SUPPLIER ONBOARDING MANUAL

Guideline for Biochar Producer and Wholesaler

How to get compensated for carbon removal services through Carbonfuture

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Carbonfuture GmbH

Authors:
Dr. Hannes Junginger-Gestrich
Marcel Eichler
Nils Gutgsell

Carbonfuture

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Glossary of Terms

Biochar
Stable, carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar may be added to soils to improve soil functions and to reduce greenhouse gas emissions from biomass and soils, and for carbon sequestration. This definition builds from IBI (2018).

Biomass Suppliers
Supplier of biomass as input material for pyrolysis.

Broker
Trader of Carbon Removal Credits who on-sells the Credits without retiring them.

Buyer
Buyer of the Carbon Removal Certificates under this Agreement: Carbonfuture.

Carbon dioxide removal (CDR) (="Carbon removal")
Anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO_2 uptake not directly caused by human activities. See also Mitigation (of climate change), Greenhouse gas removal (GGR), Negative emissions, Direct air carbon dioxide capture and storage (DACCS) and Sink.

Carbon Preserving Application
Describes an application of biochar, which ensures that the majority of the carbon stored in the biochar will not be mineralized. Carbon Preserving Applications are inter alia usage as feed additive for cows, mixture with soil aggregates, usage in animal confinements, usage as an additive to cement. They are the End-Usage of the biochar.

Carbon Removal Credit or Credit (previously C-Sink Credits)
One Carbon Removal Credit will be the share of a Portfolio of CF Certificates equal to one ton of CO_2 removed from the atmosphere. The Carbon Removal Credit will be issued by CSI into the CSI Registry. For the underlying CF Certificates, Coupons related to the end-usage of the biochar are needed, which contain the information of each Packaging Unit of biochar. The Carbon Removal Credit stands for the actual amount of one ton of carbon sequestered from the atmosphere.

CF Certificate
One CF Certificate is the documentation of the net carbon content in a packaging unit of biochar. A CF Certificate can be issued once the carbon preserving application of the biochar has been confirmed by the end-user. The CF-certificate never leaves Carbonfuture's platform. It only contains information about the carbon sequestered in one Packaging Unit.

Coupon
The Coupon is the digital justification of the carbon preserving end usage of a certain amount of biochar, which is contained in a packaging unit. The Coupon contains information about the end usage of the biochar and confirms the surrendering of the right on the climate by the end-user.
Owns the EBC including the EBC Guidelines and the EBC C-Sink Guidelines. By "equivalent Standards", Standards like the Verified Carbon Standard (VCS), or the Gold Standard are meant.

EBC C-Sink Guidelines
Are the "EBC-Guidelines for the Certification of Biochar Based Carbon Sinks" in their current version, published by the EBC.

EBC
Stands for the European Biochar Certificate, a standard which regulates qualities of biochar. The EBC is owned by Carbon Standards International.

EBC Certificate
Is the certificate issued by CSI, which reports about the qualification of the biochar. The EBC Certificate is based on a laboratory analysis of the biochar following the EBC Guidelines, and it is valid for the duration of one production batch for a maximum of one year.

EBC C-Sink Certificate (previously Production Certificate)
Is the certificate issued by CSI, describing the gross sink capacity per unit of produced biochar. It is based on (i) the specifics of biomass sourcing and the technology information gathered during the audit of the production facility, and (ii) the specifics of the biochar for the related production batch. The specifics of the biochar are noted in the EBC Certificate.

EBC Guidelines
Are the Guidelines of the European Biochar Certificate for a sustainable production of biochar in their current version, published by the EBC.

Effective Date
Date on which this Agreement gets effective, which is the date of signature of the Agreement. Should the signing occur on different dates, the date on which the last Party has signed, shall govern.

End User
Recipient of the biochar, who supplies the biochar to a carbon-conserving end use. The End User is the physical owner of the Carbon Removal.

Facility or Processing Unit
Production site (with one or more production unit).

Gross C-Sink potential
Persistent fraction of a Carbon Removal. At the example of biochar, the Gross C-Sink potential is the fraction of carbon within the biochar, which is stored long-term as a result of a Aarbon Preserving Application, before deduction of the Project Emissions.

Inspection and Certification Bodies
Inspection bodies undertake the auditing of the facilities producing biochar or operate other removal technologies. I.e. Q-inspecta.

Intermediary
Purchaser of the biochar, who sells the biochar on and does not send it to the end use.

Leakage
Emissions which from the operation of the project which occur outside the project boundary.

Methodology
Guideline how to calculate the sink potential for a CO_2 -certificate of a certain technology.

Net C-Sink potential
Amount of carbon within the biochar minus the Project Emissions and the labile fraction of the biochar.

Packaging Unit
Production unit of biochar that can be assigned to a production batch. Big bag, truckload or similar.

Portfolio
A Portfolio is a summarization of CF certificates, which refer to Packaging Units of biochar, which has been applied in a carbon preserving way.

Project Boundary
Systemic boundary around all activities, which are relevant for the operation of the project. On the example of biochar production and application, the project. Boundary includes the biomass harvesting including transport, the operation of the pyrolysis facility, the biochar processing until its final end usage.

Project Emissions
Emissions which from the operation of the project which occur outside the project boundary.

Recipient
Buyer of the supplier's biochar. The buyer can either be the end user or the intermediary of the biochar.

Registry
Carbon Standards International operates a digital registry, in which Carbon Removal Credits are listed with, their serial number, their ownership and further information.

Standard
The Standard is Carbon Standards International (CSI) which is providing Governance and the regulatory framework for the issuance of Carbon Removal Credits.

Scientific Advisory Board
The Scientific Advisory Board supports the Standard in the approval procedure of methodologies for removal activities. The entity being the scientific advisory board is the Ithaka Institute and other experts like universities, etc.

Supplier
Entity responsible for the creation of a carbon sink, e.g. biochar producer, quarry exploiting rock for enhanced weathering, etc. The definition of the supplier role depends on the type of carbon removal and needs to be defined during the preparation process of a methodology.

System provider
Manufacturer of processing units.

Systems
Synonym for processing units of different types.

Tracking System
System, which enables all parties to follow the actual Carbon Removal from its creation until its End Usage.

Preface - About This Manual

This manual is designed to help C-Sink providers with the onboarding process on the Carbonfuture platform.
It provides insights to specific standards and procedures that suppliers need to be aware of to successfully register biochar-based carbon sinks. Besides this manual, Carbonfuture may provide context-sensitive help for additional questions and problems if needed.

The manual aims to inform biochar producers, wholesalers, traders, and end users of the Carbonfuture platform. Additionally, organizations that intend to produce and distribute biochar in the near future may use this manual to find all the necessary information and documentation required to be compensated for their biochar-based Carbon Removal Credits with Carbonfuture.

The manual is organized in the following manner:

- **The first chapter (1)**
  Provides a general overview of relevant carbon sinks and highlights reasons and incentives for producers and traders to enter the carbon removal market. Furthermore, it introduces the reader to necessary standards and processes that suppliers need to uphold in order to generate credits with Carbonfuture.

- **The second chapter (2)**
  Provides information on how the carbon sink value is calculated.

- **The third chapter (3)**
  Contains a detailed manual with all the steps that are necessary to register and get certified by EBC.

- **The fourth chapter (4)**
  Shows an example of how an EBC certificate and a lab analysis looks.

1. Overview

1.1 Why Carbonfuture?

To limit global warming below catastrophic levels, significant emission reductions and carbon dioxide removal are essential. Potential pathways modeled by the IPCC show that reaching the 1.5°C is nearly impossible without removing gigatons of CO_2 from the atmosphere and at same time increasing global emission reduction efforts[1]. Atmospheric CO_2 needs to be quickly removed and safely stored over the coming centuries, thus creating new carbon sinks. Available technologies include[2]:

- Afforestation and Reforestation
- Soil organic carbon
- Biochar
- Enhanced weathering
- CO_2 sequestration in concrete
- Bioenergy with carbon capture and storage (BECCS)
- Direct Air Capture (DAC)

All of these carbon removal solutions have benefits and drawbacks. While nature-based solutions such as soil organic carbon and reforestation may provide a range of valuable ecosystem services, the accounting of their climate services is very difficult. In particular the "potentially" short durability of these sinks (i.e., due to forest fires) creates a trust problem. Other solutions such as DAC and BECCS can be accurately measured but are currently very costly, provide no additional ecosystem services and are hard to scale.

Therefore, Carbonfuture entered the emerging carbon removal market with biochar projects. We believe that biochar is currently located in "sweet spot" between the nature- based and technological carbon sequestering solutions, since biochar it allows us to foster multiple ecosystem benefits (i.e. a healthier soil environment and increased water retention capacity) with the scientifically accurate measurability of carbon sinks, which last for centuries.

Many emissions compensation schemes in various carbon markets already exist. However, very few strictly distinguish between carbon removal and emission reduction

[1] Rogelj, J., D. Shindell, K. Jiang, et al. 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 104 et seqq. https://doi.org/10.1017/9781009157940.004.

[2] You can find more detailed information on this at: https://doi.org/10.1017/9781009157940.006. Starting from page 342 et seqq.

efforts (e.g., renewable energy). In addition, most existing schemes are vague on the duration of carbon sequestration, in particular afforestation and reforestation projects. Currently, the measurability and verifiability of carbon credits is weak and therefore may create a lack of trust. Many of them are oversupplied and many have specific additionality requirements which are much more tailored to emission reductions and seem in their current forms less suited for negative emission technologies (NET) and true carbon rebalancing.

The Carbonfuture platform was created to address the shortcomings of existing schemes. In contrast to other carbon markets, Carbonfuture offers:

- True carbon sinks only
- Carbon sink tracking
- Durability over 100 years
- Guaranteed, unalterable documentation and end-to-end auditability on the Carbonfuture Blockchain[3]
- Carbon removal credits that are third-party audited on an independent standard

1.2 What is Carbonfuture and What's in it for You as a Biochar Producer and Wholesaler?

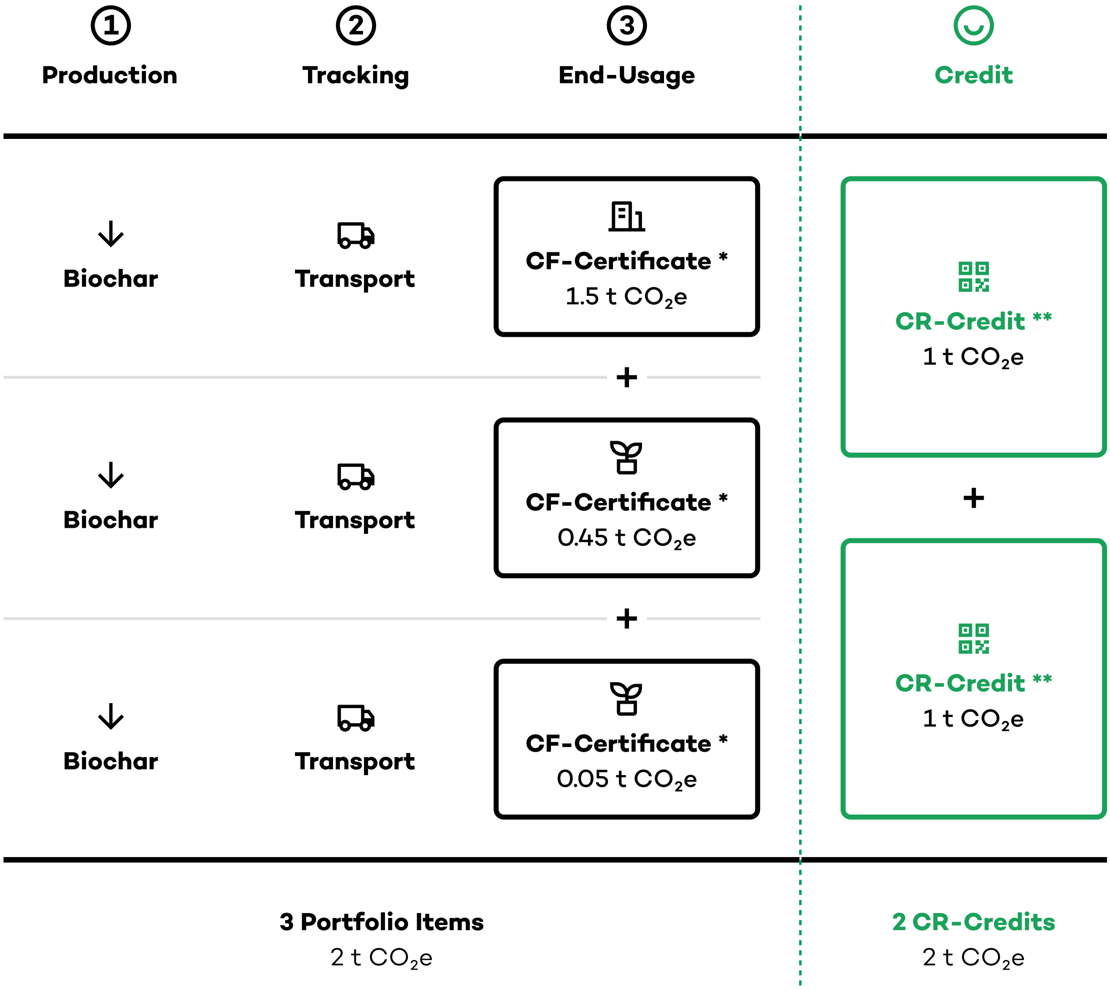
The Carbonfuture platform provides a tracking and brokerage platform for carbon sinks. Each individual carbon sink is represented and unalterably documented on the Carbonfuture blockchain by a **carbon removal certificate**.

Each carbon removal certificate must meet our basic requirements to qualify to be eligible on the Carbonfuture platform. The Carbonfuture Sink Certification Standards describe in detail the criteria that current biochar-based C-sink providers fulfil. Biochar-based C-sinks are the starting point and first use-case for Carbonfuture. By compensating producers for the climate benefit of persistent biochar applications, Carbonfuture injects money into the biochar value chain and fosters the creation of an additional revenue stream for biochar applications.

[3] We use a permissioned, non-energy intensive blockchain and guarantee data confidentiality; accordingly, we do disclose sensitive sink details only to admitted auditors and not to the general public.

The graph below shows the process from biochar production to credit issuance in detail. After the biochar is produced, tracking of the biochar begins when it leaves the company's factory gate. The tracking process is complete with the confirmation of the end usage of the biochar. In this graph, the biochar is delivered to three different end users. With it a CF-certificate is generated according to the CO2e value of the carbon sink. These different CF-Certificates are then added up to create a portfolio, from which carbon removal credits can be issued. In the portfolio, each end usage of the biochar and the amount of CO2e available is represented. One Carbon Removal Credit corresponds to one tonne of CO2e.

Process Flow of the Carbonfuture Platform



* Coupons are exchanged for CR-Certificates

** Through data compilation, CF-Certificates are exchanged for CR-Credits

- Performed on the Carbonfuture Platform
- Performed by CSI Registry

1.3 Standards and Processes

For biochar-based C-sinks, the Carbon Removal Credit is based on two elements, the **Production Certificate** and the sink documentation as evidenced by the **Carbonfuture Coupon** (see section 1.3.1). In general, Carbonfuture may accept a similar proof from any independent institution if they fulfil our Standards. Currently, the European Biochar Certificate (EBC), established by the Ithaka Institute and ensured by Carbon Standards International (CSI) is the only issuer of eligible production certificates.

We encourage alignment and collaboration between the respective national, regional and global standards and the EBC in order to ensure comparability and a level playing field. Suppliers of biochar are obliged to follow the EBC guidelines to prevent any health or environmental hazard from producing and using biochar. Furthermore, EBC requires that the feedstock used for the biochar production is harvested in a sustainable manner, not causing environmentally harmful land-use changes.
The EBC positive list defines eligible types of feedstocks.

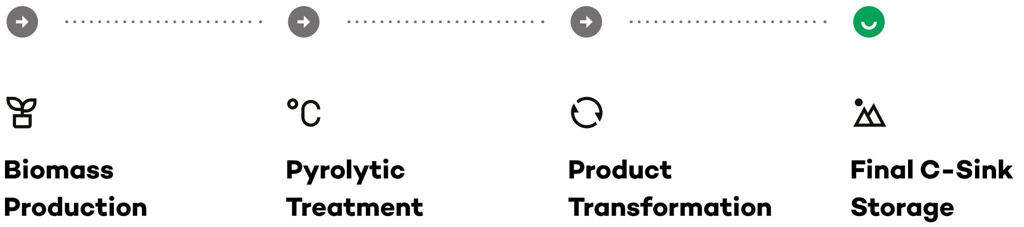
There are two aspects to the production certificate:

- The pyrolysis plant must be certified. This includes an assessment of the emissions and energy consumption of the pyrolysis process. The manufacturer of a pyrolysis plant must provide the required information to the reviewer.

- The individual production process must be certified. This includes an assessment of the feedstock production and preparation process and the energy used.

1.3.1 Biochar Assessment and Tracking

Parameters to assess to determine Biochar-based C-Sinks



Biochar as a raw material comes in a huge variety of qualities and respective price levels. In addition, biochar has a vast range of potential applications ranging from filtration material, construction additive to agricultural use. Not all of these applications necessarily lead to a stable carbon sequestration and hence not all qualify as a stable carbon sink.

Therefore, Carbonfuture requires that wholesalers and producers must follow the EBC C-Sink guidelines. According to the EBC C-Sink methodology, greenhouse gases emitted from the factory gate until the biochar is applied to soil or mixed into long-lasting construction materials must also be accounted for and subtracted from the C-sink value.
Thus, all important steps in the biochar's lifecycle, from its production until its final application need to be tracked and accounted for. Following the EBC C-Sink, the produced biochar must be tracked to confirm the end-use in a stable matrix and to assess and register all greenhouse gas emissions that occur on its downstream pathway (i.e., transporting, milling, processing). This is a service that **Carbonfuture** provides for its suppliers.

As soon as the biochar is mixed into agricultural substrates such as fodder compost, liquid manure, and fertilizer or into durable materials such as concrete or resins, the C-sink potential can be converted into tradable carbon removal certificates. In this case, further tracking of the final product (i.e., compost) is not necessary. Project emissions before and during production and transportation are included in the production certificate, which serves as the foundation for the calculation of the C-Sink (see section 2).

Overview of the C-Sink Assessment

Biomass Production
EBC C-Sink Potential certified by CSI and controlled by Q.inspecta

°C
Pyrolytic Treatment
EBC C-Sink Potential certified by CSI and controlled by Q.inspecta

Product Transformation
C-Sink Tracking controlled by Carbonfuture and accredited by Ithaka Institute

Final C-Sink Storage
C-Sink Tracking controlled by Carbonfuture and accredited by Ithaka Institute

The key to creating an accurately quantified biochar-based carbon sink is confirmation and documentation of the actual carbon preserving application of the material. To ensure that the biochar is used in a manner that does sequester carbon, the biochar producer or wholesaler along with the end user must document the end use of the material on the Carbonfuture platform.

To do this a **fully digital and streamlined sink tracking process** is available. Possible options to confirm the biochar application include:

- Scan the packaging unit's QR-code and confirm the coupon digitally through the platform.
- Click on the digital confirmation by link and confirm the coupon digitally through the platform.
- Physical or digital signatures on a paper coupon.
- Integration of the confirmation directly into your billing system.

Digital Tracking System

Biochar Producer
Production Certification

Specialist Re-packaging
Physical Biochar

Agriculture Retailer
Physical Biochar

End User
Carbonfuture Coupon

Carbonfuture
Removal Certification

This documentation validates the actual sink in a traceable way. Furthermore, the end user **agrees to transfer all rights that come with the respective carbon sink creation.** This is key to prevent double counting.

The Production Certificate and the Carbonfuture Coupon are linked on the Carbonfuture platform. After validation of both documents, Carbonfuture issues a carbon removal certificate for the biochar delivery. This carbon removal certificate represents the claim on the climate service provided by the sink and therefore has a monetary value in the carbon market.

Carbonfuture

CO_2-Sink Certificate
carbonfuture Coupon

To be filled out by the biochar wholesaler / sink registrar		Return coupons to
Name / firm	carbonfuture GmbH	Email: info@carbonfuture.earth
Date	May 25, 2022	
Shipping note (external ID)	LS00003	
Coupon Nr.	0000	
Delivery-Id		

Packaging Unit	Gross Weight	Volume
C7U24S97	12 t	n/a m³

To be filled out by the end client / biochar user		
Name / firm	Beerwein AG	
Address	**Head Office**	**Address / location of sink if different**
Street	Musterstr. 1	Musterstr. 1
City, ZIP	12345 Musterstadt	12345 Musterstadt
Country	Germany	Germany
Type of application		

By signing this document, the biochar user confirms and agrees:

- The biochar and the manure (in case of biochar application as bedding or feeding) and the digestate (in case of anaerobic digestion) will be brought into soil and will **not be burnt or pyrolyzed.**
- He or she explicitly warrants that **the claim on the carbon sink service provided is transferred** to the wholesaler / sink registrar indicated above. He or she will not claim any rights related to this service. In particular, he or she will not claim any such rights in relation to any private or public subsidy or support program in the context of soil organic carbon or as part of the CO2 accounting in his or her own sustainability report.
- He or she explicitly agrees that his or her **data** which is registered and stored in relation to the referenced sink may be used by carbonfuture. They will be made public in an anonymized way, e.g. as part of statistics on the carbonfuture platform. In addition, they will be disclosed in complete and not anonymized form for control and audit purposes to persons who are authorized for this by carbonfuture or under the EBC certificate.

Optional:

☐ I consent to the **publication of the exact sink location** on the carbonfuture platform

Place and date

Signature biochar user

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1.3.2 Cash-Flows

The owner of the carbon removal certificate can sell it to any entity which acts as a Broker on the Carbonfuture platform or directly to external balancers via our marketplace. If you sell directly to third parties, the transaction fee necessary to cover our platform services will be paid directly by the Balancer.

If Carbonfuture acts as a broker, we may compensate the sink provider directly monthly for each documented biochar delivery. However, in some cases multiple entities are necessary to realize a carbon sink (i.e., producer, wholesaler and end-user). In this case all actors provide key contributions to realize and document the climate service.

Therefore, we encourage the following supply chain model:

- The producer sells certified biochar with a sink potential. This sink potential has a value as in the end, it can be turned into a sink and reimbursed. Some producers are billing the sink potential in a separate line item in addition to the material, others just calculate it in with the biochar price.

- The end user signs the Coupon, providing relevant data, substantiating the claim related to the climate service and transferring all claims related to the climate service. The wholesaler is compensated directly by Carbonfuture and can issue a credit note (reverse bill) to the end users in return of the Coupon. Another option would be to raise two prices, one higher price with sink potential and one lower price without sink potential in case the farmer wants to transfer the claim to the climate service directly by paying the bill and agreeing to our terms and conditions.

If the wholesaler keeps a handling margin and reimburses the end user in exchange of a signed Carbonfuture Coupon, whereas the biochar producer benefits from better prices for his product, a fair supply chain model is created, leading to a growth in the production and application of biochar. Since we only have one contractual partner in the supply chain, the compensation scheme is ultimately subject to the contractual relations of producer, wholesaler and end-user. Carbonfuture merely injects money into the biochar value chain and fosters the creation of an additional revenue stream in exchange for the production and product tracking data.

We encourage fair compensation schemes along the supply chain to foster the growth and scaling of the biochar market.

2. Quantifying the Climate Benefit of Biochar-Based Sinks

To quantify the climate benefit of the biochar, it is essential to determine the overall emissions balance of the biochar from feedstock preparation, pyrolysis, transportation, and application. If this balance is positive, meaning more carbon has been permanently sequestered than emitted, it can be represented as a carbon sink.

The biomass production must be climate-neutral, i.e., it must not reduce existing carbon stocks. This can be ensured, for example, by using agricultural or other waste, rapidly growing biomass or other material recovered from the care and maintenance of biodiverse areas, the countryside, and roadsides. Wood from sustainably managed forests can also meet the criteria.

To calculate the net CO_2 equivalent value of a biochar-based sink, the following calculation steps are performed. The calculation explained below follows the C-Sink methodology of the EBC.

Project emissions can be split between upstream and downstream emissions of the biochar production.

- Upstream emissions are inter alia: Emissions resulting from biomass harvesting and transport as well as emissions from energy consumption of the pyrolysis process. These emissions are determined during the EBC audit of the facility and are summarized in the EBC production certificate (production certificate). All these emissions including a 10% security margin (i.e. to account for other indirect emissions from the pyrolysis plant manufacturing) are deducted from the carbon content of the produced biochar to come up with the gross CO_2 sink value after pyrolysis (sink potential). This value is stated in the (EBC) production certificate.

- The conversion of the gross weight of a unit of biochar into dry mass needs to be provided by the producer, either based on individual measurement of the gross weight and moisture content (the protocols must be stored and disclosed to the auditors upon request) or based on bulk density, volume and moisture measurements.

[4] This decay rate is a conservative estimation based on Lehmann, Johannes & Abiven, Samuel & Kleber, Markus & Pan, Gen-Xing & Singh, Bhupinder Pal & Sohi, Saran & Zimmerman, Andrew. (2015). Persistence of biochar in soil. Biochar for Environmental Management: Science, Technology and Implementation. 235-282. (See Figure 10.5).

- Downstream emissions: Further deductions for transport and processing of the biochar are based on data provided by the sink provider on the Carbonfuture platform. In addition to these emissions, the decay of the non-stable fraction of the biochar must be accounted for. In accordance with the EBC C-Sink standard, the annual decay is determined to be 0.3% provided the production certificate asserts H/Corg < 0.4[4]. After these deductions, the Net C-Sink potential is calculated by Carbonfuture.

The figure below shows an example for the calculation of the net C-Sink value, as used by Carbonfuture. More detailed information about the methodology and its scientific basis can be found in the EBI Whitepaper[5].

Calculation of the net C-Sink Value of the Soil Application of 1 dry metric Ton of Biochar

[5] EBI stands for European Biochar Industry Consortium e.V.

3. How to Get EBC Certified

3.1 EBC-Requirements

Carbonfuture provides a checklist and survey for suppliers to conduct an initial assessment in order to identify if they are eligible for the EBC certificate. Thus, potential obstacles to the EBC certification can be identified prior to the certification process. This helps interested suppliers save time and expenditures. Part of this questionnaire are the Lab test results, which indicate the quality of the biochar and the contained pollutants. It should be noted in advance that the values for the PAH content of biochar are very strict. A distinction can be made between PAH 16 and the subgroup PAH 8. PAH 16 are substances that are toxic and persistent for a long time. PAH 8 are carcinogenic and cannot be removed from the biochar. [6]But they typically account for only 20% of the PAHs in Biochar. At the same time, the eight non carcinogenic PAHs account for more than 80% of all analyzed PAHs. On a side-note, biochar adsorbs more PAH from the soil than it releases, nevertheless, introducing biochar containing carcinogenic PAHs or other pollutants into the environment needs to be strictly avoided[7].

3.2 EBC-Labels

The EBC distinguishes between six different **application classes:**

- Feed
- Agro Organic
- Agro
- Urban
- Consumer Material
- Basic Material

The six application classes and their scope are described and explained in more detail below. In addition, it is important to note that assignment to a particular class only regulates its scope of application but does not indicate the monetary value of the biochar nor its characteristics with regards to agricultural applications. The biochar must be labeled according to its final application. If the biochar from one production batch meets the requirement of more than one class, it can also be sold under different EBC labels. Additionally, if the biochar is EBC certified it also meets all requirements of the EU-REACH-regulation.

[6] Benzo[a]pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Dibenzo[a,h]anthracene, Indeno[1,2,3-cd]pyrene, Benzo[ghi]perylene. Benzo[e]pyrene and Benzo[j]fluoranthene will be added 2022 to the EBC-Analyses to be compliant with the EU-Reach regulation.

[7] PAHS are explained more in detail in the EBC Guidelines starting on page 25.

- **Feed**
  Meets all requirements of the EU Feed Regulation. In addition, the company must be approved as an animal feed producer according to the respective national requirements. It is recommended to also get a GMP+ certificate. Feed can also be used as a soil improver if it fulfills the same additional certification parameters as Agro and Agro Organic[8].

- **Agro Organic**
  This class is meant for use in organic agriculture. It also meets all the requirements of the EU Fertilizer Regulation. Compared to Agro, the limit values for organic and heavy metal contaminations are stricter (see table below). Some European countries (i.e., Switzerland) only allow the use AgroOrganic.

- **Agro**
  These classes meant for use conventional agriculture. Some EU countries (AUT, SWE, HUN) have approved the use of biochar in accordance with Agro. Based on these national regulations, these countries can export biochar and use it in all other EU countries. Furthermore, this class fulfills all requirements from the Urban class, so it can be also used in this area.

- **Urban**
  The purpose of this class is the use of biochar in urban areas, i.e., tree planting. At the same time its use helps in the adsorption of pollutants. It should be noted that this biochar cannot be used to improve soil health in the context of food or feed production.

- **Consumer Material**
  Addresses biochar which may come into direct skin contact with a consumer or food e.g., toothbrushes.

- **Basic Material**
  This class defines pollutant thresholds for biochar, which can be used as a sustainable raw material.

Solid residues from pyrolysis that do not meet contamination thresholds must be disposed of according to the respective national and international regulations. Pyrolysis products that do not meet the standards of any EBC class are not allowed to be traded under the EBC label. Both Consumer and Basic Material are not allowed to be used in agriculture or for other soil applications such as the planting of urban trees, soil rehabilitation or mine remediation. In addition, in this range the material can only be sold B2B.

[8] Biochar in animal feed is currently not permitted in the US.

The suitability of the produced biochar for these classes is analyzed in the EBC Basic Analysis Package. For the EBC-Feed an additional analysis package is required. The application classes are categorized according to the limit values shown in the table below:

Important Limit Values for EBC Application Classes[9]

Elemental Analysis

Clases	Feed	Agro Organic	Agro	Urban/ Consumer Materials	Basic Materials
H/Corg	<0.7	<0.7	<0.7	<0.7	
O/Corg	<0.4	<0.4	<0.4	<0.4	

Organic Containments

Clases	Feed	Agro Organic	Agro	Urban/ Consumer Materials	Basic Materials
16 EPA PAH	4+-2 g t^{-1}	4+-2 g t^{-1}	6.0+2.2 g t^{-1}	Declaration	Not required
8 EFSA PAH	1 g t^{-1}	1 g t^{-1}	1 g t^{-1}	1 g t^{-1}	4 g t^{-1}
PCB, PCDD7F	0.2 mg kg^{-1}	0.2 mg kg^{-1}	0.2 mg kg^{-1}	0.2 mg kg^{-1}	0.2 mg kg^{-1}

[9] A full overview of all limit values can be viewed here.
[10]DM stands for Dry Matter

Heavy Metal Contamination

Clases	Feed	Agro Organic	Agro	Consumer Materials	Basic Materials
Pb	10 g t^{-1} (88%DM[10])	45 g t $^{-1}$	120 g t $^{-1}$	120 g t^{-1}	
Cd	0.8 g t^{-1} (88%)	0.7 g t $^{-1}$	1.5 g t $^{-1}$	1.5 g t $^{-1}$	
Cu	70 g t $^{-1}$	70 g t $^{-1}$	100 g t $^{-1}$	100 g t $^{-1}$	
Ni	25 g t $^{-1}$	25 g t $^{-1}$	50 g t $^{-1}$	50 g t $^{-1}$	
Hg	0.1 g t^{-1} (88%)	0.4 g t $^{-1}$	1 g t $^{-1}$	1 g t $^{-1}$	
Zn	200 g t $^{-1}$	200 g t $^{-1}$	400 g t $^{-1}$	400 g t $^{-1}$	
Cr	70 g t $^{-1}$	70 g t $^{-1}$	90 g t $^{-1}$	90 g t $^{-1}$	
As	2 g t^{-1} (88%)	13 g t $^{-1}$	13 g t $^{-1}$	13 g t $^{-1}$	

3.3 EBC Certification Process

For Carbonfuture, the production certificate according to the C-Sink Standard (Methodology) is the most relevant document to onboard a facility. To receive this the following certification stages, need to be completed:

Client Registration by Operator

- Registration online on EBC website.
- Registration form CSI.
- Registration form Q.inspecta.

Technical Preaudit by CSI

- Evaluation of the documents in EBC portal.
- Evaluation of pyrolysis unit (remote audit or onsite).
- Evaluation of sampling process.

Audit by Q.inspecta

- Appointment, confirmation, preparation.
- Audit (remote or onsite) and sampling.
- Audit report.

Corrective Measures

- Operator: implement and send corrective measures.
- Laboratory: sends analysis results.
- Q.inspecta: reminders for operator, if necessary.

Certification EBC Biochar by Q.inspecta

- Validation of inspection and corrective measures.
- Certification of EBC batch ID, certification class, QR-code approval.
- Publication of EBC certificate a batches on www.easy-cert.com

Certification Carbon Sink by Q.inspecta

- Operation fills in data in EBC portal for calculation of C-Sink potential
- Validation of data
- Certification of C-sink potential on the factory gate
- Issue of C-Sink certificate

The certification process takes about 3-4 months. The audit encompasses checks on the pyrolysis systems and the biomass input.
The production certificate is issued by Carbon Standards international (CSI) AG, Frick, Switzerland. CSI is a third party and completely independent from Carbonfuture. The audit and inspection will be conducted by the accredited inspection and certification body Q.inspecta AG. The production certificate can only be issued if both the system audit and the biochar lab analysis were completed.
In case a technology provider produced standardized systems, the system audit can be simplified after successful completion of 3 system audits of similar facilities.

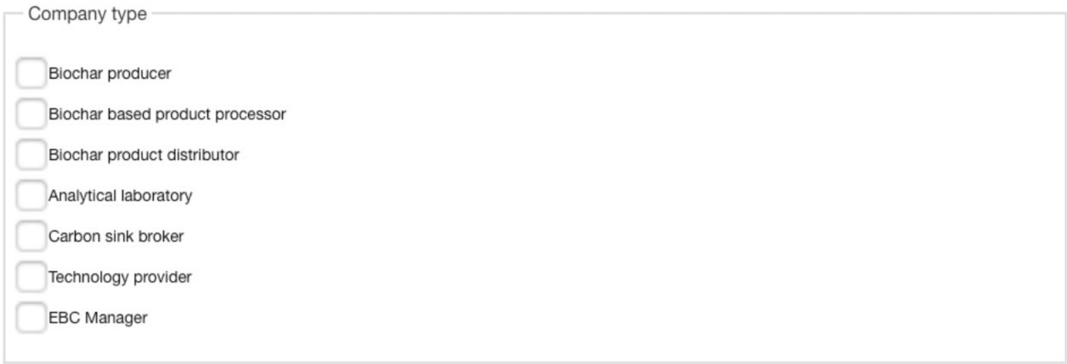
An overview of initial and annual certification costs (as of July 2022) can be found in the table below. Depending on the size of the plant and its complexity the costs for the certification may vary.

Costs	
One-time registration fee	300 €
Annual control	900 - 1.900 €
Biochar analyses per batch	700 - 900 €
EBC label fee (annual)	300 €
Technical pre-audit	300 - 3.500 €
Production certification 1 to 5000 tons	1 € per t CO_2-eq
Production certification more than 5000	0.2 € per t CO_2-eq

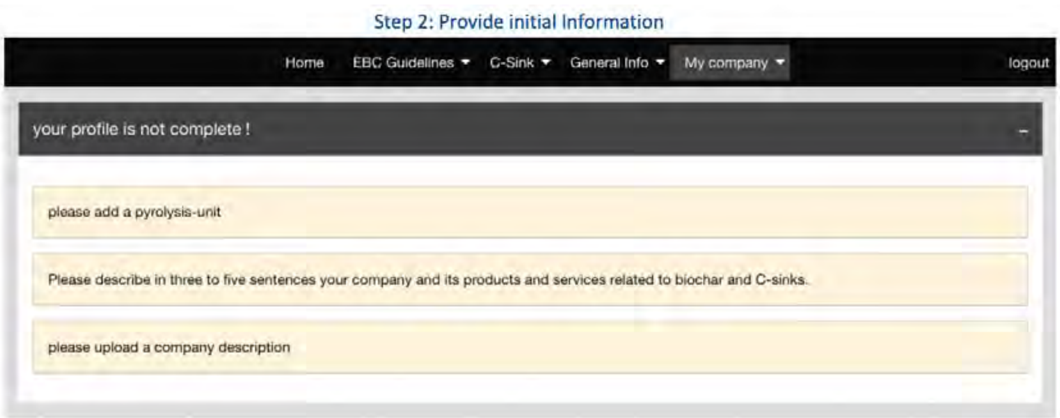
Optional costs	
Consulting and other services	170 € per hour
EBC consulting package (20 hours)	3.000 €
Sampler training	400 €

3.3.1 EBC Registration

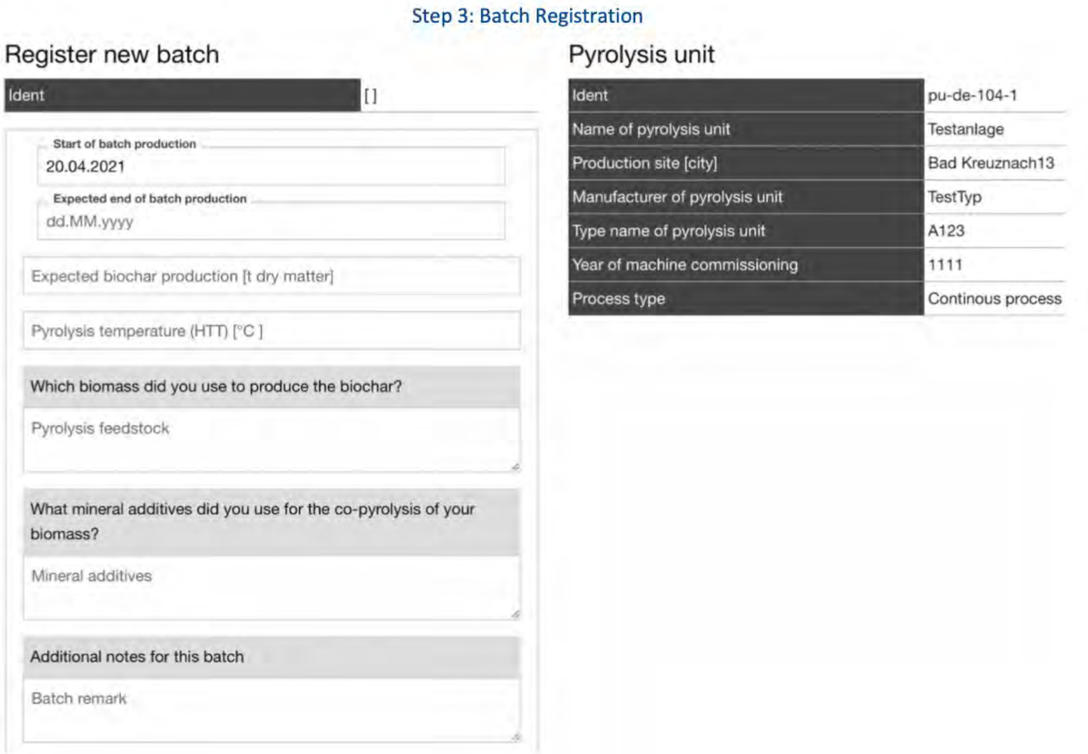
To register, create an EBC-account at the EBC website. During the initial registration a company type must be chosen as outlined in the picture below. Multiple selection is possible, if applicable.



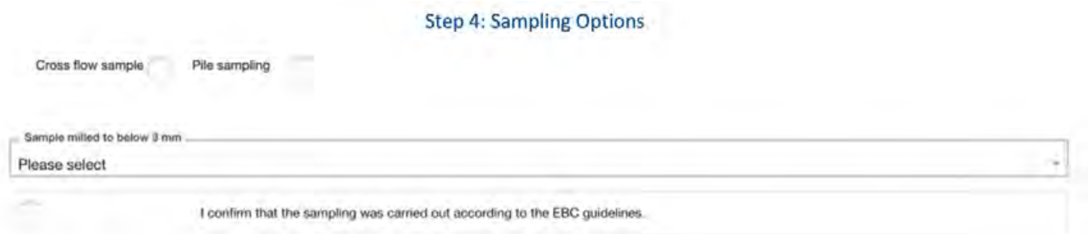
After the registration further information about the company and the pyrolysis technology in use is requested. Optionally, flowcharts of the production processes can be uploaded, starting with the delivery of the biomass until the packaging of the biochar products. This may help to speed up the process and avoid later inquires.



Next, a production batch can be registered. Production conditions within a registered batch should not deviate (i.e., feedstock, production temperature, reaction time).

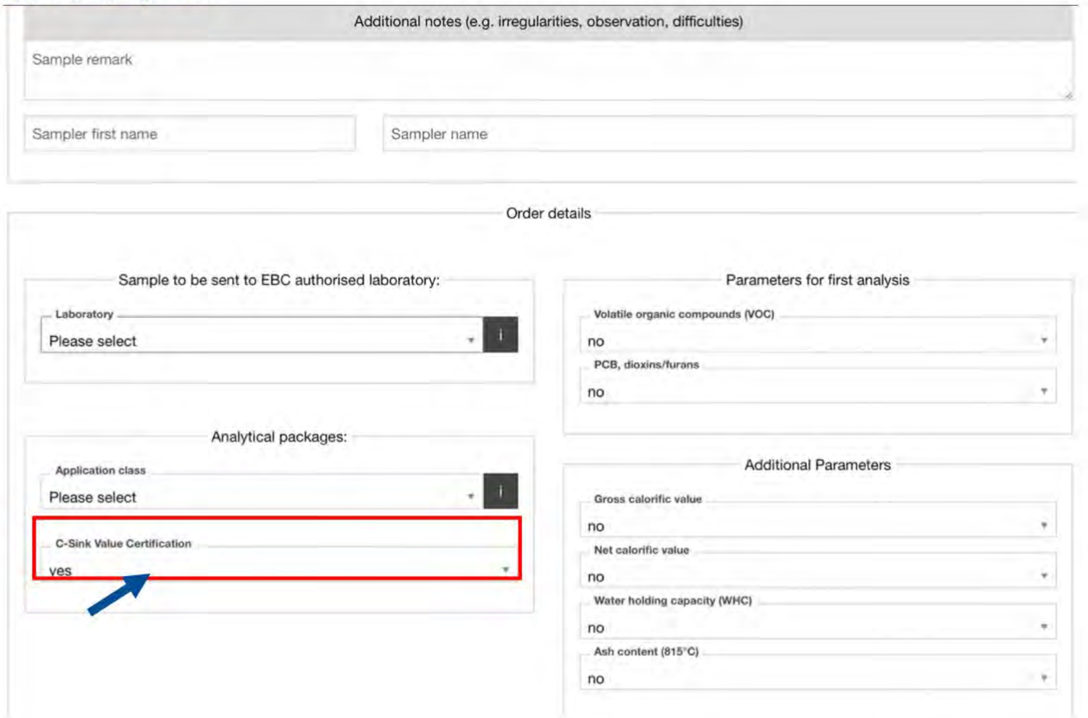


Now it is possible to request a sample for the EBC analysis. You can choose between two sampling options, namely a cross flow sample and a pile sample. If your production has a continuous outflow of the finished material, a more representative cross flow sampling is possible. If the finished material is emptied all at once (batch process), please select the second option.



As a last step the application class needs to be selected (see section 3.2). To acquire the production certification (obligatory to join the Carbonfuture platform), please select "yes" as outlined in the picture below. If a C-Sink value check is requested the EBC will control relevant parameters during the on-site control and query additional data necessary (e.g., CO2 emissions of the electricity used for the pyrolysis plant) to determine the sink potential of the batch.

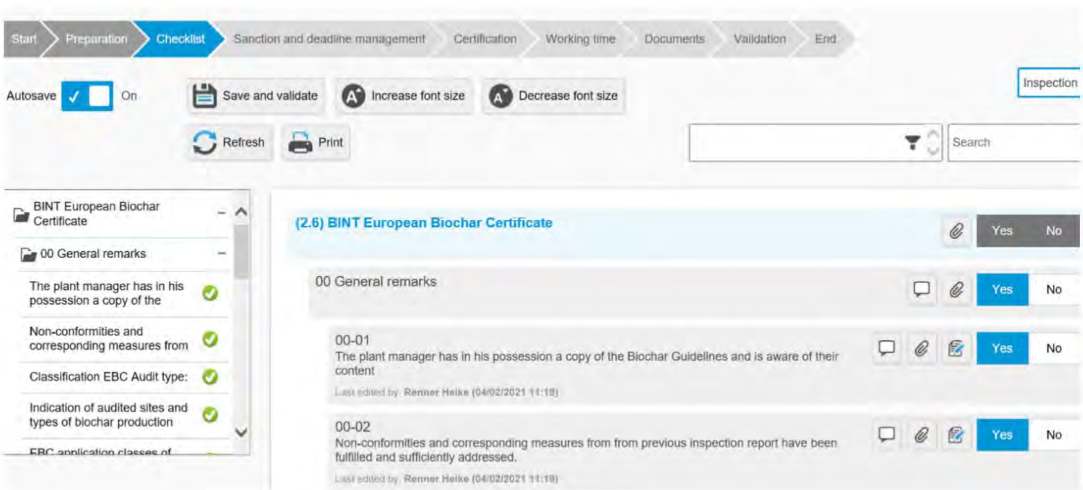
Step 5: Sampling Details



After completing the registration, you will receive a PDF document by email to sign, which you should then enclose with your sample when sending it to the selected laboratory.

3.3.2 Initial Audit and Inspection

Following a first verification of the technical information and personal phone contact with the producer through the CSI (Carbon Standards International), the company information is transmitted to the accredited inspection and certification body: Q.inspecta AG. The producer will then need to sign the inspection contract for the EBC certification from Q.inspecta AG. Once the producer has signed the inspection contract, CSI will coordinate an appointment for the initial EBC audit with the biochar producing company. The on-site inspection is conducted using a checklist on the software Intact.



The operators receive preparatory documents ahead of the inspection. At the end of the inspection, the results are discussed, any additional measures required are summarized and a timescale is set in which these must be implemented. The inspection report is then signed by both parties and is forwarded to the certification body. The inspection and certification of a product are therefore never conducted by the same person (4 eyes principle).

During the initial audit, a company-specific quality assurance and sampling plan will be drawn up. This plan is laid out in an instruction manual that will be signed by both parties. In addition, instructions are given with regards to the EBC methodology, the EBC documents, the protocols to be kept, and the procedure for the annual inspection by Q.inspecta AG. The company to be certified will need to appoint a quality manager who will be the direct contact person for Q.inspecta AG.

A representative sample of a production batch is taken during the initial audit and thereafter during each annual inspection by an accredited sampler in accordance with the sampling plan contractually specified in the initial audit and sent to an EBC accredited laboratory. The representative sample of a production batch must be carried out within the first two months after the registration.

On three consecutive days, 8 samples of 3 liters each are taken at intervals of at least one hour directly at the discharge of the freshly produced material sampler. The 24 subsamples are combined to form a composite sub-sample. The taking of each of the 24 samples (= 3 x 8 daily samples) must be documented with exact collection times in the sampling protocol.

Biochar Sampling

In addition to the EBC analysis sample, the manufacturer is obliged to regularly take retention samples (in general every day) The exact procedure will be determined during the initial audit. (in general every day). The exact procedure will be determined during the initial audit. If no deviating protocol is determined during the initial audit, the following applies: Daily, a fresh sample of one liter, either from the cross-flow or from the collected daily production has to be taken. A monthly retention sample of at least 30 liters must be kept dry and protected for two years.

3.3.3 Lab Analysis

After sample collection, the biochar can be analyzed in an accredited laboratory. The Basic analysis, which includes all important values (PAH, heavy metal, Carbon content, H/Corg). The EBC-Feed certificate requires an additional analysis package.
If you are using proprietary technology and already produced some biochar, Carbonfuture recommends analyzing the PAH values already before starting the certification process.

Biochar lab analysis costs at Eurofins GmbH Germany (2022 prices)	
Basis analysis incl. PAH	680 €
EBC feed	1.500 €
PAH only	120 €

3.3.4 EBC Certification

Once the inspection process is completed, the certifier checks all the information arising from the inspection process. If the products are given approval, a production certificate will be issued by Q.inspecta at easy-cert, and the certification process is concluded.
Biochar producers which acquired an EBC certification and want to participate in the carbon market must also request certification of the C-sink potential of their biochar. By uploading the data to the EBC portal to calculate the C-sink potential. CSI validates and certifies the data. Certified operators are allowed to use the EBC Logo for marketing and product labeling:

4. Appendix

4.1 Example of an EBC Carbon Sink Certificate

EBC

Arbaz, 24th November 2021

EBC carbon sink certificate

General Data	ID of C-sink certificate = C-sink register ID EBC ID EBC Batch ID Production period QR-Code of Biochar Batch	[redacted]
Producer GPS	[redacted]	

Biomass	Type of biomass (EBC-class)	Cocoa husk & prunings
	Total amount of biomass (dry matter) used for the certified batch	8.2 t
	Emissions due to fertilization	0 t CO_2eq
	Transportation of biomass to pyrolysis site	0.00 t CO_2eq
	Preparation of feedstock	0.00 t CO_2eq
	Emissions for drying of feedstock	0 t CO_2eq
	Feedstock storage emissions	0 t CH_4
	Total biomass related GHG emissions without CH_4 per batch	**0.0 t CO_2eq**

Pyrolysis	Source of electric energy used on site	
	Emissions due to electricity consumption for entire pyrolysis plant incl. post pyrolysis treatment	0 t CO_2eq
	Emissions due to LPG and other external fuel for reactor heating	0 t CO_2eq
	Emissions due to carrier gas	0 t CO_2eq
	CH_4-emissions of pyrolysis unit in kg CH4 / t biochar	30.00 kg CH_4
	Total pyrolysis related GHG emissions without CH_4 per batch	**0.0 t CO_2eq**

Methane	Total methane emissions	44.40 kg CH_4
	Amount of compensated methane emissions	44.4 kg CH_4
	Type of methane compensation	avoided decomposition
	Total non compensated CH_4 emissions per batch	0.00 t CH_4
	Total non compensated CH_4 emissions in CO_2eq per batch (@ GWP20 of 86)	**0.00 t CO_2eq**

Post-Pyrolysis Tracking	Total preparation of BC-based fertilizer (milling, mixing) in t CO2eq	0.00 t CO2eq
	Total transport emissions from kiln to field in t CO2eq	0.17 t CO2eq
	Total emissions from soil application of biochar in t CO2eq	1.39 t CO2eq
	Amount of compensated CO2eq from soil application in t CO2eq	2.00 t CO2eq
	Total post-pyrolysis emissions	**0.17 t CO2eq**

Margin of security	**10% of total GHG emissions (incl. GWP20 of CH_4) per batch**	**0.4 t CO_2eq**

Total emissions	**Total GHG emissions in CO_2eq per batch**	**0.4 t CO_2eq**
	Total GHG emissions in Ceq per ton of biochar (dry matter)	0.074 C

Biochar	Amount of biochar (DM) produced per certified batch	1.48 t
	H/Corg ratio	0.27
	C-content	67.4 %
	C-sink potential	**60.0% of DM**

C-sink potential	Total GHG emissions per t biochar (dry matter)		0.270 CO_2eq
	CO_2eq-content per t of biochar (dry matter)	[gross C-sink]	2.47 CO_2eq
	C-sink potential in tCO_2eq per t of biochar (dry matter)	[net C-sink]	2.20 CO_2eq

Total C-sink	**C-sink100 in tCO2eq for the entire C-sink [persistent C of the sink after 100 years when applied to soil @ P100=74%]**	**2.41 t CO_2eq**

European Biochar Certificate • www.european-biochar.org
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EBC

EBC Carbon Sink Certificate

[redacted]

The biochar batch [redacted] produced by [redacted] farmers (see annex 1) and applied as biochar-based fertilizer to their respective cocoa plantation, has a carbon sink value ($Csink_{100}$) of 60.0%. The accountable fraction of carbon that is persistent after 100 years ($Csink_{100}$) is 1.63 t CO_2eq per ton of biochar on a dry matter base.

The carbon sink value of 60.0% provides the percentage of a mass unit of biochar that, on a dry matter base, can be considered as a long-term (> 100 years) carbon sink. For example, a big bag containing 200 kg biochar (dry matter) has a carbon sink value of (200 kg * 60.0 % C_t) = 120.0 kg C which is the equivalent of 440 kg CO_2eq per bigbag when applied to soil. Or a 50-liter PP-bag would, once applied to soil, have a carbon sink value of 200 kg DM/m³ * 0.05m³ * 60.0 % C = 6.0 kg C per bag which is the equivalent of 22.0 kg CO_2eq per bag.

The production of 1 t of biochar (dry matter) caused emissions of 400 kg CO_2eq due to feedstock production, transportation, storage, preparation, operation of the pyrolysis, the biochar-based fertilizer production, and the application to soil. These emissions were deduced from the carbon sink value of the biochar.

The CO_2 emissions of the combustions of the pyrolysis gases are considered carbon neutral as the feedstock for the pyrolysis originated from harvest residues.

The CH_4 emissions caused by the production in farm scale Kon-Tiki kilns were entirely compensated by the avoidance of CH_4 emissions due to the uncontrolled decomposition of cocoa husk piles which was the common practice on the respective lands before introducing the biochar method. The time horizon for this CH4-compensation was set to a maximum of ten years (end of 2030). After this transition period, CH_4-emission of the pyrolysis must not be compensated by emission avoidance from uncontrolled cocoa husk decomposition anymore.

More than half of the biochar (62%) was applied with a diesel generator driven high-pressure injection machine. The 434 liters of diesel (1.4 t CO_2eq) consumed by the generator for this purpose were compensated through the plantation of two shade trees that will extract over the next 20 years 5.4 t of CO_2 from the atmosphere. The overcompensation of the diesel by 75% is expected to cover the risk of unforeseen events damaging the two trees.

The biochar and biochar-substrates were produced close to the [redacted] fields and were not packed in waste-causing materials. All fields where the biochar was applied are geo-localized. Every applied kg of biochar can be tracked.

The biochar that is applied to soil undergoes a slow biological degradation of 26% over the first 100 years. Therefore, only the carbon fraction that is persistent after 100 years ($Csink_{100}$) is herewith certified as C-sink certificate. Accounting only for the persistent fraction after 100 years, the **total size of the EBC certified C-sink is 2.41 tCO_2eq**.

The present *EBC carbon sink certificate* is valid for all 1.48 t of biochar registered and GIS-localized as documented in Annex 1.

The present EBC carbon sink certificate was issued by the Ithaka Institute (Switzerland) on 25th November 2021.

[redacted]

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