Puro.earth Certification Framework

Puro CRCF Program

CRCF Biochar Carbon Removal

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Glossary

Associated GHG emissions – the increase in direct and indirect greenhouse gas emissions over the entire lifecycle of the activity which are attributable to its implementation;

Atmospheric CO_2 – CO_2 well mixed in the free atmosphere at ambient air temperature, where the concentration of CO_2 is not affected by local point sources but may vary because of regional anthropogenic and natural emission sources.

Biochar – a carbonaceous material that is produced by thermal treatment of biomass or biomass fuels.

Biochar carbon removal (BCR) activity – An activity resulting in the production and permanent storage of biochar by its application to soils or by its incorporation into materials.

Biogenic emissions capture with carbon storage (BioCCS) activity – An activity resulting in a process of capturing biogenic CO_2, followed by transport and permanent storage of that biogenic CO_2 by injection at a geological storage site for which a valid permit exists in accordance with Article 8 of Directive 2009/31/EC.

Biogenic CO_2 – CO_2 produced from a source of biomass, biofuel, bioliquid or biomass fuel by a chemical or biological process acting on the carbon atoms therein, including combustion, oxidation, anaerobic digestion and fermentation.

Capital emissions – The emissions associated with the construction of facilities and equipment associated with an activity;

Captured CO_2 – CO_2 captured and concentrated from a point source of CO_2 or from the atmosphere;

Capture facility – A facility that captures CO_2 from the atmosphere or from a biogenic-CO_2 containing stream and conditions it to a form that is ready to be transported or stored, including in terms of CO_2 purity and pressure;

Certification period – The period between a re-certification audit of an activity and the most recent preceding certification audit or re-certification audit of that activity;

CO_2 fugitives – Any irregular or unintended CO_2 emissions from sources that are not localised, or are too diverse or not substantial enough to be monitored individually;

CO_2 venting – An intentional release of CO_2 occurring for operational or safety reasons;

Exit point – A point at which CO_2 is transferred out of the capture facility for the purpose of either transport or storage, which excludes any smokestack, flue or other outlet at the capture facility from which CO_2 is released into the atmosphere;

Fossil CO_2 – CO_2 generated from fossil carbon, which is inorganic and organic carbon that is not zero-rated carbon under Implementing Regulation (EU) 2018/2066;

Point source of CO_2 – A natural or anthropogenic source of gases that has a CO_2 concentration higher than that in the free atmosphere due to the generation of CO_2 by an oxidation process or other chemical process or the release of CO_2 from some form of storage or containment;

Union – The European Union as established by the Treaty on European Union.

Useful heat — Heat generated to satisfy an economically justifiable demand for heat, for heating or cooling purposes

Note to the reader

REMARK: This methodology provides general information as well as actual requirements that must be met by all projects seeking certification under the Puro CRCF Program and related Biochar methodology. Across the entire methodology, the requirements correspond to numbered rules with formatting conforming to the example below.

0.0.1 This is an example of a numbered rule. The requirements set within numbered rules must be followed by all projects seeking certification under this methodology.

Please note that in addition to the requirements of this methodology document, all projects seeking certification under the Puro CRCF Program must also comply with the Puro Certification Procedures, the Puro CRCF Program Annex, and where applicable the Puro Common Criteria. Projects must also comply with any applicable local laws, regulations, and other binding obligations.

Access to all Puro CRCF Program documents is available in the Puro Document Library.

Introduction

This document sets the requirements for certification of permanent carbon removals generated by biochar carbon removal (BCR) activities under the EU Carbon Removal and Carbon Farming (CRCF) framework as implemented by Puro.earth. This methodology shall be read together with the *Puro Certification Procedures*, the *Puro CRCF Program Annex,* and where applicable the *Puro Common Criteria*.

For activities certified under this Methodology, the Common Criteria apply only where expressly referenced in this Methodology or in the CRCF Program Annex, and only to the extent and in the manner specified by that reference. The Common Criteria provide supporting documentation, evidence, monitoring, reporting, and conformity-assessment requirements; they do not modify the eligibility, quantification, permanence, monitoring-period, sustainability, or other methodology-specific requirements set out in this Methodology.

In the event of inconsistency between this Methodology and the Common Criteria, this Methodology shall prevail.

This methodology is derived from the following EU normative documents:

A. Regulation (EU/ 2024/3012) of the European Parliament and of the Council of 27 November 2024, establishing a Union certification framework for permanent carbon removals, carbon farming and carbon storage in products
B. Commission Implementing Regulation (EU) 2025/2358 of 20 November 2025 laying down rules on certification schemes, certification bodies, and audits under Regulation (EU) 2024/3012 of the European Parliament and of the Council
C. Commission Delegated Regulation (EU) 2026/285 of 3 February 2026 supplementing Regulation (EU) 2024/3012 of the European Parliament and of the Council by establishing the certification methodologies for permanent carbon removals activities

1. Description of the carbon removal activity

1.1. Eligibility

General eligibility of a biochar carbon removal (BCR) activity

1.1.1. A BCR activity shall comply with the following requirements:

(a) the eligibility criteria laid down in rules 1.1.2, 1.1.3, 1.1.4, 1.1.5, and 1.1.6;

(b) the activity and monitoring periods laid down in Section 1.2;

(c) the rules for identifying the carbon removal sinks and GHG emission sources laid down in Section 2.1;

(d) the rules for calculating the baseline laid down in Section 2.2;

(e) the rules for calculating the total carbon removals laid down in Section 2.3;

(f) the rules for calculating the greenhouse gas associated laid down in Section 2.4;

(g) the rules on long-term storage and liability laid down in Section 3;

(h) the rules on the minimum sustainability requirements laid down in Section 4.1;

(i) the rules on monitoring and reporting requirements laid down in Sections 1.3.

1.1.2. A BCR activity shall ensure that the biochar production facility and the storage of the biochar are located in the Union.

Biochar carbon removal activity

1.1.3. A BCR activity shall consist of biochar production at one or more biochar production facilities that are owned by the same legal entity and that apply the same biochar production technology as each other. Biochar produced at different locations may never be assigned to the same production batch (see rules 2.5.1 – 2.5.3) even if the feedstock and production conditions are similar. Biochar from a single activity may be applied in soils or incorporated in products at several sites.

Eligibility criteria for the production

1.1.4. The biochar production process shall:

(a) heat biomass or biomass fuel to temperatures of at least 350 °C;

(b) be designed with the intention of fully capturing or destroying any methane produced with the biochar;

(c) utilise the co-produced heat for biomass drying or to satisfy another economically justifiable demand for heat, for heating or cooling purposes. As an exception to this rule, mobile biochar facilities may operate without utilisation of produced heat if it would be impractical in their specific context for the heat to be utilised.

Eligible forms of biochar applications

Biochar applied in soils

1.1.5. Biochar may be applied to soils to provide permanent carbon storage. Operators of activities where biochar is applied to soils shall ensure that there is no significant risk that the net climate benefit of the BCR is offset by heat absorption due to albedo decreases.

(a) Biochar applied in agricultural and forest soils

(i) Biochar application shall be eligible for certification if it has been, either directly without first intermixing it with any other product, or after intermixing with a matrix consisting of soil or one or more additional soil amendment products in compliance with Article 5 of Regulation (EU) 2019/1009 of the European Parliament and of the Council[1], or after feeding to animals and recovery as manure:

(I) applied to agricultural soils;

(II) applied to forest soils;

(III) applied to soil in greenhouses.

Total application of biochar to agricultural and forest soils shall be limited to no more than 50 tonnes per hectare cumulatively over time [t/ha], including any forms of biochar application whether or not they are certified and including applications that were made prior to the adoption of this methodology. Operators shall maintain geographically specific application records to enable cumulative application to be monitored.

(b) Biochar applied in soils other than agricultural and forest soils

(i) Biochar application shall be eligible for certification if it has been, either directly without first intermixing it with any other product, or after intermixing with a matrix consisting of soil or other appropriate materials:

(I) used in landscaping, for daily cover at landfill sites or for filling holes, including disused mines and oil wells;

(II) applied to urban soils, including growing media used in flowerbeds or for urban tree planting and in public parks and public or private gardens.

Operators of activities that produce biochar that is used for landscaping, landfill or hole filling shall intermix the biochar with at least one other material prior to application and shall ensure that the intermixture cannot self-sustain combustion.

Biochar incorporated in products

1.1.6. Only BCR activities that incorporate biochar in cement, concrete or asphalt shall be eligible for certification.

1.2. Activity period, monitoring period and certification period

Activity period

1.2.1. The duration of any activity period for a BCR activity shall not exceed 5 years. At the end of every activity period operators may start a new activity period by submitting a new activity plan.

Monitoring period

1.2.2. The monitoring period for BCR activities shall be:

(a) for activities that use biochar by application to soil, where application to soil is directly overseen by the certification body the period up to application, otherwise the period up to one year after the end of the certification period during which the biochar is reported to have been applied to the soil;

[1] OJ L, 2024/3012, 6.12.2024

(b) for activities that use biochar by incorporation in products, the period up to the point at which it is demonstrated that the biochar has been incorporated.

Certification period

1.2.3. The certification period for a BCR activity shall not exceed one year. Carbon removals and associated emissions shall be recorded in the certification period in which the CO2 is permanently stored by application of biochar to soils or incorporation of biochar in products.

1.3. Planning and reporting

Activity plan

1.3.1. Before the certification audit, the operator shall submit to the certification body an activity plan that includes the information necessary to assess compliance with the requirements of this methodology, as referred to in rule 1.3.3.

1.3.2. Where an operator wishes to change the activity plan during the activity period, that operator shall submit a rationale behind the changes to the certification bodies without delay and shall include any adjustment to the initial plan, in particular the recalculation of the expected greenhouse gas ('GHG') emissions and removals and impacts on sustainability requirements.

1.3.3. The activity plan shall include:

(a) a general description of the activity, the technologies and the infrastructure to be utilised, including georeferenced boundaries of the activity such as the location of the said infrastructure;

(b) details of all entities of the carbon removal value chain involved in delivery of the activity, including legal ownership and contact information of the operator;

(c) identification and demonstration of compliance of the activity with any relevant local, regional and national laws, statutes and regulatory frameworks;

(d) a list of emission sources and sinks that are relevant to the activity, in accordance with Section 2.1;

(e) estimates of total carbon removals and GHG associated emissions of the activity for the activity period, in accordance with points (k), (l) and (m) of Annex II to Regulation (EU) 2024/3012 of the European Parliament and of the Council[2], as well as the expected net carbon removal benefit generated by the activity calculated from these estimates;

(f) a description of any materiality assessment undertaken in accordance with Section 2.8;

(g) a description of the assessment of uncertainty, in accordance with Section 2.13;

(h) proof of compliance with the minimum sustainability requirements, in accordance with Section 4.1;

(i) funding sources received or applied for with regard to the activity, in accordance with Section 2.2;

[2] Regulation (EU) 2024/3012 of the European Parliament and of the Council of 27 November 2024 establishing a Union certification framework for permanent carbon removals, carbon farming and carbon storage in products (OJ L, 2024/3012, 6.12.2024, ELI: http://data.europa.eu/eli/reg/2024/3012/oj)

(j) any other information necessary for the certification body to conduct the certification audit in accordance with Article 9 of Regulation (EU) 2024/3012;

(k) the start date of the activity;

(l) information on the operator's previous involvement with other certification schemes, where required under Article 8(1) of Regulation (EU) 2024/3012.

1.3.4. The activity plan shall be prepared using the applicable *Puro.earth Project Activity Description template*, and in line with the *Puro.earth Common Criteria 1.1. Project Activity Description*.

Monitoring plan

1.3.5. Before the certification audit, operators shall submit a monitoring plan to the certification body. That monitoring plan shall comply with the following criteria:

(a) it shall include a description of the activity to be monitored, covering all emission sources and sinks that are relevant to the activity in accordance with Section 2.1;

(b) it shall include a description of the procedure for managing the assignment of responsibilities for monitoring and reporting, and for managing the competences of responsible personnel;

(c) it shall include, where applicable, the default values used for calculation factors indicating the source of the factor, or the relevant source, from which the default factor will be retrieved periodically;

(d) it shall include, where applicable, a list of laboratories engaged in carrying out relevant analytical procedures;

(e) it shall include, where measurements are taken, a description of the measurement method including descriptions of all written procedures relevant for the measurement;

(f) it shall include, where applicable, a detailed description of the monitoring methodology where transfer of CO_2 is carried out, including a description of continuous measurement systems used and of procedures for preventing, detecting and quantification of leakage events from CO_2 transport infrastructure;

(g) it shall apply, where applicable, the minimum frequencies for analysis listed in Annex VII to Commission Implementing Regulation (EU) 2018/2066[3];

(h) it shall apply the standard for quality assurance laid down in Article 60 of Implementing Regulation (EU) 2018/2066;

(i) it shall include a record keeping requirement for all relevant data and information consistent with the record keeping requirements laid down in Article 67(1) of Implementing Regulation (EU) 2018/2066;

(j) where biochar is applied to agricultural or forest soils, as per rule 1.1.5(a), it shall describe the system for maintaining geographically specific application records sufficient to monitor cumulative biochar application over time.

1.3.6. In the case that it is not possible to fully detail the monitoring plan when an operator applies for certification, the monitoring plan shall be submitted as completely as

[3] Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334 31.12.2018, p. 1).

possible, clearly indicating any non-final aspects and providing an indication of how the operator expects these aspects to be addressed. The activity may be certified on this basis provided the certification body accepts that the omissions are properly justified. The monitoring plan shall be finalised and presented to the certification body prior to the first re-certification.

1.3.7. Operators shall obtain, record, compile, analyse and document monitoring data, including assumptions, references, activity data and calculation factors in a transparent manner that enables the checking of performance achieved during the various activity stages, and, when requested, report this information to the certification bodies or certification schemes.

1.3.8. Each parameter monitored shall be accompanied with the following information:

(a) entity responsible for collection and archiving;

(b) data source;

(c) equipment, measurement methods and procedures used for monitoring, including details on accuracy and calibration;

(d) monitoring frequency;

(e) quality assessment and quality check procedures.

1.3.9. All measurements shall be conducted with calibrated measurement equipment according to industry standards, following the requirements in Articles 42 of Implementing Regulation (EU) 2018/2066, and any necessary data aggregation shall be undertaken following the requirements in Article 44 of that Implementing Regulation (EU) 2018/2066.

1.3.10. The Monitoring Plan shall be prepared using the applicable *Puro.earth Monitoring Plan template*, and in line with the *Puro.earth Common Criteria 1.2. Monitoring Plan*.

Monitoring report

1.3.11. Before each re-certification audit, the operator shall submit to the certification body a monitoring report including the net carbon removal benefit, the total amount of gross carbon removal generated by the activity, the amount of greenhouse gases associated to the activity and all the necessary information relating to the quantification of the net carbon removal benefit and any relevant information on the compliance of the activity with storage, liability and sustainability requirements. In particular, the monitoring report shall include the following:

(a) all the parameters specified in rules 2.5.22, 2.6.3 and 2.7.8 measured and calculated for the quantification of carbon removals and GHG emissions associated with the activity. All removals and emissions of CO2 and emissions of other GHGs shall be assessed over the certification period that is to be audited and reported in the monitoring report. Emissions of GHGs other than CO2 shall be converted to tonnes of CO2eq by use of the 100-year Global Warming Potentials set out in Annex I to Commission Delegated Regulation (EU) 2020/1044[4];

(b) the biomass feedstock or feedstock mix consumed as required under rule 4.2.1(b);

[4] Commission Delegated Regulation (EU) 2020/1044 of 8 May 2020 supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (OJ L 230 17.07.2020, p.1, ELI: http://data.europa.eu/eli/reg_del/2020/1044/oj).

(c) the quantity of carbon farming sequestration units that have been purchased in accordance with rule 4.3.2;

(d) financing received or applied for with regard to the activity, in accordance with Section 2.2.

(e) the results of laboratory analyses required in Section 4.4.

1.3.12. The Monitoring Report shall be prepared using the applicable Puro.earth Monitoring report template, and in line with the *Puro.earth Common Criteria 1.3. Monitoring Report*.

2. Quantification of Baseline, Total Carbon Removal and associated GHG emissions

2.1. GHG sources and sinks

2.1.1. BCR activities shall consider GHG sources and sinks included in Table 1.

TABLE 1: SINKS AND SOURCES THAT SHALL BE INCLUDED FOR A BCR ACTIVITY

Phase of the operation	Emission sources/sinks	Gases included
Biochar production	Biochar production facility: Equipment used to produce biochar.	Greenhouse gases
	Biochar production facility: Any biochar processing equipment that is used to treat the biochar prior to its shipping for application or incorporation.	Greenhouse gases
	Biochar production facility: Any associated energy generation equipment that is geographically contiguous with the facility.	Greenhouse gases
	Biochar production facility: Any treatment equipment for processing wastes or byproducts of the biochar production process.	Greenhouse gases
	Biomass and biomass fuel supply emissions: Production, collection and transportation of biomass and biomass fuel used by the biochar production facility.	Greenhouse gases
	Input emissions: Production and supply of inputs used by the biochar production facility.	Greenhouse gases
	Waste treatment: Processing and treatment of any wastes (including wastewater and exhaust gases) generated by the biochar production facility.	Greenhouse gases
	Capital emissions: Emissions associated with the construction and installation of the biochar production facility.	Greenhouse gases
Transport of biochar	Transportation: Fuel combustion and electricity consumption at land transportation (e.g. tank trucks,	Greenhouse gases

	rails), maritime transportation (e.g. sea tanker) and other vehicles.	
Application to soils or incorporation in products	Quantity of CO2 permanently stored in the form of biochar	CO2 only
	Application/incorporation site: Any energy consumption and/or generation associated with the process of application or incorporation.	Greenhouse gases

2.2. Baseline

2.2.1. A standardised baseline set to 0 tCO2/year shall apply for BCR activities.

2.2.2. Where the activity is financed through a combination of public and private funding, in order to document that there is no overcompensation of costs, when submitting the activity plan to the certification scheme operators shall indicate any form of public financing received or applied for with regard to the activity. This information shall be included in the certificate of compliance.

2.3. Quantification of the total removals of the activity

2.3.1. The operator shall calculate the total carbon removals (CR_{total}) in accordance with equation (1).

$$\mathrm{CR_{total}} = -3.664 * \mathrm{F_{perm}} * \mathrm{C_{org}} * \mathrm{Q_{biochar}} \quad (1)$$

Variable	Description
$\mathrm{F_{perm}}$	permanence fraction of the biochar calculated following the rules 2.7.1 to 2.7.5, as a percentage;
$\mathrm{C_{org}}$	the organic carbon content of the biochar, $\mathrm{C_{org}}$, which shall be established by laboratory analysis as the ratio of the mass of organic carbon in the biochar to the total mass of the biochar;
$\mathrm{Q_{biochar}}$	the mass of biochar applied or incorporated during the certification period, in tonnes on a dry matter basis. The mass of biochar shall exclude any fraction from non-biogenic material also processed in the biochar production process. If the biochar feedstock may be expected to contain a fraction of non-biogenic carbon greater than 2 % of the total carbon feedstock by mass, the biogenic carbon fraction in the biochar product shall be identified by carbon 14 (^{14}C) testing;
3.664	the mass ratio of a CO_2 molecule to a carbon atom.

2.3.2. The operator may determine the organic carbon content of the biochar by applying a default value for inorganic carbon content, without direct measurement, provided that the biochar is produced from wood biomass and prior laboratory analyses, conducted on at least two separate production batches, demonstrate that the inorganic carbon content is consistently below 0.5 % on a dry matter basis. In such cases, the inorganic carbon content (C_{inorg}) shall be set to a default value of 0.005 kg C per kg dry biochar, and the organic carbon content (C_{org}) shall be calculated as the

difference between the total carbon content (C_{tot}) determined by laboratory analysis and the inorganic carbon content (C_{inorg}) default value.

2.4. Quantification of the greenhouse gases associated to the activity

2.4.1. The greenhouse gases associated shall be calculated according to the equation (2).

$$GHG_{associated} = GHG_{biochar} + GHG_{transport} + GHG_{use} \quad (2)$$

Variable	Description
$GHG_{biochar}$	GHG emissions associated with the production of biochar, calculated following the rules 2.5.9 to 2.5.18.;
$GHG_{transport}$	GHG emissions associated with biochar transport from the production facility to the point of application or incorporation, calculated following the rules 2.6.1 to 2.6.2;
GHG_{use}	GHG emissions associated with the application or incorporation of biochar, calculated following the rule 2.7.6.

2.5. Production of Biochar

Production batches

2.5.1. The amount of biochar produced shall be measured and assigned to production batches that share feedstock mix and common processing conditions, i.e. the same underlying process is used and target temperature of biochar production, the biochar residence time and any techniques used to manage the oxygen concentration are consistent across the batch. Common feedstock mix requires shares of feedstock types in the mix to be similar across the batch. Production batches may not include biochar produced in more than one certification period.

2.5.2. During re-certification units may be issued in relation to all production batches applied or incorporated during the relevant certification period. If only part of a production batch has been applied or incorporated at the point of re-certification, then units shall be issued for the part that has been applied or incorporated, and units may be issued for the remainder if it has been applied or incorporated at the point of a later re-certification.

2.5.3. A production batch may be interrupted and restarted at a later time. If biochar produced from the same feedstock under the same conditions is split into more than one consignment for sale to different end uses, this may still be treated as a single production batch for the purpose of quantification.

Biochar properties

2.5.4. Operators shall undertake laboratory testing on each production batch of biochar. During recertification audits, the list of properties to be reported to certification bodies shall at least include the properties required in order to follow this methodology:

(a) the organic carbon content of the biochar, C_{org}, as required in equation (1);

(b) the molar ratio of hydrogen to organic carbon in the biochar (H/C_{org} ratio), as required in Section 3 and when the decay function is used to assess the permanence fraction of the biochar (rule 2.7.4);

(c) the energy density of the biochar on a lower heating value basis;

(d) where the random reflectance assessment is used to assess the permanence fraction of the biochar (rule 2.7.3), the fraction of the biochar that is identified as having a R_o reflectance value of 2 % or greater and associated measurements;

(e) compliance with the maximum thresholds for the limited substances detailed in Section 4.4.

Biochar sampling

2.5.5. All production batches of biochar shall be sampled. Samples shall be representative of the average properties of the production batch being sampled. Operators shall include a description of the sampling protocol in the monitoring plan for review by the certification body at the certification audit, and shall follow this protocol during the activity period. The sampling protocol may be amended during the activity period where operators demonstrate that the sample data is at least equally representative of the batches. Sampling protocols shall be consistent with Article 33 of Implementing Regulation (EU) 2018/2066, with the exception of the last sentence of paragraph 1 of that Article.

2.5.6. The biochar to be sampled shall be well-mixed, and operators shall take an adequate number of samples to ensure that the data from the samples is representative of the production batch. When a production batch is produced over a period of time (in one or more production runs) sampling shall be undertaken either after mixing of the biochar produced over the full production period, or on subsets of the batch and a sufficient number of samples shall be taken to robustly establish the average properties of the biochar across the full production batch. The certification body or certification scheme may require analysis of retention samples if this is deemed necessary to establish a representative characterisation of a production batch, or to confirm that measurements taken are representative.

2.5.7. Sampling protocols may allow for a reduction in the frequency of sampling over time if it is demonstrated that a process reliably produces biochar with consistent characteristics from a given feedstock.

2.5.8. The biochar producer shall take retention samples of the biochar produced which shall be made available on request to the certification body, certification scheme or relevant representatives of competent national authorities. One litre retention samples shall be taken for each production batch every day that biochar is produced and may be aggregated across the calendar month for storage, keeping samples of each production batch separate. Retention samples shall be stored for at least two years.

Quantification of associated GHG emissions

2.5.9. The emissions associated with the operation of the biochar facility shall be calculated in accordance with equation (3).

$$\mathrm{GHG_{biochar}} = \mathrm{F_{alloc}} * \left(\mathrm{GHG_{facility}} + \mathrm{GHG_{inputs}}\right) \quad (3)$$

$$F_{alloc} = \begin{cases} 0, & \text{if the biochar is treated as a residue} \\ \dfrac{E_{biochar}}{E_{biochar} + \sum_{co-products} E_{co-products}}, & \text{otherwise} \end{cases} \quad (4)$$

Variable	Description
F_{alloc}	allocation fraction for biochar, calculated in accordance with equation (4). The biochar shall be treated as a residue of another process if the chemical energy in the biochar produced (LHV) is less than 10 % of the total energy of the produced co-products, and in that case $F_{alloc} = 0$ and it is not necessary for the terms $GHG_{facility}$ and GHG_{inputs} to be calculated;
$GHG_{facility}$	total GHG emissions from operation and construction of the biochar production facility, calculated in accordance with rules 2.5.10 to 2.5.18.;
GHG_{inputs}	total emissions associated with inputs to the biochar production facility, calculated using equation (11).
$E_{biochar}$	chemical energy in the biochar in mega joule per kg [MJ/kg] of biochar produced, assessed by laboratory testing on a lower heating value basis;
$co - products$	an index of the energy-containing co-products of the biochar production process. Outputs from the process that are exported from the facility to be used elsewhere and that contain at least 10 % of the total energy in all the outputs of the process are co-products. Electricity, useful heat and materials containing chemical energy (assessed on a lower heating-value basis) exported from the facility shall be treated as co-products if they meet these conditions. Electricity or heat used by the activity, including for drying biomass, shall not be counted as being exported from the facility and therefore are not co-products. Co-products that are subject to further processing before export from the facility shall be included based on their energy content prior to this additional processing. Outputs with no heating value (e.g. ash) or outputs sent for disposal shall not be considered in the allocation calculation;
$E_{co-products}$	In the case of material co-products, the chemical energy in each co-product in MJ/kg of biochar produced, assessed by laboratory testing on a lower heating value basis. In the case of electricity and heat as co-products, the amount of electricity or useful heat supplied to a grid, network or user outside the activity, where useful heat is defined as heat generated to satisfy an economical justifiable demand for heat, for heating and cooling purposes (cf. Paragraph 1 of Part C of Annex V to Directive (EU) 2018/2001).

Emissions from the biochar facility

2.5.10. The emissions $GHG_{biochar}$ associated with the biochar production facility, including any emissions associated with preparation and packaging of biochar, shall be calculated in accordance with equation (5).

$$GHG_{facility} = GHG_{bio} + GHG_{bio\text{-}storage} + GHG_{combustion} + CH_{4_{release}} + GHG_{elec} + GHG_{heat} + GHG_{capital} + GHG_{disposal} \quad (5)$$

Variable	Description
GHG_{bio}	emissions associated with the production and supply of biomass and biomass fuel used at the biochar-producing facility, calculated in accordance with rule 2.5.11;
$GHG_{bio\text{-}storage}$	CH_4 emissions due to biomass storage prior to processing at the biochar production facility, as further defined in rule 2.5.12;
$GHG_{combustion}$	emissions due to fuel consumption at the biochar production facility, including CH_4 and N_2O emissions from biomass, biogas and bioliquid combustion for energy, whether brought in from outside the facility or co-produced by the process, as further defined in rule 2.5.13;
$CH_{4_{release}}$	any emission into the atmosphere of methane generated by the biochar production process, as further defined in rule 2.5.14;
GHG_{elec}	emissions due to electricity consumption at the biochar production facility, as further defined in rule 2.5.15;
GHG_{heat}	emissions due to net consumption of useful heat at the biochar producing facility, as further defined in rule 2.5.16;
$GHG_{capital}$	capital emissions from construction and installation of the biochar production facility, as further defined in rule 2.5.17;
$GHG_{disposal}$	emissions from the treatment or disposal of any wastes generated by the biochar production facility, as further defined in rule 2.5.18.

2.5.11. The parameter GHG_{bio} refers to the emissions associated with the production and supply of biomass and biomass fuel used at the biochar-producing facility. GHG_{bio} shall be calculated in accordance with equation (6).

$$GHG_{bio} = \sum_{fuels} Q_{biomass} * EF_{biomass} \quad (6)$$

Variable	Description
$Q_{biomass}$	quantity of the biomass or biomass fuel that is consumed by the biochar production facility in the certification period, expressed in an appropriate unit, excluding any non-biomass contamination (e.g. soil, rocks);
$EF_{biomass}$	emission factor, expressed in tCO_2e/unit, selected in accordance with the rules 2.11.6 to 2.11.9 in Section 2.11.

2.5.12. The parameter $GHG_{bio-storage}$ refers to the CH_4 emissions due to biomass storage prior to processing at the biochar production facility shall be calculated for each quantity of feedstock of a given type that is harvested or collected at the same time and stored in the same way. $GHG_{bio-storage}$ shall be set to zero for a quantity of feedstock if one or more of the following practices are followed for all biomass utilised:

(a) biomass stored for use in the biochar production process consists of coarse woody material that naturally remains well aerated;

(b) biomass that is stored in a form that does not necessarily remain naturally aerated shall either:

(i) be stored for no more than four weeks prior to processing; or

(ii) be stored with a maximum of 30 % residual moisture;

(c) biomass is pelleted for storage;

(d) operators otherwise demonstrate that biomass is stored in a way that avoids significant methane emissions from anaerobic decomposition given the nature of the feedstock and the local conditions

Otherwise, $GHG_{bio-storage}$ shall be calculated in accordance with equation (7).

$$GHG_{bio-storage} = GWP_{CH_4} * 1.335 * 0.0013 * \sum_{feedstock} Q_{feedstock} * C_{feedstock} * (T_{storage} - 1) \quad (7)$$

Variable	Description
$Q_{feedstock}$	Quantity of feedstock stored for more than four weeks in potentially anaerobic conditions;
$C_{feedstock}$	carbon content of the feedstock, expressed as a mass %;
$T_{storage}$	Period in months for which feedstock is stored in potentially anaerobic conditions;
$feedstock$	an index of the feedstocks consumed;
GWP_{CH_4}	global warming potential of methane, 100 year basis;
0.0013	assumed monthly fractional loss of biomass carbon from storage;
1.335	the mass ratio of a methane molecule to a carbon atom.

2.5.13. The parameter $GHG_{combustion}$ refers to emissions due to fuel consumption at the biochar production facility, including CH_4 and N_2O emissions from biomass, biogas and bioliquid combustion for energy, whether brought in from outside the facility or co-produced by the process. $GHG_{combustion}$ shall be calculated in accordance with equation (8).

$$GHG_{combustion} = \sum_{fuels} (Q_{fuel} * EF_{fuel}) + CO_{2\ stored,fossil} \quad (8)$$

Variable	Description
Q_{fuel}	quantity of the fuel consumed in the certification period, expressed in an appropriate unit, including in the case of mixed biogenic and non-biogenic feedstocks any fossil-carbon-based material in the input that is combusted to CO_2;

EF_{fuel}	emission factor, expressed in tCO_2e/unit, selected in accordance with the rules in in Section 2.11.;
$CO_{2\ stored,fossil}$	minus the quantity of fossil CO_2 from fuel combustion at the biochar production facility captured and permanently stored at a site permitted under Directive 2009/31/EC;
fuels	an index of the fuels consumed.

2.5.14. The parameter $CH_{4_{release}}$ refers to any emission into the atmosphere of methane generated by the biochar production process. CH_4 emissions shall be measured at least twice per production unit during the first certification period with an interval of at least a third of the certification period, and measured in grams of methane emission per kilogram of biochar production.

If these measurements are consistent, the average of the measurements may be taken as characteristic of the production unit. CH_4 emissions measurements shall be considered consistent if either:

(a) both measurements demonstrate that CH_4 is only emitted at trace levels, defined as a level of CH_4 emissions that would amount to less than 1% of CR_{total} if continued for the entire certification period and expressed in tCO_2e on a GWP 100 basis; or

(b) the measured level is similar for the two measurements, defined as the higher of the two measurements being not more than 40% above the lower measurement.

If the measurements are not consistent, additional measurements shall be taken until a reliable estimate of average CH_4 emissions is established. In the case that CH_4 emissions above a trace level are identified, the operator shall produce and implement a CH_4 reduction plan to eliminate these emissions that shall be measured again in the subsequent certification period. If CH_4 emissions are found to be emitted at only trace levels, such measured level may be taken as representative for that production unit for the following five years, after which CH_4 emissions shall be measured again.

2.5.15. The parameter GHG_{elec} refers to emissions due to electricity consumption at the biochar production facility. GHG_{elec} shall be calculated in accordance with equation (9).

$$GHG_{elec} = \sum_{\text{electricity source}} Q_{elec} * EF_{elec} \quad (9)$$

Variable	Description
Q_{elec}	net quantity of electricity consumed in the certification period, selected in accordance with Section 2.9, expressed in an appropriate unit;
EF_{elec}	emission factor for the consumed electricity, expressed in tCO_2e/unit, selected in accordance with Section 2.11;
electricity source	an index across electricity sources.

2.5.16. The parameter GHG_{heat} refers to emissions due to net consumption of useful heat at the biochar producing facility. GHG_{heat} shall be calculated in accordance with equation (10).

$$GHG_{heat} = \sum_{heat\ source} Q_{heat} * EF_{heat} \quad (10)$$

Variable	Description
Q_{heat}	net quantity of useful heat consumed in the certification period for the biochar production process, selected in accordance with Section 2.9, expressed in an appropriate unit;
EF_{heat}	emission factor for the consumed heat, expressed in tCO_2e/unit, selected in accordance with Section 2.11;
heat source	index of all utilised external heat sources.

2.5.17. The parameter $GHG_{capital}$ refers to capital emissions from construction and installation of the biochar production facility. $GHG_{capital}$ shall be calculated in accordance with the principles detailed in Section 2.12.

2.5.18. The parameter $GHG_{disposal}$ refers to emissions from the treatment or disposal of any wastes generated by the biochar production facility. This shall include emissions associated with the supply of any energy and inputs consumed in the course of waste disposal and any other GHG emissions associated with the disposal process including emissions of N_2O and/or CH_4 due to aerobic or anaerobic degradation of biogenic wastes.

Emissions from inputs

2.5.19. Where there are inputs including chemicals, but excluding anything within the scope of capital emissions, consumed by the biochar production facility, other than fuels that are considered in the $GHG_{combustion}$ term, the emissions associated with the consumption of these inputs during the certification period shall be calculated in accordance with equation (11).

$$GHG_{inputs} = \sum_{inputs} Q_{input} * EF_{input} \quad (11)$$

Variable	Description
Q_{input}	quantity of the input consumed in the certification period, expressed in an appropriate unit;
EF_{input}	emission factor for the input consumed, expressed in tCO_2e/unit, selected in accordance with Section 2.11.

2.5.20. The operator may group any number of inputs whose collective emissions are considered non-material on the basis of a materiality assessment and substitute for them an emission term equal to $2\% * CR_{total}$ (cf. Section 2.3), i.e. a group of inputs for which when taking a high end estimate of expected associated emissions, in accordance with equation (12).

$$\sum_{inputs} Q_{input} * EF_{input} < 2\% * CR_{total} \quad (12)$$

CO_2 capture at the biochar production facility

2.5.21. Where CO_2 capture of biogenic CO_2 is implemented at the biochar production facility, this shall not be counted as a negative emission in $GHG_{associated}$ but may be eligible for certification as a BioCCS carbon removal activity.

Monitoring and reporting

2.5.22. In accordance with Section 1.3, operators shall include in the monitoring report before each re-certification audit the measured or calculated parameters listed in Table 2. Where a parameter is noted as to be monitored, it shall be included in the monitoring plan in accordance with Section 1.3.

2.5.23. If a quantity of biochar is produced during one certification period but applied or incorporated in a later certification period, the emissions and removals associated with that quantity of biochar shall be recorded in the later certification period.

TABLE 2: PARAMETERS FOR INCLUSION IN THE MONITORING REPORT

Equation	Parameter	Unit	Definition	Notes
(2),(3)	$GHG_{biochar}$	tCO_2e	Emissions associated with the operation of the biochar facility	Calculated using eq. (3)
(3),(4)	F_{alloc}	%	Allocation fraction of biochar	Calculated using eq. (4)
(3),(5)	$GHG_{facility}$	tCO_2e	Total GHG emissions from operation and construction of the biochar production facility	Calculated using eq. (5)
(3),(11)	GHG_{inputs}	tCO_2e	Total GHG emissions associated with inputs to the biochar production facility	Calculated using eq. (11)
(4)	$E_{biochar}$	MJ/kg biochar produced	Chemical energy in the biochar	To be monitored
(4)	$E_{co-products}$	MJ/kg biochar produced	Chemical energy in each co-product in case of material co-products	To be monitored
(5),(6)	GHG_{bio}	tCO_2e	GHG emissions associated with the production and supply of biomass and biomass fuels used at the biochar producing facility	Calculated using eq. (6)
(5),(7)	$GHG_{bio-storage}$	tCO_2e	CH_4 emissions due to biomass storage prior to processing at the biochar production facility	Calculated using eq. (7)
(5),(8)	$GHG_{combustion}$	tCO_2e	Emissions due to fuel consumption at the biochar production facility, including CH_4 and N_2O emissions from biomass and biomass fuel combustion for energy	Calculated using eq. (8)

(5)	$CH_{4_{release}}$	tCO_2e	Quantity of methane emitted from the biochar producing process	To be monitored
(5),(9)	GHG_{elec}	tCO_2e	Emissions due to net electricity consumption at the biochar production facility	Calculated using eq. (9)
(5),(10)	GHG_{heat}	tCO_2e	Emission due to net consumption of useful heat at the biochar producing facility	Calculated using eq. (10)
(5),(30)	$GHG_{capital}$	tCO_2e	Capital emissions	Calculated using eq. (30)
(5)	$GHG_{disposal}$	tCO_2e	Emissions from treatment or disposal of any waste generated by the biochar producing facility	To be monitored where relevant
(6)	$Q_{biomass}$	[appropriate unit]	Quantity of biomass and/or biomass fuel consumed for biochar producing process	To be monitored
(6)	$EF_{biomass}$	tCO_2e/unit	Emission factor for that biomass and/or biomass fuel	
(7)	$Q_{feedstock}$	[appropriate unit]	Quantity of feedstock stored for more than four weeks in potentially anaerobic conditions	To be monitored where relevant
(7)	$C_{feedstock}$	%	Carbon content in that feedstock	To be monitored where relevant
(7)	$T_{storage}$	months	Period for which feedstock is stored in potentially anaerobic conditions	To be monitored where relevant
(8)	Q_{fuel}	[appropriate unit]	Quantity of the fuel consumed in the certification period	To be monitored
(8)	EF_{fuel}	tCO_2e/unit	Emission factor for the consumed fuel	
(8)	$CO_{2\ stored,fossil}$	tCO_2	Quantity of fossil CO_2 from fuel combustion at the biochar production facility captured and permanently stored at a site	To be monitored

(9)	Q_{elec}	[appropriate unit]	Net quantity of electricity consumed in the certification period	To be monitored
(9)	EF_{elec}	tCO_2e/unit	Emission factor for the consumed electricity	
(10)	Q_{heat}	[appropriate unit]	Net quantity of useful heat consumed in the certification period	To be monitored
(10)	EF_{heat}	tCO_2e/unit	Emission factor for the consumed heat	
(11)	Q_{input}	[appropriate unit]	Quantity of the input consumed in the certification period	To be monitored
(11)	EF_{input}	tCO_2e/unit	Emission factor for the input consumed	
(30), (31)	$GHG_{materials}$	tCO_2e	Emissions from the materials utilised in the construction of the facility	Calculated using eq. (31)
(31)	$Q_{materials}$	t	Quantity of materials utilised in the construction of the facility	To be monitored
(31)	$EF_{materials}$	tCO_2e/t of material	Emission factor for the utilised materials	

2.6. Transport of Biochar

This section provides rules for the quantification of GHG emissions associated with biochar transportation.

2.6.1. Any emissions associated with biomass or biomass fuel transportation from the point of harvest/collection to the biochar production facility do not fall under this section (section 2.6), but shall be included in the term GHG_{bio} in equation (6).

Quantification of associated greenhouse gas emissions for transport

2.6.2. Following the principles in Section 2.11 for transport, GHG emissions associated with the transport of biochar, $GHG_{transport}$, shall either be calculated based on actual data on fuel consumption in accordance with equation (13) or based on vehicle efficiencies and actual data about vehicle distance travelled in accordance with equation (14). Operators are permitted to use different approaches for different transport modes, in which case $GHG_{transport}$ shall be calculated as the sum of the emissions calculated with each approach.

$$GHG_{transport} = \sum_{trips} (Q_{fuel} * EF_{fuel}) \quad (13)$$

$$GHG_{transport} = \sum_{L=1}^{O} (K_L * EF_{vehicle,loaded}) + \sum_{L=1}^{R} (K_L * EF_{vehicle,unloaded}) \quad (14)$$

Variable	Description
Q_{fuel}	quantity of fuel consumed for each trip, including empty return trips, expressed in an appropriate unit;
EF_{fuel}	emission factor for the consumed fuel, expressed in $tCO_2e/unit$, selected in accordance with the rules in Section 2.11;
trips	an index of the trips taken;
K_L	distance of each trip in kilometres;
$EF_{vehicle,loaded}$	the CO_2 emissions per kilometre of the vehicle when loaded, in tCO_2e/km travelled;
$EF_{vehicle,unloaded}$	the CO_2 emissions per kilometre of the vehicle when unloaded, in grams of CO_2e/km travelled. If no data/default is available for the unloaded vehicle but a value is available for $EF_{vehicle,loaded}$, then the operator may set $EF_{vehicle,unloaded} = EF_{vehicle,loaded}$;
O	total number of outbound trips taken;
R	total number of empty return trips taken;
L	an index of the trips.

Monitoring and reporting

2.6.3. In accordance with Section 1.3, operators shall include in the monitoring report before each re-certification audit the measured or calculated parameters listed in Table 3. Where a parameter is noted as to be monitored, it shall be included in the monitoring plan in accordance with Section 1.3.

TABLE 3: PARAMETERS FOR INCLUSION IN THE MONITORING REPORT.

Equation	Parameter	Unit	Definition	Notes
(13),(14)	$GHG_{transport}$	tCO_2e	GHG emissions due to energy use for biochar transportation	Calculated using eq. (13) or (14)
(13)	Q_{fuel}	[appropriate unit]	Quantity of the fuel consumed in the certification period	To be monitored
(13)	EF_{fuel}	tCO_2e	Emission factor for consumed fuel	
(14)	K_L	km	Distances of trips	To be monitored
(14)	$EF_{vehicle,loaded}$	tCO_2e/km	CO_2 emission per kilometre of the loaded transport vehicles	
(14)	$EF_{vehicle,unloaded}$	gCO_2e/km	CO_2 emission per kilometre of the unloaded transport vehicles	

2.7. Application of Biochar

This section provides rules for the quantification of the permanence fraction of the CO_2 removals generated by the BCR activity and GHG emissions associated with the application of biochar to soils or incorporation of biochar to products.

Calculation of the permanence fraction

2.7.1. The permanence fraction of the biochar, F_{perm}, may be calculated using one of the approaches described in rules 2.7.3 or 2.7.4.

2.7.2. Operators may choose for each production batch which approach to use to calculate the permanence fraction, but may not combine elements of these two approaches to assess the permanence of a single production batch.

Random reflectance assessment

2.7.3. Operators using *random reflectance assessment* shall submit at least three random samples from each production batch of biochar for random reflectance assessment at a qualified laboratory. The reflectance assessment shall involve two analytical elements:

(a) Part of each sample shall be thermochemically analysed to identify the reactive organic carbon fraction, $F_{reactive}$. This analysis shall involve heating the sample to identify the fraction of the material that is subject to thermal decomposition when heated to high temperature. The laboratory must use a methodology consistent with best practice.

(b) Part of each sample shall be analysed with incident light microscopy to measure the random reflectance of the non-reactive solid fraction, and identify the fraction of the sample that has a random reflectance, R_o, of at

least 2%. The assessment shall be conducted as further detailed in subrules (i)-(v).

(i) In the analysis, each sample shall be prepared by embedding crushed particles from the sample in a resin, grinding and polishing one of the faces of the resulting pellet and assessing the reflectance by taking 500 point measurements per sample, evenly distributed across the polished surface. A distribution shall be fitted to these point measurements using kernel density estimation with a univariate Gaussian kernel, where given a set of measured R_o values $x_1, x_2, x_3, \ldots, x_{500}$ the fitted function shall be defined:

$$\hat{f}(x) = \frac{1}{500h}\sum_{i=1}^{500} K\frac{(x - x_i)}{h} \quad (15)$$

Variable	Description
$\hat{f}(x)$	the estimated probability density function at point x;
h	the bandwidth, a smoothing parameter that determines the width of the kernel and is to be calculated $h = 0.9 * \min\left(\sigma_{R_o}, \frac{IQR}{1.34}\right) * 500^{-0.2}$ where σ_{R_o} is the standard deviation of the R_o values and IQR their inter-quartile range.
$K(u)$	the Gaussian kernel function $K(u) = \frac{1}{\sqrt{2\pi}} e^{-\frac{u^2}{2}}$ where $u = \frac{(x - x_i)}{h}$.

(ii) The fraction of the non-reactive material with a R_o greater than 2%, $F_{R_o>2\%}$, shall then be calculated by numerical integration of the fitted function using the composite Simpson's 1/3 rule to estimate the value of the integral of the probability function for $R_o > 2\%$

$$F_{R_o>2\%} = \int_{2\%}^{\infty} \hat{f}(x)dx \quad (16)$$

(iii) The permanence fraction in each submitted sample i of biochar shall then be calculated as:

$$F_{perm_i} = \left(1 - F_{reactive_i}\right) * F_{R_o>2\%i} \quad (17)$$

(iv) For a number of tested samples *n*, the estimated permanence fraction of the sampled biochar shall be calculated as the arithmetic mean of the permanence fractions measured for each sample:

$$F_{perm} = \frac{\sum_1^n F_{perm_i}}{n} \quad (18)$$

(v) For the purpose of the uncertainty assessment required in Section 2.13, the assessment of F_{perm} by the random reflectance method shall be treated as having an associated uncertainty calculated in accordance with equation (19).

$$\text{Uncertainty}_{F_{perm}} = 1.65 * \frac{\sigma_{\overline{R_o}}}{\psi_{\overline{R_o}} * \sqrt{n}} + 2.5\% \quad (19)$$

Variable	Description
$\sigma_{\overline{R_o}}$	the standard deviation of the mean value of R_o for each of the n samples;
$\psi_{\overline{R_o}}$	the arithmetic mean of the mean value of R_o for each of the n samples;
2.5%	a conservatism factor.

Decay function assessment

2.7.4. The decay function assessment consists in the application of a decay function parameterised by the H/C_{org} ratio of the biochar, which shall always be less than or equal to 0.7, and the annual average temperature at its location of application or incorporation, i.e. soil temperature for application to soils and air temperature for incorporation in products.

(a) Operators using this option for permanence assessment shall use the H/C_{org} ratio for the biochar and the expected average temperature for the location of biochar application or incorporation (soil temperature in the case of application, air temperature in the case of incorporation) to calculate F_{perm} in accordance with equation (20) using the appropriate parameters m and c from Table 4, rounding temperature up to the next 5 °C interval. This estimates the remaining carbon after 200 years using the decay data documented by Woolf et al. (2021)[5].

$$F_{perm} = m * H/C_{org} + c \quad (20)$$

Variable	Description
H/C_{org}	ratio of hydrogen to organic carbon in the biochar production batch;
m	a parameter for the linear part of the modelled relationship between H/C_{org} ratio and permanence;
c	a parameter for the constant part of the modelled relationship between H/C_{org} ratio and permanence;

(b) For the purpose of the uncertainty assessment required in Section 2.13, the assessment of F_{perm} by the decay function method shall be treated as having an associated uncertainty of zero, as the decay function is already considered a conservative basis for estimation.

TABLE 4: PARAMETERS FOR CALCULATING F_{perm}.

Temperature (°C)	m	c
5	-0.5	1.108
10	-0.650	1.001

[5] Woolf, D., Lehmann, J., Ogle, S., Kishimoto-Mo, A. W., McConkey, B., & Baldock, J. (2021). *Greenhouse gas inventory model for biochar additions to soil*. Environmental Science & Technology, 55(21), 14795–14805. https://doi.org/10.1021/acs.est.1c02425.

15	-0.653	0.896
20	-0.636	0.829
25	-0.621	0.789

2.7.5. Puro.earth, as a certification scheme, makes available a dataset of location-specific default values for assessing the annual average soil temperature at a depth of 5 to 15 cm, averaged at sub-national regions, which is derived from Lembrechts et al., 2022[6] (specifically, the layer representing annual mean temperature at a soil depth of 5 to 15 cm, SBIO1_Annual_Mean_Temperature_5_15cm). This dataset can be used for selection of the expected average temperature for the location of biochar application to soils.

Quantification of associated GHG emissions

2.7.6. The GHG emissions associated with the application and/or incorporation of biochar into soils and products across one or more application or incorporation sites shall be calculated in accordance with equation (21). Only emissions that are directly related to the use of the biochar shall be included. In the case that biochar is intermixed with another material, such as fertiliser, prior to application or incorporation, emissions associated with producing and handling those second materials shall not be included, and the emissions from application or incorporation shall be allocated on a mass basis.

$$\mathrm{GHG_{use}} = \sum_{S} \left(\mathrm{F_S} * \mathrm{GHG_{biochar\ site,S}}\right) \quad (21)$$

Variable	Description
$\mathrm{F_S}$	mass fraction of the biochar from the activity in the total mass of soil amendment applied to soils or of material incorporated into products at each site. The total mass includes the biochar from the activity, any biochar sourced from other activities for use at the same site, and any other materials intermixed with the biochar;
$\mathrm{GHG_{biochar\ site,S}}$	is as defined in equation (22).

Emissions from application or incorporation

2.7.7. The GHG emissions associated with application or incorporation at each site shall be calculated in accordance with equation (22).

$$\mathrm{GHG_{biochar\ site}} = \mathrm{GHG_{combustion}} + \mathrm{GHG_{elec}} + \mathrm{GHG_{heat}} \quad (22)$$

$$\mathrm{GHG_{combustion}} = \sum_{\text{fuels}} \mathrm{Q_{fuel}} * \mathrm{EF_{fuel}} \quad (23)$$

$$\mathrm{GHG_{elec}} = \sum_{\text{electricity source}} \mathrm{Q_{elec}} * \mathrm{EF_{elec}} \quad (24)$$

[6] Lembrechts, J. J., Van Den Hoogen, J., Aalto, J., Ashcroft, M. B., De Frenne, P., Kemppinen, J., Kopecký, M., Luoto, M., Maclean, I. M. D., Crowther, T. W., Bailey, J. J., Haesen, S., Klinges, D. H., Niittynen, P., Scheffers, B. R., Van Meerbeek, K., Aartsma, P., Abdalaze, O., Abedi, M., … Lenoir, J. (2022). Global maps of soil temperature. Global Change Biology, 28(9), 3110–3144. https://doi.org/10.1111/gcb.16060

$$GHG_{heat} = \sum_{heat\ source} Q_{heat} * EF_{heat} \quad (25)$$

Variable	Description
$GHG_{combustion}$	GHG emissions due to fuel consumption at the application or incorporation site, including by vehicles and mobile equipment, in tCO_2e, calculated in accordance with equation (23);
GHG_{elec}	GHG emissions due to electricity consumption at the application or incorporation site in tCO_2e., calculated in accordance with equation (24) ;
GHG_{heat}	GHG emissions due to heat consumption at the application or incorporation site, in tCO_2e., calculated in accordance with equation (25);
Q_{fuel}	quantity of the fuel consumed in the certification period, expressed in appropriate unit;
EF_{fuel}	emission factor for the fuel consumed, expressed in tCO_2e/unit, selected in accordance with Section 2.11;
Q_{elec}	net quantity of electricity consumed in the certification period, selected in accordance with Section 2.9, expressed in appropriate unit;
EF_{elec}	emission factor for the consumed electricity, expressed in tCO_2e/unit, selected in accordance with Section 2.11;
Q_{heat}	net quantity of useful heat consumed in the certification period, selected in accordance with Section 2.9, expressed in appropriate unit;
EF_{heat}	emission factor for the consumed heat, expressed in tCO_2e/unit, selected in accordance with Section 2.11.

Monitoring and reporting

2.7.8. In accordance with Section 1.3, operators shall include in the monitoring report before each re-certification audit the measured or calculated parameters listed in Table 5. Where a parameter is noted as to be monitored, it shall be included in the monitoring plan in accordance with Section 1.3.

TABLE 5: PARAMETERS FOR INCLUSION IN THE MONITORING REPORT.

Equation	Parameter	Unit	Definition	Notes
(1)	$Q_{biochar}$	t	Quantity of biochar in the production batch	To be monitored
(1)	C_{org}	%	Fractional content of organic carbon in the biochar production batch	To be monitored

(1),(18), (20)	F_{perm}	%	Permanence fraction of each biochar production batch determined using either the random reflectance assessment approach or the decay function approach	Calculated using equation (18) or (20).
(16)	$F_{Ro>2\%}$	%	Fraction of non-reactive biochar in a sample that has random reflectance greater than 2%	To be monitored
(20)	H/C_{org}	dimensionless	Ratio of hydrogen to organic carbon in biochar production batch. H/C_{org} ratio is to be measured for every production batch.	To be monitored
(21)	GHG_{use}	tCO_2e	GHG emissions associated with the application or incorporation of biochar into soils and products across one or more application/incorporation sites	To be monitored
(21)	F_S	%	Mass fraction of the biochar from the activity in the total mass of soil amendment applied to soils or of material incorporated into products at each site.	To be monitored
(21),(22)	$GHG_{biochar\ site,S}$	tCO_2e	GHG emissions associated with energy use and operation to apply or incorporate the biochar or biochar-containing matrix	Calculated using eq. (22)
(22),(23)	$GHG_{combustion}$	tCO_2e	GHG emissions due to fuel consumption at the application or incorporation site	Calculated using eq. (23)
(22),(24)	GHG_{elec}	tCO_2e	GHG emissions due to electricity consumption at the application or incorporation site	Calculated using eq. (24)
(22),(25)	GHG_{heat}	tCO_2e	GHG emissions due to heat consumption at the application or incorporation site	Calculated using eq. (25)
(23)	Q_{fuel}	[appropriate unit]	Quantity of the fuel consumed in the certification period	To be monitored

(23)	EF_{fuel}	tCO_2e/unit	Emission factor for the fuel consumed	
(24)	Q_{elec}	[appropriate unit]	Net quantity of electricity consumed in the certification period	To be monitored
(24)	EF_{elec}	tCO_2e/unit	Emission factor for the consumed electricity	
(25)	Q_{heat}	[appropriate unit]	Net quantity of useful heat consumed in the certification period	To be monitored
(25)	EF_{heat}	tCO_2e/unit	Emission factor for the consumed heat	

2.8. Completeness and materiality

2.8.1. The quantification of associated GHG emissions shall be complete and shall cover all process and combustion emissions from all material emission sources and source streams belonging to the permanent carbon removal activities and all other relevant emissions.

2.8.2. Where an operator or a certification body identifies emissions from a source, or from a group of sources, associated with an activity that are material but are not covered by the present methodology, the operator shall ensure that such emissions are included in the calculation of the associated GHG emissions.

2.8.3. Unless otherwise stated, all emission sources identified in these rules must be assessed and must be included in the calculation of $GHG_{associated}$, even if they do not reach the level of materiality described here, i.e., Section 2.8. There are two potential exceptions to this principle, contexts in which a materiality assessment may be undertaken and emissions assessed as being below the materiality threshold do not need to be directly assessed. These contexts are capital emissions (Section 2.12), and input emissions (Rules 2.5.19 and 2.5.20).

2.8.4. A materiality assessment may also be required, as noted in rule 2.8.2 above, if the operator or certification body identified emissions from a source that is associated with the activity but is not explicitly identified in the present methodology. Where a materiality assessment is required on a specified emission source or group of emission sources, the operator must present to the certification body an estimate of the potential range of emissions across the activity period associated with that source. If the emissions at the high end of this range are equal to or greater than 2 % of the gross carbon removals delivered, or expected to be delivered, over the course of the activity period, then the emissions from that source are considered potentially material and must be directly assessed. At the certification audit operators shall carry out the materiality assessment based on expected emissions and removals over the activity period, and the basis for concluding that any emissions are immaterial shall be described in the activity plan. At re-certification audits the certification body shall assess whether there has been a significant deviation from the operational conditions declared at the certification audit. If such a deviation is identified operators shall carry out the materiality assessment again.

2.9. Net consumption of useful heat or electricity

2.9.1. Any energy recovery resulting from process configurations may lead to a reduction in the additional net consumption of a specified type of energy or a shift in net demand from one energy type to another. Therefore, for the calculation of net electricity or net useful heat consumption, operators shall assess the overall change in demand after such recovery processes have been implemented. The calculation of net consumption shall exclude any electricity or heat both produced and consumed on-site at the biochar production facility or the storage site or for the transport infrastructure. Emissions associated with electricity or heat generated on-site at a facility shall be accounted for separately by consideration of the fuel consumed. The overall change in demand corresponds to the difference between the quantity of electricity or heat imported from outside the facility for use directly by the activity and the quantity of electricity or heat that is exported for other uses that was recovered from processes directly required for the activity, including downstream processes such as CO_2 liquefaction. The calculation of net electricity or net useful heat consumption shall not include any heat or electricity that is produced specifically for export from the facility rather than recovered from a necessary process.

2.9.2. Where the net quantity of consumed heat or electricity is less than the gross quantity and this heat or electricity originates from more than one source, the net consumption from each source shall be calculated proportionally so that:

$$Q_{heat/elec,net,source} = Q_{heat/elec,gross,source} * \frac{\sum_{sources} Q_{heat/elec,net,source}}{\sum_{sources} Q_{heat/elec,gross,source}} \quad (26)$$

Variable	Description
$Q_{heat/elec,gross,source}$	gross quantity of electricity or useful heat from a given source consumed in the certification period;
Sources	Index of sources of heat or electricity.

2.9.3. In case of a net increase in availability of a type of energy as a result of energy recovery, the quantity (Q_{heat} or Q_{elec}) may be reported as a negative value. Operators shall ensure that any above-mentioned negative quantity is substantiated through correct process assumptions. In the case that one or both of the terms Q_{heat} or Q_{elec} calculated for a process element is negative, then the accompanying emission factor (EF_{heat} or EF_{elec}) shall be set to zero (i.e. there shall never be a negative term for GHG_{heat} or GHG_{elec}).

2.10. Additional biomass consumption

2.10.1. Additional biomass consumption refers to the biomass, biofuel, bioliquid and biomass fuel that is consumed specifically to provide energy for a biochar production process. In the case that heat is recovered from an existing biomass-based process whose primary aim is not the production of heat or electricity, and is used by the biochar production facility, this shall not be treated as a form of additional biomass consumption and shall instead by assessed using an emission factor for the consumed heat following Section 2.11.

Bioenergy facilities generating only electricity

2.10.2. In the case that carbon is captured at a bioenergy facility generating only electricity and some of this own electricity is consumed to power the biochar production process,

the additional biomass consumption $Q_{biomass}$ shall be calculated from the net amount of own electricity consumed in accordance with equation (27).

$$Q_{biomass} = \frac{Q_{elec}}{\eta_{elec}} \quad (27)$$

Variable	Description
Q_{elec}	the net consumption of own electricity;
η_{elec}	the electrical efficiency of the facility, defined as the electricity produced in the certification period, including the electricity consumed for biochar production, divided by the fuel input in the certification period based on its energy content.

Bioenergy facilities generating only heat

2.10.3. In the case that carbon is captured at a bioenergy facility generating only heat and some of this own heat is consumed to power the biochar production process, the additional biomass consumption $Q_{biomass}$ shall be calculated from the net amount of own heat consumed in accordance with equation (28).

$$Q_{biomass} = \frac{Q_{heat}}{\eta_{heat}} \quad (28)$$

Variable	Description
Q_{heat}	the net consumption of own heat;
η_{heat}	the heat efficiency of the facility, defined as the heat produced in the certification period, including the heat consumed for biochar production, divided by the fuel input in the certification period based on its energy content.

Bioenergy facilities generating a mix of heat and electricity

2.10.4. In the case that carbon is captured at a bioenergy facility generating both electricity and heat, the additional biomass consumption $Q_{biomass}$ shall be calculated from the net amount of own electricity and own heat consumed in accordance with equation (29), whereby the value $Q_{biomass}$ shall be > 0).

$$Q_{biomass} = \frac{(C_{elec} * Q_{elec} + C_{heat} * Q_{heat})}{(C_{elec} * \eta_{elec} + C_{heat} * \eta_{heat})} \quad (29)$$

Variable	Description
Q_{elec}	the net consumption of own electricity;
η_{elec}	the electrical efficiency of the facility under typical operational conditions. This may either be calculated as the electricity produced in the certification period, including the electricity consumed for biochar

	production, divided by the fuel input in the certification period based on its energy content, or may be set for the whole activity period based on technical documentation (design values) of the installation;
Q_{heat}	the net consumption of own heat;
η_{heat}	the heat efficiency of the facility under typical operational conditions. This may either be calculated as the heat produced in the certification period, including the heat consumed for biochar production, divided by the fuel input in the certification period based on its energy content, or may be set for the whole activity period based on technical documentation (design values) of the installation;
C_{elec}	The fraction of exergy in the electricity, set to 1;
C_{heat}	Carnot efficiency (fraction of exergy in the useful heat), defined as $C_{heat} = \frac{(T_{heat} - T_0)}{T_{heat}}$ where T_{heat} is the average temperature of the consumed heat in K (kelvin), and T_0 is 273.15 K.

The two parameters η_{elec} and η_{heat} must be set consistently, either both by calculation or both by reference to technical documentation. If the values are based on technical documentation then they must be set on the same basis as if they were calculated (i.e. expected electricity and heat output, respectively, divided by expected fuel consumption in a representative mode of operation) and the certification body shall verify that the values used are consistently achievable under nominal operation of the facility, and that the mode of operation used to set the values is a reasonable representation of the way in which the installation is actually operated.

2.11. Emission factors

Electricity

2.11.1. The emission factor applied in the calculation of emissions associated with any net electricity consumption (EF_{elec}) shall be calculated in accordance with paragraphs 5 and 6 of Part A of the Annex to Commission Delegated Regulation (EU) 2023/1185[7].

By way of derogation from the first paragraph:

(a) the calculation period for the electricity emission factor may be less than a calendar year and may span across parts of two calendar years; the certification period includes only part of one or two calendar years:

(i) if the certification period falls entirely within a single calendar year, the electricity emission factor shall be calculated either based on data for the exact certification period or on data for the full calendar year;

[7] Commission Delegated Regulation (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels (OJ L 157 of 20.6.2023, p.20).

(ii) if the certification period spans across two calendar years, an electricity emission factor shall be calculated for electricity consumed in each of those calendar years either based on data for the exact part of the certification period falling in each year or on data for the full calendar years;

(b) for any activity based on a new biochar production facility for which a final investment decision is made and construction has started no later than 31 December 2029, and for which the operator claims a zero emission factor for consumed electricity on the basis that the electricity is fully renewable, then if the operator is required to demonstrate temporal correlation between the consumption and generation of the renewable electricity, that temporal correlation may be assessed on an annual basis instead of on an hourly basis until 31 December 2044 or the end of the first activity period, whichever is sooner.

2.11.2. Operators may choose the approach to attribute greenhouse gas emissions values to the electricity for each source of consumed electricity independently, i.e. they are not required to use the same approach for setting the emission factor for electricity consumed in different locations.

2.11.3. In the case of net electricity export (a negative value for Q_{elec}) the emission factor shall be zero.

Heat

2.11.4. The following emission factors shall be applied in the calculation of emissions associated with any net heat consumption:

(a) for heat that is recovered from a process that is part of the activity: there are no additional emissions;

(b) for heat that is generated by combustion of fossil fuels: lifecycle emission factors for fossil fuel supply and combustion set out in the latest version of the Joint Research Centre document *Definition of input data to assess GHG default emissions from biofuels in EU legislation*[8] divided by the thermal efficiency of the heat generation process;

(c) for heat that is generated from biomass, biofuel, bioliquid or biomass fuel other than the case of own-heat consumption by a facility capturing CO_2 from biomass consumption for energy generation: emission factors for the supply and combustion (excluding CO_2 from combustion) of the biomass, biofuel, bioliquid or biomass fuel used, calculated in accordance with Annex VI to Directive (EU) 2018/2001 divided by the thermal efficiency of the heat generation process;

(d) for heat that is generated from non-biomass renewable sources: the emission factor is equal to zero;

(e) for heat from nuclear energy production: the emission factor is equal to zero;

(f) for heat that is recovered from a process from which heat was not previously recovered until a maximum of three months prior to the start of the activity): emission factor is equal to zero;

[8] Edwards, R., O'Connell, A., Padella, M., Giuntoli, J., Koeble, R., Bulgheroni, C., Marelli, L., Lonza, L., Definition of input data to assess GHG default emissions from biofuels in EU legislation, Version 1d - 2019, EUR 28349 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-02907-6, doi:10.2760/69179, JRC115952. https://data.europa.eu/doi/10.2760/69179.

(g) for heat that is recovered from a process from which heat was already recovered or from a new process, i.e. a process coming into operation less than 6 months prior to the start of the activity, and that process is not directly related to the activity: the emission factor shall be set to the EU ETS benchmark emission factor for heat;

(h) for heat that is supplied from a heat network: the emission factor shall be set to the EU ETS benchmark emission factor for heat.

2.11.5. In the case of net heat export (a negative value for Q_{heat}) the emission factor shall be zero.

Biomass

2.11.6. When biomass, biofuel[9], bioliquid[10] or biomass fuel[11] meeting the sustainability requirements set out in Article 29 of Directive (EU) 2018/2001 is consumed for an activity (see Section 2.5), any CO_2 produced by chemical processes from the carbon atoms therein contained shall be accounted for with a CO_2 emission factor equal to zero, but the supply chain emissions for provision of the biomass, biofuel, bioliquid or biomass fuel shall be accounted for, and any non-CO_2 emissions associated with biomass combustion (primarily CH_4 and N_2O) shall be accounted for.

2.11.7. The emission factor applied in the calculation of supply chain emissions associated with any consumption of biomass, biofuel, bioliquid or biomass fuel for the activity shall be calculated in accordance with the rules for calculating the GHG emissions associated with biomass, biofuel, bioliquid or biomass fuel supply set out in Annex V and Annex VI to Directive (EU) 2018/2001, considering the emissions up to the point of consumption associated with the terms e_{ec}, e_l, and e_p as defined in those annexes plus emissions associated with transport (see rule 2.11.8), and converting where necessary from emissions per unit of energy produced by a bioenergy facility to emissions per unit of feedstock consumed. As in Directive (EU) 2018/2001, wastes and residues shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials. For municipal waste, post-consumer wood waste and sewage sludge the 'process of collection' for the purposes of emissions calculation under Regulation (EU) 2024/3012 shall be understood to start only when the material is deposited at the facility at which the CO_2 capture activity will be implemented (for example at an energy recovery facility).

2.11.8. Emissions for transport of the biomass, biofuel, bioliquid or biomass fuel to the biochar production facility shall be calculated based on the actual distance travelled and mode of transport, whereby the disaggregated default emission factors listed for the e_{td} term shall not be used. With regard to indirect land-use change (ILUC) emissions, the requirements set in Section 4.2.4 prevent the increase in the consumption of food and feed crops or food and feed-crop based biofuels, bioliquids or biomass fuels to supply on-site heat or electricity used for the CO_2 capture process and therefore ILUC emissions shall be set to zero.

2.11.9. In the event that an operator uses biomass feedstocks that do not have disaggregated default values in the Annexes to Directive (EU) 2018/2001, the calculation of the associated biomass supply chain emissions shall be performed following a similar scope as in this Directive and attributional LCA conventions. This shall include all relevant life cycle stages up to the system boundary defined in the Directive, using activity data and emission factors that reflect average or activity-specific conditions rather than marginal effects. Where relevant, calculations shall be

[9] Liquid fuel for transport produced from biomass.
[10] Liquid fuel for energy purposes other than for transport produced from biomass.
[11] Gaseous or solid fuel produced from biomass.

consistent with the principles and framework set out in ISO 14067 (Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification).

Inputs and fuels

2.11.10. Where the quantification rules require the calculation of emissions associated with the use of inputs to that activity, including fossil fuels and materials used in the construction of capital equipment, lifecycle emission factors for those inputs shall be taken from the following hierarchical list of sources, sourcing the emission factors from the first source in the list from which it is available and using, where available, the most recent version of the sources:

(a) part B of the Annex to Delegated Regulation (EU) 2023/1185;

(b) the most recent version of the Environmental Footprint datasets, or EF-compliant datasets;

(c) the Joint Research Centre document, *Definition of input data to assess GHG default emissions from biofuels in EU legislation*;

(d) the JEC Well-to-Wheels report[12];

(e) the ECOINVENT database, version 3.5 or a more recent version, or other comparable commercial databases;

(f) official sources such as the Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA), or government;

(g) other reviewed sources or peer-reviewed publications.

Where access to any databases under subrule (e) is not possible, operators may rely on subrules (f) or (g) above.

2.11.11. **The lifecycle emission factors shall reflect the emissions associated with supplying those inputs up to the point of use by the activity. If necessary, emission factors taken from** the sources listed in rule 2.11.10 **shall be adjusted to exclude any carbon contained within the input material itself. If such carbon is oxidised and emitted as a result of processes associated with the activity this shall be counted as an emission source directly. The use of data from divergent sources may lead to slight inconsistencies in the scope of lifecycle accounting applied to different inputs. Operators are not required to recalculate data from these sources to achieve full consistency in lifecycle scope across the utilised input data.**

Transport

2.11.12. Emissions from transport, whether of CO_2 or of bulk materials, may be calculated based on assessment of the fuel consumption and consequent emissions associated with the specific vehicles and routes utilised.

2.11.13. Where default values are not used, operators may estimate the emissions either by recording the actual fuel consumption of the vehicles and other infrastructure utilised; or by calculating the product of the average GHG emissions associated with operating the specific vehicle or infrastructure (in gCO_2e/km) and the distance travelled. GHG emission factors for fuels consumed shall be set on a lifecycle basis (i.e. including upstream emissions) in accordance with rule 2.11.10. GHG emission factors for vehicles transporting CO_2 shall account for the mass of the CO_2 containment equipment and for energy expenditures to compress and liquefy the CO_2 and maintain it in that state. Operators shall account for the emissions associated with the return trip of vehicles

[12] Prussi, M., Yugo, M., De Prada, L., Padella, M., Edwards. JEC Well-To-Wheels report v5. EUR 30284 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-20109-0, doi:10.2760/100379, JRC121213, https://data.europa.eu/doi/10.2760/100379.

used to transport CO_2 or bulk materials considering them empty, unless they demonstrate that the return trip is used to provide another transport service. In that case the return emissions allocated to the activity may be set at zero for those trips.

2.12. Capital emissions

2.12.1. If the quantification rules require the consideration of capital emissions associated with one or more facilities, the following shall apply:

(a) if any facility first came into operation or has been expanded or refitted within 15 years prior to the certification date of the activity, or will be expanded or refitted within the activity period, the capital emissions associated with that construction, expansion or refit shall be considered;

(b) for any other facility, the capital emissions shall be considered to be zero;

(c) a materiality assessment shall be undertaken for the sum of all capital emissions across all relevant facilities. If the certification body concludes on the basis of this assessment that capital emissions may be material, the capital emissions shall be assessed;

(d) any capital emissions associated with non-biomass renewable energy generating equipment shall be excluded from the calculation;

(e) capital emissions shall only be assessed for the part of facilities or equipment that is directly required for the performance of the activity (i.e. specifically required for the CO_2 capture and not solely for the underlying activity from which CO_2 is captured).

2.12.2. If capital emissions are to be assessed, the total capital emissions for each facility or facilities shall be calculated by taking an inventory of the construction materials utilised and fuel and energy consumed in the construction of the facility and summing the associated emissions. Emissions factors used in assessing capital emissions shall consider the full lifecycle of the materials and energy utilised. The calculated capital emissions for each facility shall be amortised by dividing them across either fifteen or twenty years. In cases where not all of the CO_2 handled by the facility is associated with the activity certified under Regulation (EU) 2024/3012 (e.g. if some of the CO_2 is transferred for utilisation) a pro-rata fraction of the capital emissions shall be allocated to the activity. In the case that a facility has equal or lower material requirements for construction than a previously constructed facility of the same type, operators may use the capital emission for that previous facility as an estimate of capital emissions for the new facility.

2.12.3. This amortised emission shall be added to the associated GHG emissions for the activity for each year until either the fifteenth or the twentieth year (depending on the operator's chosen amortisation period) following the year in which the facility came into operation, was expanded or was refitted, as relevant, in accordance with equation (30).

$$\mathrm{GHG_{capital}} = \frac{\mathrm{Q_{activity}}}{\mathrm{Q_{total}}} * \frac{(\mathrm{GHG_{combustion}} + \mathrm{GHG_{elec}} + \mathrm{GHG_{heat}} + \mathrm{GHG_{materials}})}{\mathrm{T}} \quad (30)$$

Variable	Description
T	amortisation period of either 15 or 20 years;
$\mathrm{Q_{activity}}$	utilisation of the capital equipment by the activity in a relevant unit;

Q_{total}	expected annual average total utilisation of the capital equipment over its operational lifetime in the same unit (so that $Q_{activity}/Q_{total} = 1$ if the equipment is used only by the activity)
$GHG_{combustion}$	emissions due to fuel consumption in the construction of the facility, calculated as in rule 2.5.13;
GHG_{elec}	emissions due to electricity consumption in the construction of the facility, calculated as in rule 2.5.15;
GHG_{heat}	emissions due to net consumption of useful heat in the construction of the facility, calculated as in rule 2.5.16;
$GHG_{materials}$	emissions due to consumption of materials utilised in the construction of the biochar production facility, as further defined in rule 2.12.4.

2.12.4. The parameter $GHG_{materials}$ refers to the emissions due to consumption of materials utilised in the construction of the biochar production facility. $GHG_{materials}$ shall be calculated in accordance with utilisequation (31)

$$GHG_{materials} = \sum_{materials} Q_{materials} * EF_{materials} \quad (31)$$

Variable	Description
$Q_{materials}$	quantity of materials utilised in the construction of the facility, expressed in t;
$EF_{materials}$	emission factor for the utilised materials, expressed in tCO_2/t of material, selected in accordance with Section 2.11.

2.13. Measured data and uncertainties

2.13.1. Measurements shall be undertaken in a way consistent with the requirements of Article 42 of Implementing Regulation (EU) 2018/2066.

2.13.2. Where measured, estimated or default data are used as the basis for calculations of sources or sinks, the operator shall assess the uncertainty introduced into the calculation of net carbon removals.

(a) Operators shall follow the principles for combining uncertainties set out in Section 3 of Chapter 6 ('Quantifying Uncertainties in Practice') of the IPCC document *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*[13]. Uncertainty shall be assessed based on the 95 % confidence interval.

[13] Penman, J., Kruger, D., Galbally, I., Hiraishi, T., Nyenzi, B., Emmanuel, S., Buendia, L., Hoppaus, R., Martinsen, T., Meijer, J., Miwa, K., & Tanabe, K. (Eds.). (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, IPCC National Greenhouse Gas Inventories

(b) If the total resulting uncertainty estimate is greater than ± 20 %, no units shall be issued for that certification period.

Programme, Institute for Global Environmental Strategies ISBN 4-88788-000-6, https://www.ipcc-nggip.iges.or.jp/public/gp/english/.

3. Carbon storage and liability

3.1.1. The H/C_{org} ratio of each batch of biochar shall be measured. No carbon removal units may be issued in respect of any batch of biochar that is measured to have an H/C_{org} ratio greater than 0.7.

3.1.2. The use of produced biochar shall be monitored up to the point of application to soil or incorporation in a product, and carbon removal units shall be issued in relation to the quantity of biochar applied or incorporated. Biochar from certified activities shall be segregated in the supply chain from any biochar produced by non-certified activities until reaching the point of application or incorporation. Certified and non-certified biochar may be mixed at that point and then applied or incorporated. If biochar from multiple production batches produced by certified activities is mixed together prior to application or incorporation it shall be well mixed, and the mixed material shall be treated as consisting of fractions of the original batches in proportion to the quantities originally mixed. A segregated supply for each production batch is mandatory unless production batches can be demonstrated to be well mixed. The chain of custody shall in particular ensure that biochar is only used in ways that are appropriate to its production and characteristics.

3.1.3. Where biochar is applied to soils and this application is not directly overseen by a representative of a certification body, operators shall grant access to the location of application to certification schemes, certification bodies or relevant competent national authorities upon request, during the monitoring period, to allow the soil to be tested in order to confirm that biochar has been applied. After this point the application of the biochar shall be treated as having been demonstrated.

3.1.4. Operators are not subject to further monitoring requirements after the end of the monitoring period as the risk of reversals is characterised through the assessment of the permanence fraction of the biochar and it is not practically possible to directly identify reversals after the point of application or incorporation.

4. Sustainability

4.1. Minimum sustainability requirements

Climate change mitigation

4.1.1. The eligibility requirements listed in Section 1.1 prevent the certification of activities that significantly harm the objective of climate change mitigation.

Climate change adaptation

4.1.2. Operators shall comply with the criteria related to climate adaptation set out in Appendix A to Annex 1 to Commission Delegated Regulation (EU) 2021/2139[14].

Sustainable use and protection of water and marine resources

4.1.3. Operators shall evaluate and address any potential risks due to the activity to the good status or the good ecological potential of bodies of water, including surface water and groundwater, or to the good environmental status of marine waters. In the case that pollutants that are scrubbed from flue gases in order to reduce air pollution may be released to a body of water, the air pollution benefit and the availability of alternative discharge strategies shall be taken into consideration when evaluating the impact on water quality.

Transition to a circular economy, including the efficient use of sustainably sourced bio-based materials

4.1.4. Operators shall evaluate and address any potential risks to the circular economy objectives from the activity, by considering the types of potential significant harm as set out in Article 17(1), point (d), of Regulation (EU) 2020/852 of the European Parliament and of the Council[15]. Operators shall comply with the requirements set in Sections 4.2 and 4.2.4.

Pollution prevention and control

4.1.5. Operators shall evaluate and address any potential risks to generate a significant increase in the emissions of pollutants to air, water or land from the activity. Where facilities are within the scope of Directive 2010/75/EU of the European Parliament and of the Council[16] they shall comply with all requirements arising from that Directive.

4.1.6. Operators of BCR activities where biochar is applied to agricultural, forest or urban soils shall demonstrate that:

(a) the biochar complies with the limit values on heavy metals and organic contaminants stated in rule 4.4.3;

(b) the biochar meets all requirements relating to pyrolysis and gasification materials in Regulation (EU) 2019/1009, including the limitations on permissible input materials.

[14] Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives (OJ L 442, 9.12.2021, p. 1)

[15] Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (OJ L 198, 22.6.2020, p. 13).

[16] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial and livestock rearing emissions (integrated pollution prevention and control) (recast) (OJ L 334, 17.12.2010).

Protection and restoration of biodiversity and ecosystems including soil health, as well as avoidance of land degradation

4.1.7. Operators shall evaluate and address any potential risks to the good condition or resilience of ecosystems or to the conservation status of habitats and species, including those of Union interest or to the achievement of targets or obligations set out in national restoration plans established under Regulation (EU) 2024/1991 of the European Parliament and of the Council[17], from the activity.

4.1.8. Operators of BCR activities where biochar is being applied to agricultural and forest soils shall demonstrate that the local context has been considered and that it is reasonable to expect no overall negative effect on biomass production, site condition or soil health and no significant reductions in the storage of other soil organic carbon through positive priming effects from the application of biochar. Where significant loss of other soil organic carbon or deleterious impacts on agricultural productivity, on biodiversity, on ecosystems receiving the biochar and the ones located downstream in the watershed, soil health, or on any other environmental aspects are considered likely by the certification body, no carbon removal units shall be issued in relation to that applied quantity.

4.1.9. To promote scientific advancement and facilitate collective progress in the field of biochar carbon removals, operators shall share relevant data and information that is not commercially sensitive upon request by certification schemes, competent national authorities or the European Commission, and without creating undue administrative burden for farmers. Puro.earth, as a certification scheme shall enable knowledge sharing between operators by providing a platform to allow the dissemination of data gathered in the course of any post-application monitoring activities undertaken by operators. This platform takes the form of a publicly accessible webpage maintained by the certification scheme, where operators may voluntarily request the publication of relevant content. Operators are invited, at their discretion and at any time, to submit materials related to post-application monitoring activities. Such materials may include, but are not limited to, reports, datasets, posters, presentations, recordings, or proposals for webinars or similar knowledge-sharing events. All submitted content is reviewed by the certification scheme to ensure basic quality and appropriateness, including clarity, absence of offensive material, and no manifestly incorrect or misleading information. This review does not constitute a scientific validation of the content.

4.2. Biomass sustainability

4.2.1. All biomass, biofuel, bioliquid or biomass fuel that is used to generate the CO_2 captured by the activity or as a feedstock for biochar production and any additional biomass, biofuel, bioliquid or biomass fuel consumed to produce energy for the activity shall comply with the following requirements:

(a) where Article 29 of Directive (EU) 2018/2001 sets requirements that are to be met in order for biofuels, bioliquids and biomass fuels to be taken into account for the purposes referred to in Article 29(1), points (a), (b) and (c), of that Directive, those requirements shall be applied by the certification body also to biomass, biofuel, bioliquid or biomass fuel consumed in relation to an activity that seeks to generate carbon removal units, even if the activity does not generate renewable energy that is taken into account under Directive (EU) 2018/2001;

[17] Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869 (OJ L, 2024/1991, 29.7.2024).

(b) operators shall disclose the biomass feedstock or feedstock mix consumed by the activity, and the biomass feedstock or feedstock mix used to produce consumed biofuels, bioliquids or biomass fuels, disaggregating feedstock to the level required in Directive (EU) 2018/2001 reporting, in national guidance and in relevant industrial standards;

(c) certification bodies are required to verify that the requirements in Article 29(10) of Directive (EU) 2018/2001 are met only in the case of a capture activity or of biochar production taking place at a facility producing heat or electricity or a biofuel, bioliquid or biogas, and with regard to the heat, electricity, biofuel, bioliquid or biogas produced;

(d) the biomass, biofuel, bioliquid or biomass fuel produced from wastes or residues other than agricultural, aquaculture, fisheries and forestry residues, is not subject to the requirements set out in Article 29(2) to (7) of Directive (EU) 2018/2001

4.2.2. Voluntary schemes approved by the Commission in accordance with Article 30(4) of Directive (EU) 2018/2001 and national schemes recognised by the Commission in accordance with Article 30(6) of Directive (EU) 2018/2001 shall be treated as providing accurate data for the demonstration of compliance with the biomass sustainability requirements for permanent carbon removal activities of this methodology. Similarly, any other schemes that have been recognised by competent national authorities in the state where the biochar production facility is located shall be treated as providing accurate data in relation to the demonstration of compliance with these requirements.

4.2.3. With regard to facilities regulated under Directive (EU) 2018/2001, periodic assessments of the compliance with sustainability requirements by Member State competent authorities shall not prevent certification bodies approving the issuance of units. However, if such assessment subsequently results in any non-conformity with Article 29 of that Directive, the non-conformity shall be notified to the certification bodies.

4.2.4. If biomass is sourced from areas designated by the national competent authority for conservation, including areas covered by the national restoration plan pursuant to Regulation (EU) 2024/1991, or in habitats that are protected, the sourcing shall be in accordance with the conservation and restoration objectives for those areas.

4.3. Avoidance of unsustainable demand for biomass raw material

4.3.1. Any production batch of biochar in which the produced biochar is expected to account for 50% or more of the total energy outputs in the co-products of the biochar production facility (see equation (4), rule 2.5.9) shall only be produced from waste or residual feedstocks, or from biofuel, bioliquid or biomass fuel produced from waste or residual feedstocks, as defined in Article 2, points (23) ('waste') and (43) ('residue'), of Directive (EU) 2018/2001.

4.3.2. To support the regeneration of natural carbon stocks used for the generation of permanent carbon removals, operators of carbon removal activities that are based on consumption of biomass feedstock may purchase carbon farming sequestration units.

(a) The quantity of carbon farming sequestration units purchased by the operator shall be reported in the certificate of compliance.

4.4. Requirements regarding risks of pollution associated with biochar

4.4.1. Operators shall perform sampling and laboratory testing for each production batch (see definition in section 2.5.1), against the applicable threshold values defined in this section 4.4. In the case of biochar for application to agricultural and forest soils, the minimum frequency of sampling and laboratory testing shall always be consistent with (i.e., at least equal or more conservative than) the requirements of Regulation (EU) 2019/1009, even in the context of a reduced sampling and testing regime. Reduced sampling and testing regimes, e.g., by consideration of the properties of the feedstock and process or by reference to the distribution of historical samples for comparable production batches, may be suggested by operators for approval and incorporation by the certification scheme in a rule change. In this case, the operator shall provide a risk-based justification, including historical laboratory results, explaining why a reduced sampling and testing regime is unlikely to pose environmental risks. The certification scheme reserves the right to reject requests for reduced sampling and testing, if the risk-based justification is deemed insufficient or conflicting with requirements of Regulation (EU) 2019/1009.

4.4.2. If non-biogenic material is co-processed in the biochar production process, the char produced shall not be applied to agricultural and forest soils.

Limit values on heavy metals and organic contaminants for biochar applied to agricultural and forest soils

4.4.3. Operators shall demonstrate by lab analysis that biochar has no more than the listed concentrations of the following substances in units of grammes per tonne dry matter [g/t dm]:

(a) Lead; 120 g/t dm;

(b) Cadmium; 1.5 g/t dm

(c) Copper; 100 g/t dm

(d) Nickel; 50 g/t dm

(e) Mercury; 1 g/t dm

(f) Zinc; 400 g/t dm

(g) Chromium; 90 g/t dm

(h) Arsenic; 13 g/t dm

(i) Benzo[e]pyrene; 1 g/t dm

(j) Benzo[j]fluoranthene; 1 g/t dm

(k) PCB 0.2 g/t dm

(l) PCDD/F 0.000020 g TE/t dm (WHO-TEQ 2005)

(m) PAH_{16}[18]; 6 g/t dm

(n) PAH_{8}[19]; 1 g/t dm

[18] Sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene and benzo[ghi]perylene.

[19] A subset of PAH16 being the sum of benzo[a]pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene and benzo[ghi]perylene.

In addition, the biochar shall comply with any relevant national or local requirements.

Additional requirements for biochar incorporated into a matrix prior to application to agricultural and forest soils

4.4.4. Biochar may be applied to soil either directly without being intermixed with any other material, after incorporation into a mixture, intermixed with the digestate from anaerobic digestion following the use of the biochar as an additive to the anaerobic digestion process, or in the manure of livestock animals that have been fed the biochar as a feed additive. Mixtures shall consist of biochar and of other component materials complying with the relevant component material category requirements under Regulation (EU) 2019/1009. Such materials may include manure, compost, liquid fertiliser, anaerobic digestate and other substrates. Such mixtures shall be identified in a Product Function Category, and the mixture shall comply with the requirements for that Product Function Category under Regulation (EU) 2019/1009. Operators may assume that the permanent fraction F_{perm} of the biochar is unaffected by its use as an additive to anaerobic digestion or feed additive.

4.4.5. If biochar is applied to soils in the form of manure after use as a livestock feed additive, operators shall meet the following requirements, additional to those in Section 4.4.1, with regard to the biochar utilised:

(a) the biochar feedstock shall consist only of pure plant biomass or biomass fuel produced from pure plant biomass;

(b) the feed hygiene requirements of Regulation (EC) No 183/2005 of the European Parliament and of the Council[20] shall be complied with;

(c) the H/Corg ratio of the biochar shall be no greater than 0.4;

(d) the biochar shall be demonstrated by lab analysis to have no more than the listed concentrations of the following substances in units of grammes per tonne on an 88% dry matter basis [g/t 88% dm]:

(i) Lead; 10 g/t 88% dm;

(ii) Cadmium; 0.8 g/t 88% dm;

(iii) Mercury; 0.1 g/t 88% dm;

(iv) Arsenic; 2 g/t 88% dm;

(v) PCDD/F; 0.00000075 g TE/t 88% dm (WHO-TEQ 2005);

(vi) PCDD/F + dl-PCB; 0.00000125 g TE/t 88% dm (WHO-TEQ 2005);

(vii) Sum of 6 DIN PCB[21]; 0.00001 g/t 88% dm;

(viii) Fluorine; 150 g/t 88% dm.

4.4.6. Operators shall ensure that all manure produced by the animals receiving the biochar amended feed product will either be naturally applied to soils by the animal in situ, or be collected and applied to the soil. Operators may assume that the permanent fraction F_{perm} of the biochar is unaffected by its use in livestock feed.

[20] Regulation (EC) No 183/2005 of the European Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene (OJ L 035 8.2.2005, p. 1).
[21] PCB-28, PCB-52, PCB-101, PCB-138, PCB-153, and PCB-180.

Limit values on heavy metals and organic contaminants for biochar incorporated in products or applied to soils other than agricultural and forest soils

4.4.7. Only BCR activities that incorporate biochar in cement, concrete or asphalt are eligible for certification.

4.4.8. Operators shall demonstrate by lab analysis that biochar has no more than the listed concentrations of the following substances in units of grammes per tonne dry matter [g/t dm]:

(a) PAH_8; 4 g/t dm;

(b) Benzo[e]pyrene; 1 g/t dm;

(c) Benzo[j]fluoranthene; 1 g/t dm;

(d) PCB 0.2 g/t dm;

(e) PCDD/F 0.000020 g/t dm (WHO-TEQ 2005).

In addition, the biochar shall comply with any relevant national or local requirements

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V 1.0	01 June 2026	Initial version published

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