# Completion aid

The document is written from the perspective of a producer.

The red parts must be adapted or overwritten by the project proponent.

The *red parts in italics* give an explanation of what the project proponent has to provide at this place.

The black parts are default entries, which will apply to most projects. The project proponent is free to change them, but must use the track-change-mode if doing so.

**Instruction: Please delete all red instruction parts before handing in the PDD for validation.**

The black parts are default entries, which will apply to most projects. The project proponent is free to change them but must use the track-change-mode if doing so.

Once the certifier has validated your PDD and all open points are fulfilled, the project proponent can change the font color to black.

**Please note:**

The final validated and verified PDD will be published together with the corresponding C-sinks in the Global C-Sink Registry, Annexes will not be published.

Default text blocks which are not modified/deleted, are considered as written by the project proponent.

**About the structure of this document:**

This document covers all steps from produced biochar until the application to a C-sink matrix with the corresponding calculations.

Description part

After a cover page chapter 1 provides a general overview about the activities of the producer and justifies why the chosen methodology is applicable. Chapter 2 gives an estimate on the impact these activities can have in terms of established C-sinks. Chapter 3 provides more details on technology and some other points raised in chapter 1.

Calculation part

Chapter 4 provides all monitoring parameters and calculations needed by the producer to calculate the emissions caused and the C-sink potential. In 4.1 the monitoring plan is outlaid. It does not contain any specific values but gives information about how the producer plans to monitor their activities. It shall answer questions like: What are appropriate indicators/parameters to report on the activities/emissions? What data sources can the producer provide to substantiate this data in the event of an audit? What frequency is appropriate to collect the data (here you can specify both a temporal frequency (continuous, monthly, ...) and one that is triggered by an event (in case of ...))?

The data monitored in 4.1 will be used in the calculations in 4.2. That means all parameters that are used in the calculations in 4.2 have to be listed in chapter 4.1. The subsections 4.1.x of the calculation part are structured from the overall formula to the detail.

Chapter 5 covers all steps from the factory gate to the final C-sink. For the steps “biochar processing” (5.1) and all remaining steps until application to the matrix (5.2) the same structure is applied. 5.1.1 and 5.2.1 represent the monitoring plans and the monitored parameters are used in the subsequent sections.

**Project Design Document**

Logo of the project to be inserted here

Project ID xxx *(known at end of validation process)*

Name of project: xxx

Name of quality manager: xxx

Date of issue: xx.xx.xxxx

Version of the PDD: Version x.x

Methodology: EBC-Guidelines for the Certification of Biochar Based Carbon Sinks Version 2.1

Project location: xxx

Project start date: XX.XX.XXXX *(Date of contract conclusion with Carbon Standards or registration date for the EBC Biochar C-Sink service. Or, in the case of retroactive certification, the production date of the batch.)*

Project period: The project has no end date, but it is verified on an annual basis

Project summary: *(2 sentences about the project)*

The project will increase carbon sequestration by working the produced biochar into different matrixes and in this way create a long-term carbon storage with a persistence of up to 100 years as according to the EBC Biochar C-Sink Standard. Without the project, no C-sink would be created since *feedstock* does not constitute a long-term carbon reservoir.

In the initial 5 years of the project we expect carbon sequestration of approximately xxx CO2eq in total or xxx CO2eq / year.

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# Purpose and general description of project

The project *(projectname)* compromises xx pyrolysis plants for biochar production from *(feedstock).* Biochar is a hyper versatile material with an increasing number of applications in agriculture, environmental engineering, and basic industry. Biochar applied a matrix permitted by the Global C-Sink Standard poses a stable carbon sink (C-sink). Without the project, no C-sink would be created since Pomace does not constitute a long-term carbon reservoir.

*(Write about 2 sentences about baseline.)*

Another objective of the project is to improve the soil quality in xx by marketing biochar as soil amendment. Biochar can improve soil quality significantly because of its impact on the soil pH, its water retention capacity, and its ability to store nutrients.

Furthermore, the biochar may be used as temporary C-sink or as additive in construction materials or consumer products.

## Project location

*(Where will the project take place?)*

*(Provide GPS location of pyrolysis unit)*

The geographical locations of the subsequently installed plants will be documented in the biochar tool *(or other dMRV tool*).

*(Where will biochar sold to)*

*(Provide map indicating the before mentioned regions)*

## Description of baseline scenario

*(Describe Baseline)*

The baseline scenario for carbon removal accounting is the "business as usual", in which no permanent biochar-based carbon sink is generated and is considered as zero. The fact that biomass could have been used differently in the baseline scenario does not deplete a long-term natural or otherwise registered carbon sink., and thus has no impact on the consideration of the baseline as zero. This is ensured by following the regulations of chapter 5 of the Global Biochar C-sink Standard.

$$C-sink (Baseline) = 0 tCO2e$$

## Biochar carbon sinks

When plant biomass is burnt or decomposed, the assimilated carbon is released again in the form of CO2. However, if the plant biomass is pyrolyzed, about half of the plant carbon is transformed into a mixture of predominantly very persistent carbon compounds that form a solid material known as biochar. While in the environment, any carbon compound is subject to degradation; for most components of biochar, this process is extremely slow, and mostly even so slow, that it is hard to measure for thousands of years. Provided that the biochar is not burned, the biochar carbon remains as a C-sink in the terrestrial system.

## Project Boundary

For the creation of a C-sink the emissions from Scope 1 and 2 of each involved and registered organization (producers and processors) are recorded. All scope 1 and scope 2 emissions from the biochar producing company are fully recorded and attributed to the biochar production.

If not otherwise specified by the processors in their annexes to the PDD they account for all emissions from Scope 1 and 2. Processor are obliged to provide details in their annexes to the PDD if they are deviating from the default.

For Scope 3 emissions of involved organizations, only the emissions from biomass production transport of biomass or biochar and derived products are directly quantified. Other indirect emissions from Scope 3 are not recorded individually due to their comparatively low volume but are instead included in the calculation with a flat margin of safety to account for the whole value chain.

Organizations are required to include the emissions upstream to the next organization in their emissions portfolio. The last organization in the chain before the C-sink is established and registered is also responsible for reporting transport emissions downstream in their emission portfolio.

*A graphic can be added to visualize the system boundary*

## Eligibility

*(All checkmarks have to be ticked)*

[ ]  Production of biochar according to EBC/WBC criteria in place.

[ ]  Producer is a legal entity and hold an operating license for the entire project region.

[ ]  Social Impact: The project complies with the requirements set by the methodology, see annex 17-0-2EN Self-Assessment Social Responsibility.

[ ]  The C-sinks issued in this project are not claimed in any other Carbon Crediting Scheme.

## Ownership

By default the owner of a potential C-sink is the owner of the material that contains carbon in a stable form, thus the owner of the physical products as biomass or biochar or biochar containing products. With each sale of biochar or biochar-based products the ownership of the material that eventually forms a C-sink is transferred to the new owner.

If the product is traded without its climate effect represented by the C-sink value it must be labeled informing the buyer that the C-sink of the product is already registered and cannot be claimed for other emission compensations. This reference must at least be made by printing the following Carbon Standards registered seal: "Registered C-Sink" and a QR-Code with the web link to more detailed information about the C-sink registration and use. This applies especially to diffuse C-sinks and biochar applied to soil.

The C-sink value is therefore the property of the owner of the material, unless it is clearly stated on the receipts that the C-sink was not sold with it.

## Additionality

The required additionality test consists of 3 steps. The project is deemed additional if it leads to additional carbon removal.

## Assessment of regulatory requirements for biochar production and application as a removal technology

*(Assess whether biochar production and carbon preserving application is required in the country where the producer operates. All relevant permits and regulations need to be presented. A project is only additional, if no legally binding requirements for the production and carbon-preserving application of biochar can be identified.)*

## Additional Carbon Removal

Biochar C-sinks are the result of the active removal of CO2 from the atmosphere. Complete and batch-accurate tracking of each sequestered unit of carbon must be ensured to guarantee the removal of CO2 from the atmosphere and to quantify C-sinks. The accurate representation of the climate impact of each C-sink is ensured by the basic structure of the calculation methodology and the requirement to fully offset all emissions from the process (EBC C-Sink standard chapter 4).

## Biomass Feedstock Additionality

*(Biochar C-sinks must be additional to natural C-sinks that could or would have been realized with the same biomass feedstock in the absence of the biochar C-sink solution. Asses your baseline thoroughly (chapter 1.2 and 3.2 of the PDD) regarding natural C-sinks that could have been realized. Demonstrate that the C-sink potential of the project is superior by showing that your feedstock sourcing complies with the safety measures given in the EBC C-sink standard chapter 2.)*

# Ex-ante estimate of impact

The estimations are based on the dry matter amounts of biomass and the resulting biochar. The C-sink potential is calculated as the expected amounts of biochar multiplied by the expected carbon content.

The established permanent C-sinks are estimated as based on the PAC fraction of the biochar (75%), when the biochar is applied to soils and has an H/C ratio below 0.4.

The ex-ante estimate is based on the following values:

Yield factor (feedstock to biochar) : xx t biochar (DM)/t feedstock (DM)

Ccontent of biochar: xx (based on preliminary analysis)

*(Please fill the below table with the estimated amounts for your production for the first 5 years.)*

|  |  |  |  |
| --- | --- | --- | --- |
| Year of operation | Amount of feedstock (DM) | C-sink potential (tCO2eq) | Established permanent C-sinks (tCO2eq) |
| 1 | X | X | X |
| 2 | X | X | X |
| 3 | X | X | X |
| 4 | X | X | X |
| 5 | X | X | X |
| sum | X | X | X |

# Technology and business cases

## Production unit

Biochar is produced via pyrolysis technology. Pyrolysis means the thermo-chemical decomposition of the feedstock under the exclusion of oxygen.

By converting sustainable biomass into biochar by pyrolysis, a long-term carbon reservoir is created. At the factory gate of the production unit the biochar poses a potential of C-sink (C-sink potential). It could still be burned. By safety measures, such as marketing and labeling the biochar with the aim of becoming ana C-sink and monitoring all distribution channels in a digital Measurement, Reporting and Verification tool (dMRV), it is ensured in the best possible way, that the biochar is used to form a C-sink. C-sink certificates are only issued for those parts of the biochar for which it can be proven that they have been put in a matrix. Without the project, no C-sink would be created, as non-pyrolytic biomass does not ensure persistent carbon storage.

The produced biochar is certified under the xx Biochar Certification (xBC) standard, what guarantees that the biomass feedstock is sustainably procured and produced, biochar fulfils the analytical threshold values so no damage is caused to the environment, emissions limits of the pyrolysis unit are adhered to and storage procedures are environmentally sound.

The biochar production follows the xx Biochar Certification (xBC) standard, which ensures:

* Compliance with laws regarding air pollution control
* Minimization of risks on human health, social and environmental impacts
* Energy and carbon efficiency
* Sustainable origin of the feedstock

Type of pyrolysis unit

Xxx,

Planned operating hours per year: xx

Planned feedstock consumption: xx

Nominal biochar production: xx

Concept for waste energy and/or carbon recovery

*(Provide details on how you plan energy recovery, concerning energy and technical implementation. )*

*(Insert production flowchart from technical pre-audit)*

## Feedstock

All used feedstock corresponds to the EBC positive list.

Only C-neutral biomass input materials are permitted for the production of biochar C-sinks. Biochar produced from biomass whose harvesting resulted in the destruction or depletion of a natural C-sink (e.g., clear-cutting of a forest) or has contributed to the disappearance of an existing sink (e.g., inappropriate agricultural practices on bog soil) does not render any positive climate service and must not be used for C-sink-potential certification.

However, it must be ensured that the removal of harvest residues does not decrease soil organic carbon stocks .

In the project the following feedstock is used which is eligible with the sustainability criteria:

|  |
| --- |
| xxxx |

Origin of feedstock:

*(Describe what feedstock the producer is using and how it was used before the biochar production started.)*

The feedstock mentioned above corresponds to the general feedstock classes:

[ ]  (1) Agricultural biomasses

[ ]  (2) Organic residues from food processing

[ ]  (3) Wood from landscape conservation, short rotation plantations, arable forestry, forest gardens, field margins, and urban areas

[ ]  (4) Biomass from forest management

[ ]  (5) Wood waste

[ ]  (6) Other biogenic residues

To avoid methane emissions during storage of biomass the following principles should be followed:

*(Producers can also get a custom storage plan approved by Carbon Standards.)*

* Wood and other biomass should be chipped only a few days and at a maximum of four weeks before pyrolysis. Log storage is considered unproblematic regarding methane emissions; coarse wood (thinner logs, branches, cuttings, etc.) should be stored as airy as possible and not mixed with green waste.
* If just-in-time chipping is not possible, the wood chips or biomass should be dried as soon as possible, e.g., with the excess heat from pyrolysis and stored dry with a maximum of 20% residual moisture. If the biomass is sufficiently dry, biodegradation does not take place or is slowed down considerably.
* Alternatively, the wood chips or the biomasses can be stored in small, well-ventilated containers such as lattice boxes (max. 2 m3). Due to sufficient ventilation, anaerobic degradation and thus methane emissions can be prevented.

If compliance with these principles cannot be fulfilled, actual practice and parameters according to the monitoring plan will be documented.

## Distribution channels of biochar

The following applications are possible for this project:

* Geological C-sink (biochar applied to soil)

*(If other applications are planned please name them and amend section 5 accordingly.)*

## Planned business development

*Describe producers plans for business development. E.g. feedstock usage, distribution channels, scale-up.*

# Determination of C-sink potential

## Monitoring plan

All data which are required to calculate the C-sink potential is entered into a dMRV System. The dMRV system is either provided by Carbon Standards or by an external MRV systemprovider. External MRV systems and tools must be endorsed by Carbon Standards annually. The data will be monitored as mentioned below. Each packaging unit containing more than 1 m3 of biochar must be labeled with a scannable identification code provided by the biochar dMRV System, which shows the following information:

- Date of production

- EBC certification class

- Feedstock used

- Highest pyrolysis temperature

- Bulk density

- Biochar properties as per lab analysis

- Indication whether C-sink value has already been sold elsewhere on the packaging and the delivery bill by stating if the C-sink value of the biochar has already been compensated.

Packaging units smaller than 1 m3 biochar may be grouped into a larger unit (e.g., 20 bags of 50 l packed on a palette) where the larger unit is labeled with the scannable identification code, given that all smaller units have the same destination.

### General data

The following general data will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Batch Start Date | per batch | Internal documentation |
| Batch End Date | per batch | Internal documentation |
| H/Corg ratio | per batch | laboratories endorsed by Carbon Standards, see <https://www.carbon-standards.com/en/standards/service-501~ebc-c-sink.html> section Laboratories |
| C-content of biochar | per batch | laboratory endorsed by Carbon Standards, see <https://www.carbon-standards.com/en/standards/service-501~ebc-c-sink.html> section Laboratories |
| M\_biochar (DM)(Total biochar production of batch (expected) in t dry matter) | Per batch | Protocols documenting the sampling.Dry weight and total carbon content per big bag is recorded by means of drying a sample of biochar all 10 m3, according to methods explained in EBC Biochar C-sink Standard, chapter 5.1. |
| Biochar Production (DM) | continous | operation recordings |

The following general conversion rates are fixed ex-ante:

*(If project proponent wants to use different parameters they have to be well justified and accepted by Carbon Standards.)*

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Ex-ante definition; value** | **Source of data** |
| CO2 emissions from diesel | 3.2 kg CO2eq / kg diesel or 2.7 kg CO2eq / l diesel | Methodology, Juhrich, 2016 |
| CO2 emissions from heavy fuel | 65 t CO2eq / TJ | Methodology, Juhrich, 2016 |

### Emissions from fossil fuels

#### Feedstock

For the feedstock the following parameters will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Type of feedstock (with ID of EBC positive list) | continuous | purchase receipts and EBC positive list |
| Average water content of feedstock at delivery | per batch | documentation of frequent measurements |
| Amount of feedstock (DM) processed for the last batch | per batch | production protocols |
| Total amount of feedstock (dry matter) used for the batch | per batch | production planning |
| Amount of fertilizers used as per the following table in kg N | for each feedstock delivery | x |
| Area on that pesticides were used as per the following table in ha | for each feedstock delivery | x |
| Amount of input of fuels for cultivation and harvest | for each feedstock delivery | x |
| Amount of diesel used for feedstock preparation | continuous | purchase receipts |
| Amount of electricity used for feedstock preparation | continuous | electricity meter |
| CO₂eq of electricity used for the pyrolysis plant in g CO₂eq/kWh | per batch | electricity provider |
| How do you dry the feedstock? | continuous | Statement |
| Amount of fuel equivalent used for drying per ton (DM) of feedstock? | continuous | purchase receipts |
| Amount of electric energy used for drying per ton (DM) of feedstock | continuous | purchase receipts |

The following general conversion rates are fixed ex-ante:

*(If project proponent wants to use different parameters they have to be well justified and accepted by Carbon Standards.)*

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Ex-ante definition; value** | **Source of data** |
| CO2 emissions from Nitrogen fertilizer | 1 t CO2eq / 100 kg N | Methodology, Zhang et al., 2013 |
| CO2 emissions from pesticides | 94 kg CO2eq per hectare | Methodology, Audsley et al., 2009 |

#### Pyrolysis

For pyrolysis the following parameters will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Electricity consumption of pyrolyser for the entire batch (in kWh) | per batch | x |
| Source of electric energy for the pyrolysis plant  | per batch | x |
| CO₂eq footprint of electricity used for the pyrolysis plant in g CO₂eq/kWh | per batch | electricity provider |
| Energy source to preheat the pyrolysis reactor | per batch | x |
| Amount of fuel which is used to preheat the pyrolysis reactor in t per batch | per batch | x |
| CO₂eq of fuel used for the pyrolysis plant per t | per batch | invoices for purchasing fossil fuels |

If it is assumed that the carbon yield in the biochar is less than 10% of the carbon contained in the biomass the biochar C-sink may be established using the pro rata approach*. If you are holding an exception permit regarding pro rata approach, please provide the additional data you monitor.*

#### Post-treatment

For post-treatment of the biochar the following parameters will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Amount of diesel used for biochar post-treatment | per batch | purchase receipts |
| Amount of electricity used for biochar post-treatment | per batch | purchase receipts |

#### Compensation of Fossil Emissions

Emissions resulting from the provision of biomass (fuel consumption, N2O from fertilizer) affect the carbon footprint and are compensated by deductions in the C-sink calculation.

### Methane emissions

#### Storage of biomass

When biomass is stored, methane emissions can be produced, which need to be included in the C-sink potential calculation. This is why the storage period needs to be monitored. Not only the storage on the premises of the pyrolysis plant is considered, but the entire storage period of the biomass, be it at the harvest site or the site of any biomass processor or trader.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| $$\#months of storage$$ | continuous | operation recordings |
| A) Is storage duration less than a month?  | continuous | operation recordings |
| B) Is biomass stored well ventilated? | Whenever the answer to A) is no | operation recordings |
| C) Is moisture content below 20%? | Whenever the answer to A) and B) is no | operation recordings |
| core temperature of the biomass for all sites where biomass is stored for more than one month | annually | measurement during on-site inspection |

Impact of the monitored parameters:

If at least one Point A) to C) is answered with yes: methane emissions are negligible.

If all points A) to C) are answered with no or temperatures of more than 5°C above ambient temperature is measured during on-site inspection: methane emissions are included in the C-sink potential calculation.

#### Pyrolysis

During pyrolysis, the pyrolysis gases are usually oxidized in a suitably designed combustion chamber. Usually, the gaseous combustion products pass a filtration step and are then emitted mostly as CO2. If the pyrolysis process is well-adjusted and the combustion chamber correctly designed, non-CO2 GHGs and other pollutants can be kept at very low levels in the exhaust. However, CH4, NOx, CO, and particulate matter (PM) are, as in all combustion processes, never completely absent and must be controlled. Concerning the net climate impact, methane emission is particularly important to measure. CO, NOx, SOx, and PM are also harmful to the environment, but according to the IPCC, they do not have a clear greenhouse gas effect (IPCC, 2013) and are therefore not accounted for the emission portfolio, while CH4 is included.

Measuring methane emissions below 5 ppm is technically complex. Continuous measurement over an entire production year is not possible with currently available technology. Therefore, either at least two CH4-emission tests per pyrolysis unit with the same feedstock representing the typical operation of the unit are required, or the pyrolysis unit must have a system certification according to EBC or WBC.

The average methane emission of a type of system is then set to be the mean value plus one standard deviation. If an emission measurement for methane or CxHx is below the measuring accuracy of the instruments, the limit of quantification (LOQ) is used. The assessed methane emissions are thus higher than the calculated average and provide a sufficiently high safety margin to cover any potential emission peaks, e.g., during start-up and shutdown of operation.

|  |  |
| --- | --- |
| □ | Default: Pyrolysis unit used in the project has a system certification, see system certification. |
| xxx  |

Accordingly, ex-ante definition of the following parameter:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Ex-ante definition; value** | **Source of data** |
| [CH4\_emissions\_pyrolysis] | xxx | system certification |

|  |  |
| --- | --- |
| □ | Pyrolysis unit used in the project has no system certification. A detailed measurement strategy with precise details of the measurement technology, measurement intervals, and measurement for CH4 emission tests will be provided to Carbon Standards and approved. *Provision of details on testing strategy required.* |

Accordingly, following parameter will be monitored once during first monitoring period:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| [CH4\_emissions\_pyrolysis] in kg CH4/t DM feedstock | At least 2 measurements during first monitoring period | measurements |

#### Compensation of CH4 Emissions

Methane emissions can be compensated with short-term C-sinks, provided they guarantee at least 20 years of carbon storage.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Proof of compensation | per batch | xx |

## Calculation of C-sink potential at factory gate

The C-sink potential at factory gate reflects the remaining C-content of the biochar at factory gate, for which all fossil emissions have been offset against a permanent sink. Preferably the permanent portion of the biochar itself.

### Emissions from fossil fuels

Emissions from fossil fuels are calculated based on the following formulas:

$$\left[Total GHG emissions in CO2eq per batch\right]=\left[Total biomass related GHG emissions without CH4 per batch\right]+ \left[Total pyrolysis related GHG emissions without CH4 per batch\right]+\left[Emissions for post treatment of feedstock per batch\right]+[safety margin for leakage] $$

$$\left[Total GHG emissions in C per ton of biochar \left(dry matter\right)\right]= \left[Total GHG emissions in CO2eq per batch\right]\*\frac{12}{44} / [Amount of biochar (dry matter) produced per batch] $$

#### Feedstock

The production of biomass usually causes emissions that need to be accounted for as carbon expenditures of the C-sink. Emissions are calculated in t CO2eq.

* If mineral nitrogen fertilization was used to produce the biomass, its carbon footprint, including soil borne N2O emissions, must be accounted for according to the formula 100 kg N = 1 t CO2eq (Zhang et al., 2013). This represents a consideration of the GWP100 for N2O and the production emissions for nitrogen fertilizer.

$$\left[Emissions due to fertilization per batch\right]=\frac{\left[Amount of fertilizers used\right]}{100kgN}$$

* If pesticides were used, a flat value of 94 kg CO2eq per hectare (Audsley et al., 2009) is applied for their production-related emissions.

$$\left[Emissions due to pesticides per batch\right]= \left[Area on that pesticides were used \right]\*0,094 t CO2eq$$

* The input of fuels for cultivation and harvest or preparation of feedstock must also be added to the emission portfolio with a conversion factor of 3.2 kg CO2eq / kg diesel or 2.7 kg CO2eq / l diesel (Juhrich, 2016).

$$\left[Emissions for Preparation of feedstock per batch\right]=[diesel used for feedstock preparation]\*2.7 kgCO2eq/l+electricity for prepartion\*CO2eq\\_elec$$

* The fuel for trucks for transporting the biomass from the source to the biochar production facility must be calculated with the conversion factor of 2.7 kg CO2eq per liter diesel and the road distance according to google maps. If the truck returns back empty, the distance will be multiplied by 2.

$$\left[Emissions due to transportation of biomass to pyrolysis site per batch\right]=\frac{\left[Amount of feedstock (DM)\right]}{15t} \*[distance] \* 0.2 l diesel/km \* 2.7 kg CO2eq/l$$

* Emissions for drying feedstock are calculated, fuel and electricity are considered. The fuel for drying feedstock is calculated with a conversion factor of 2.7 kg CO2eq per liter diesel.

$$\left[Emissions for drying of feedstock per batch\right]=\left[fuel used for drying\right]\*CO2eq\\_elec+[diesel used for drying]\*2.7 kgCO2eq/l$$

The total biomass related GHG emissions without Methane per batch is calculated according to the following formula:

$$\left[Total biomass related GHG emissions without CH4 per batch\right]= \left[Emissions due to fertilization per batch\right]+\left[Emissions due to pesticides per batch\right]+ \left[Emissions due to transportation of biomass to pyrolysis site per batch\right]+\left[Emissions for Preparation of feedstock per batch\right]+ \left[Emissions for drying of feedstock per batch\right] $$

#### Pyrolysis

Emissions which are produced during the pyrolysis process contain electricity consumption and fuel for preheating the pyrolysis reactor. The emissions are calculated in **tCO2eq.**

$$\left[Emissions due to electricity consumption\right]= \left[Electricity consumption\right]\*\left[CO2eq of electricity\right]\*1000000$$

Note: If renewable energy is used, a CO2eq footprint of zero is assumed. If the pyrolysis plant itself generates at least as much electricity on an annual average as is consumed in the production facility, a CO2eq of zero is assumed for electricity consumption.

$$\left[Emissions due to fuel for preheating\right]= \left[Fuel consumption\right]\*\left[CO2eq of fuel\right]$$

The total production emissions are calculated with the formula:

$$ \left[Production emissions\right]= \left[Emissions due to electricity consumption\right]+\left[Emissions due to fuel for preheating\right]$$

$$\left[Total pyrolysis related GHG emissions without CH4 per batch\right]=[Production emissions]$$

*If you are holding an exception permit regarding pro rata approach please provide the formulas how to calculate* $\left[Total pyrolysis related GHG emissions without CH4 per batch\right]$*.*

#### Post-treatment

If the biochar will be post-treated, the emissions are calculated according to the following formula:

$$\left[Emissions for post treatment of feedstock per batch\right]=\left[diesel used for biochar post treatment\right]\*2.7\frac{kgCO2eq}{l}+[electricity for biochar post treatment]\*CO2eq\\_elec$$

#### Leakage emissions

The Global C-Sink Standard prohibits non-sustainable biomass cultivation, land use change and soil organic carbon depletion - thus, leakage in sense of carbon expenditure outside of the project boundaries is avoided as much as possible. It is assumed that activity shifts to biochar production causes only minimal leakage emissions.

For the EBC Biochar C-Sink, the emissions from Scope 1 and 2 are fully recorded. As per project boundary, from Scope 3, only the emissions from biomass production and its transport are directly quantified. Other indirect emissions from Scope 3 are not recorded individually due to their comparatively low volume but are instead included in the calculation with a flat margin of safety.

This includes, for example, the emissions caused by:

- Production and disposal of polypropylene bags,

- Electricity for the operation and cooling of the company's external computer servers,

- Potential methane emissions during the first month of storage of the biomass,

- Fuel consumption by employees for commuting to work and for business trips,

- Marketing and management activities including trade shows and conference attendance,

- Operation of chainsaws or harvesters for felling and peeling trees and for digging up roots,

- Emissions from machine fuels during cultivation of agricultural land and plant protection measures,

- Production, maintenance, repair, and disposal of pyrolysis equipment, transport vehicles, warehouses, and other machinery.

- The margin further contains unavoidable imprecisions of the C-sink accounting such as sampling, packaging, volume and dry mater analysis, etc.

- Unlikely loss of c-sink material e.g. by burning small portions of diffuse C-sinks in waste incineration plants

The margin of safety generally to 10% of the total emissions from biochar production deducted from the C-sink value and is rounded to 0.1%.

$$\left[safety margin\right]=0.1\*\left[Total GHG emissions in CO2eq per batch\right]$$

### Methane emissions

During biomass storage and pyrolysis process methane emissions are produced. They are calculated according to the following formula:

$$\left[Total methane emissions\right]=\left[CH4 emissions from pyrolysis of entire batch\right]+\left[Feedstock storage emissions per batch\right]$$

#### Emissions from the storage of the biomass

If methane emissions are negligible according to section 3.1.3.1.: 0 tCH4

If methane emissions are included in the C-sink potential calculation: Emissions are calculated in **tCH4**:

$\left[Feedstock storage emissions per batch\right]= \left( \left[\#months of storage\right]-1\right)\* \left[amount of biomass dry matter \left(batch\right)\right]\*[Ccontent of biomass]\*[methane emissions per month]$

Default values given in the methodology are used:

|  |  |
| --- | --- |
| $$[methane emissions per month]$$ | 0,15% of C-content for woody biomass 0,25% of C-content for non-woody biomass |
| $$[Ccontent of biomass]$$ | 48% for woody biomass50% for non-woody biomass |

#### CH4 Emissions from Pyrolysis reactor

Emissions are calculated in **tCH4.**

*Adjustment may be needed.*

$$\left[CH4 emissions from pyrolysis of entire batch\right]=\frac{\left[CH4\_{emissions\_{pyrolysis}}\right]}{1000}\* \left[amount of biomass dry matter \left(batch\right)\right]$$

#### Compensation of CH4 Emissions

The greenhouse gas emissions caused by biochar production, quantified from planting the biomass to the packaging of the biochar, are then converted from CO2eq into the rate of carbon expenditure (= CO2eq / 44u \* 12u) per ton of biochar. This carbon expenditure rate is then subtracted from the carbon content of the biochar, which results in the value of the C-sink of the biochar at the factory gate.

$$\left[CO2e of CH4 emissions of entire batch\right]=\left[Total methane emissions\right]\* GWP20\\_CH4$$

With GWP20\_CH4 = 86 CO2eq

The methane emissions can be compensated with short-term C-sinks, provided they guarantee at least 20 years of carbon storage.

### Value of C-sink potential

The C-sink potential at factory gate reflects the remaining C-content of the biochar at factory gate.

$$\left[CSink Potential\right]=[CContent]- [Total GHG emissions in C per ton of biochar (dry matter)]$$

$$\left[CSink Potential per batch\right]= \left[CSink Potential\right] \*m\\_biochar(DM)$$

# Determination of C-sink

Once the C-sink potential of the biochar has been determined and the label has been applied to the packaging units in accordance with the requirements in chapter 3.1, the further fate of the biochar is only indirectly influenced by the producer. In the further chain up to the final C-sink, there are processors and users. It is incumbent on all of them to play their part in quality assurance and monitoring as well as reporting on their emissions. The final C-sink is registered by the first C-sink owner.

## Biochar processing

If the biochar is delivered to a processing company who makes new biochar-based products from the biochar, the receiving company must be EBC or WBC certified as a processing company and/or trader. This allows the verification of the climate relevant processes as part of annual on-site inspection. All processing steps must be recorded with their CO2eq footprint.

Once the products are repackaged, they must be registered as new product and C-sink unit providing the following information:

- Product processor

- Biochar production batch ID and/or QR code to access EBC/WBC biochar analysis.

- Date of biochar production

- Point of new departure (GPS)

- Biochar C-content of product

- C-sink matrix, if mixed to one

- Emission that occurred during processing

- Indication whether C-sink value has already been sold elsewhere on the packaging and the delivery bill by stating if the C-sink value of the biochar has already been compensated.

### Monitoring of processing parameters

Processors are obliged to monitor the following data. They are obliged to define appropriate monitoring frequencies and data sources in annexes to this PDD.

|  |
| --- |
| **Parameter** |
| Amount of diesel used for transportation  |
| Amount of diesel used for biochar processing |
| Amount of electricity used for biochar processing |
| Input biochar and output biochar based-product documentation |
| Any other GHG emitting process |

### Calculation of processing emissions

The calculation of the processing emissions is done with the following formula:

$$\left[Emissions for processing\right]=\left(\left[diesel used for biochar processing\right]+\left[diesel used for transportation\right]\right)\*2.7\frac{kgCO2eq}{l}+\left[electricity for biochar processing\right]\*CO2eq\_{elec}+[additional emissions]$$

# Registration of C-sink

Biochar carbon sinks must be registered with the geo-localized area where the biochar or its derived products have been applied. This encompasses scenarios where biochar serves as a soil amendment or finds application in various contexts, such as construction for residential, infrastructural, or road-related purposes.

If the registration of the geographical location and site owner of the C-sink is not possible or practicable, but the biochar is nevertheless shown to have been introduced into a matrix that precludes combustion (e.g., compost, biogas slurry, cement, etc., see above), the sink is considered a diffuse C-sink.

The following information are registered for biochar carbon sink:

* C-sink owner (e.g. owner of the land where the C-sink is established, owner of the material that contains the biochar, producer of biochar containing products).
* KLM-file of land or area where the C-sink was established.
* Date of C-sink establishment.
* EBC/WBC batch number.
* Biochar analysis
* Type of C-sink (geo-localized or diffuse).
* C-sink matrix.
* Amount of biochar in dry tons.
* Amount of carbon in CO2eq.
* C-sink project design document
* Validation report of the validation body
* Verification report of the verification body
* Monitoring report of the operation

### Monitoring of transport parameters until final location

First C-sink owners are obliged to monitor the following data. They are obliged to define appropriate monitoring frequencies and data sources in annexes to this PDD.

|  |
| --- |
| **Parameter** |
| Amount of diesel used for transportation from last processor to application site |
| Amount of diesel used for application |
| Any other GHG emitting process |
| Emission reports from Producer and Processors |

*If you want to be the first c-sink owner for at least parts of your production fill in the following table, otherwise delete it:*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For the part of the production that is brought into the producer's sphere of influence, we record:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Amount of diesel used for transportation from last processor to application site | continuous | Distance and amount of trucks; in case of diffuse C-sink: statistically determined mean distance |
| Amount of diesel used for application | continuous | operation recordings |
| Any other GHG emitting process | continuous | operation recordings |
| Emission reports from Producer and Processors | per C-sink | Producer and Processors |

 |

### Calculation of C -sink

The C-sink is registered in the Global C-sink Registry.

If H/Corg ratio is < 0,4, the calculation of the C-sink at day of application is :

$$\left[C(year=0)\right]=\left[CSink Potential\right] \*[dry mass of biochar applied]-(\sum\_{processors}^{}\left[Emissions for processing\right]+([diesel used for transportation to final sink]+[diesel used for application])\*2.7\frac{kgCO2eq}{l})$$

*If the biochar used has a H/Corg ratio > 0,4 individual process of offsetting emissions must be described.*

However, every biochar C-sink underlies a time-dependent evolution, and the C-sink is a measure of the mass of carbon that is physically present in the C-sink matrix at any given moment in time since the establishment of the C-sink. The size of a biochar C-sink is, thus, a function of the type of biochar determining its specific persistence in a specific C-sink matrix and the time since the application to the C-sink matrix.

$$C-sink\left(year\right)= C-sink(year=0) \* specific persistence (year)$$

### Geological C-sink

Biochar which is applied to soil can be registered as geological C-sink if the biochar has an H/Corg ratio < 0.4.

A conservative average degradation rate of 0.3% per year may be assumed for higher temperature biochars with a H : Corg ratio below 0.4 (following: Budai et al., 2013; Camps-Arbestain et al., 2015).

Thus, 100 years after soil application, 74% of the original carbon in biochar could still be accounted for as sequestered carbon. The annual rate of 0.3% is based on the most conservative metanalytical estimate for biochar carbon degradation published to date.

$$C-sink\left(100\right)= C-sink\left(year=0\right)\* 74\%$$

*Provide details if biochar is used other than soil application.*

# Annexes

1. Social Responsibility