Puro.earth Biochar Methodology

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Annex A: Biochar Methodology

This methodology quantifies the net CO_2 Removal achieved over the time horizon of 100 years by the production of **biochar**, when used in applications placed in the environment.

CO_2 Removal results from the conversion of biomass to biochar with long-term chemical and biological stability, i.e. high resistance to degradation process when placed in the environment. Carbon captured in biomass by photosynthesis is stabilised in biochar and return to the atmosphere delayed by orders of magnitude compared to parent biomass.

This methodology is applicable to certificates issued for the CO_2 Removal Marketplace.

1 Eligible activity type

An eligible activity is an activity capable of producing as output biochar with long-term stability. CO_2 Removal results from organic biomass being heated with no or limited supply of oxygen, such as pyrolysis or gasification processes. The pyrolysis gases must undergo engineered emissions control to decrease methane to negligible levels.
In such processes, the biomass undergoes a carbonization reaction forming solid biochar. Biochar is a material in which the carbon atoms have bonds stronger than those found in the parent biomass, and is therefore resistant to biotic and abiotic degradation processes when placed in the environment.

Biochar stability can be estimated from biochar properties, specifically the molar hydrogen to organic carbon ratio (H/C_{org}). Material with an (H/C_{org}) ratio lower than 0.2 is characterized as being hardly degradable in the environment[4].

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

Requirements for activities to be eligible under the methodology

1.1.1. Use of biochar in applications placed in the environment (e.g. greenhouse substrates, surface water barrier, animal feed additive, wastewater treatment, insulation material, landfill/mine absorber, soil additive). Biochar sequesters carbon over centennial timescales, when not used as fuel or reductant. Therefore, its energy and reductant use is excluded, and all other uses are eligible.

1.1.2. Biochar needs to be produced from sustainable biomass: sustainably sourced biomass, or waste biomass such as agricultural waste, biodegradable waste, urban wood waste or food waste. A list of biomass types can be found in IPCC Appendix 4 Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments (Table 4AP.1)[5] and the positive list of biomass feedstock of the European Biochar Certificate[6].

[4] Schimmelpfennig, S. and Glaser, B. (2012), One Step Forward toward Characterization: Some Important Material Properties to Distinguish Biochars. J. Environ. Qual., 41: 1001-1013. https://doi.org/10.2134/jeq2011.0146

[5] Appendix 4 Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Ap4_Biochar.pdf . https://doi.org/10.1021/acs.est.1c02425

[6] Positive list of biomass feedstock https://www.european-biochar.org/en/ct/2-EBC-guidelines-documents-for-the-certification

- In case of agricultural waste sustainable collection means that 30% of residues are left to the field to avoid decreasing soil health and crop levels[7].
- Timber that has been damaged by a natural disaster (e.g. fire, pests, flood) and cannot be economically recovered or used as originally intended
- Use of invasive species, meaning plants that are not native to the region of activity and are causing environmental harm, are eligible biomass for biochar activity when following requirements are met: i) the species to be cleared are recognized by an appropriate state or national authorities and ii) the carbonization of the cleared waste is not mandated or legally required by relevant authorities and iii) the CO2 removal Supplier has procedures in place to differentiate the invasive species from other local species, and to avoid unintended clearing of existing native vegetation within the project area

1.1.3. The producer must demonstrate net-negativity with results from a life cycle assessment (LCA) or carbon footprint of the biomass production and supply, the biochar production process, and of the biochar use, including disaggregated information on the emissions arising at different stages. Life cycle assessment (LCA) shall present carbon footprint cradle-to-grave according to ISO standard or WRI GHG protocol.

1.1.4. The direct use of fossil fuels for heating the pyrolysis reactor is prohibited, unless only used for ignition/pre-heating or in a mobile unit and the emissions are fully included in the LCA. The use of waste heat from other industrial processes, such as bio-digesters or cement production is permitted.

1.1.5. In the biochar production process, the pyrolysis gases must be combusted or recovered through an engineered process that either negates or makes negligible any methane emissions to the atmosphere. Bio-oil and pyrolysis gases can be stored for later use as renewable energy or materials.

1.1.6. The molar H/C_{org} ratio must be less than 0.7. The H/C_{org} ratio is an indicator of the degree of carbonization and therefore of the biochar stability. Values exceeding 0.7 are an indication of non-pyrolytic chars or pyrolysis deficiencies[8].

1.1.7. Measures have to be taken for ensuring safe working environment and 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.

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

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 general rules of Puro Standard and the specific requirement in this methodology (section 1.1.), and the Proofs and evidence needed from the CO_2 Removal Supplier (section 5).

1.2.2. The Production Facility Auditor checks that the Production Facility is able to demonstrate Environmental and Social Safeguards through one or several of the following:

- Environmental Impact Assessment (EIA)
- Environmental permit
- Other documentation on the environmental and social impacts
- When applicable, informed consent from local communities

[7] Battaglia, M., Thomason, W., Fike, J. H., Evanylo, G., von Cossel, M., Babur, E., Diatta, A. (2020). The broad impacts of corn stover and wheat straw removal for biofuel production on crop productivity, soil health and greenhouse gas emissions. https://doi.org/10.1111/gcbb.12774

[8] Schimmelpfennig, S. and Glaser, B. (2012), One Step Forward toward Characterization: Some Important Material Properties to Distinguish Biochars. J. Environ. Qual., 41: 1001-1013. https://doi.org/10.2134/jeq2011.0146

1.2.3. The Production Facility Auditor checks that the Production Facility is able to demonstrate additionality, meaning that the project must convincingly demonstrate that the CO2 removals are a result of carbon finance. Suppliers must also show that the project is not required by existing laws, regulations, or other binding obligations.

1.2.4. The Production Facility Auditor checks that the Production Facility is capable of metering and quantifying the biochar output in a reliable manner, for the Quantification of CO_2 Removal (section 4). This check also prepares the CO_2 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 4.2., 5.3., 5.4 and 5.5.)
- Relevant meters are in place and they are calibrated;
- The emissions from the cultivating, harvesting and transporting of the biomass are estimated and calculated in a reliable manner (section 4.3.)
- The energy use of the Production Facility can be quantified and the emissions from the process calculated (section 4.4.);
- The auditor goes through the Quantification of CO_2 Removal requirements with the CO_2 Removal Supplier, so that the Supplier is able to calculate the CO_2 Removal independently in its Output Report.

1.2.5. Collection of standing data of the Production Facility. The Production Facility Auditor collects and checks the standing data of the Production Facility and the CO_2 Removal Supplier. The data to be collected by the Auditor includes:

- CO_2 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.
- Documentation on Environmental and Social Safeguards imposed

2 Point of creation of the CO_2 Removal Certificate (CORC)

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, the end use of the biochar product needs to be proven to be other than energy use.

2.1.2. The producer of the biochar is the CO_2 Removal Supplier.

3 Assessment of life cycle greenhouse gas emissions and baseline

3.1. The CO_2 Removal Supplier shall provide a life cycle assessment (LCA) for biochar activity including disaggregated information on the emissions arising at different stages. The system boundary is set cradle-to-grave and shall include emissions from production and supply of the biomass, from biomass conversion to biochar, and from biochar distribution and use.

3.2. Life cycle assessment (LCA) shall follow ISO standard, WRI GHG protocol or similar method.

3.3. The default baseline emission scenario for the project activity feedstock is zero, which is a conservative assumption since it is not taking into account methane emissions derived from decay of manure or combustion of waste biomass. However, supplier could submit non-zero baseline emission claims if sufficient scientific demonstration is provided and accepted by Puro.Earth[9].

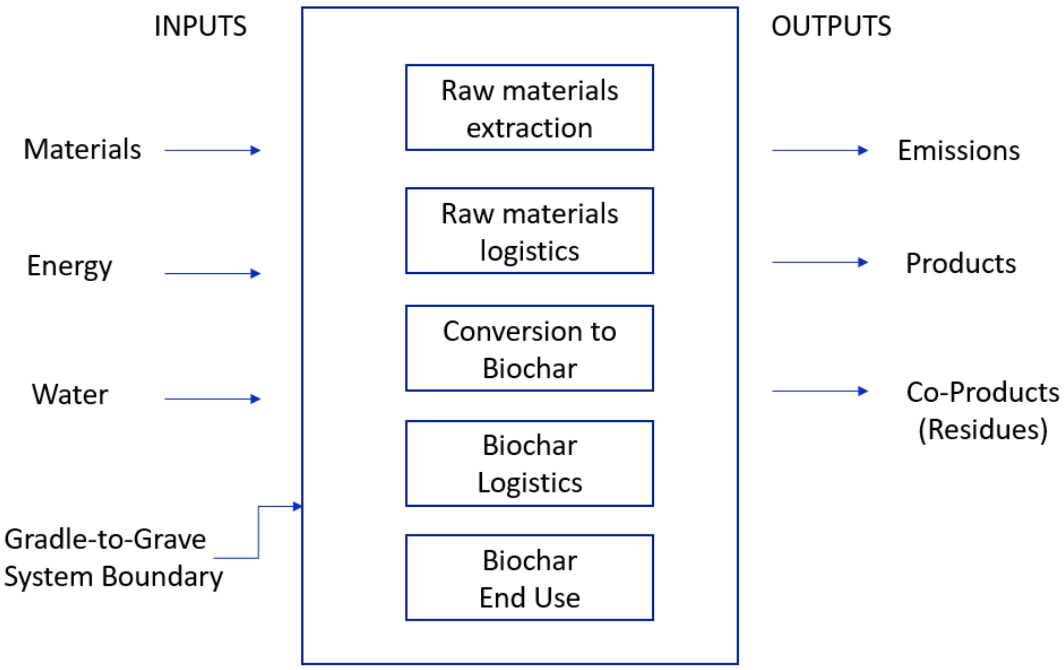

Figure 1. Overall System Boundary for life cycle assessment of a biochar activity. The details about the calculation of greenhouse gas emissions for each stage are described in Chapter 4.

[9] Bergman, Richard D.; Gu, Hongmei; Page-Dumroese, Deborah S.; Anderson, Nathaniel M. 2017. Life cycle analysis of biochar, https://www.fs.usda.gov/treesearch/pubs/54276

$E_{biomass}$= (A1) raw material extraction + (A2) raw material logistics
$E_{production}$= (A3) thermochemical conversion
E_{use}= (A4) biochar logistics + (B1) biochar end uses

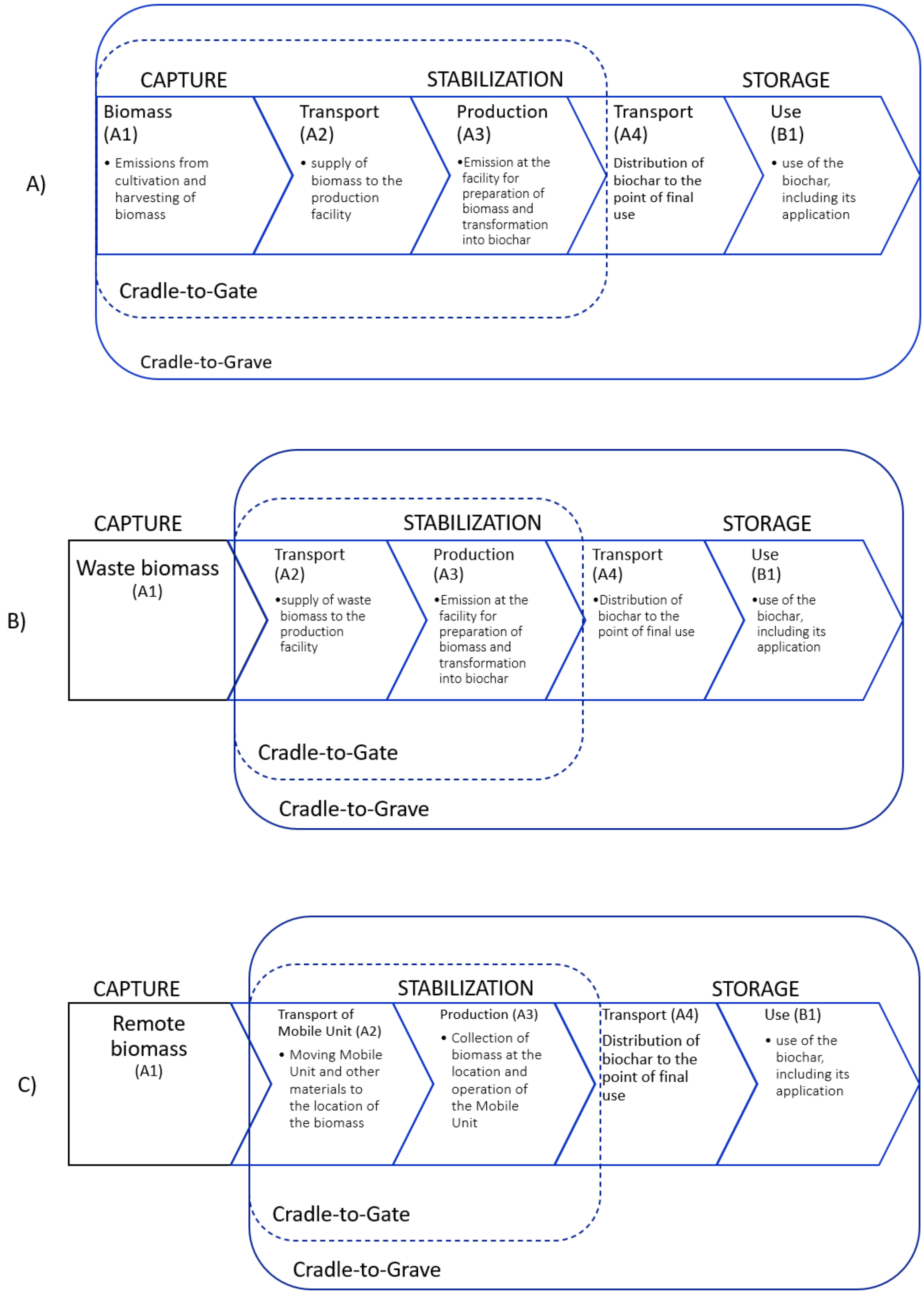

Figure 2. Overall System Boundary for life cycle assessment of a biochar activity (continued). The details about the calculation of greenhouse gas emissions for each stage are described in Chapter 4.

4 Calculation methodology for the quantification of CO_2 Removal

The purpose of this section is to present how to calculate the amount of carbon dioxide removal certificates (CORCs) resulting from the biochar production activity over a given reporting period, i.e. for a given amount of biochar produced. First, the overall equation and its parameters are presented. Then, details about the calculation of each term are summarized.

4.1 Overall equation for net carbon sequestration over 100 years

$$CORCs = E_{stored} - E_{biomass} - E_{production} - E_{use}$$

	$CORCs$	E_{stored}	$E_{biomass}$	$E_{production}$	E_{use}
Description	Amount of net CO_2-eq removed over 100-year period by the biochar production activity	Amount of CO_2 sequestered over a 100-year time horizon by the amount of biochar produced over the reporting period.	Life cycle greenhouse gas emissions arising from the production and supply of biomass to the production facility, including direct land use changes.	Life cycle greenhouse gas emissions arising from the transformation of the biomass into biochar, at the producing facility.	Life cycle greenhouse gas emissions arising from the use of the biochar, including its distribution up to the point of final use.
Unit	tonnes CO_2-eq	tonnes CO_2-eq	tonnes CO_2-eq	tonnes CO_2-eq	tonnes CO_2-eq

Figure 3. Overall equation to calculate the amount of CORCs supplied by the biochar production activity over a given reporting period. The tonnes unit refers here to metric tonnes (i.e. 1000 kg). All terms are counted as positive.

The overall equation is made of four terms (*Figure 3*). The first term (E_{stored}) describes the amount of carbon dioxide sequestered over a 100-year time horizon by the amount of biochar produced. Its calculation is explained in section 0, and is based on new results published in the peer-reviewed scientific literature[10]. The second term ($E_{biomass}$) describes the life cycle greenhouse gas emissions arising from the production and supply of biomass to the production facility, including direct land use changes. The third term ($E_{production}$) describes the life cycle greenhouse gas emissions arising from the transformation of the biomass into biochar, at the producing facility. Finally, the fourth term (E_{use}) describes the life cycle greenhouse gas emissions that occur along the distribution of the biochar up to its point of final use. Guidelines for calculation of $E_{biomass}$, $E_{production}$, and E_{use} are given in sections 4.3, 4.4, and 4.5, respectively.

Remark on sign conventions: In the equation above (*Figure 3*), the amount of CORCs and the four terms are positive numbers. The amount of CORCs supplied is equal to the amount of carbon dioxide sequestered by the biochar *minus* life-cycle emissions from the pyrolysis process, the biomass provision, and the biochar use.

4.2 Biochar carbon storage (E_{stored})

The term E_{stored} is calculated based on the methodology by Woolf and colleagues (2021)[10] that provides an estimate of biochar carbon sequestration at any given time horizon TH, for biochar used in soils at any soil temperature T_S. For the purpose of this methodology, the time horizon TH is set to 100 years. If needed, results can be calculated at any other time horizon using the supplementary information provided by Woolf and colleagues (2021)[10]. Regarding soil temperature T_S, there are large differences in 100-year biochar carbon sequestration between climates. Therefore, the methodology must be applied for a mean annual soil temperature T_S representative of the climate where the biochar is distributed and used. The global mean annual cropland temperature is about 14.9°C, but can vary between 5°C and 25°C between world regions.

[10] Woolf D, Lehmann J, Ogle S, et al (2021) Greenhouse Gas Inventory Model for Biochar Additions to Soil. Environ Sci Technol. https://doi.org/10.1021/acs.est.1c02425

Biochar used first in non-soil applications may have slower degradation rates. However, to date, no peer-reviewed methodology exists for estimating long-term carbon sink in such products. Therefore, the existing methodology for decomposition in soils is used even for non-soil applications, and it can be seen as a conservative estimate.

The methodology presented by Woolf and colleagues (2021) suggests three ways of calculating biochar carbon sequestration, based on the available information. Here, for the purpose of the Puro Standard methodology, only the first option is used, as is it recommended as the most accurate option.

The term E_{stored} is therefore given by the equation:

$$E_{stored} = Q_{biochar} \times C_{org} \times F_p^{TH,T_s} \times \frac{44}{12}$$

In this equation, three parameters are involved as well as a conversion factor:

- $Q_{biochar}$ is the amount of biochar produced over the reporting period. It is expressed in dry metric tonnes of biochar. Care must be taken to exclude any moisture, as including water would lead to an overestimation of the carbon actually sequestered.

- C_{org} is the *organic* carbon content of the biochar produced. It is expressed in dry weight of organic carbon over dry weight of biochar. C_{org} is determined by laboratory analyses of the biochar produced, with a representative sampling methodology. Care must be taken in case of very diverse biomass is used to produce biochar, so that the laboratory analyses are made for each type or batch separately.

- F_p^{TH,T_s} is the permanence factor of biochar organic carbon over a given time horizon TH in a given soil at temperature T_S. It is also known as biochar carbon stability, and it is expressed as a percentage (%). At a given TH and T_s, the permanence factor F_p^{TH,T_s} is only a function of the *molar* H/C_{org} ratio of the biochar and follows the linear relationship below:

  $$F_p^{TH,T_s} = c + m \times H/C_{org}$$

  The *molar* H/C_{org} ratio of a biochar sample is derived from the laboratory analysis as given or calculated from laboratory analyses dividing the hydrogen *mass* content by the *organic* carbon *mass* content of the biochar, and multiplying this with the ratio of carbon molar mass over hydrogen molar mass. In other words:

  $$H/C_{org}\,(molar) = \frac{m_H(\%)}{m_C\,(\%)} \times \frac{M_C\,(g\,mol^{-1})}{M_H(g\,mol^{-1})} = \frac{m_H(\%)}{m_C\,(\%)} \times \frac{12}{1.0}$$

  The regression coefficients c and m are a function of the time horizon TH and the soil temperature T_s. *Table 1* below provides the values of these two coefficients for a time horizon TH of 100 years, and for a range of soil temperatures T_s. To select the appropriate coefficients c and m to use, the biochar producer should consider the regions where the biochar is likely to be used[11]. If a main region for biochar use cannot be defined, the global mean soil temperature of 14.9°C can be used as a default value.

  <u>Remark on F_p^{TH,T_s} values above 100%:</u> at lower soil temperatures and with biochars having a low H/C_{org}, it is possible that the linear regression provides F_p^{TH,T_s} above 100%. In that case, the value should be set equal to 100%.

[11] Annual mean soil temperature in a specific area or country could be obtained from national statistical offices, or alternatively could be derived from the global soil temperature regime map. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_054019

Table 1. Regression coefficients for estimating biochar stability for a time horizon TH of 100 years at various soil temperatures T_S. Values for the closest soil temperature should be used.

Soil temperature T_S	c	m
5°C	1.13	-0.46
10°C	1.10	-0.59
15°C	1.04	-0.64
20°C	1.01	-0.65
25°C	0.98	-0.66
14.9°C	*1.04*	*-0.64*

- Finally, the factor $\frac{44}{12}$ is the ratio between the molar mass of carbon dioxide and the molar mass of carbon. This factor converts an amount of carbon to its corresponding amount of carbon dioxide.

Calculation examples

Five biochars were produced by different suppliers (A-E). After accounting for the moisture in the biochar, the biochar production amount is 1000 dry metric tonnes. Lab analyses were performed to determine the organic carbon content and the hydrogen content of the biochar, expressed in dry mass. With this information, the E_{stored} term is calculated at three different soil temperature.

At 10°C, the E_{stored} values are:

Biochar	$Q_{biochar}$	C_{org}	H	H/C_{org}	F_p^{TH,T_s}	E_{stored}
#	dry tonnes	%	%	mol/mol	%	tonnes CO_2
A	1000	93.8%	1.3%	0.16	100%	3439
B	1000	93.2%	1.1%	0.15	100%	3417
C	1000	83.9%	1.68%	0.24	95.8%	2948
D	1000	47.9%	1.1%	0.27	94.1%	1652
E	1000	87.7%	1.41%	0.19	98.8%	3177

At 14.9°C, the E_{stored} values are:

Biochar	$Q_{biochar}$	C_{org}	H	H/C_{org}	F_p^{TH,T_s}	E_{stored}
#	dry tonnes	%	%	mol/mol	%	tonnes CO_2
A	1000	93.8%	1.3%	0.16	93.8%	3225
B	1000	93.2%	1.1%	0.15	94.4%	3226
C	1000	83.9%	1.68%	0.24	88.6%	2727
D	1000	47.9%	1.1%	0.27	86.7%	1523
E	1000	87.7%	1.41%	0.19	91.8%	2953

At 25°C, the E_{stored} values are:

Biochar	$Q_{biochar}$	C_{org}	H	H/C_{org}	F_p^{TH,T_s}	E_{stored}
#	dry tonnes	%	%	mol/mol	%	tonnes CO_2
A	1000	93.8%	1.3%	0.16	87.4%	3007
B	1000	93.2%	1.1%	0.15	88.1%	3011
C	1000	83.9%	1.68%	0.24	82.2%	2528
D	1000	47.9%	1.1%	0.27	80.2%	1408
E	1000	87.7%	1.41%	0.19	85.5%	2748

4.3 Biomass production and supply ($E_{biomass}$)

The term $E_{biomass}$ should be derived from a life cycle assessment of the biomass production and supply to the biochar production site. Typically, the life cycle assessment of biomass production and supply includes three terms:

- Biomass production: this term shall include greenhouse gas emissions arising from all activities involved in the biomass cultivation and harvesting process, like the use of machinery and fuel, the production of fertilisers, emissions from soils following fertiliser use, machinery manufacturing and disposal.

- Direct land use changes: this term represents emissions arising at the site of cultivation of the biomass that are related to a change in land cover or land management. This can represent the emissions of carbon dioxide and other greenhouse gases from reforestation but also the loss of carbon in aboveground and belowground stocks when harvesting forest residues or agricultural residues. In many cases, direct land use changes are given a null value (0 emission from changes in biogenic carbon stocks), but this must be justified adequately with an explicit reference situation.

- Biomass transport: this term shall include emissions arising from transport of the biomass from the harvest site to the biochar production site, ideally including fuel emissions, but also vehicle and road infrastructure emissions.

  Mobile unit transport: when a mobile carbonizer or similar movable unit is used, this term shall include emissions arising from moving the unit to the biomass location.

4.4 Biochar production ($E_{production}$)

The term $E_{production}$ should be derived from a life cycle assessment of the biochar production process. This term should include all greenhouse gas emissions from the activities involved in the conversion of biomass to biochar.

List of activities that may be relevant to include in the life cycle assessment:
- Biomass handling on site (transport or conveying of the biomass within the facility)
- Drying, chipping, comminution, and/or sieving of the biomass
- Operation of the pyrolysis reactor and post-pyrolysis equipment (e.g. combustion chamber for pyrolysis gases and oil, flue gas treatment systems) or operation of the gasifier reactor and post-processing equipment
- Biochar quenching and other post-processing operations (e.g. packaging, activation)
- Biochar handling on site (transport or conveying of the biochar within the facility)
- Mobile unit fuel consumption associated with the operation of the mobile carboniser, near-location collection and handling of the biomass, but also the transport of the fuel to the location where the mobile unit is operated.

For each of the activities above, all life cycle stages (manufacturing, use and disposal) should be included. For instance, the operation of the pyrolysis reactor should include manufacturing and installation of the reactor, material and energy inputs for operating the reactor, direct air emissions from the stack of the reactor, and maintenance and disposal of the reactor. Likewise, biomass drying and chipping should for instance include manufacturing and disposal of the drying and chipping equipment, direct energy use from operation of the equipment (e.g. electricity or external heat), and eventually other consumables involved in the operation and maintenance of the equipment.

<u>Remark on handling of co-products from the pyrolysis process:</u>
- Depending on the configuration of the pyrolysis reactor, several other products may be generated, such as heat, electricity, or bio-oil. In most cases, a fraction of the heat generated from the combustion of the pyrolysis gases is used for sustaining the pyrolysis reaction and drying the biomass. This is an energy flow internal to the pyrolysis process and has no effect on the life cycle assessment (i.e. it does not need to be included).
- However, any excess heat, excess electricity or excess bio-oil that is not used within the pyrolysis process leads to a multi-functionality issue in life cycle assessment. In classical life cycle assessment, this can be dealt with in several ways depending on the goal and scope of the LCA, mainly: allocation or substitution.
- Here, for the purpose of the methodology, the following approach should be used:

- If the pyrolysis co-products represent high-value products or a large share of the initial biomass energy content, then an energy allocation between the biochar and the co-products must be applied. The life cycle assessment must specify how the allocation factors were calculated, in particular which energy unit was used (lower heating value, higher heating value, or another method).
- If the pyrolysis co-products are not deemed an important product, then all the burdens are allocated to the biochar production (allocation factor of 100%), and any excess co-product is considered as burden free (allocation factor of 0%).

4.5 Biochar use (E_{use})

The term E_{use} should be derived from a life cycle assessment of the expected biochar use, to the extent that it is known by the biochar producer. This term should include at least all greenhouse gas emissions from the transportation and handling of biochar until it is used in a mineral matrix (soil or concrete) from which it cannot be separated.

5. Proofs needed from the CO_2 Removal Supplier

5.1 Principle

5.1.1. The biochar output from a production facility is determined as eligible for issuance of CO_2 removal certificates once the facility has undergone a process of third-party verification by an auditor against the specific methodology for biochar. This verification is done in a **Production Facility Audit**. The verification ensures that the corresponding CO_2 removal has taken place, and relevant Environmental and Social Safeguards are in place and that the CO_2 removal is considered permanent as defined in the methodology.

5.1.2 For the activity to be eligible for producing biochar for which CO_2 removal certificates can be issued, the following proofs (5.2- 5.4) need to be presented by the CO_2 Removal Supplier (in this case, the producer of biochar).

5.2 Biomass production and supply

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

In case of forest biomass raw material:

- Forest Stewardship Council (FSC) Forest Management Certification; or
- Sustainable Forestry Initiative (SFI) Forest Management Certification; or
- Programme for the Endorsement of Forest Certification (PEFC) Sustainable Forest Management Standard; or
- Other reputable sustainable forest certification programs with high scientific standards and market recognition, regardless of whether they are public or private in nature. Puro.Earth reserves the right to make the determination of eligibility of the certification program.

In case of other waste biomass raw material:

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

5.2.2 Life cycle assessment data for the biomass production and supply must be provided and documented. In particular, climate change impact must be presented in a disaggregated way exhibiting the contribution of the different life cycle stages described in section 0.0

5.3 Biochar production

5.3.1. The biochar producer must provide data trail and documentation on the amount of biochar produced. This includes: i) continuous production documentation for the whole period (record keeping), taking into account any significant changes or stops in production, and ii) data and methodology applied to calculate the dry mass of biochar produced

5.3.2. The mobile unit or carbonizer operator must, at a minimum, provide the following data on the amount of biochar produced: i) continuous load cell measurement of the biochar production for the whole period ii) water input measurement. Dry mass of the amount of produced biochar is calculated using the measured weight of biochar from load cells deducted with the weight of the water that was input. Additional measurement equipment for greater accuracy can be proposed by the operator.

5.3.2. Life cycle assessment data for the biochar production process must be provided and documented. In particular, climate change impact must be presented in a disaggregated way exhibiting the contribution of the different life cycle stages described in section 0.

5.3.3 The following biochar properties must be determined via laboratory analyses, as they are required for the quantification of the biochar carbon sequestration: total organic carbon content, total hydrogen content, and calculated H/C_{org} ratio.

5.4 Biochar use

5.4.1. Life cycle assessment data for the biochar use must be provided and documented. In particular, climate change impact must be presented in a disaggregated way exhibiting the contribution of the different life cycle stages described in section 4.

5.4.2. Proof that the end-use of the product does not cause CO_2 returning to the atmosphere (it is not used as fuel or reductant). The proof can be an offtake agreement, documentation of the sale or shipment of the product, indicating the intended use of the product. Care should be taken to exclude amount of biochar that is likely to end up in waste incineration and not in a mineral matrix (soil or construction use) from which it cannot be separated.

5.4.3. Justification on the soil temperature selected for the calculation of the biochar carbon sequestration.

5.5 No double-counting

5.5.1. Double counting is avoided by the use of the Puro Registry, with a system of unique identification of each CORC that guarantees it is only used once. Each CORC in the registry contains information on Production Facility registration and crediting period dates, verification, issuance and retirement transactions as well as the title and ownership over time.

5.5.2 A statement is needed from the CO_2 Removal Supplier that the underlying physical product (biochar) in which the CO_2 is stored will not be sold or marketed as "climate positive" if the CO_2 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.

5.5.2. Check of the packaging of the product (how the product is branded) is needed, if CO_2 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, when the decoupled CO_2 removal certificate has been sold to and accounted by another stakeholder not re-associated with the underlying physical product. The proof can be an offtake agreement, documentation of the sale or shipment of the product, indicating the procedures for claiming the CO_2 removal certificate.