)**: This is a measure of how recent the data is and if it accurately represents the company's current operations. This criterion does not apply to batch specific primary data (since batch specific data is by definition representative of the situation in the batches time period).

Primary data quality is rated as "good" or "fair" if it achieves a "good" or "fair" rating for the above applicable characteristics, following the criteria provided by Table 3.

Table 3: Primary Data Quality Rating

Primary Data Quality Rating Index			
Score	**Rating**	**Precision/Accuracy (PA)**	**Time-Related Representativeness ($TIR_{Primary}$)**
3	Good	The data point(s) is measured or calculated, internally verified, and its plausibility is checked by a reviewer.	The data point(s) refers to a maximum of two annual administration periods regarding the CFP calculation time period.
2	Fair	The data point(s) is either measured, calculated, or referenced from literature without plausibility checked by a reviewer.	The data point(s) refers to a maximum of three annual administration periods regarding the CFP calculation time period.
1	Poor	Above conditions not met	Above conditions not met

In addition, the accuracy of measured data shall as far as reasonably possible be +/- 2.5% or better.

7.2 Secondary Data

Default values, such as those used for combustion emissions, upstream emissions for supply of natural gas or utilities such as nitrogen, fall under the category of secondary data. Further discussion of default values can be found in the Annex .

For secondary data, data quality is assessed with regards to the following three characteristics:

1. **Technological Representativeness (TR)**: This measures how well the data reflects the specific technology or technologies used within the company.

2. **Geographical Representativeness (GR)**: This assesses how well the data represents the specific geographical location or locations of the company's operations.
3. **Time-Related Representativeness ($TIR_{Secondary}$)**: This evaluates how recent the data is and if it accurately reflects the company's current operations.

Secondary data quality is rated as “good” or “fair” if it achieves a “good” or “fair” rating for all the above characteristics, following the criteria provided by Table 4.

Table 4: Secondary Data Quality Rating Index

Secondary Data Quality Rating Index				
Score	**Rating**	**Time-Related Representativeness ($TIR_{Secondary}$)**	**Technology Representativeness (TR)**	**Geographical Representativeness (GR)**
4	Excellent	The CFP calculation utilizes data within the time validity of the dataset and does not extend more than two years beyond that time validity.	The CFP calculation utilizes technology data representative of the exact or included technologies in the scope of the dataset.	The CFP calculation utilizes data representative of the country or geographical region for which the dataset is valid.
3	Good	The CFP calculation utilizes data no later than 4 years beyond the time validity of the dataset.	The CFP calculation uses technologies partly representative of those included in the dataset's scope.	The CFP calculation utilizes data representative of one of the regions for which the dataset is valid.
2	Fair	The CFP calculation utilizes data no later than 6 years beyond the time validity of the dataset.	The CFP calculation uses technologies that are somewhat representative of those included in the dataset's scope.	The CFP calculation utilizes data that represents a country not included in the geographical regions for which the dataset is valid, but there are estimated sufficient similarities based on expert judgement.
1	Poor	The CFP calculation utilizes data more than 6 years after the time validity of the dataset, or the time validity is not specified.	The CFP calculation utilizes technologies not representative of those included in the scope of the dataset.	The CFP calculation utilizes data representative of a different country than the one for which the dataset is valid.

Annex

Default carbon footprint values

Transport type	Carbon footprint		Source
Natural gas	Upstream	9.7 g CO2e/MJ	JRC Science for policy report, Definition of input data to assess GHG default emissions from biofuels in EU legislation, 2019.
	Combustion	56.2 g CO2e/MJ	
Biomethane	Upstream	Total default value for biomethane depending on origin and production system used provided by the table at the end of RED II Annex VI part D, ***minus*** 56.2 gCO2e/MJ to reflecting that the carbon contained was removed from the atmosphere. Example: biomethane from biowaste using closed digestate and with off-gas combustion: RED II default value 14 g CO2e/MJ Upstream CFP = 14 – 56,2 = –41,8 g CO2e/MJ	
	Combustion	56.2 g CO2e/MJ	Same as natural gas