



Puro.earth CO₂ Removal Marketplace

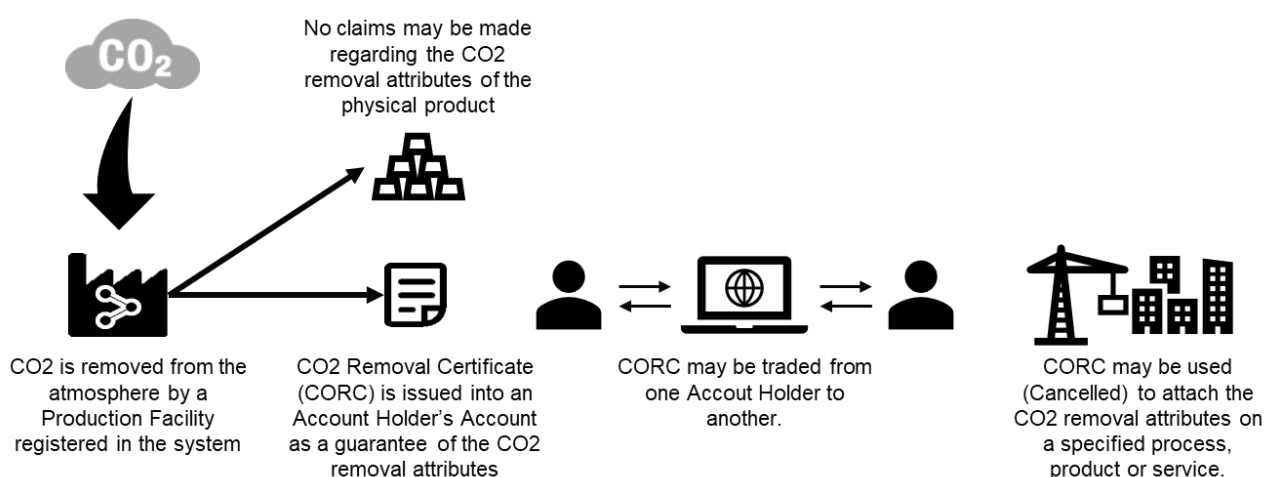
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1 General

1.1 CO2 REMOVAL MARKETPLACE DESCRIPTION:

- 1.1.1. The aspiration of the System is to create a functioning market for Long-Term CO2 Removal, which is reliable, efficient and location independent. The aim is to generate an incentive for CO2 Removal and to provide companies means to realize their societal value in reversing climate change.
- 1.1.2. CO2 Removal Marketplace is a platform for the Issuing, trading and cancelling of CO2 Removal Certificates (CORCs). In the System, Production Facilities capable of removing CO2 are registered and audited. CORCs are Issued for volume of Long-Term net CO2 Removal realized over a time period in these Production Facilities. These CORCs are then transferable to other Account Holders. The value of the CORC is realized by Cancellation, thereby removing it from circulation and making the Beneficiary of the Cancellation the sole owner of the CO2 Removal Attributes.



- 1.1.3. All processes aim to exclude the possibility of more than one CORC being Issued for the same volume of CO2 Removal and that the CORC Issued represents the sole proof of ownership of the associated CO2 Removal Attributes.
- 1.1.4. All CO2 Removal Marketplace participants need to be registered Account Holders of the System and need to have signed the CORC Marketplace Agreement.

1.2 PURPOSE OF THESE RULES

- 1.2.1 These rules form the basis of the CORC Marketplace Agreement between the Account Holders and the Issuing Body. These rules define the roles and responsibilities of different actors in the System and facilitate assessment of contractual compliance. The aim of these rules is to protect the rights of Account Holders of the System and to guarantee equal treatment.

1.3 RULES GOVERNANCE

- 1.3.1 Any of the original 22 signatories of the Letter of Intent has veto right concerning changes to these rules and may oppose Change Requests initiated by the Issuing Body. A Change Request is not implemented if at least 5 signatories oppose it. The Signatories are listed in Annex F, which is not publicly available.
- 1.3.2 A Committee, which is independent from all CORC market actors will be founded to give statements concerning Removal Method Methodologies. The Committee is elected for a period of 1 year at a time.

1.4 DEFINITIONS

Account – account in the Registry in which CORCs held by Account Holders are stored.

Account Holder – Legal person who has been approved as an Account Holder in the System and who thereby possesses an Account and rights to execute specified Transactions.

Attribute – Characteristic of CO₂ Removal such as production dates, Removal Method and location, which are recorded in the CORC.

Auction – An auction for CORCs facilitated by the Issuing Body and where Account Holders may execute CORC trading by placing and selecting Bids.

Auction Closing Time - Time announced by the Issuing Body before which all CORC Bids must be placed and selected in an Auction.

Beneficiary - A legal person who is named as the benefitting party of the CORC Cancellation. The Beneficiary is the sole owner of the Attributes represented by the CORCs, which are Cancelled for its benefit. Examples of beneficiaries might include, but are not limited to: companies, public entities, private or public organizations.

Biochar - production of which is a Removal Method. CO₂ Removal results from the pyrolytic conversion of organic biomass to biochar with high fixed carbon content and long-term chemical and structural stability.

Buffer - A Buffer is used to correct the volume of Output for the purpose of Issuing to account for e.g. metering inaccuracies and product life-time emissions. The Buffer is set by default at 10% for all Removal Methods unless otherwise specified in the relevant Audits or Removal Method Methodology. This means that for every 100 tons of CO₂ Removal Output, 90 CORCs are Issued, i.e. $\text{Issuance} = \text{Output} \times (100\% - \text{Buffer})$.

Cancellation – Retirement of a CORC from circulation by realizing its value and making the Beneficiary of the Cancellation the sole owner of the CO₂ Removal Attributes.

Cap Price – The maximum price for which the Account Holder is willing to purchase a specific set of CORCs from the Auction.

Cancellation Purchase – A type of Transaction where any actor, whether or not an Account Holder, may purchase and immediately cancel CORCs to its own or another actor's benefit.

Cancellation Request - A template to be filled by an Account Holder for initiating a Cancellation. The request shall have the contents as specified in Annex E.

Carbonated Building Element – production of which is a CO2 Removal Method. CO2 Removal results from the chemical binding of CO2 into the building element during the hardening phase.

Certificate Listing Service – An online service facilitated by the Issuing Body, which lists CORCs made available for Direct Purchase or Cancellation Purchase.

Change Request – A proposal for amending these rules.

CO2 Removal – CO2 Removal is achieved by a) absorbing CO2 from or b) preventing its entrance to the atmosphere and converting the CO2 to a stable storage, which for a Long-Term prevents the CO2 from being released to the atmosphere.

CO2 Removal Supplier - An Account Holder registering a Production Facility capable of CO2 Removal according to the relevant Removal Method specific Methodology.

Committee - A market-independent Committee who gives statements on Removal Method Methodologies. The Committee is elected for a 1-year period at a time.

CORC - CO2 Removal Certificate is an electronic document, which records the Attributes of CO2 Removal from registered Production Facilities. Each CORC represents a volume of 1 ton of Long-Term CO2 Removal.

Country of Origin - The country of location of the Production Facility generating Output for which the CORC was issued.

Direct Purchase – A type of Transaction where any actor, whether or not an Account Holder, directly purchases CORCs through the Certificate Listing Service

Expiry – Removal of CORC from circulation due to the cessation of its lifetime.

Issuance – Transaction performed by the Issuing Body to create CORCs based on Output from registered Production Facilities.

Issuance date - The date of Issuance recorded in the CORC.

Issuing Body - Body responsible for Issuing CORCs, for operating the System and for overseeing the reliability of the System. The Issuing Body of the System is Fortum Power and Heat Oy.

Long-Term - Long-Term is defined as minimum length of 50 years.

Marketplace Agreement – A contract for joining the System made between the Issuing Body and the Account Holder.

Methodology – Methodology provides procedures to verify the compliance of CO2 Removal activity with the Removal Method. Methodology provides sound CO2 Removal quantification Methodology specific to each Removal Method. It specifies the activity boundaries, detailed calculation formulas and the proof needed of the activity performance. A Methodology may be revised and the latest valid version must be used when issuing new certificates.

Optional Criteria - Additional criteria on Removal Method and Country of Origin of the CORC, which may be associated with a CORC Purchase.

Output – Volume of CO2 Removal within a certain time period which is eligible to receive CORCs. CORCs are always Issued for net CO2 Removal in the production process, which means that the total volume of Output is determined by subtracting from the CO2 Removal volume the CO2 emissions generated directly or

indirectly due to the production process or materials used according to the Removal Method specific Methodology.

Output Report - The CO2 Removal Supplier reports the Output of a Production Facility periodically to the Issuing Body by submitting an Output Report. An Output Report can be generated manually or automatically. The contents of Output Reports are specified in Annex E.

Output Audit – Audit performed by a 3rd party for determining that the volume of CORC Issuance corresponds to the Output of CO2 Removal of that time period from a registered Production Facility according to the Removal Method specific Methodology. In the Audit, CORCs Issued are compared with the reported Output in the Output Report(s) for the same period.

Output Audit Report - A report generated by the Output Auditor based on the Output Audit. The Report shall have the contents as defined in Annex E.

Output Auditor – Independent 3rd party verifier accredited by the Issuing Body to perform Output Audits. An Output Auditor may be the same body as the Production Facility Auditor. List of approved Output Auditors is available in Annex D.

Pay-as-Bid Auction – An auction mechanism where multiple homogeneous products are sold at different prices.

Pre-Purchase Agreement – a bilateral agreement between two Account Holders made known to Issuing Body by one of the agreement parties or their representative.

Pre-Purchase Agreement Identifier – A unique identifier of a Pre-Purchase Agreement assigned by Puro when a Pre-purchase Agreement is made known to Puro.

Production Facility – A facility capable of CO2 Removal according to one or several Removal Method specific Methodologies.

Production Facility Audit – Audit performed by a 3rd party to verify the details and eligibility of a Production Facility to be approved into the System according to the relevant Removal Method specific Methodology.

Production Facility Audit Report - A report generated by the Production Facility Auditor based on the Production Facility Audit. The Report shall have the contents as defined in Annex E.

Production Facility Audit Statement - A statement published by the Issuing Body with regard to the outcome of a Production Facility Audit. The Statement shall have the contents as defined in Annex E.

Production Facility Auditor – Independent 3rd party verifier accredited by the Issuing Body to perform Production Facility Audits. A Production Facility Auditor may be the same body as the Output Auditor. List of approved Production Facility Auditors is available in Annex D.

Production Facility Registration Form - A template to be filled by a CO2 Removal Supplier for initiating a Production Facility registration process. The form shall have the contents as specified in Annex E.

Purchase Bid - A bid for purchasing CORCs from the Auction with a set Cap Price, Volume and where applicable, Optional Criteria.

Registry - The electronic database of the System in which CORCs are deposited and transacted.

Registry Operator - Body responsible for the technical operation of the Registry and Auction System. The Registry Operator of the System is Grexel Systems Oyj, which is a subcontractor of Fortum Power and Heat Oy.

Removal Method – Method for a) absorbing CO₂ from or b) preventing its entrance to the atmosphere and keeping it stored for a Long-Term. Removal Methods include capture, conversion of CO₂ to a stable format, and the Long-Term storage. List of approved Removal Methods is available in Annexes A, B and C.

System – CO₂ Removal Certificate (CORC) system provided by the Issuing Body.

Trade Value – The total monetary value of a trade of CORCs between the Account Holder acting in the role of seller and Account Holder acting in the role of buyer. Trade Value = Trade Volume * Trade Price per CORC.

Trade Volume - The total number of CORCs included in a trade between the Account Holder acting in the role of seller and Account Holder acting in the role of buyer.

Transaction – Processing of CORCs in the Registry database. Transactions include Issuance, Settled Trade, Certificate Purchase, Transfer, Cancellation, Expiry and Withdrawal.

Transfer – The transfer of CORC from one Account Holder to another

Transfer Request – A request made by an Account Holder to the Issuing Body to Transfer CORCs to another Account Holder.

Underlying Product - The physical product the production of which a) removes CO₂ from prevents its entrance to the atmosphere and b) is the basis for Issuing CORCs.

Wooden Building Element – production of which is a Removal Method. CO₂ Removal results from the wooden building elements storing the carbon captured by trees. The CO₂ removal is considered long-term, when used in construction of buildings.

1.5 OTHER GENERAL RULES

1.5.1. The Issuing Body is responsible for retention of all records for a minimum of 5 years in the past.

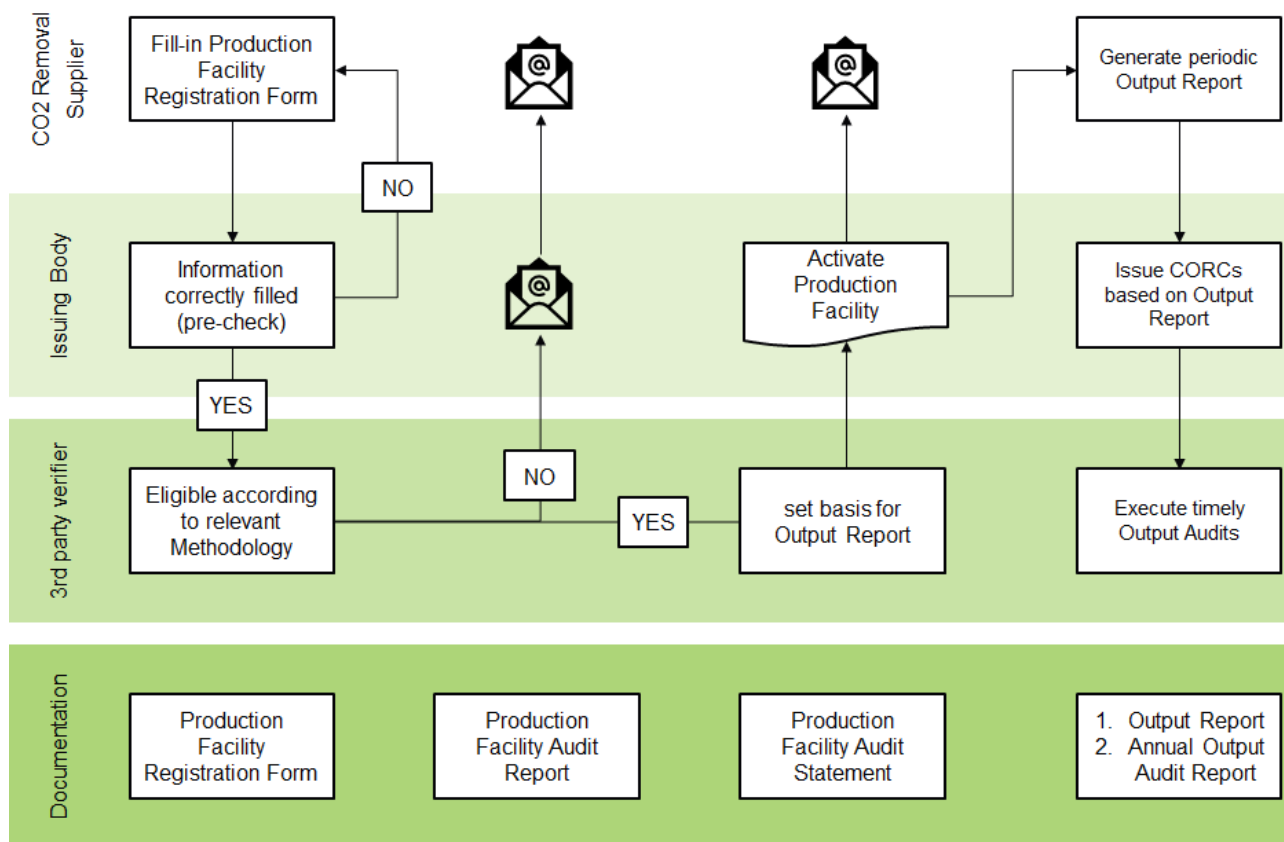
1.5.2 The Issuing Body is responsible through contractual and other means to ensure that no volume of Output is duplicated in the Issuance or Auctioning process and that the Cancellation of CORCs represents the sole ownership of the CO₂ Removal Attributes.

1.5.3. The Issuing Body has the right to perform ad-hoc audits concerning the Cancellations and associated claims made by Account Holders to ensure that CORCs are used according to the principles set out in these rules.

1.5.4. The terms with a capitalized first letter which are used in these rules shall have the meanings respectively ascribed to them in the Definitions chapter.

2 Production Facility Registration

2.1 PROCESS DESCRIPTION



2.1.1. Production Facility registration is initiated by the CO2 Removal Supplier by filling in Production Facility details in the Production Facility Registration Form. Once all information is recorded, the CO2 Removal Supplier submits the Production Facility for approval by the Issuing Body. The CO2 Removal Supplier must also include information proving its right as the owner of the Production Facility to register the Production Facility.

- In case the CO2 Removal Supplier is not the (sole) owner of the Production Facility, it must include a power of attorney signed by all the (other) owner(s) of the Production Facility with an ownership share, which is higher than 10%. This power of attorney shall accredit the CO2 Removal Supplier the right to register the Production Facility in the System.

2.1.2. Within 2 weeks from the submission of the Production Facility for approval, the Issuing Body ensures that the Production Facility data is correctly filled.

- In case the application needs to be amended, the Issuing Body requests the CO2 Removal Supplier to fill in the relevant data.
- The Issuing Body may also deem that the Production Facility is not eligible for the System in case it cannot generate Output according to any of the Removal Method specific Methodologies.

2.1.3. Where a Production Facility registration is approved by the Issuing Body, it then undergoes a 3rd party verification (Production Facility Audit) by a Production Facility Auditor who assesses the eligibility of the Production Facility for one or several Removal Methods according to the relevant Methodology. The Production Facility Audit also sets the basis for the Output Report.

- In case the verification is passed the Production Facility Auditor informs the Issuing Body and the CO2 Removal Supplier of the successful result by submitting the Audit Report and Statement.
- In case the verification is not passed, the Production Facility Auditor informs the Issuing Body and the CO2 Removal Supplier of the failure and the reasons thereof along with the Audit Report.

2.1.4. Where a Production Facility registration is approved by both the Issuing Body and the Production Facility Auditor, the Issuing Body activates the Production Facility in the Registry and its Output becomes eligible to receive CORCs.

2.2 PRODUCTION FACILITY STANDING DATA

2.2.1 Each registered Production Facility includes the following information:

- Facility unique identifier;
- CO2 Removal Supplier registering the Production Facility;
- Name;
- Location;
- Date on which the Production Facility became eligible to receive CORCs;
- Volume of Output during the full calendar year prior to registration;
- Removal Method(s) for which the plant is eligible to receive CORCs;
- Whether the Production Facility has benefited from public support; and
- + Removal Method specific information as may be specified in the relevant Removal Method specific Methodology.

2.3 MAINTENANCE OF PRODUCTION FACILITY STANDING DATA

2.3.1. CO2 Removal Supplier is responsible for informing the Issuing Body without any delay on changes, which have resulted in the registered Production Facility standing data becoming inaccurate and which might impact the Attributes of Issued CORCs. Due to the information changes a new Production Facility Audit needs to be performed.

2.3.2. The Issuing Body has the right to commission an accredited 3rd party verifier (Production Facility Auditor) to perform an ad-hoc Production Facility Audit and Output Audits. The CO2 Removal Supplier is in such case responsible for providing the Production Facility Auditor with documentation and access rights necessary to perform the Audit.

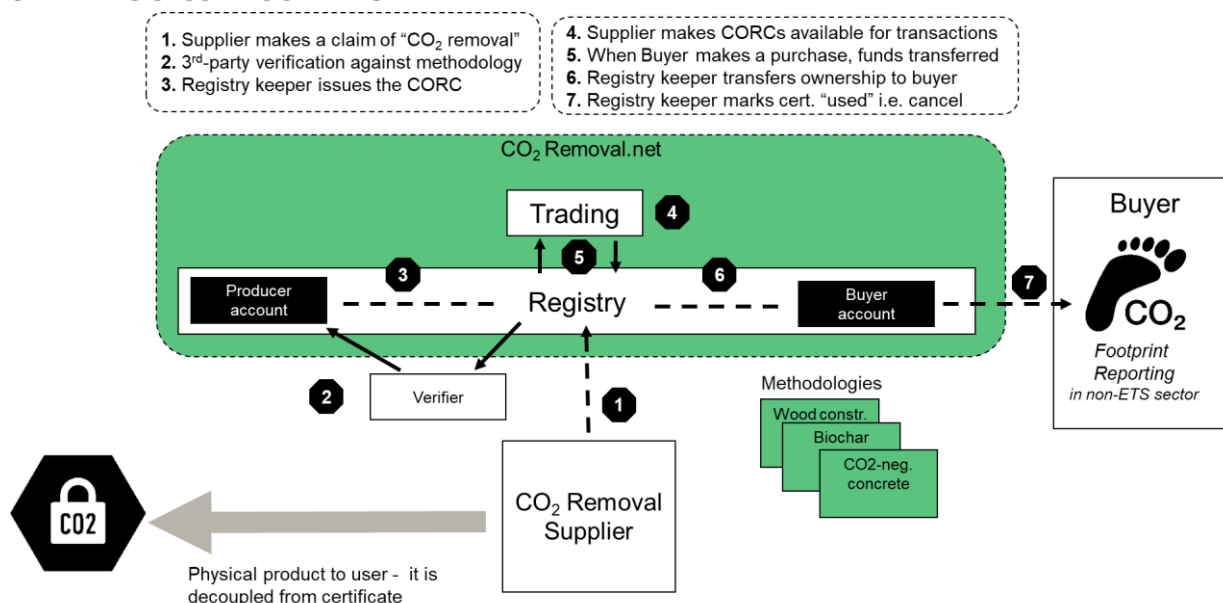
2.3.3. The Production Facility registration is valid for up to 5 years. The validity may be extended by 5 years (and then on every 5 years) by performing a new Production Facility Audit.

2.4 DEREGISTRATION

2.4.1. Where a CO2 Removal Supplier seeks to deregister a Production Facility from the System it may do so by notifying this to the Issuing Body. The deregistration is activated within a month from the receipt of this information by the Issuing Body. In such case, the CO2 Removal Supplier is responsible for any Production Facility fees still due.

3 Certificate Transactions

3.1 PROCESS DESCRIPTION



3.2 CERTIFICATE ISSUING

3.2.1. The Issuing process eliminates the possibility of Issuing more than one CORC for the same Output.

3.2.2. CORCs are Issued based on an Output Report from the CO₂ Removal Supplier for a specified time period and produced in a Production Facility registered in the System.

A CO₂ Removal Certificate CORC represents a volume of 1 (one) ton of CO₂ Removal. Each CORC shall specify the following Attributes:

- Certificate Unique identifier;
- Issuance date;
- Country of Issue;
- Removal Method;
- Facility Identity, Name and Location of the Production Facility;
- the start and end dates of Output;
- date on which the Production Facility became eligible to receive CORCs;
- whether the Production Facility has benefitted from public support; and
- Removal Method specific information as may be specified in the corresponding Methodology.

3.2.3. CORCs are always Issued for net CO₂ Removal in the production process, which means that the total volume of Output is determined by subtracting from the CO₂ Removal volume the CO₂ emissions generated directly or indirectly due to the production process or materials used according to the Removal Method specific Methodology.

3.2.4. CORCs may be Issued for Output, which at the time of Issuing has

- i) not been sold in the form of or associated with the Underlying Product; and

ii) taken place maximum of 18 months in the past,

from Production Facilities registered. This may include time periods when the Production Facility was not registered into the System as long as the Output of that period may be verified according to the relevant Removal Method specific Methodology.

3.2.5. To initiate the Issuance process, a CO2 Removal Supplier with a registered Production Facility sends an Output Report to the Issuing Body annually, quarterly or monthly. Issuing Body checks that the Production Facility Audit is valid and Issues the amount of CORCs corresponding to the CO2 Removal volume in the Output Report corrected with the Buffer to the CO2 Removal Supplier's Account.

3.2.6. Any leftover, representing a volume less than 1 ton, is stored and added into the Output volume of the following Issuance.

3.2.7. Once a CORC is Issued no claims may be associated for the Underlying Product, that overlap with the Attributes represented by the CORC. This provision dictates that the Underlying Product for which the CORC was Issued shall not be associated with any claims of CO2 Removal nor other Attributes represented by the CORC.

3.2.8. An Output Audit is done by a 3rd party Output Auditor annually against the Output Reports for past 12 months and the Removal Method specific Methodology. Required proofs and evidence, which define the Output of CO2 Removal that has taken place and that the CO2 Removal is Long-Term, are specified in the Removal Method specific Methodology.

i) In case the Output Audit finds that too many CORCs have been Issued, the Issuing Body shall be entitled to withdraw the corresponding amount of CORCs from the CO2 Removal Supplier's Account. Where these CORCs are no longer in the CO2 Removal Supplier's Account, the Issuing Body shall Withdraw the corresponding amount of other CORCs, which are of similar financial value to ensure that no unjust enrichment occurs.

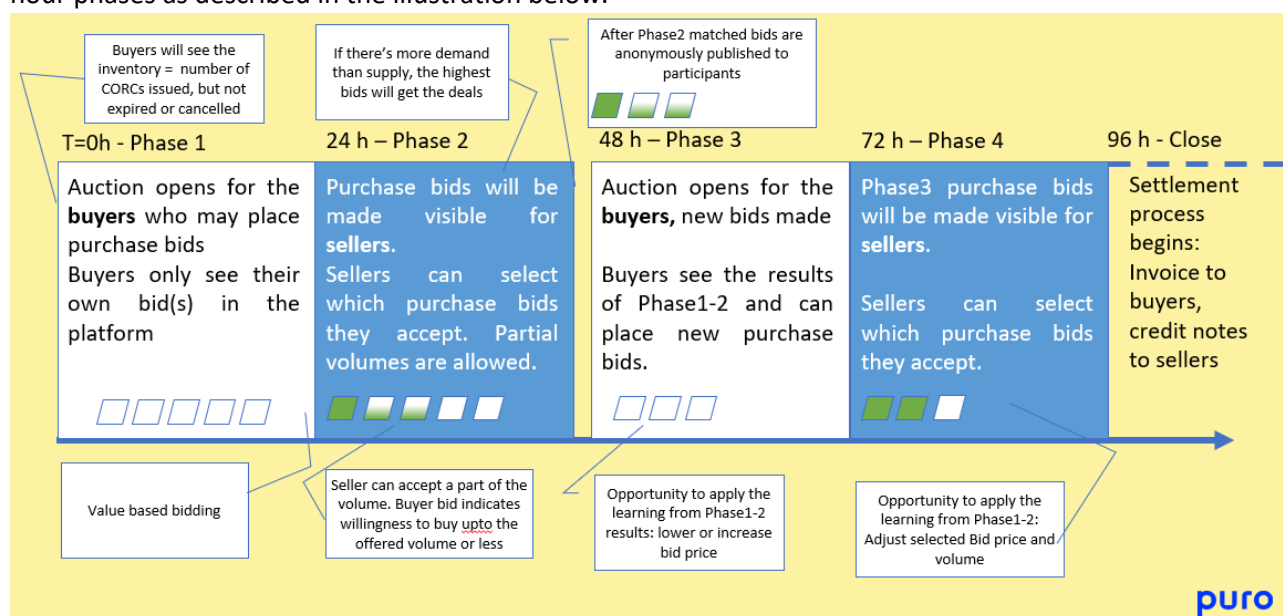
ii) In case the Output Audit finds that too few CORCs have been Issued, the Issuing Body shall Issue the corresponding amount of CORCs to the CO2 Removal Supplier's Account.

3.3 CERTIFICATE AUCTIONING

3.3.1. Issued CORCs may be traded via the Auction. CORC trading is settled using a Pay-as-Bid Principle.

3.3.2. Any CORC placed for sale in the Auction must be Issued no more than 15 months prior to the Auction Closing Time.

3.3.3. The Auction opens 96 hours before the Auction Closing Time. The auction process consists of four 24 hour phases as described in the illustration below.



3.3.4. In Phase 1, Account Holders who aim to buy CORCs in the Auction, place Purchase Bids with specific volume and Cap Price. Purchase Bids may also include Optional Criteria on Removal Method and Country of Origin of the CORC.

3.3.5. In phase 2, Account Holders who aim to sell CORCs in the Auction, select the Purchase Bids they want to fulfill. By selecting and confirming a Purchase Bid, the Account Holder commits to sell CORCs with the price specified in the Purchase Bid. Account Holder aiming to sell can choose whether to fulfill the Purchase Bid volume completely or partially.

3.3.6. After phase 2, the matched bids will be anonymously published to Account Holders participating in the Auction.

3.3.7. Phase 3 and 4 are same as Phases 1 and 2, respectively. No bids are carried over from Phases 1 and 2.

3.3.8. The amount of collateral needed to place a Bid is 0€.

3.3.9. Purchase Bids with Optional Criteria can only be selected by Account Holders aiming to sell CORCs if they have CORCs with the required Optional Criteria in their account at the time of the Auction.

3.3.9 Buyers are able to modify or delete already placed Purchase Bids at any time during Phase 1 and 3 of the Auction.

3.3.10. After Auction Closing, the Issuing Body executes the settling process and transfers CORCs between the Accounts of selling and buying Account Holders according to the outcome of the settlement process.

3.4 CERTIFICATE DIRECT PURCHASE

3.4.1. An Account Holder may purchase CORCs directly through the Certificate Listing Service provided by the Issuing Body.

3.4.2 To initiate a Direct Purchase, the Account Holder selects the type and amount of CORCs it seeks to buy from the Certificate Listing Service as well as fills in payment and other required information.

3.4.3 The price of CORCs is determined by the selling Account Holder and is made visible to the buying Account Holder when selecting the CORCs from the Certificate Listing Service.

3.4.4. Subsequent to a successful Direct Purchase transaction and payment thereof, the Issuing Body Transfers the relevant CORCs to the buying Account Holder's Account within two [2] office days from the payment.

3.4.5. Direct Purchase transactions are executed outside of the Auctions and may not be initiated during the Auctions or three [3] hours before or after the 96 hour period when the Auction is open.

3.4.6. CORCs for Direct Purchase transactions are selected from the nominated CORC Accounts of Account Holders who have authorized the Issuing Body to sell CORCs through Direct Purchase on their behalf.

3.4.7. CORCs requested for each Direct Purchase transaction are selected in the order of the Issuing Date, starting from the earliest.

3.4.8. Direct Purchase transactions are not visible publicly or to other Account Holders of the CO2 Removal marketplace.

3.5 CERTIFICATE PRE-PURCHASE

3.5.1. Two Account Holders may make a bilateral Pre-Purchase Agreement of CORCs and make it known to the Issuing Body by sending a copy of the mutually signed Pre-Purchase Agreement by one of the agreement parties or their representative to salesbids@puro.earth unless otherwise instructed.

3.5.2. Issuing Body assigns a unique Pre-Purchase Agreement Identifier to the Pre-Purchase Agreement.3.4.3. The selling Account Holder takes on to ensure that CORCs for the Pre-Purchase Agreement are available in its Account at the time when the Transfer of CORCs in relation to a Pre-Purchase Agreement is due. For this purpose, the selling Account Holder may request the Issuing Body to store such CORCs in a separate Account.

3.5.3. When the Issuing Body receives a Transfer Request in relation to a Pre-Purchase Agreement from the selling Account Holder, the Issuing Body transfers CORCs between the Accounts of the selling and buying Account Holders as agreed in the Pre-Purchase Agreement

3.5.4. CORCs for Pre-Purchase transactions are selected in the order of the Issuing Date, starting from the earliest.

3.5.5. Pre-Purchase transactions are not visible publicly or to other Account Holders of the CO2 Removal marketplace.

3.6 CERTIFICATE CANCELLATION PURCHASE

3.6.1. Any actor, whether or not an Account Holder, may purchase and immediately cancel CORCs through the Certificate Listing Service to its own or another actor's benefit by Cancellation Purchase.

3.6.2 To initiate a Cancellation Purchase, the actor selects the type and amount of CORCs it seeks to buy from the Issuing Body's online shop service as well as fills in payment, purpose of cancellation and other required information.

3.6.3 The price of CORCs for Cancellation Purchase is determined by the selling Account Holder and is made visible to the buyer when selecting the CORCs for the Cancellation Purchase.

3.6.4. Minimum and maximum limits for the amount of CORCs that can be included in a single Cancellation Purchase transaction are set by the Issuing Body.

3.6.5. Subsequent to a successful Cancellation Purchase and payment thereof, the Issuing Body cancels the requested amount of CORCs and delivers a Cancellation Statement for the actor within two [2] office days from the payment.

3.6.6. Cancellation Purchase transactions are executed outside of the Auctions and may not be initiated during the Auctions or three [3] hours before or after the 96 hour period when the Auction is open.

3.6.7. CORCs for Cancellation Purchase transactions are selected from nominated CORC Accounts of Account Holders who have authorized the Issuing Body to sell CORC through Cancellation Purchase on their behalf

3.6.8. CORCs requested for each Cancellation Purchase transaction are selected in the order of the Issuing Date, starting from the earliest.

3.6.9. Cancellation Purchase transactions are not visible publicly or to other Account Holders of the CO2 Removal marketplace.

3.7 CANCELLATION

3.7.1. Cancellation is used to prove that the amount of CO2 corresponding to the volume of cancelled CORCs has been removed and that the Cancellation entitles for exclusive ownership of the quantity and other Attributes of the CO2 Removal.

3.7.2. Account Holders may cancel CORCs for their own or another Beneficiary's benefit. In case the CORC has not been traded via the Auction, the Beneficiary must be named as the Account Holder executing the Cancellation.

3.7.3. Account Holder initiates the Cancellation by filling in a Cancellation Request and submitting it to the Issuing Body. The Cancellation Request shall specify the specific set(s) of CORCs to be Cancelled along with the following Cancellation information:

- Beneficiary name and business identity
- Beneficiary Country
- Use purpose (e.g. Brand name, corporate reporting)
- Use time period

3.7.4. The Issuing Body may either approve or reject the Cancellation Request.

- In case the Cancellation Request is approved, the CORCs are Cancelled by the Issuing Body and removed from circulation

- In case the Cancellation Request is rejected, the Issuing Body informs the Account Holder of the reasons thereof.

3.8 EXPIRY

3.8.1. Expiry is the removal of CORC from circulation due to the cessation of its lifetime. CORCs Expire 18 months after the Issuance date.

4 Other Processing of Certificates

4.1 WITHDRAWAL

4.1.1. For the purpose of maintaining the accuracy and veracity of the System, the Issuing Body has the right to withdraw CORCs from an Account Holder's Account in case:

- An error has occurred in the Issuing, transferring or other processing of the CORC;
- Due to a Material Breach of the CORC Marketplace Agreement.

4.2 ALTERATIONS

4.2.1. The Issuing Body is entitled to alter the details of CORCs so as to rectify any errors that have occurred in the Issuance or Transfer process provided that the Account Holder who currently possesses the corresponding CORCs in its Account has agreed to the alteration and that the alteration doesn't result in any unjust enrichment.

4.3 SALE OF CORC IN EXTERNAL MARKETPLACES

4.3.1. Account Holders in the CO2 Removal marketplace may, through a separate sale authorization, authorize the Issuing Body to place CORCs for sale in external marketplaces. The CORCs allocated for such purpose are transferred by the Issuing Body to a separate certificate Account of the authorizing Account Holder and are not simultaneously available for sale in the CO2 Removal marketplace.

4.3.2. Where CORCs are sold in external marketplace, the Issuing Body Transfers the relevant CORCs to its own Account and performs the necessary subsequent Transfer or Cancellation.

5 Reports

5.1. Reports published by the Issuing Body:

- Audit Statement for Production Facilities. Detailed Audit Report is not publicly available.
- Auction results report, with volumes and volume-weighted average prices of traded CORCs. The Auction results report is made publicly available after each Auction. The Issuing Body does not publish information which would reveal data on individual trades.
- Annual Report on Transaction data

5.2. Reports available at request:

- Account Statement of the Account(s) owned by the requesting Account Holder
- Cancellation Statement, which includes the details of the Cancellation Transaction as well as the CORCs included. The Issuing Body Issues a Cancellation Statement for the Account Holder at request.
- Auction results for the requesting Account Holder

6 Other Provisions

- 6.1. Account Holder is subject to these rules once the Application has been approved until the Resignation or Expulsion. The provisions of governing law, liabilities and dispute resolution survive the termination of the agreement.
- 6.2. Any CORCs Issued in the Experiment expires 12 months after the Issuance date.
- 6.3. In the future, it might be possible to include a new type of certificate which doesn't comply with the CO₂ Removal longevity requirement of the current CORC. In such case, the process is called delaying of CO₂ emissions rather than removal.
- 6.4. CO₂ Removal Supplier of the marketplace aims to invest the income of sales of CORCs to the growth of the production volume.
- 6.5. Unless otherwise instructed CORCs are always selected for Transfer starting from the CORC with the earliest Issuance Date fulfilling the required characteristics and Optional Criteria.
- 6.6. All Transactions are subject to service fees as defined in the Marketplace Agreement. Where the buyer is not an Account Holder, the service fee of the Transaction for the buyer is stated at the marketplace.

Annex A: Biochar Methodology

This methodology quantifies the CO₂ Removal achieved by the production of **biochar**, when used in applications other than energy generation.

CO₂ Removal results from the pyrolytic conversion of organic biomass to biochar with high fixed carbon content and long-term chemical and structural stability.

This methodology is applicable to certificates issued for CO₂ Removal Marketplace.

1. Eligible activity type

Activity capable of producing as Output carbonised **biochar** with long-term stability. CO₂ Removal results from organic biomass being heated in absence of oxygen in a pyrolysis process. The biomass undergoes a chemical reaction - carbonization - that forms covalent bonds far stronger than those found in the biomass parent material. The biochar production process pyrolysis gases must be recovered, not allowed to escape to the atmosphere

The Long-Term CO₂ Removal is achieved by the stability of carbonised biochar, which is measured with the Oxygen-to-Carbon ratio.

The eligibility of the production facility is determined in the **Production Facility Audit**.

1.1. Requirements for activities to be eligible under the methodology

- 1.1.1. Use of biochar in applications other than energy (e.g. greenhouse substrates, surface water barrier, animal feed additive, wastewater treatment, insulation material, landfill/mine absorber, soil additive). Biochar stores stable fixed carbon for centuries to millennia, when not used for energy. Therefore, its energy use is excluded, all other uses are eligible.
- 1.1.2. Biochar needs to be produced from sustainably sourced forest biomass raw materials from the EU (PEFC or FSC certified forest), or waste biomass raw materials such as agricultural waste, biodegradable waste or food waste. The full eligible list of biomass types can be found in the Annex 1 of the Requirements of the European Biochar Certificate.¹
- 1.1.3. Forest biomass shall not be harvested from peatlands.
- 1.1.4. In case of forest biomass, the eligible types include harvest leftovers, thinnings, bark, chippings, sawdust and wood shavings. Timber that can be used in construction is not eligible for biochar production in this methodology.
- 1.1.5. Biochar production process needs to have a valid certificate from the European Biochar Foundation ([EBC](http://www.european-biochar.org)) or similar certificate of sustainable biochar production. Also, the date of the certificate issuance is important to register, as there are periodic changes to the requirements. Current EBC version is 8.1, valid from Apr/2019. In case there is no EBC issued to the producer, the producer needs to present LCA/carbon footprint results of the biochar production process,

¹ Positive list of biomass feedstock approved for use in producing biochar (version 1, 2013): <http://www.european-biochar.org/biochar/media/doc/feedstock.pdf>

including information on the emissions from the process, the carbon content of the biochar, and other requirements listed in 1.1.6 - 1.1.11.

- 1.1.6. The use of fossil fuels for heating the pyrolysis reactor is prohibited. The use of waste heat from other industrial processes, such as bio-digesters or cement production is permitted.
- 1.1.7. In biochar production process pyrolysis gases must be recovered, not allowed to escape to the atmosphere. Bio-oil and pyrolysis gases can be stored for later use as renewable energy or materials.
- 1.1.8. In biochar production process at least 70 % of waste heat produced by pyrolysis must be used (in e.g. drying of biomass or in district heating). This requirement applies to production facilities with annual output of over 50 tonnes.
- 1.1.9. Biochar produced shall have high stabile carbon content - higher than normal charcoal (typically 20%). The stabile fixed carbon content shall be over 50 %. The stabile carbon content shall be verified from sampling results of the biochar product with laboratory tests.
- 1.1.10. The molar H/Corg ratio must be less than 0.7. H/Corg ratio is an indicator of the degree of carbonisation and therefore of the biochar stability. Values exceeding 0.7 are an indication of non-pyrolytic chars or pyrolysis deficiencies (Schimmelpfennig and Glaser 2012).
- 1.1.11. The molar O/Corg ratio must be less than 0.4. O/Corg ratio is an indicator of the chemical and microbial stability of the biochar and correlates with the degradation schedule better than the production temperature.
- 1.1.12. Measures have to be taken for safe handling and transport of biochar to prevent fire and dust hazards. Such safety measures are, but not limited to, providing a Material Safety Data Sheet, laboratory test results from UN test N.4, using a steam activation process or by other means ensuring that the biochar is sufficiently covered, moist and cool during transport and handling.
- 1.1.13. The eligibility of the production facility is determined in the **Production Facility Audit**.

1.2 Requirements for the Production Facility Audit

- 1.2.1 The Production Facility Auditor checks the Production Facility against the Requirements for activities to be eligible under the methodology (section 1.1.), and the Proofs and evidence needed from the CO2 Removal Supplier (section 5). The main requirements include:

- The raw material used in the biochar production is of eligible type and is sustainably sourced (see sections 1.1.2. – 1.1.4. and 5.2.1.)
- The Production Facility has a valid European Biochar Certificate or similar certificate, date of certificate issuance (see sections 1.1.5. and 5.3.1.). In case there is no EBC issued to the producer, the producer needs to present LCA/carbon footprint results of the biochar production process, including information on the emissions from the process and the carbon content of the biochar, and other requirements listed in 1.1.6 - 1.1.11;
- There are no fossil fuels used for the heating of the pyrolysis reactor (see section 1.1.6.);
- Pyrolysis gases are recovered in the biochar production process (see section (1.1.7.);
- At least 70% of waste heat is used, if annual output of the Production Facility exceeds 50 tonnes (see section 1.1.8.);

- Stable carbon content of biochar is over 50 % (see section 1.1.9.);
- Molar O/Corg ratio is less than 0.4 (see section 1.1.11.).

1.2.2 The Production Facility Auditor checks that the Production Facility is capable of metering and quantifying the Output in a reliable manner, for the Quantification of CO₂ Removal (section 4). This check also prepares the CO₂ Removal Supplier for producing the periodic Output Report.

- The quantity of the biochar produced and sold is quantified and documented in a reliable manner (sections 4.1.1., 5.3.2. and 5.4.)
- Relevant meters are in place and they are calibrated;
- The energy use of the Production Facility can be quantified and the emissions from the process calculated (section 4.4.2.);
- The emissions from the harvesting and transporting of the raw material are estimated and calculated in a reliable manner (section 4.4.4.)
- The size of the buffer for uncertainty (section 4.3.3.) is correct for the Production Facility in question
- The auditor goes through the Quantification of CO₂ Removal requirements with the CO₂ Removal Supplier, so that the Supplier is able to calculate the CO₂ Removal independently in its Output Report.

1.2.3. Collection of standing data of the Production Facility

The Production Facility Auditor collects and checks the standing data of the Production Facility and the CO₂ Removal Supplier. The data to be collected by the Auditor includes:

- CO₂ Removal Supplier registering the Production Facility;
 - A certified trade registry extract or similar official document stating that the organization is validly existing and founded under the laws of the mother country.
- Location of the Production Facility;
- Volume of Output during the full calendar year prior to registration;
- Removal Method(s) for which the plant is eligible to receive CORCs;
- Date on which the Production Facility becomes eligible to receive CORCs;
- Whether the Production Facility has benefited from public support.

2. Point of creation of the CO₂ Removal Certificate (CORC)

2.1. Point of creation

- 2.1.1. The point of creation of the certificate is the production process of biochar (pyrolysis of biomass to biochar). However, end use of the product needs to be proven to be other than energy use.
- 2.1.2. The producer of the biochar is the CO₂ Removal Supplier.

3. Activity boundary for the CO₂ Removal Certificate

3.1. Activity

- 3.1.1. Issues inside the blue box are inside the activity boundary. Emissions from the raw materials, transport of raw materials and production are included in the calculation of the CO₂ Removal of the carbonated elements. See figure 1 below.

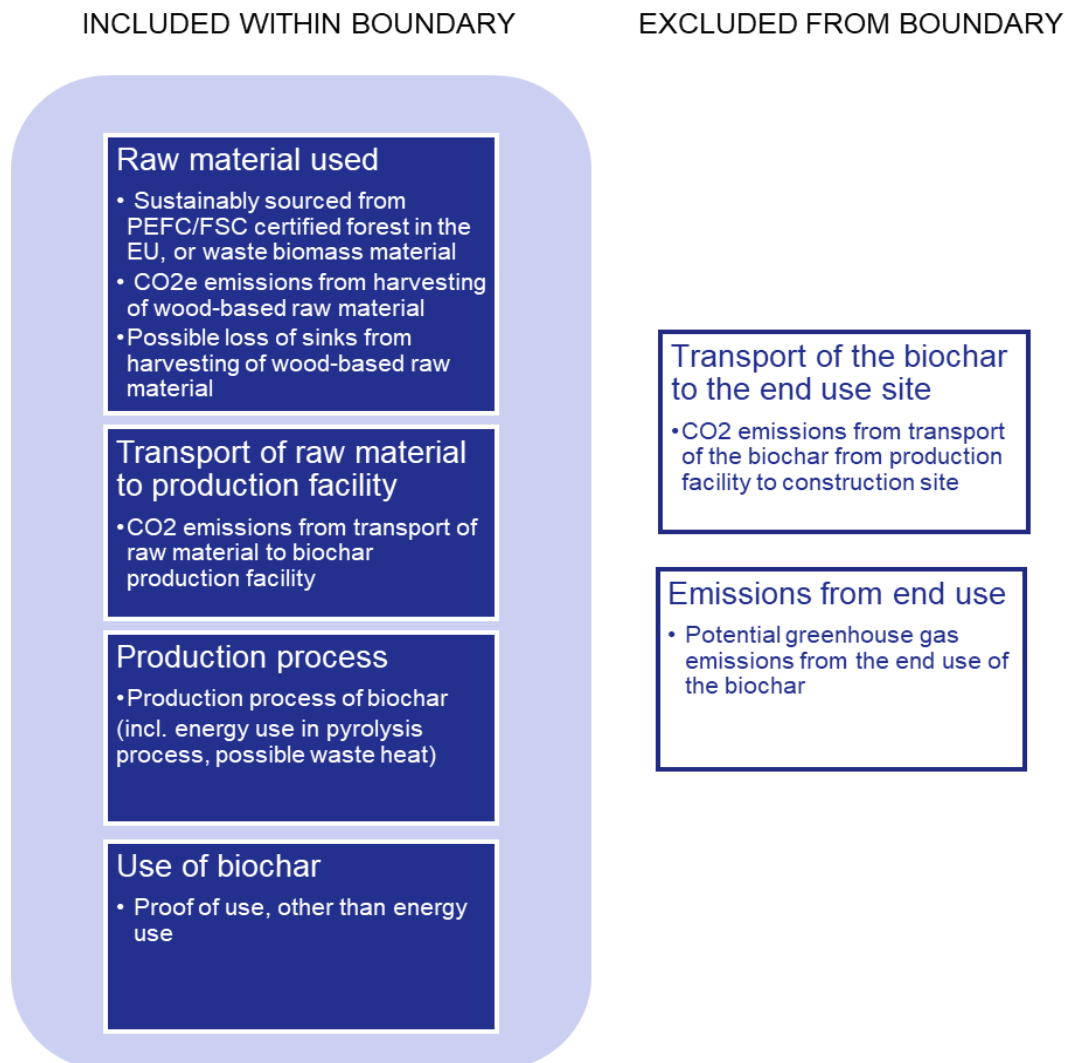


Figure 1: Activity boundary

- 3.1.2. Included within the boundary:

- Raw material used in the biochar production process, with proof that it is sustainably sourced from the EU. For forest biomass a PEFC or FSC certificate is needed. For non-forest waste biomass, no certificate about the raw material is needed.
- The CO₂e emissions from harvesting of the forest-based raw material, including estimates of energy use of forest machinery. In case of multiple users of the same raw material, need to estimate the emissions attributed to the biochar production.

- Possible loss of sinks from sourcing wood-based raw material from the forest, taking into account the type of wood-based material used.
- Transport of the raw material to the biochar production facility. According to the latest version 8 of the EBC, sourcing of the raw material can be done from anywhere in Europe. This can cause significant transport emissions.
- The production process of biochar, including emissions and possible waste heat from the pyrolysis process and other manufacturing processes at the biochar production facility.
- The end use of the biochar is included to the extent, that it needs to be proven not to be energy use. When the use is proven to be non-energetic, the CO₂ storage in biochar is considered permanent.

3.1.3. Outside the activity boundary:

- Transport to the biochar end use site is not included. This is because there are several small-scale buyers of the biochar (including households), transport emissions of which are not trackable by the producer of biochar. The biochar can also be sent by post to the small-scale users, and the direct transport emissions from the postal process in the EU are not easily trackable.
- The possible emissions from biochar end use is outside of the project boundary, as the emissions from eligible non-energetic uses are negligible, and not trackable by the biochar producer.

4. Quantification of CO₂ Removal – calculation methodology

4.1. Production volume

- 4.1.1. The producer of the biochar (CO₂ Removal Supplier) provides data and documentation on the production volume (in kg) of the biochar produced in the production process of the eligible production facility.

4.2. CO₂ storage volume (CO₂ captured in the biochar)

- 4.2.1. Carbon content of biochar is proved by sampling process (e.g. according the European Biochar Certificate, EBC), sampling results for the EBC on the carbon content can be used for quantification of the CO₂ Removal.
- 4.2.2. Carbon content in biochar is described as kg CO₂ / kg biochar

4.3. Buffer for uncertainty assessment

- 4.3.1. A Buffer is used to correct the Output to account for possible uncertainties in e.g. metering inaccuracies, losses of the CO₂ storage after production, or other losses that may occur. A correction in the form of a buffer in percentage (%) is used to reflect the uncertainty and to reduce the volume of CO₂ removal Output to be certified i.e. uncertainty-corrected CO₂ Removal Output=Output*(100%-Buffer)

- 4.3.2. During production: Metering inaccuracies in production volumes, in CO₂ storage volumes due to sampling or testing techniques, or other metering used in quantification needs to be estimated and a corresponding buffer-percentage defined.
- 4.3.3. During use: The amount of decomposing or re-emitting of CO₂ in the normal use of the product needs to be estimated. In case of biochar, the stability of the CO₂ storage depends on the molar O/Corg ratio of the biochar, which according to the eligibility requirements of this methodology and the EBC must be less than 0.4.

In case the molar O/Corg ratio of the biochar is less than 0.2, the buffer is set at 2,5% of the CO₂ storage volume. In case the O/Corg ratio is less than 0.2, it is scientifically proven that the biochar has a minimum 1000-year half-life². This means that after 1000 years from production, half of the CO₂ is re-emitted in the atmosphere. Estimating a linear re-emitting of half of the CO₂ by 1000 years from production. The buffer is defined as 2,5 %.

In case the molar O/Corg ratio of the biochar is more than 0.2 but less than 0.4, the buffer is set at 5 % of the CO₂ storage volume. According to scientific studies, lower O/C ratios result in more stable biochar material. When the molar O/C ratio is greater than 0.6 then biochar will have a half-life of approximately 100 years³. Calculating as an average of molar ratios of 0.2 and 0.6, for biochar with ratio of O/Corg less than 0.4 the half-life is estimated to be approximately 500 years or more. The buffer is defined as 5 %.

- 4.3.4. Any other uncertainties or other losses of the CO₂ Removal Output that may occur needs to be estimated and corresponding buffer-percentage defined.

4.4. Emissions from the activity of producing the biochar and for the supply chain that is included within the boundary

4.4.2. Emissions from the activity (production of biochar)

- Calculation of emissions from the production process, for the whole year (or monitoring period)
 - CO₂e emissions from net energy use in the production process, calculation from actual energy use data. Net energy use means that the calculation:
 - takes into account the energy (e.g. waste heat) created by the biochar production process, which is utilized in the process as an energy source.
 - takes into account the energy source used in the production process, and the emissions generated from the energy use. Note that in the case of the EBC, the pyrolysis is done with non-fossil fuels, so the emissions from energy use are low or zero.

4.4.3. Leakage

² Spokas (2010): Review of the stability of biochar in soils: predictability of O:C molar ratios. In Carbon Management (2010) 1(2), 289–303

³ Spokas (2010): Review of the stability of biochar in soils: predictability of O:C molar ratios. In Carbon Management (2010) 1(2), 289–303

- Possible CO₂e emissions from the waste heat/gas from the biochar production process (not captured and used).

4.4.4. Emissions from the sourcing of the raw material

Forest biomass:

- In case the raw material for the biochar is forest biomass, estimate on the CO₂e emissions from the harvesting of the raw material, taking into account the type of the raw material, e.g. thinnings.
- Possible loss of sinks from harvesting the forest biomass, taking into account the type of the raw material, e.g. thinnings.
- Estimate of the CO₂ emissions from transport of the raw material to the biochar production facility, taking into account the distance transported and the fuel used for transport.

Other waste biomass:

- In case of non-forest waste biomass, the emissions from sourcing the raw material are considered to be zero.
- Estimate of the CO₂ emissions from transport of the raw material to the biochar production facility, taking into account the distance transported and the fuel used for transport.

4.5. Use of existing biochar certificate as proof

- 4.5.2. The carbon content and the molar O/Corg ratio of biochar is proved by sampling process (e.g. according the European Biochar Certificate, EBC). The sampling results done for the EBC on the can be used for the calculation. In case there is no EBC issued to the producer, the producer needs to present LCA/carbon footprint results of the biochar production process, including information on the emissions from the process, the carbon content of the biochar, and other requirements listed in 1.1.6 - 1.1.11.

4.6. Calculation parameters

Q_{biochar} = Quantity of biochar produced and sold to end user (in kg)

C_{biochar} = CO₂ storage volume of the biochar (in kg CO₂ / kg biochar)

B_{biochar} = Buffer for possible CO₂ re-emitted during Product life-time (in percentage)

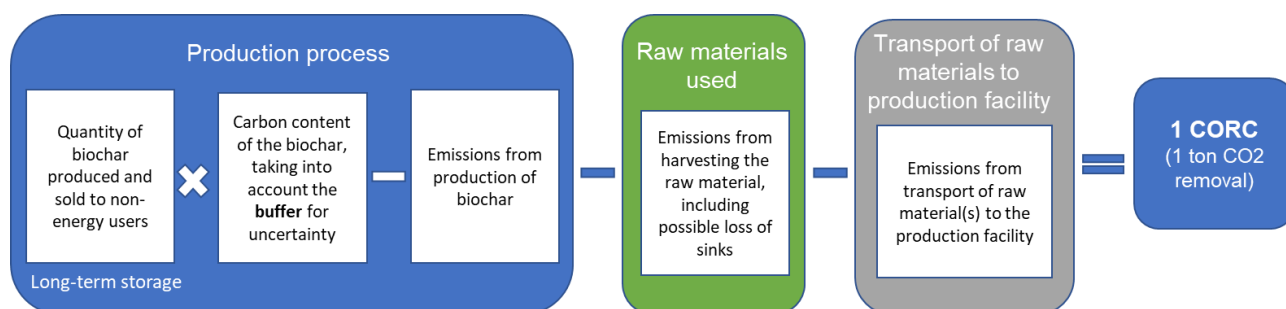
E_{biochar} = Net emissions from biochar production (in CO₂e) to the atmosphere, taking into account the own use of energy in a closed system.

L_{biochar} = Possible leakage from biochar production (e.g. waste heat, in CO₂e)

E_{rawmaterial} = Emissions from harvesting the raw material, including possible loss of sinks (in CO₂)

ET_{rawmaterial} = Emissions from transport of raw material to production site (in CO₂)

4.7. Calculation formula of CO₂ removal



4.7.2. Mathematical formula:

$$Q_{\text{biochar}} * (C_{\text{biochar}} * (100\% - B_{\text{biochar}})) - (E_{\text{biochar}} + L_{\text{biochar}}) - (E_{\text{rawmaterial}} + E_{\text{T rawmaterial}}) = \text{CO}_2 \text{ Removal (in kg)}$$

Note: 1 certificate = removal of 1000 kg CO₂

5. Proofs and evidence needed from the CO₂ Removal Supplier

5.1. Principle

- 5.1.1. Output from a production facility is determined as eligible for issue of CO₂ removal certificates once the facility has undergone a process of third-party verification by an auditor against the specific methodology for the carbonated building element. This verification is done in a **Production Facility Audit**. The verification ensures that the corresponding CO₂ removal has taken place and that the CO₂ removal is considered permanent as defined in the methodology.
- 5.1.2 For the activity to be eligible for producing biochar for which CO₂ removal certificates can be issued, the following proofs (5.2- 5.4) need to be presented by the CO₂ Removal Supplier (in this case, the producer of biochar).

5.2. Raw material use

5.2.1 Proof of the sustainability of the raw material used. Proof to be presented:

In case of forest biomass raw material:

- Programme for the Endorsement of Forest Certification (PEFC) Sustainable Forest Management Standard: National standard under the PEFC, such as PEFC Finland Standard ([PEFC FI 1002:2014](#)); or
- Forest Stewardship Council (FSC) Forest Management Certification, e.g. FSC Standard for Finland ([FSC-STD-FIN-\(Ver1-1\)-2006](#))

- Proof that the raw material used is eligible for the European Biochar Certificate⁴

In case of non-forest waste biomass raw material:

- Raw material needs to be sourced sustainably, however certificates are not needed, as it is waste material.

5.3. Production process of biochar and quality of the product

5.3.1. Product quality

Proof of CO₂ removing production – proof that the production technology of the CO₂ removing end product (biochar) is net CO₂-negative.

Proof to be presented:

- European Biochar Certificate (EBC)
- Proof of energy use in the biochar production facility and the CO₂e emissions from energy use
- Lab results on the quality of the biochar, e.g. carbon content and H/Corg content of the product (sampling done as defined in the EBC)
- In case there is no EBC issued to the producer, the producer needs to present LCA/carbon footprint results of the biochar production process, including information on the emissions from the process and the carbon content of the biochar.

5.3.2. Proof of production volume

Producer provides data and documentation on the amount of biochar produced

Proof to be presented:

- Continuous production documentation for the whole period (book-keeping), taking into account any significant changes or stops in production.

5.4. Proof of the end use of CO₂ removing product

5.4.1. Proof that the end-use of the product does not cause CO₂ returning to the atmosphere (it is not burned or sold for energy use).

Proof to be presented:

Documentation of the sale of the product to an end user, stating the intended use of the product (not energy).

5.5. Proof of no double counting

5.5.1. A statement is needed from the Removal Supplier that the underlying physical product (biochar) in which the CO₂ is stored will not be sold or marketed as “carbon positive” if the CO₂ removal certificate associated with the underlying physical product (biochar) is removed from the underlying product and sold to another stakeholder not associated with the underlying physical product.

⁴

- 5.5.2. Check of the packaging of the product (how the product is branded) is needed, if CO₂ removal certificate associated with the underlying physical product (biochar) is removed from the underlying product.
- 5.5.3. No marketing and branding claims can be made by the end-user (user of biochar) that the underlying physical product (biochar) is a carbon sink, if the decoupled CO₂ certificate has been sold to and cancelled by another stakeholder not associated with the underlying physical product.

Annex B: Carbonated Building Element Methodology

This methodology quantifies the CO₂ Removal achieved by production of **Carbonated Building elements**.

CO₂ Removal results from the chemical binding of CO₂ into the building element during the hardening phase.

This methodology is applicable to certificates issued for the CO₂ Removal Marketplace.

1 Eligible activity type

Activity capable of producing as Output **carbonated building element** that is net CO₂ removing. CO₂ Removal is achieved through carbonation. Carbonation is a chemical reaction between CO₂ and Metal hydroxides or oxides (CaOH, MgOH, CaO, MgO) to form a strongly-bonded, stable carbonate mineral (CaCO₃, MgCO₃).

The Net CO₂ Removal is determined by subtracting the CO₂ emissions generated directly or indirectly due to the production process from the CO₂ absorbed and stored due to the carbonation reaction.

The eligibility of the production facility is determined in the **Production Facility Audit**.

2. Requirements for the Production Facility Audit

2.1. Eligibility of the Production Facility to be approved into the System

- 2.1.1. The Production Facility Auditor checks the Production Facility against the Requirements for activities to be eligible under the methodology (section 1), and the Proofs and evidence needed from the CO₂ Removal Supplier (section 6). The main requirements include:
- Verifying that the production facility is technologically capable of producing the eligible Output (carbonated building elements) and that the carbon content is as specified (6.3.).
 - The raw material used in the carbonated building element production is of eligible type and that EU and national legislation is followed in its sourcing and extraction (see sections 1. and 6.2).
 - If the supplier has referred to a voluntary sustainability scheme or certificate as proof of sustainability (the sustainability is verified by a third party), the validity of the certificate is checked by the Auditor (6.2.).
- 2.1.2. The Production Facility Auditor checks that the Production Facility is capable of metering and quantifying the Output in a reliable manner, for the Quantification of CO₂ Removal (section 5). This check also prepares the CO₂ Removal Supplier for producing the periodic Output Report.
- The quantity of the carbonated building elements produced is quantified and documented in a reliable manner (sections 5.1. and 5.4.)

- Relevant meters are in place and they are calibrated;
- The energy use of the Production Facility can be quantified and the emissions from the process calculated (section 6.3.);
- The emissions from the extracting and transporting of the raw material are estimated and calculated in a reliable manner (section 6.2.)
- The size of the buffer for uncertainty (section 5.3) is correct for the Production Facility in question
- The auditor goes through the Quantification of CO₂ Removal requirements with the CO₂ Removal Supplier, so that the Removal Supplier is able to calculate the CO₂ Removal independently in its Output Report.

2.1.3. Collection of standing data of the Production Facility

The Production Facility Auditor collects and checks the standing data of the Production Facility and the CO₂ Removal Supplier. The data to be collected by the Auditor includes:

- CO₂ Removal Supplier registering the Production Facility;
 - A certified trade registry extract or similar official document stating that the organization is validly existing and founded under the laws of the mother country.
- Location of the Production Facility;
- Volume of Output during the full calendar year prior to registration;
- Removal Method(s) for which the plant is eligible to receive CORCs;
- Date on which the Production Facility becomes eligible to receive CORCs;
- Whether the Production Facility has benefited from public support.

3. Point of creation of the CO₂ removal certificate

3.1. Point of creation

- 3.1.1. The point of creation of the CO₂ removal certificate is the production of the carbonated building element that has absorbed CO₂ at the eligible production facility.
- 3.1.2. The producer of the carbonated building element is the CO₂ Removal Supplier.
- 3.1.3. The carbonated building element that possesses the CO₂ absorbing characteristics is used in construction to replace currently used concrete elements that are manufactured using conventional technologies.

4. Activity boundary for CO₂ removal certificate

4.1. Activity boundary

4.1.1. Issues inside the blue box are inside the activity boundary. Emissions from the raw materials, transport of raw materials and production of the carbonated building elements are included in the calculation of CO₂ emissions of the carbonated elements. See figure 1 below.

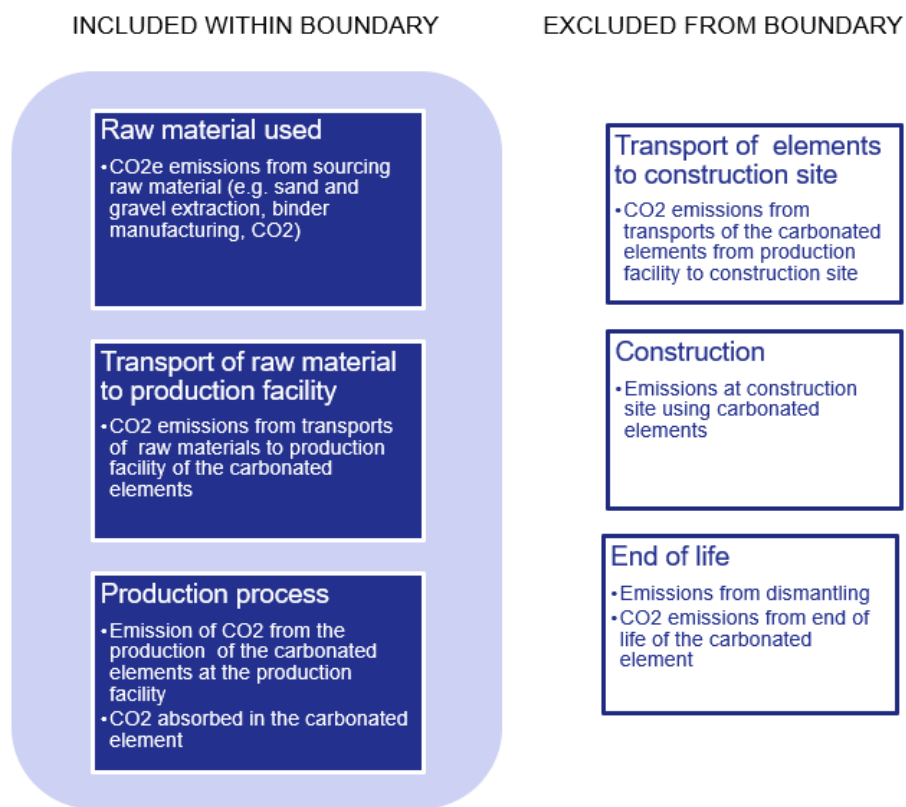


Figure 1. Activity boundary

4.1.2. Included within the boundary

- Raw material used: CO₂ emissions from extraction and production of the raw material used for the production of the carbonated elements.
- CO₂ emissions from transporting the raw material to the production facility where the carbonated building elements are produced.
- If the raw material is classified as a waste product the emissions are zero at the point of creation of the waste. CO₂ emissions for transport from the point of creation of the waste to the production site are in this case included within the boundary.
- Leakage of CO₂ from the finished product in normal use conditions does not occur (but is within the boundary).
- The carbonated element will be used for construction purposes only and the storage of CO₂ is a priori permanent regardless of the use of the carbonated building elements. Thus, no further proof regarding its specific end-use is required other than that its characteristics make it possible to use for construction (proof is obtained in the Production Facility Audit).

4.1.3. Excluded from the boundary

- Transport of the carbonated building elements from the production facility, where the carbonated building element is produced, to the construction site are not within the boundary.
- End of life emissions from demolition or other transformations at end of life are not considered. At end of life the carbonated element retains the stored CO₂ – hence the removal is a priori permanent. The demolition of a house or other constructions made from the carbonate building element does not impact the CO₂ storage capability.

5. Quantification of CO₂ Removal – calculation methodology

5.1. Production volume

5.1.1. The producer of the carbonated building element (Removal Supplier) provides data and documentation on the production volume (in kg) of the carbonated elements produced in the production process of the eligible production facility.

5.2. CO₂ storage volume (CO₂ captured in the carbonated building element)

- 5.2.1. The amount of storage of CO₂ in the carbonated element is based on measurements or on other scientifically sound methods verified by a qualified third party auditor.
- 5.2.2. The information from a reliable LCA or EPD verified by a third party auditor can also be used.

5.3. Buffer for uncertainty assessment

- 5.3.1 A Buffer is used to correct the Output to account for possible uncertainties in e.g. metering inaccuracies, losses of the CO₂ storage after production, or other losses that may occur. A correction in the form of a buffer in percentage (%) is used to reflect the uncertainty and to reduce the volume of CO₂ removal Output to be certified i.e. $\text{uncertainty-corrected CO}_2 \text{ Removal Output} = \text{Output} * (100\% - \text{Buffer})$
- 5.3.2. During production: Metering inaccuracies in production volumes, in CO₂ content in the element due to sampling or testing techniques, or other metering used in quantification needs to be estimated and a corresponding buffer-percentage defined
- 5.3.3. During use: The amount of decomposing or re-emitting of CO₂ in the normal use of the product needs to be estimated. If there is no re-emitting or decomposition, proof needs to be presented that the product does not leak CO₂ and the storage is permanent in normal conditions (e.g. theoretical calculations, chemical formulas or test results).
- 5.3.4. Any other uncertainties or other losses of the CO₂ Removal Output that may occur needs to be estimated and corresponding buffer-percentage defined.

5.4. Emissions from the activity of producing the carbonated CO₂ absorbing elements and for the supply chain that is included within the boundary

- 5.4.1. Calculation of CO₂e emissions from the supply chain of the raw material used in the production of the element, including transport of the raw material to the production facility.

- 5.4.2. Calculation of CO₂ emissions from the production process of the carbonated building elements, for the monitoring period. Emissions from e.g. energy use or other CO₂ losses in the production process are calculated from actual data.
- 5.4.3. The calculations need to be done according to standards ISO 14067 Greenhouse gases- Carbon footprint of products - Requirements and guidelines for quantification, EN 15804 or similar.
- 5.4.5. The information from a reliable LCA or EPD verified by a third party auditor can also be used.
- 5.4.6. Leaking CO₂ during production process is included in the emissions calculation.

5.5. Use of existing EPD or LCA as proof

- 5.5.1. Existing Life Cycle Analysis (LCA) results or Environmental Product Declaration (EPD) that has the same scope and boundaries as described above (A1-A3) and which has been verified by a third party can be used as sufficient proof for (4.2 – 4.4).

5.6. Calculation parameters

Q_{elements} = Production volume of carbonated elements produced (in kg)

C_{elements} = CO₂ storage volume per element (in kg CO₂ / kg elements)

B_{elements} = Buffer for possible CO₂ re-emitted during Product life-time (in percentage)

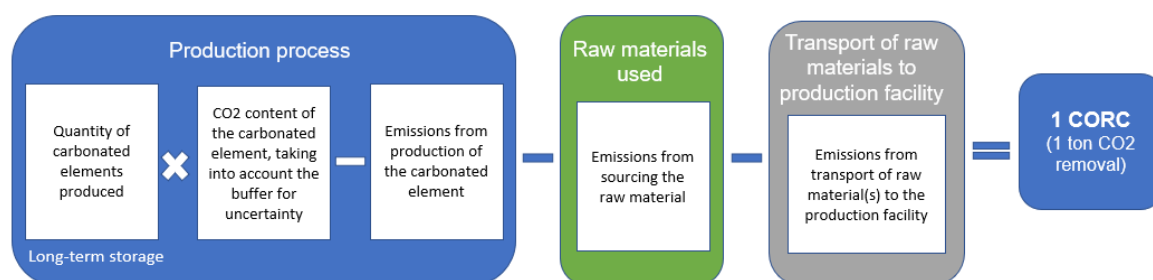
E_{element} = Net emissions from carbonated element production at the production facility (kg)

L_{elements} = Leakage of CO₂ in production process (kg)

ET_{rawmaterial} = Emissions from transport of raw materials to the carbonated element production facility (kg)

E_{rawmaterial} = Emissions from extraction or production of raw material before transport to the element production facility (kg)

5.7. Calculation formula of CO₂ content



$$Q_{\text{element}} \times (C_{\text{element}} * (100\% - B_{\text{element}})) - (E_{\text{element}} + L_{\text{element}}) - (ET_{\text{rawmaterial}} + E_{\text{rawmaterial}}) = \text{CO}_2 \text{ Removal (kg)}$$

6 Proofs and evidence needed from the CO2 Removal Supplier

6.1 Principle

- 6.1.1. Output from a production facility is determined as eligible for issue of CO2 removal certificates once the facility has undergone a process of third-party verification by an auditor against the specific methodology for the carbonated building element. This verification is done in a **Production Facility Audit**. The verification ensures that the corresponding CO2 removal has taken place and that the CO2 removal is considered permanent as defined in the methodology.
- 6.1.2. For the activity to be eligible for producing carbonated building elements for which a CO2 removal certificate can be issued, the following proofs (6.2- 6.4) need to be presented by the CO2 Removal Supplier (in this case, the producer of CO2 positive carbonated building elements).

6.2 Raw materials used

- 6.2.1. Proof of raw material use: Information is needed on the used materials and their composition, CO2 emissions from extraction and manufacturing. The raw materials (e.g. sand, gravel, binder, CO2, water) should be sustainably sourced and sourced in accordance to local and EU legislation. If there is a national or other applicable scheme for sustainable sourcing, it is recommended that it is used. (One example is the Dutch, Environmental Performance based on the Determination Method, which enables comparing the sustainability of raw-materials, more information www.nibe.info.)
- 6.2.2. The proofs can be in the form of third party verified LCA or EPD.

6.3 Production process of the CO2 positive carbonated product and quality of the product

- 6.3.1. Proof of CO2 positive production: Proof is needed that the production process and technology used for the manufacturing of the carbonated building element results in a net CO2-positive product. Description of the technology used is needed (capability of the facility of producing carbonated elements).
- 6.3.2. Lab test results or other scientifically reliable analysis or evaluation by a trusted third party is needed on the amount of CO2 that is absorbed in an element as well as for the CO2 emissions created in the production process (e.g. energy use or CO2 emitted or lost in the production process).
- 6.3.3. Proof is needed on of the amount of leakage or no leakage of CO2 from the carbonated element after production. The proof can be in the form of a chemical formula or other science-based method that can be verified by a qualified third party.
- 6.3.4. Proof of quality of the carbonated element must be presented utilizing existing, credible lab test results of product quality (composition of the product) and assessment by a third party that the product can be used for construction purposes.
- 6.3.5. The data regarding the producer of the carbonated building element needs to come from primary sources and needs to be valid (representative) for the period for which the declaration is issued.

- 6.3.6. Standards to be used are ISO 14067 Greenhouse gases- Carbon footprint of products - Requirements and guidelines for quantification and EN 15804 or similar.

6.4 Proof of the end use of CO2 removing product

- 6.4.1. Proof of the end use of the CO2 removing product: No separate proof of end use or use in construction is necessary for the carbonated building element. The product is used in construction and will in normal use not be heated to temperatures where CO2 leaks (temperature where there could be a CO2 leak is at temperatures above 800 C). The CO2 stored in the product will not be re-emitted in case the house or construction where the product is used is demolished. The crushed elements can be reused (e.g. used for road construction or used again in new carbonated products) without the captured CO2 leaking.

6.5 Proof of no double counting

- 6.5.1. A statement is needed from the Removal Supplier that the underlying physical product (carbonated building element) in which the CO2 is stored will not be sold or marketed as “carbon positive” if the CO2 removal certificate associated with the underlying physical product (carbonated building element) is removed from the underlying product and sold to another stakeholder not associated with the underlying physical product.
- 6.5.2. No marketing and branding claims can be made by the end-user (e.g. construction company) that a building constructed with the underlying physical product (carbonated building element) is a carbon sink if the decoupled CO2 certificate has been sold to and cancelled by another stakeholder not associated with the underlying physical product.

Annex C: Wooden Building Element Methodology

This methodology quantifies the CO2 Removal achieved by production of **wooden building elements**.

CO2 Removal results from the wooden building elements storing the carbon captured by trees. The CO2 removal is considered long-term, when used in construction of buildings.

This methodology is applicable to certificates issued for the CO2 Removal Marketplace.

1 Eligible activity types

1.1 Requirements for activities to be eligible under the methodology

- 1.1.1. Production of engineered wooden building elements (mass timber elements, glued laminated timber, cross-laminated timber, laminated veneer lumber or cellulose fiber insulation CFI), sourced from sustainably managed forests and plantations in Europe, and used for the construction of buildings.
- 1.1.2. Elements need to be installed-to-measure, pre-cut and ready for construction when shipped from the production facility, so that there is no material loss at the construction site which would decrease the CO2 Removal captured by and embedded in the product.
- 1.1.3. The eligibility of the production facility is determiner in the **Production Facility Audit**

1.2 Requirements for the Production Facility Audit

- 1.2.1. The Production Facility Auditor checks the Production Facility against the Eligible activity types (section 1), and the Proofs and evidence needed from the CO2 Removal Supplier (section 5). The main requirements include:
 - The raw materials used in the production of the elements are sustainably sourced (see section 1.1 and 5.2.1.)
 - The Production Facility has a valid Environmental Product Declaration or similar certificate, Auditor checks date of certificate issuance (see section 5.3.1.);
 - The building elements are of eligible type and the elements are pre-cut and ready for construction when shipped from the production facility, so that there is no material loss at the construction site which would decrease the CO2 Removal impact after shipping.
- 1.2.2. The Production Facility Auditor checks that the Production Facility is capable of metering and quantifying the Output in a reliable manner, for the Quantification of CO2 Removal (section 4). This check also prepares the CO2 Removal Supplier for producing the periodic Output Report.
 - The quantity of the wooden building elements produced and shipped is quantified and documented in a reliable manner (sections 4.1.1., 5.3.2. and 5.4.)
 - Relevant meters are in place and they are calibrated;

- The energy use of the Production Facility can be quantified and the emissions from the process calculated (section 4.4.2.);
- The emissions from the harvesting and transporting of the raw material are estimated and calculated in a reliable manner (section 4.4.4.)
- The size of the buffer for uncertainty (section 4.3.3.) is correct for the Production Facility in question
- The auditor goes through the Quantification of CO₂ Removal requirements with the CO₂ Removal Supplier, so that the Supplier is able to calculate the CO₂ Removal independently in its Output Report.

1.2.3. Collection of standing data of the Production Facility

The Production Facility Auditor collects and checks the standing data of the Production Facility and the CO₂ Removal Supplier. The data to be collected by the Auditor includes:

- CO₂ Removal Supplier registering the Production Facility;
 - A certified trade registry extract or similar official document stating that the organization is validly existing and founded under the laws of the mother country.
- Location of the Production Facility;
- Volume of Output during the full calendar year prior to registration;
- Removal Method(s) for which the plant is eligible to receive CORCs;
- Date on which the Production Facility becomes eligible to receive CORCs;
- Whether the Production Facility has benefited from public support.

2 Point of creation of the CO₂ Removal Certificate (CORC)

2.1 Point of creation

- 2.1.1. The point of creation of the CO₂ Removal Certificate is the production process of engineered wooden building elements, when the elements are produced and shipped. The end use of the product in construction needs to be proven.
- 2.1.2. The producer of the engineered wooden building elements is the CO₂ Removal Supplier.

3 Activity boundary for CO₂ Removal Certificate

3.1 Activity boundary

The blue box in the figure 1 below illustrates the activities included in the activity boundary. Emissions from the raw materials, transport of raw materials and production of the wooden building elements are included in the quantification and calculation of CO₂ Storage of the wooden building elements.

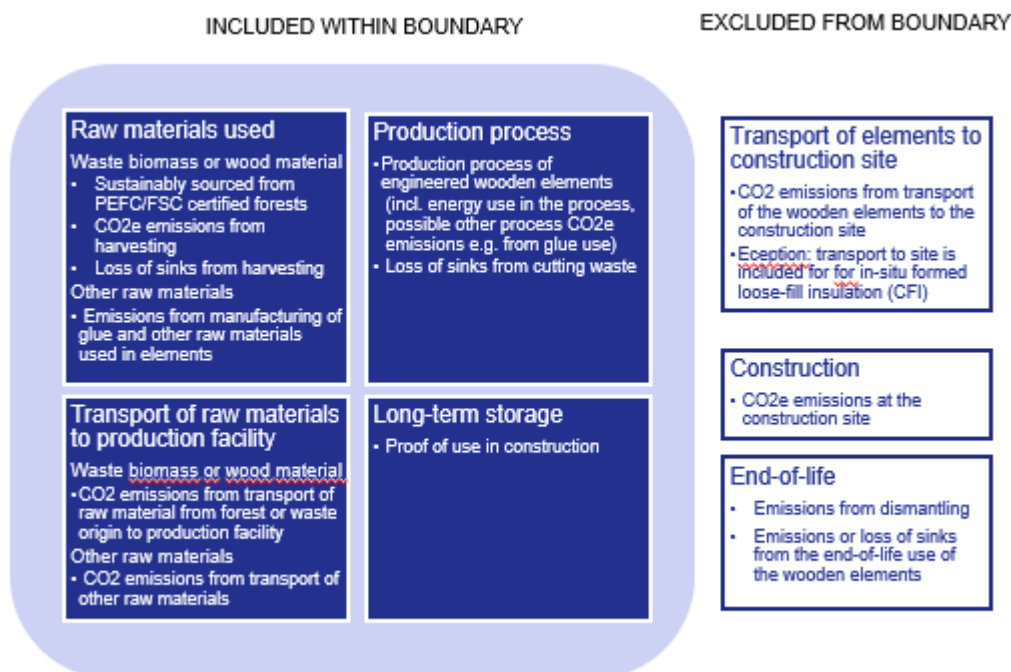


Figure 1: Activity boundary

3.1.1. Included within the boundary:

- Waste biomass or wooden raw material needs to be sourced from forest or plantations in the European Union that are certified with Programme for the Endorsement of Forest Certification (PEFC) Sustainable Forest Management Standard or Forest Stewardship Council (FSC) Forest Management Certification.
- Waste biomass or wooden raw materials sourcing: Quantify emissions and possible loss of sinks from sourcing or harvesting of the raw material, as included in the Environmental Product Declaration (EPD) requirements for construction products⁵ and described in the EPD of the engineered wooden building element.
- Other raw materials like glues, adhesives, resins, finishing, fire retardants etc.: Quantify the emissions caused by manufacturing the amount of other raw material used in the wooden building element.
- Emissions from the transport of raw materials to the production facility, as included in the EPD of the engineered wooden building element.
- Quantify emissions of the production process of the engineered wooden building elements including energy use in the process and potential other emissions from the production process, such finishing or blowing in-situ.
- Quantify CO2 storage or carbon content (kg CO2eq.) in the finished element as defined in the Environmental Product Declaration, laboratory tests or other similar verified documents.
- Quantify Duration of the CO2 storage, related to the construction use in specific type of building.

⁵ EN 15804:2012+A1:2013 Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.

3.1.2. Outside the activity boundary:

- Emissions from transport of the wooden building elements to the construction site, as they should be calculated in the carbon footprint of the constructing activity
- Emissions from the construction process, as they should be calculated in the carbon footprint of the constructing activity. Exception: in case of in-situ formed loose-fill CFI the emissions of transport of the CFI insulation material and the installation equipment to construction site is included.
- Use of the wooden material after the dismantling of the building. Depending on the recycling method the CO₂ storage of the wooden building element may remain or be decomposed. The CO₂ removal impact after life-time of the building is therefore not included in the CO₂ Removal Certificate.

4 Quantification of CO₂ Removal – calculation methodology

This calculation can be done with using corresponding figures from an existing Environmental Product Declaration (EPD) of the engineered wooden building elements, using Sections A1-A3 of the EPD. Alternatively, other figures can be used, e.g. from an LCA or carbon footprint calculation, if proof of their quality can be presented.

4.1 Production volume

- 4.1.1. The producer of the wooden building element (CO₂ Removal Supplier) provides data and documentation on the production volume (in kg) of the elements produced in the production process of the eligible production facility.

4.2 CO₂ storage volume (CO₂ captured and embedded in the product)

- 4.2. Calculation of the CO₂ storage volume (biogenic carbon content) can be based on data from the Environmental Product Declaration (EPD) or similar certification/declaration of the product. In the EPD the biogenic carbon content of wood is calculated by EN 16449 standard, which is based on the ISO 14067 standard.

4.3 Buffer for uncertainty assessment

- 4.3.1. A Buffer is used to correct the Output to account for possible uncertainties in e.g. metering inaccuracies, losses of the CO₂ storage after production, or other losses that may occur. A correction in the form of a buffer in percentage (%) is used to reflect the uncertainty and to reduce the volume of CO₂ removal Output to be certified i.e. $\text{uncertainty-corrected CO}_2 \text{ Removal Output} = \text{Output} \times (100\% - \text{Buffer})$
- 4.3.2 During production: Metering inaccuracies in production volumes, in CO₂ content in the element due to sampling or testing techniques, or other metering used in quantification needs to be estimated and a corresponding buffer-percentage defined.
- 4.3.3. During use: Possible decomposing or re-emitting during the life-time of the product: In case of wooden building elements there is a small risk that the CO₂ is re-emitted to the atmosphere before the end of

life of the building (see section 4.8.2.). Such unlikely incidents include fire in the building, flooding causing building elements decomposing, and other unlikely incidents.

4.3.4. In case of wooden building elements, the buffer is set at 10%. The buffer can later be amended by the Issuing Body.

4.4 Emissions from the activity of producing wooden building elements and for the supply chain that is included within the boundary

4.4.1. Emissions from sourcing or harvesting the raw material

Wood material:

- Estimate of CO₂ emissions from sourcing or harvesting the raw material (as per EPD or similar)
- Estimate of CO₂ emissions from transport of the wood material from the forest to the production facility (as per EPD or other similar).

Other raw material (e.g. adhesives, finishing, fire retardant etc.):

- Estimate of CO₂ emissions from the manufacturing of the raw material
- Estimate of CO₂ emissions from the transport of the raw material to the production facility

4.4.2. Emissions from the activity of production of the product

- Calculation of emissions from the production process for the reported Output period
 - Energy use in the production process, calculation from actual data
 - Other possible Green House Gas emissions from the production process (in ton CO₂eq.)

4.5 Use of existing EPD or LCA as proof

4.5.1. Existing Life Cycle Analysis (LCA) or Environmental Product Declaration (EPD) that has the same scope and boundaries as described above (A1-A3) and which has been verified by a third party can be used as sufficient proof for (4.2 – 4.4).

4.6 Calculation parameters

Q_{element} = Quantity of wooden building elements produced and shipped to construction company (in kg or m³)

C_{element} = Carbon content of the wooden building elements (in kg CO₂ / kg or m³ of product)

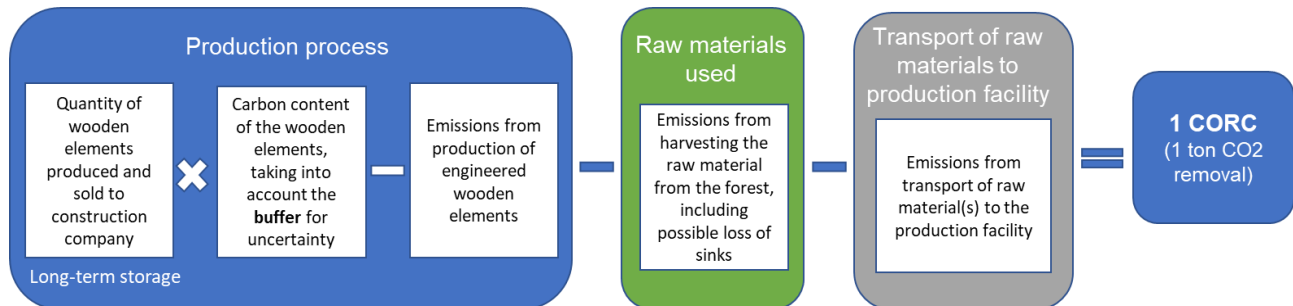
B_{element} = Buffer for possible CO₂ re-emitted during Product life-time (in percentage)

E_{element} = Emissions from production of wooden building elements

$E_{\text{rawmaterial}}$ = Emissions from sourcing or harvesting the raw material from the forest, including possible loss of sinks from harvesting

$ET_{\text{rawmaterial}}$ = Emissions from transport of raw material to the production facility

4.7 Calculation formula of CO₂ removal



4.7.1. Mathematical formula

$$Q_{\text{element}} \times (C_{\text{element}} (100\% - B_{\text{element}})) - (E_{\text{element}} + E_{\text{rawmaterial}} + ET_{\text{rawmaterial}}) = \text{CO}_2 \text{ Removal (in kg)}$$

Note: 1 certificate = removal of 1000 kg CO₂

4.8 Long-term CO₂ storage

- 4.8.1. The element withholds CO₂ captured in the waste biomass or wooden biomass in the forest. The stored amount of CO₂ is calculated with the formula above deducting the production process emissions and other emissions from the stored CO₂ content in the element.
- 4.8.2. The wooden building element functions as a long-term CO₂ storage, when used in a building with long lifetime. Buildings are designed for a lifetime for over 50 years, as required in the European Standard EN 1990 (2002): Eurocode - Basis of structural design⁶. According to the Eurocode standard, the minimum designed lifetimes for all buildings in the EU are the following:

Design working life category	Working life in years
4. Building structures and other common structures	Minimum 50 years

⁶ EN 1990 (2002) (English): Eurocode - Basis of structural design [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]. Available at: <https://www.phd.eng.br/wp-content/uploads/2015/12/en.1990.2002.pdf> Page 28.

5. Monumental building structures, bridges and other civil engineering structures	Minimum 100 years
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Because buildings in the EU designed to last over 50 years, the CO₂ storage in a wooden building is considered long-term.

5 Proofs and evidence needed from the CO₂ Removal Supplier

5.1 Principle

- 5.1.1. Output from a production facility is determined as eligible for issue of CO₂ Removal Certificates once the facility has undergone a process of third-party verification by an auditor against the specific methodology for the wooden building element. This verification is done in a **Production Facility Audit**.
- 5.1.2. For the activity to be eligible for producing wooden building elements for which a CO₂ removal certificate can be issued, the following proofs (5.2- 5.4) need to be presented by the CO₂ Removal Supplier, in this case, the producer of wooden building elements.

5.2. Raw material use

- 5.2.1. Proof of the sustainability of the raw material used. Proof to be presented:
 - Programme for the Endorsement of Forest Certification (PEFC) Sustainable Forest Management Standard: National standard under the PEFC, such as PEFC Finland Standard ([PEFC FI 1002:2014](#)); or
 - Forest Stewardship Council (FSC) Forest Management Certification, e.g. FSC Standard for Finland ([FSC-STD-FIN-\(Ver1-1\)-2006](#));
 - or similar

5.3. Production process of the engineered wooden building elements and the quality of the product

- 5.3.1. Product quality

Proof of CO₂ removing production – proof that the production technology of the product is net CO₂-removing

Proof to be presented:

 - Ecological Balance Sheet and/or

- Environmental Product Declaration (EPD) for the wooden building element or the product
- In the case of the EPD, standards EN 15804⁷ and EN 16485⁸ serve as the core product category rules for the assessment. Biogenic carbon content of wood is calculated by EN 16499⁹ standard.

or

- LCA results of the production process, if possible, including information on the carbon sink qualities of the timber; and/or
- Lab results on the quality of the timber, e.g. carbon content of the product.

5.3.2. Proof of production volume

The production volume needs to be proven, as it is the basis of the amount of Certificates to be issued to the Production Facility.

Producer provides Output Report, containing data and documentation on the amount of engineered wooden building elements produced (in kg or m3)

Proof to be presented:

- Continuous production documentation for the whole period (book-keeping), taking into account any significant changes or stops in production

5.4. Proof of the end use of CO2 removing product

5.4.1. Proof of long-term CO2 storage: proof that the end-use of the product does not cause CO2 returning to the atmosphere

Proof to be presented:

- Shipping documentation of the delivery of the product to a building site, indicating that it is going to be used in construction of buildings.

5.5. Proof of no double counting

5.5.1. Proof of no double counting on product level: Proof that the final end-use product (e.g. building) will not be sold as “carbon positive/sink” if the certificate is removed from the activity and sold to another organization.

- A statement is needed from the Removal Supplier that the underlying physical product in which the CO2 is stored will not be sold or marketed as “carbon positive/sink” if the certificate

⁷ EN 15804: Sustainability of construction works, Environmental product declarations, Core rules for the product category of construction products

⁸ EN 16485: Round and sawn timber. Environmental Product Declarations. Product category rules for wood and wood-based products for use in construction

⁹ EN 16499: Wood and wood-based products. Calculation of the biogenic carbon content of wood and conversion to carbon dioxide

associated with the underlying physical product is removed from the underlying product and sold to another stakeholder not associated with the underlying product.

- No marketing and branding claims can be made by the end-user (construction company) that a building constructed with the underlying physical product is a carbon sink if the decoupled CO₂ certificate has been sold to and cancelled by another stakeholder.

Annex D: List of Issuing Body's Agents

List of Output Auditors:

DNV GL

List of Production Facility Auditors:

DNV GL

Annex E: Report and Document Templates

Cancellation Request

Question	Answer
Volume of CORCs to be cancelled	
Identifier of CORCs to be cancelled	
Beneficiary name and business identity	
Beneficiary country	
Use purpose (please specify, where applicable, if the CORC is used for a specific product, general CSR, etc...)	
Use time period (e.g. calendar year) (please specify the time period of operation for the benefit of which the CORC Cancellation is used).	
Has the Production Facility benefitted from public support? (yes/no)	

Output Report

Output Audit Report

Production Facility Audit Report

Production Facility Audit Statement

Production Facility Registration Form

Question	Answer
Name of the CO2 Removal Supplier registering the Production Facility	
Name of the Production Facility	
Production Facility street address	
Production Facility geographical coordinates	
Estimated volume of CO2 Removal during the previous calendar year	

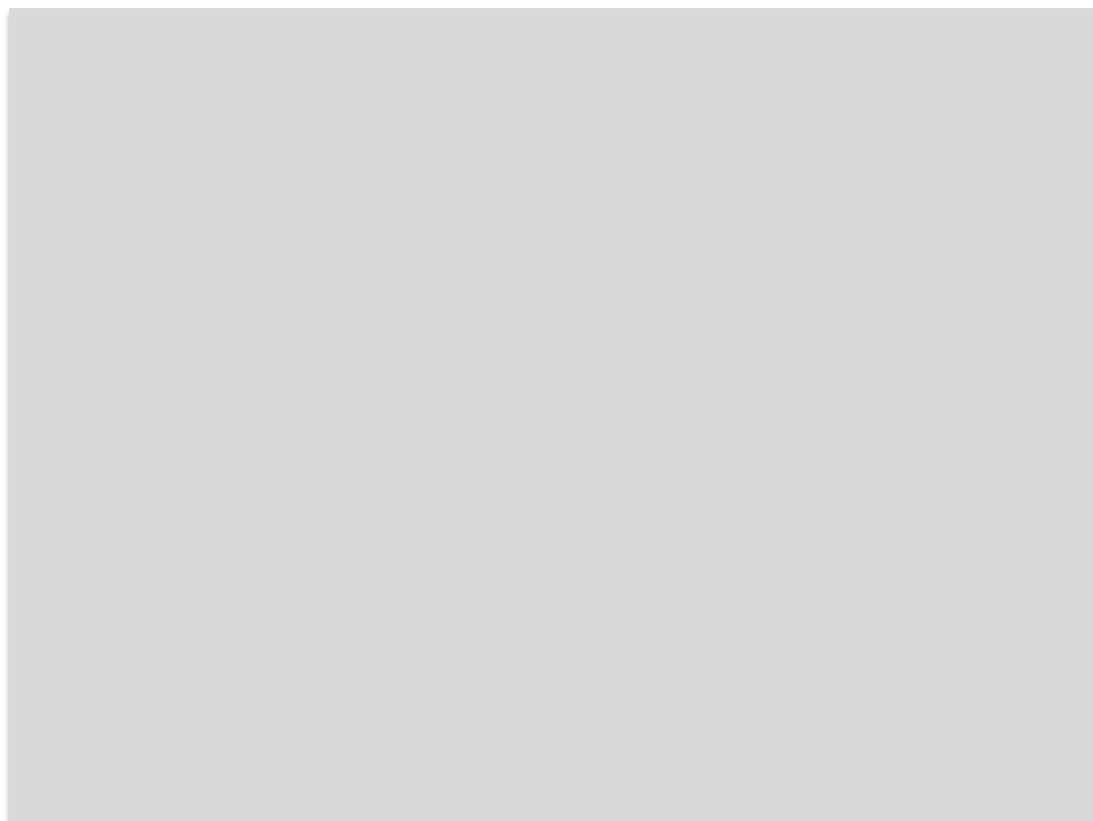
Removal Method(s) for which registration is sought, being either: <ul style="list-style-type: none">• Biochar• Carbonated building element• Wooden building element	
Has the Production Facility benefitted from public support? (yes/no)	

Annex F: List of Signatories (not public)

List of signatories of Puro CO2 Removal marketplace by 14th of March 2019.

For each signatory the main contact person's email address is listed. If you want to change the main contact person, please send email to contact@puro.earth.

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Document History

The new version of the document is effective on Issue Date.

Version	Issue Date	Comment
v1.0	17 April 2019	Initial version elaborated with List of Signatories and publish on puro.earth website on the launch date of Puro CO2 removal marketplace.
V1.1	13 June 2019	Update to annex C and F - Annex C. Wooden Building element methodology modified to incorporate also biomass-based insulation materials. - Annex F. List of signatories included confidentially (not changed)

V1.2	08 October 2019	<p>Updates</p> <ul style="list-style-type: none"> • Chapter 3.2.4: CORCs may be issued for 18 months old production (previously 12 months) • Chapter 3.3: editorial changes • Chapter 3.4: Pre-purchase of Certificates (CORCs) • Chapter 6.4: Aim to use CORC income for growth
V1.3	06 December 2019	<p>Updates</p> <ul style="list-style-type: none"> • Chapter 3.3: Certificate auctioning (changes from 48h blind to 96h half-blind) • Chapter 3.4: Pre-purchase of Certificates (changes due to action mechanism update) • Chapter 3.5 Certificate online purchase (added) • Chapter 6.2: CORCs issued in Experiment phase will expire normally 12 months after Issuance date.
V1.4	April 2020	<p>Updates</p> <ul style="list-style-type: none"> • Chapter 3.7 and 6.2: Extension of the expiry date by 6 months • Chapter 3.5.6: Online shop closed for 3 hours before and after the auction • Chapter 3.5: Possibility to select removal method in online shop • Numbering of subparagraphs in Chapter 1.5. and Annex A,B,C
V2.0	June 2020	<ul style="list-style-type: none"> • Chapter 3.1: Settlement is no longer tied to auctions • Chapter 3.4: Purchase through Certificate Listing Service enabled • Chapter 3.4: Pre-Purchase transactions enabled outside auctions • Chapter 3.4.3: Transfer Request added to Pre-purchase agreement process • Chapter 4.3: Sale of CORCs enabled in external marketplaces • Annex A, 1.1.12: requirements for safe handling of biochar