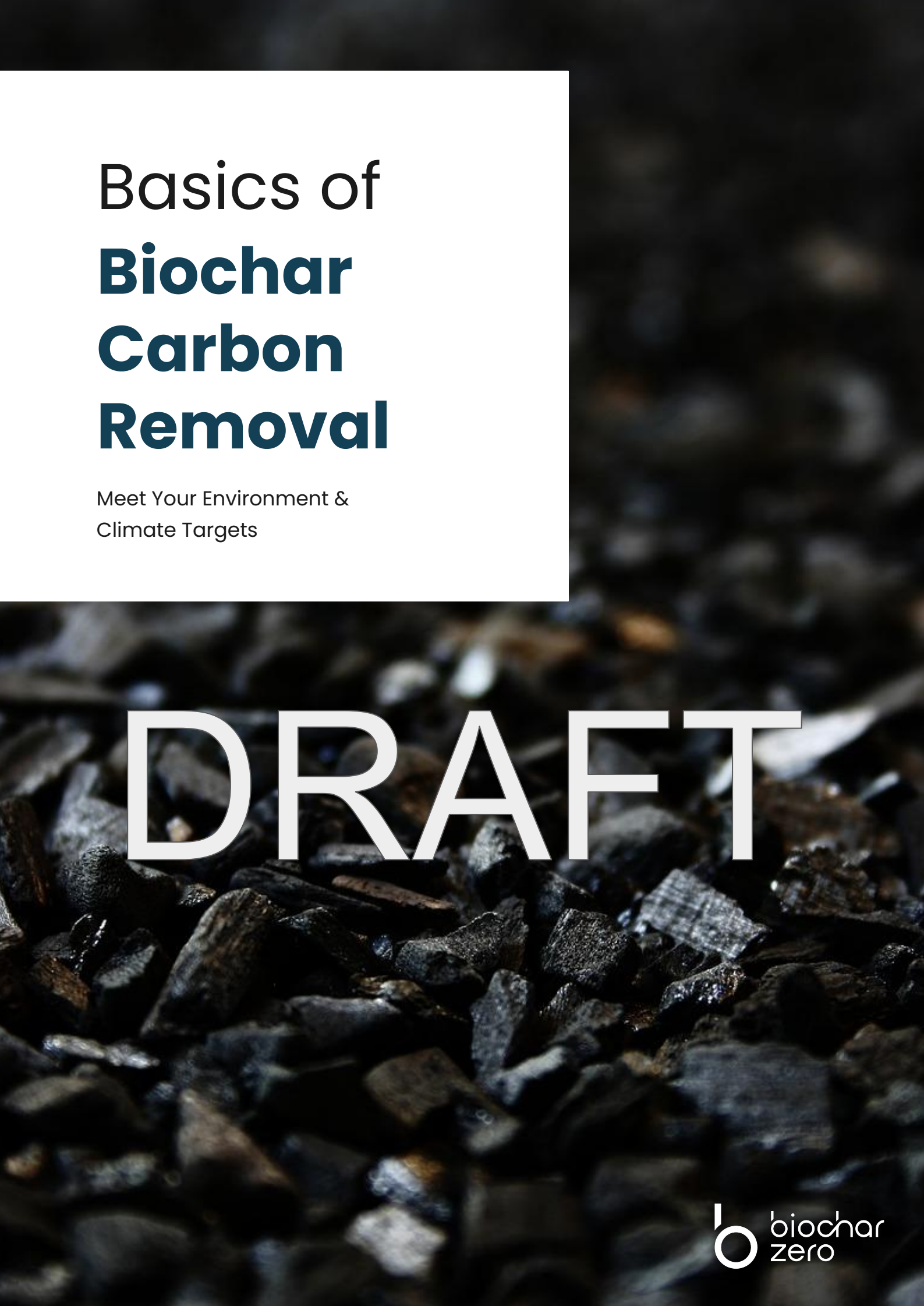
Basics of **Biochar Carbon Removal**

Meet Your Environment & Climate Targets



biochar zero

Unlocking biochar carbon removal: A basic guide for industry leaders to support their sustainability targets with the help of pyrolysis

Many organisations currently research how they can operate more sustainably without losing their competitive advantage. Pyrolysis with the production of biochar, energy and carbon credits is frequently discussed as an **option for decarbonisation, circular economy, and defossilisation**. This is especially true for organisations with a high demand for heat, available residual biomass, or greenhouse gas emissions originating from raw material processing.

To help you better understand this technology and its implications, we developed this guide.

We dive into details of what biochar is, how pyrolysis works, what by-products are created throughout the process, what can serve as biomass inputs and how carbon removal credits work. This understanding will **help you to evaluate** whether **operating a pyrolysis plant** may be an option for your organisation and be a key contributor to complement your existing environmental and climate action efforts. If you're already familiar with the basics of biochar carbon removal, check out our project developer guide from our website as well.

We are a consultancy for biochar production and utilization, with three years of domain experience. We support organisations in Europe in evaluating, setting up, and operating a profitable, industry-scale biochar production.

Let's dive right in!

Motivations for Biochar & Biochar Carbon Removal: **Decarbonisation, Circular Economy and Defossilisation**

Meeting corporate **climate and environmental protection goals** like net-zero, Science Based Targets initiative (SBTi), or Climate Pledge require to transition out of direct and indirect use of fossil fuels and materials.

Decarbonisation is the overall process of reducing greenhouse gas emissions down to zero, which biochar carbon removal can support by producing green energy in the form of process heat or syngas (can be converted to electricity) through pyrolysis of biomass.

A more environmental focus is behind the concept of **circular economy** that aims to e.g. avoid waste and re-use or recycle material. As biochar production converts biomass waste into biochar – a valuable resource – it is part of the circular economy.

Defossilisation is the process of substituting materials made of fossil carbon with non-fossil alternatives. As biochar is biogenic carbon it can be a replacement for certain use cases, e.g. in metallurgy to remove oxygen from metal-oxides, or in filtration to replace active carbon.

Products that cause greenhouse gas emissions during their raw material processing, can balance out these emissions with **carbon removal credits** generated through biochar production and application. Alternatively it is possible to **inset biochar** into products to create a carbon sink and at the same time enhance product properties, e.g. for concrete, asphalt or composites.

Pyrolysis–a thermo-chemical process that allows to convert biomass waste into valuable biochar, heat, syngas, bio oil and more.

When organic material like wood is heated at high temperatures in a (nearly) oxygen-free atmosphere, it is **broken down into its components**. Volatile components exit as gases, condensed oil, or tars. What remains is biochar, a stable carbon, and mineral ashes. As the process is in part exotherm and resulting synapses can be burnt, pyrolysis can be used to generate process heat and drive a generator to produce electricity.

Pyrolysis is considered a **carbon neutral process**. About half of the CO_2 that was previously captured through photosynthesis by plants, is released as gas, the other half remains in a stable form of biochar.

Depending on the target temperature and heating rate, pyrolysis is distinguished between:

- **Slow pyrolysis** (>300 °C for minutes) produces equal amounts of biochar, gases and bio oil
- **Fast pyrolysis** (>500 °C for few seconds) and **flash pyrolysis** (<1s) produce less biochar in favor of bio oil

Fast or flash pyrolysis may be more relevant for organisations that have a high energy demand.

Biochar – An existing tool against climate change with co-benefits

Biochar is a lightweight black residue, which remains after the pyrolysis of biomass and consists of up to **90% carbon**. It can be compared to charcoal, but is used as a material instead of a fuel.

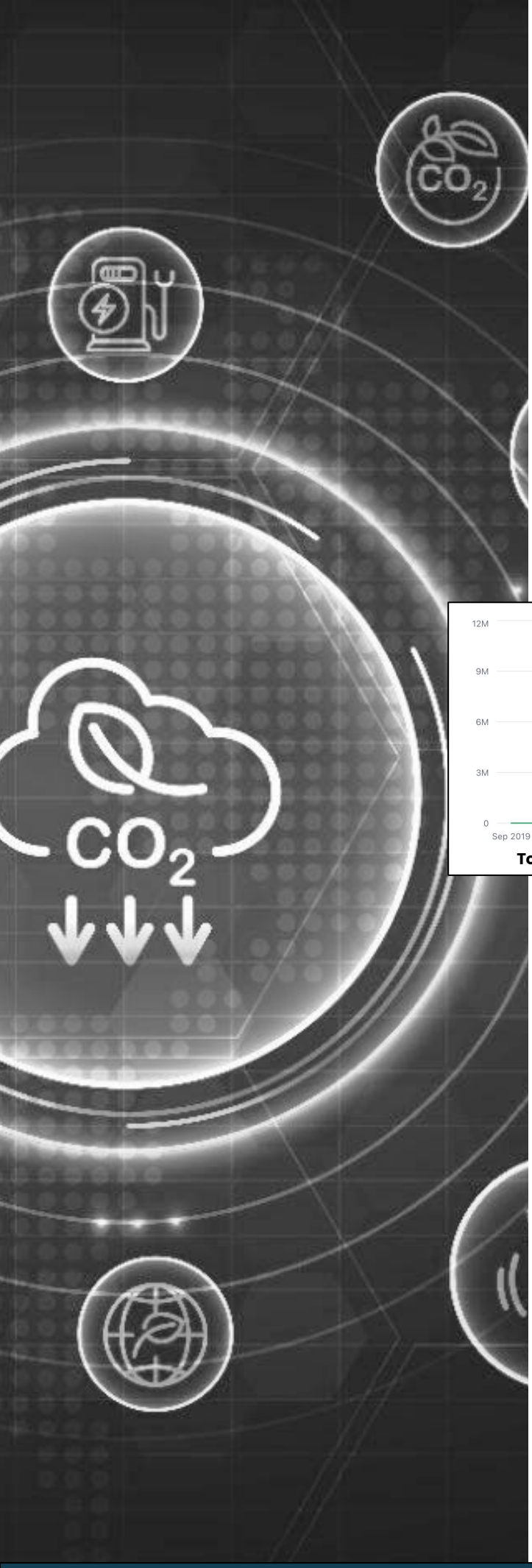
The **properties of biochar** depend mainly on the used biomass, pyrolysis temperature, heating rate and residence time in the pyrolysis reactor. Some key characteristics are:

- carbon content, which is e.g. relevant as a climate mitigation tool,
- surface area and porosity, which is e.g. relevant for filtration,
- grain size, which is e.g. relevant for use in materials

Biochar applications are plentiful, but often require some modification, hence raw biochar should not be treated as a product by itself. Most common applications are:

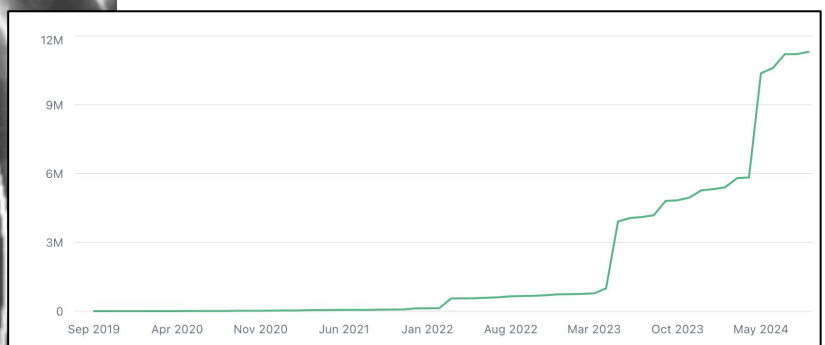
- soil amendment, e.g. direct application after loading with nutrients, for improved yield
- feed supplement for livestock, after milling or pelletizing, for improved animal health
- concrete additive, after milling, for insetting and improving concrete properties

To produce **1 tonne of biochar**, it requires typically 3-4 tonnes of biomass. The climate effect of 1 tonne of applied biochar though equates to about **2.8 tonnes of removed CO_2**.



Transferring negative emissions between organisations with **Carbon Removal Credits**

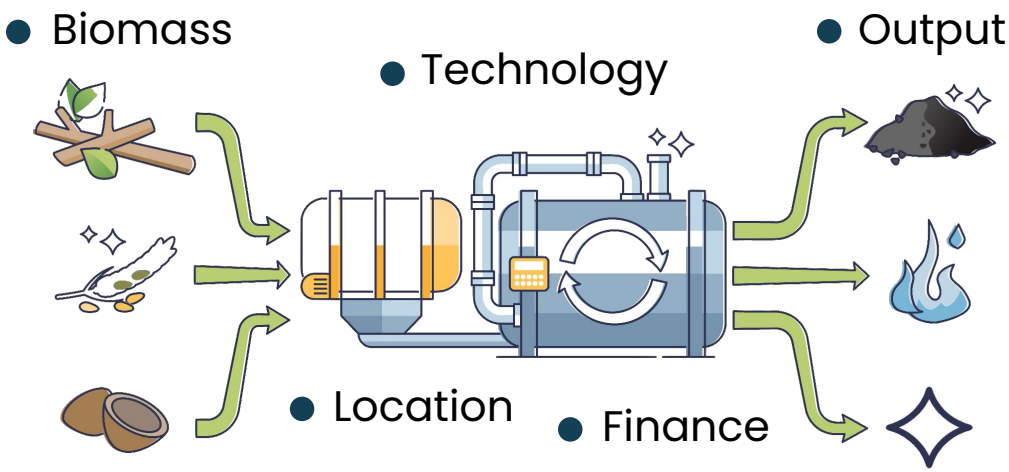
Organisations that produce biochar create a **carbon sink potential**. This potential can be realized when the biochar is applied in a way that guarantees the bound carbon will not be released for 100 or more years.



Total sales of carbon removals in tonnes (Source: cdr.fyi)

For each tonne of realized carbon removal, a **carbon credit** can be generated under a carbon removal frameworks. There are various certification frameworks for carbon removal with Puro and EBC C-sink being the most widely used ones.

The certificates can then be sold on the **voluntary carbon market** either directly or through a marketplace. Typical buyers today have a high margin and low emissions themselves and include IT companies like Microsoft, service companies like Shopify, and global consultancies like Boston Consulting Group. The voluntary carbon removal market is still small today, but growing heavily and expected to be integrated in the EU Emissions Trading System, which will allow to reduce the need to buy pollution allowances.



Five domains to get **Biochar production** right: location, biomass, technology, outputs and financing

Organisations with a high internal heat demand or ability to sell heat, e.g. to a heating network, check the first condition for a successful biochar operation. Additionally it helps if you have one or more of the following present at your **location**: available residual biomass, use for biochar, or greenhouse gas emissions within your process that don't originate from burning fossil fuels.

The type of used **biomass** can vary greatly, as illustrated in the EBC positive list. Most common are wood chips, crop residues, nut shells, organic waste and sewage sludge. Pyrolysis is also a sustainable way to eliminate your waste biomass.

Biochar production commonly requires different kinds of **technology**: equipment for biomass pre-processing, depending on its quality, a reactor for slow pyrolysis, and post-processing equipment, e.g. for milling or pelletizing. Additionally many biochar producers convert resulting gases via turbines and generators into electricity that they use themselves or sell to the grid.

To make biochar production a profitable business, all main **outputs** of pyrolysis: biochar, energy, and carbon credits need to find a consumer. Preferably an internal one, or alternatively an external buyer. Most biochar producers have use for at least one output themselves, but many business models with combinations of internal and/or external supply of biomass and internal and/or external usage of outputs exist.

If **biochar** has no internal use, the raw material is best converted into a readily usable product internally or via a partner.

Energy has many options to sell: as process heat to a nearby organisation, district heating, offered as a drying services, bio oil sold as input for fuel, and conversion of syngas to electricity, e.g. via a gas turbine and generator.

Carbon credits can be sold to larger buyers directly or through marketplaces.

To **finance** a biochar project, organisations typically look into multi-million € EU grants.

If you consider entering the biochar carbon removal business, you are not alone to get all these puzzle pieces right. Check out our other resources on our website and feel free to contact us anytime.

"Transforming your biochar project into a success story"

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Fascinated by biochar, we started in 2021 with the intention to produce it ourselves. We went through the whole process from finding a location, biomass, selecting equipment and potential buyers. In the end we realised we didn't have the needed equity to complete the project.

Since then we conducted more research, market studies and built an enormous biochar network in Europe.

Today we **work with** many **biochar project developers** and existing **producers** to share our market knowledge, experience, conduct feasibility studies, and support project planning, certification, and financing.

If you want to become a biochar producer, you are in good company! The European biochar market is growing: 54 new plants expected in 2024, policy support is on its way and the biochar ecosystem is growing.

The time is now–let's tackle climate change together at scale!

Visit our website for more resources or contact us.

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