**Completion aid**

The red parts must be 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.

# Project Design Document

Logo of the project to be inserted here

Name of project: xxx

Name of quality manager: xxx

Date of issue: xx.xx.xxxx

Methodology: Global Artisan C-Sink 2.1

Project location: xxx

Project start date: XX.XX.XXXX *(Date of contract conclusion with Carbon Standards or registration date for the Global Artisan C-Sink service.)*

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 1000 years as according to the Global Artisan 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 Artisan Biochar Producers 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 Artisan C-Sink Standard poses a stable carbon sink (C-sink). Without the project, no C-sink would be created since *(feedstock)* 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.

The monitoring and tracking of this project will be carried out by Name of C-sink Manger. In the project the digital MRV technology named xxx will be used. This will monitor, report and verify biochar production and carbon sequestration.

## Project location

*(Where will the project take place?)*

*(Provide GPS location of pyrolysis unit)*

The geographical locations of the subsequently installed Biochar Artisan Producers will be documented in the *dMRV tool*.

*(Provide map indicating the before mentioned regions)*

## Stakeholders and partners involved

*(Write which stakeholders and companies are involved in the project including their roles. Visualize the chain from C-Sink Manager to Artisan Biochar Producer. Add an organigram as well.)*

## Description of baseline scenario

*(Describe Baseline situation (What happened to the feedstock before the project? Is there an activity shift relevant to the project for some stakeholders?)*

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, has no impact on the consideration of the baseline as zero.

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

## 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.

If biochar with an H to Corg ratio < 0.40 is applied to soil, a major part of its carbon is considered Persistent Aromatic Carbon (PAC, the portion of biochar carbon bound in clusters of more than seven aromatic rings as analyzed by the hydro pyrolysis method) and will constitute a carbon sink for several millennia. A minor though relevant part of the biochar-carbon is less persistent (semi persistent carbon, SPC) and likely to be microbially degraded within decades to centuries, presenting a mean residence time of 50 years. The biochar carbon that may be decomposed within the first 1000 years after the application to soil is called Semi-Persistent Carbon (SPC) and constitutes a temporary C-sink. For biochars presenting an H to Corg ratio < 0.4, the PAC fraction is conservatively fixed by the standard at 75% and the SPC fraction at 25%.

## Project Boundary

All emissions occurring due to biomass sourcing, biochar production and application must be accounted and need to be adequately offset by registered carbon sinks.

Scope 1 and Scope 2 emissions as well as transport emissions from Scope 3 in connection with the production, processing and application of biochar for the creation of a C-sink.

## Eligibility

*(All checkmarks have to be ticked)*

□ Production of biochar according to Global Artisan C-Sink conditions.

□ Farmers and Artisan Biochar Producer are not certified under any other methodology for nature-based climate service (i.e. biomass production and soil organic carbon).

□ Social Impact: Involved parties have to be compensated fairly and transparent.

□ Project location: Project is located in low- or middle-income country according to the World Bank classification.

□ Biochar production does not exceed 100m3/year for a single C-Sink Farmer or 1500m3/year for a single Artisan Pro and is done with a low-tech production unit.

## Additionality

Artisanal Biochar Producers do not generate income yet with biochar in most regions, there is no market for biochar-based fertilizers, and the production costs are higher than the expected agronomic benefit, or tropical smallholder farmers do not have the financial resources to pay biochar-based fertilizers. Farmers could produce their biochar from their feedstock to improve their yields, but without the training provided by the Global Artisan C-Sink Manager, they would hardly acquire the craft to do so. The Community Service Activity is a central aspect of the project.

The Global Artisan C-sink will, thus, be the decisive monetary incentive and knowledge transfer to produce climate positive biochar and thus carbon sinks. The Global Artisan C-Sink Manager will provide not only training on biochar production but also on the preparation and application of biochar-based fertilizers, which (a) will enable most farmers to establish this practice and (b) will avoid the adoption of unsustainable biochar production practices which could result in pollution and GHG-emissions. Moreover, methane compensation, as introduced by the Global Artisan C-sink is a key element to achieving net negative emissions with Kon-Tiki based biochar C-sinks.

Global Artisan C-sink assures the adoption of low-emission technology, methane compensation, and the use of sustainably sourced biomass. Without those boundary conditions, biochar production in countries with low purchasing power and limited financial and technical possibilities would hardly result in net negative emissions. Hence, additionality of any C-sink certificates issued under this standard is guaranteed.

Not all feedstock types are allowed within the Global Artisan C-Sink Standard. The restriction of eligible biomass for biochar production is explained by the intention to avoid by all means the overexploitation of ecosystems and the impairment of food security for the sake of C-sink maximation.

# Ex-ante estimate of impact

|  |  |  |  |
| --- | --- | --- | --- |
| Year of operation | Amount of feedstock (DM) | Established temporary C-sinks (tCO2e) | Established permanent C-sinks (tCO2e) |
| 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

## Artisan Biochar Producer

*Description of which type of system will be conducted in this project (C-Sink Cooks, C-Sink Farmer or Artisan Pro)*

|  |
| --- |
| The C-Sink Farmer is an Artisan Biochar Producer who produces up to 100 m3 of biochar per year from residues of her/his farm and applies this biochar back to his/her soil. Exceptionally, biomass from neighboring farms or debris can be used, and biochar can be sold to other farmers when correctly tracked. C-Sink Farmers are grouped in Artisan Networks with a maximum of 1000 participating farmers managed by an Artisan C-Sink Manager. |

|  |
| --- |
| The C-Sink Cook is usually a family or household that uses one or several TLUD pyrolysis stoves for cooking, producing an average 30 kg (DW) of biochar per month. Well-trained TLUD cooks using dried woody feedstock produce biochar qualities that meet WBC-Agro certification standards. The Biochar Processor collects, controls, and measures the biochar every few weeks. The biochar is usually delivered to a central processing location where it is mixed with a C-sink matrix (link) and transformed into biochar-based fertilizer or other biochar-based materials. C-Sink Cooks are grouped in C-Sink Villages. Preferably, the biochar is applied as biochar-based fertilizer in the gardens and farms of the C-Sink Village, although, in most cases the biochar is collected by an Artisan Biochar Processor who trades biochar-based products in- and outside the C-Sink Village. |

|  |
| --- |
| An Artisan Pro is a registered company or part of a registered company. An Artisan Pro may have several production units and artisans that run these. Artisan Pro biochar is professionally produced by a company, an association, or an individual using all sorts of eligible biomass found within a radius of 10 km from the production site. Artisan Pro biochar is not necessarily applied back to the fields where the biomass was grown but is mostly traded to other farms and industries. Artisan Pro biochar is produced at a registered production site with registered production equipment. It can be produced by several trained Artisan Biochar Producers (i.e., employees of the certified company), though they work at the same site with the same equipment. The maximum annual biochar production still considered artisanal is 1500 m3 per year. |

The (Sample) contract between the Global Artisan C-Sink Manager and Artisan Biochar Producers (C-Sink Farmers, C-Sink Cooks, as well as Artisan Pro) was presented to the Certifier.

### Training of Artisan Biochar Producer

The Global Artisan C-Sink Manager proves how the Artisan Biochar Producers were qualified to produce high-quality biochar with low emissions. The Artisan Biochar Producer follows a biochar production training given by a qualified trainer and prove their proficiency in an exam. The training includes principles of feedstock selection and biomass drying, the biochar kiln operation principles, the volume measurement of the produced biochar, a biochar sampling procedure, and the proficient use of the Artisan smartphone app.

Regular training is provided as per internal training protocol.

## Feedstock

The Global Artisan C-Sink Managers ensures that the biochar is made from biomass feedstock that originated *from the artisan’s farm or from biomass processing such as cocoa mills, coffee pealing, rice thrashing, sawmills, and comparable industries. Biomass may also come from disaster debris, maintenance of fallow fields, or dedicated biomass production like bamboo or switch grass plantations.*

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

|  |
| --- |
| Pomace is considered as carbon-neutral residue material as described in the Global Artisan C-Sink Standard. |

Origin of feedstocks:

*(Describe what feedstock the producer is using and how it was used before the biochar production started. As well as the storage possibilities of the feedstock)*

Feedstock from own production. Wine yard of 100 ha in XYZ.

In the business as usual scenario the pomace from olive groves is left to degradation (without energetic valorization).

### Methane emission during storage

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

* The feedstock must not be used freshly cut or from a feedstock pile where it rained upon.
* Feedstock needs to be stored airy and protected from rain.
* To avoid methane emissions from feedstock storage, wet feedstock must not be piled higher than a meter. Otherwise, the humid feedstock will self-heat, consume the oxygen inside the pile and decompose anaerobically, which produces significant amounts of methane.
* When feedstock got exposed again to rain, a new period of at least three days of thinly layered sun drying has to start.
* Touching the feedstock must not feel humid.
* The water content of feedstock should be below 25% when used in the Kon-Tiki or TLUD. Simple, low-cost digital devices exist to measure feedstock humidity, which must be used at the biochar trainings so that Artisan Biochar Producer get the experience of how to test the feedstock for humidity even without digital devices. Producers of more than 100 m3 biochar per year are required to measure the feedstock humidity with an appropriate device and record it in the production protocols. Here, the average humidity is recorded using five measurements with the handhold device per m3 of feedstock.
* Both, feedstock drying and correct bulkiness of the feedstock blend, is an essential part of the initial Artisan Biochar Producer and C-Sink Cook training.

## 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. The produced 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 an 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 Global Artisan C-Sink 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 Global Artisan C-Sink standard, which ensures:

* Only trained Artisan Biochar Producer are allowed to produce biochar
* Minimization of risks on human health, social and environmental impacts
* No forest wood and slash of forest trees are permitted as feedstock

Description (incl. designs or pictures) of the pyrolysis unit, i.e. Kontiki or soil pit.

|  |
| --- |
| **Flame Curtain Pyrolysis (the Kon-Tiki method)**The principle of flame curtain pyrolysis consists of pyrolyzing biomass layer by layer in a conically-, polygonal-, rectangular-, or cylindrical-formed metal, concrete, or soil kiln. A fire is started in the kiln, and the embers spread to form a first layer on the bottom of the kiln. A thin layer of biomass is then added on top of the embers, heats quickly and starts outgassing. The rising pyrolysis gas is caught in the flame curtain and reacts with combustion air entering the kiln from the top. When ash appears on the outside of the carbonizing biomass, the next layer of biomass is homogenously spread on top. Convective and radiant energy from the flames above and from the hot pyrolyzing layers below heat up the fresh biomass layer, which starts to pyrolyze. The biochar below the upper pyrolysis layer is shielded from oxygen access by the fire curtain itself. The combustion zone thus forms a flame curtain that protects the underlying biochar from oxidizing and cleanly burns all pyrolysis smoke and gases as they pass through this hot fire front. The manual layering of biomass is repeated until the metal kiln or soil pit is filled. The pyrolysis process is then actively ended by quenching with water or a nutrient solution (e.g., diluted urine, dissolved fertilizer) which is fed into the kiln from below if possible or, where water is not easily available, by snuffing with a layer of soil.A fire pit with wood burning in it  Description automatically generated |

|  |
| --- |
| **Pyrolysis Cook Stoves (TLUD micro gasifier)**Traditional open-fire cooking is associated with low feedstock efficiency, high greenhouse gas (GHG) emissions per meal, and adverse health effects, particularly among women and children. TLUD stoves offer a more environmentally friendly alternative by pyrolyzing dried, mostly woody feedstock and utilizing the resulting pyrolysis gas for cooking. This method is significantly cleaner than using a simple wood fire or wood-burning stoves is more feedstock efficient, and still produce some biochar with every run. In a TLUD stove, biomass is loaded into a predominantly cylindrical container and ignited at the top. Only in this initial phase, the feedstock is heated by the reflective heat of the stove flame, which results from the interaction of pyrolysis gas and secondary air. As the process continues, the pyrolysis front gradually moves downward through the biomass feedstock. The exothermic pyrolysis and the reaction between pyrolysis gas and primary air, funneled through the feedstock cylinder, provide the necessary heat for the process. At this stage, the TLUD stove functions more like a gasifier than a pyrolizer. TLUDs require pyrolysis gases to pass through a fire front before being released into the atmosphere. This crucial feature significantly reduces non-CO2 emissions. |



## Suitability of Artisan Biochar for Agriculture

Based on the Global Artisan C-Sink standard, Kon-Tiki and TLUD biochar was extensively analyzed following the EBC and WBC analytical requirements. All biochar that was produced from eligible feedstock with the Artisan endorsed technologies fulfilled all requirements of EBC and WBC certification. PAHs and other potential contaminants were found with generally low contents that allowed in all cases the certification as WBC-Agro. As PAH contents of biochar are mainly technology dependent and generally low in Kon-Tiki and TLUD biochars, the Global Artisan C-Sink standard does not require its regular analysis. Meeting the PAH thresholds is covered by the pyrolysis-type accreditation of the *Kon-Tiki.* Therefore, biochar produced under the Artisan Standard are suitable for agricultural uses as they fulfill all requirements of WBC-Agro.

The sample plan was presented to Carbon Standards International.

## Application and trade of biochar

*Description of the application/selling of biochar*

The following applications are possible for this project:

* Geological C-sink (biochar applied to soil)
* Temporary C-sink (biochar used in materials)

## Methane emissions compensation

*Please only leave those ones that are used in your project.*

|  |
| --- |
| **Compensation of methane emissions by growing additional biomass**To compensate methane emissions, the Global Artisan C-Sink accepts the plantation of trees to create forest gardens on fallow land, silvo-pastures on pastures, agroforestry on annual and perennial crop land, re- and afforestation. Replacing existing older trees in a tree-crop or forest garden cultivation cannot be accounted for methane compensation. However, the active management of natural regeneration of eroded, deforested steppe land where natural regrowth of trees is promoted through measures such as scrub removal, weeding, irrigation, pruning, etc. can equally be accepted for methane compensation.Describe on a high level, where you will plant tree, which species, how many you need to cover the methane emission and as well how you track/manage those trees.Including a list of which feedstocks are eligible for this option. |

|  |
| --- |
| **Offsetting methane emissions with the SPC-fraction of biochar**The global warming effect of methane emissions caused by a Kon-Tiki or TLUD can at least partly be offset by the global cooling effect of the first 20 years of the SPC fraction. To calculate it correctly, the annual global cooling of the SPC for each of the first 20 years must be summed-up and match the GWP100 of the CH4 emission to be compensated.Describe the calculation/part of methane compensation possible with your resulting biochar and its SPC fraction.Including a list of which feedstocks are eligible for this option. |

|  |
| --- |
| **Compensation of methane emissions by avoiding GHG-emissions from burning crop residues**In many tropical countries, crop residues are burnt directly in the fields. While it has some positive effects on farming (ash fertilization, some pyrogenic carbon, elimination of pests), emissions of such practices are massive. Besides significant emissions of particulate matter that cause smog (the main reason for air pollution, e.g., in Delhi, methane and carbon monoxide emissions are very high due to the uncontrolled combustion of mostly wet or humid residues. Based on Global Artisan C-Sink standard, it is assumed that the overall climate impact of pyrolysis within Global Artisan C-sink is in any case not worse than direct burning of crop residues in the field. Therefore, abandoning crop residue burning can be accounted as an offset for emissions of Kon-Tiki pyrolysis.A declaration of honor was submitted to Carbon Standards and approved. Including a list of which feedstocks are eligible for this option. |

|  |
| --- |
| **Compensation of methane emissions by avoiding GHG-emissions from biomass decomposition**When biomass is pyrolyzed that otherwise would decompose uncontrolled, the avoided emissions from biomass decomposition can equally be used to compensate for CH4 emissions of the Kon-Tiki. Examples are cocoa pods, sawdust from sawmills, pulp from coffee, oil palm residues, and sugar cane filter cake. Uncontrolled decomposition, especially in the humid tropics, can cause significant methane emissions in the same or higher range than CH4 emissions during Kon-Tiki pyrolysis.A detailed description and flow chart with the current practices was submitted to Carbon Standards and approved. Including a list of which feedstocks are eligible for this option. |

## digital Monitoring, Reporting and Verification (dMRV)

Technically, the C-Sink Artisan certification procedure is based on a digital monitoring, reporting, and verification (dMRV) tool, which is usually a dedicated smartphone application.

In this project the dMRV system of XX, which is endorsed by Carbon Standards will be used to fulfil the requirements of the Global Artisan C-Sink Standard.

## Planned business development

*Describe Artisan C-Sink Managers plans for business development. E.g. feedstock usage, distribution channels, scale-up.*

## Internal Control System

A blueprint of an Internal Control System (ICS) was presented to the Certifier.

The template for the “internal inspection report” was presented to the Certifier.

# Determination of C-sink

## Monitoring

All data which are required to calculate the C-sink is entered into a dMRV System. The dMRV system is either provided by Carbon Standards or by an external MRV system provider. External MRV systems and tools must be endorsed by Carbon Standards annually. The data will be monitored as mentioned below.

### 4.1.1 General data

The following general data will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Artisan Biochar Producer Registration | per year | Internal documentation |
| Proof of successful participation in an artisan biochar workshop | per year | Internal documentation |
| Producers list | per year | Internal documentation |
| H/Corg ratio | per feedstock type | laboratories endorsed by Carbon Standards, see <https://www.carbon-standards.com/en/standards/service-505~global-artisan-c-sink.html> section Laboratories |
| C-content of biochar | per feedstock type | laboratories endorsed by Carbon Standards, see <https://www.carbon-standards.com/en/standards/service-505~global-artisan-c-sink.html> section Laboratories |
| Bulk density of biochar | per feedstock type | Internal documentation, dMRV |
| Feedstock preparation | per feedstock type | production protocols, dMRV |
| Documentation of technology used | per Artisan Biochar Producer | Internal documentation, dMRV |
| Volume measuring device | per Artisan Biochar Producer | Internal documentation, dMRV |
| Definition of a production load | per production unit type | Internal documentation, dMRV |

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 / l diesel | Methodology, Juhrich, 2016 |
| CO2 emissions from heavy fuel | 65 t CO2eq / TJ | Methodology, Juhrich, 2016 |

### 4.1.2. Artisan Biochar Production

*Only take this one system, that applies to your project and delete the others.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C-Sink farmer & Artisan Network**For each C-Sink Farmer the following parameters will be monitored for each Artisan Biochar Producer:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Annual on-site visit | per year | Internal documentation, dMRV |
| GPS data of cultivated land | continuous | dMRV |
| Crop rotation, harvest data, harvest amount | continuous | dMRV |
| Total amount of feedstock (dry matter) used for the load | per load | dMRV |
| Feedstock type | per load | dMRV |
| Documentation of biochar making | per load | dMRV |
| Amount of biochar produced | per load | dMRV |
| Documentation of biochar mixing to matrix | per load | dMRV |
| Amount of volume applied to each matrix | per load | dMRV |
| Registration of biochar amount, date and location applied | per load | dMRV |
| Receiver address/location when biochar (mix) is sold | per trade | dMRV |
| Other parameters that you measure | x | x |

 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C-Sink Cook, C-Sink Village and Biochar Processor**For each C-Sink Cook, C-Sink Village and Biochar Processor the following parameters will be monitored:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Annual on-site visit | per year | Internal documentation, dMRV |
| Description of biomass | per C-Sink Village | Internal documentation, dMRV |
| Amount of biochar produced | per month | dMRV |
| Documentation of biochar mixing to matrix | continuous | dMRV |
| Amount of volume applied to each matrix | continuous | dMRV |
| Receiver address/location when biochar (mix) is sold | per trade | dMRV |
| Other parameters that you measure | x | x |

 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Artisan Pro***For each Artisan Pro the following parameters will be monitored:*

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Annual on-site inspection | per year | Internal documentation, dMRV |
| Feedstock type | per load | dMRV |
| Moisture content of feedstock | per load | dMRV |
| Total amount of feedstock (dry matter) used for the load | per load | dMRV |
| Average feedstock size | per load | dMRV |
| Location of production unit | per load | dMRV |
| Documentation of biochar making | per load | dMRV |
| Amount of biochar produced | per load | dMRV |
| Proof of retention sample | per load | dMRV |
| Documentation of biochar mixing to matrix | per load | dMRV |
| Amount of volume applied to each matrix | per load | dMRV |
| Receiver address/location when biochar (mix) is sold | per trade | dMRV |
| Other parameters that you measure | x | x |

 |

### 4.1.3. Compensation of Fossil Emissions

All fossil CO2 emissions, must be offset by long-term carbon sinks before the registration of a biochar C-sink can be validated in the Global C-Sink Registry.

CO2 must only be offset with geological C-sinks, such as the persistent aromatic carbon (PAC) fraction of soil-applied biochar, that are registered in the Global C-Sink Registry.

The emission offsets can be realized with the registered permanent biochar C-sink whose production had caused the emission.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Proof of compensation | annually | emission portfolio |

### 4.1.4. Production unit

|  |  |
| --- | --- |
| □ | The production unit used in the project has a system certification, see system certification. |
| Pyrolysis system Kontiki/Soil pit is accredited by Carbon Standards. The mean methane emission for Kontiki/Soil pit is known to be 30 kg CH4/t DM biochar produced.  |

Accordingly, ex-ante definition of the following parameter:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Ex-ante definition; value** | **Source of data** |
| [CH4\_emissions\_pyrolysis] | 30 kg CH4/t DM biochar | Methodology |

### 4.1.5. Compensation of CH4 Emissions

Methane compensation is defined as creating a carbon sink for 20 years that has a climate cooling effect equal to the climate warming effect of a methane emission over 100 years after the emission occurred. Thus, the total climate forcing of a methane emission must be compensated within 20 years after the initial emission.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Monitoring frequency** | **Source of data** |
| Proof of compensation | per C-Sink Unit | Emission portfolio |

### 4.1.6. 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 Global Artisan C-Sink, the emissions from Scope 1 and 2 are fully recorded. As per project boundary, from Scope 3, only the emissions from biochar transport are directly quantified if the distance is more than 100 km. 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 security margin.

This includes, for example, the emissions caused by:

* the fuel for transportation of the biomass feedstock to the kiln,
* or the transportation of the biochar to the field (up to 100 km),
* the displacement of the kiln
* a pump for quenching water
* fuel for a chain saw for pruning, milling, and blending of the biochar

To keep the certification procedures reasonably lean, Artisan Biochar Producers

are not required to provide a detailed account of these potential emissions, but a margin of security of 20 kg CO2e per ton of biochar (DM) is levied.

$$\left[security margin\right]=\left[produced biochar \left(t\right)\right]\*0.02 (t CO2e per t biochar)$$

### 4.1.7. Methane emissions

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

$$\left[Total methane emissions\right]=\left[CH4 emissions from pyrolysis unit per ton of biochar\right]\*[amount of biochar produced]$$

#### 4.1.7.1. CH4 Emissions from Production unit

Emissions are calculated in **kgCH4.**

$$\left[CH4 emissions from production unit per load\right]=[CH4\_{emissions\_{pyrolysis}}]\* \left[amount of biomass dry matter \left(batch\right)\right]$$

#### 4.1.7.2. Compensation of CH4 Emissions

To compensate methane emissions, the GWP100 of the emitted amount of methane is calculated using the factor 25 kg CO2eq per kg CH4. We then calculate the absolute global warming potential (AGWP) over 100 years using Jeltsch-Thömmes & Joos (2019). The AGWP must then be compensated by a same-sized absolute global cooling potential (AGCP) over a maximum of 20 years. The compensating global cooling must start in the same year as the CH4 emission occurred, provide annual global cooling in every following year, and finalize the compensation latest 20 years after the methane emission.

$$\left[CO2e of CH4 emissions per load\right]=\left[Total methane emissions\right]\* GWP100\\_CH4$$

With GWP100\_CH4 = 25 CO2eq

Greenhouse gases decay in the atmosphere. The quantities of CO2 still present in the atmosphere each year are added up over the 100 years, resulting in the absolute global warming potential (AGWP) over 100 years.

CO2 decay is described by:



With the values

|  |  |  |
| --- | --- | --- |
| i | ai | ti |
| 0 | 0.008 |  |
| 1 | 0.044 | 68521 |
| 2 | 0.112 | 5312 |
| 3 | 0.224 | 362 |
| 4 | 0.31 | 47 |
| 5 | 0.297 | 6 |

$$AGWP\\_CH4(100) = \sum\_{y=0}^{100}(IRF\left(CO2,a\left(y\right)\right)\* \left[CO2e of CH4 emissions per load\right] )$$

If SPC fraction of biochar is used for compensation AGCP(20) is calculated as the cumulated sum of:

$AGCP=\sum\_{y=0}^{20}(Sf\*exp(-kf\*y)+Ss\*exp(-ks\*y)+P)$)

with

|  |  |
| --- | --- |
| Sf | 0.045341876 |
| kf | 0.5134 |
| Ss | 0.212136124 |
| ks | 0.009451 |
| P | -0.007478 |

In order to claim that methane emissions where compensated it must be proven that

$AGCP(20)\geq AGWP\\_CH4(100)$.

# 5. 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.

In certain specific instances where marginal quantities of biochar are applied or utilized in products, the registration of so-called diffuse carbon sinks (i.e., non-geo-localized) is permitted.

The following information are registered for biochar carbon sink:

1. Feedstock of biochar production
2. Technology of production
3. Date or period of production
4. C-content and H/C ratio of biochar (measured or taken from the Ithaka database)
5. Matrix into which the biochar was mixed (compost, manure, feed, cement etc.)
6. Location of the C-sink (vector file of field location; for fields < than 1000 m2 one GPS point per field is sufficient, for C-Sink Networks and C-Sink Villages only the vector file of the network and village, respectively, is needed)
7. Amount of biochar applied in tons (dry matter tons)
8. Date of application
9. Owner of the C-sink site (name, address, birth date – not necessary for C-Sink Network and C-Sink Village)
10. C-sink project design document
11. Validation report of the validation body
12. Verification report of the verification body
13. Monitoring plan of the operation
14. Confirmation of the compensation of the emission portfolio of the biochar

## Calculation of C -sink

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

Based on the Global Artisan C-Sink standard, the calculation of the C-sink at day of application is:

$$\left[C\left(year=0\right)\right]=\left[dry mass of biochar applied\right]\*\left[C content\right]\*\frac{44}{12} -\left[security margin\right]$$

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

According to the Global Artisan C-Sink standard, Biochar made in a Kon-Tiki or TLUD reach highest treatment temperatures above 650°C and present an H/Corg ratio well below 0.4, indicating a PAC fraction of at least 75% when applied to soil. Certified artisan biochar is, therefore, registered with a PAC-fraction of 75% and SPC fraction of 25% in the Global C-Sink Registry.

The remaining carbon for soil-applied biochar is calculated with the following conservative approximation:

$[remaining C (year)]$*=[* $dry mass of biochar applied$ *]/1000 \* Ccontent \* ( 750 + 45 \* e-0.5232 \* year + 205 \* e-0.009966 \* year)*

When C-sinks are sold to offset CO2 emissions only the PAC fraction must be used.

The SPC-fraction of biochar can be used for methane emission offsets.

*If other matrixes than soil are used, please add the corresponding calculations, which are approved by Carbon Standards.*

# Public consultation

During public consultation the following comments were raised:

|  |  |  |
| --- | --- | --- |
| **Comment** | **Was comment taken into****account (Yes/ No)?** | **Explanation/ justification (Why? How?)** |
| xx | xx | xx |
| xx | xx | xx |

# Annexes