EBI European Biochar Industry

European Biochar

Market Report 2022 | 2023

March 2023

Outline Introduction

a

Impressions from recent installations

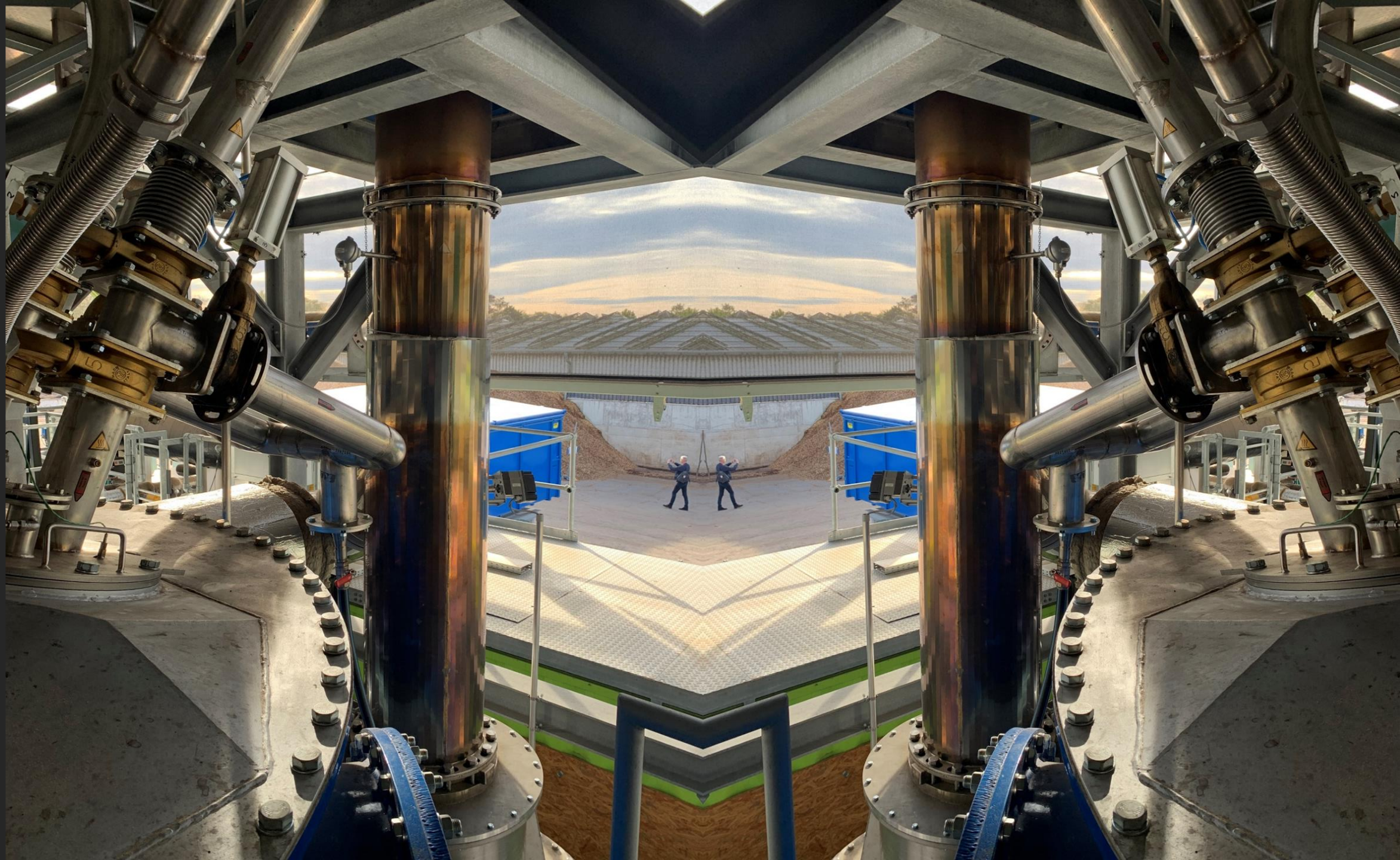
b

Thoughts on Biochar Carbon Removal (BCR)

c

EBI members and activities

cts | CARBON TECHNIK SCHUSTER

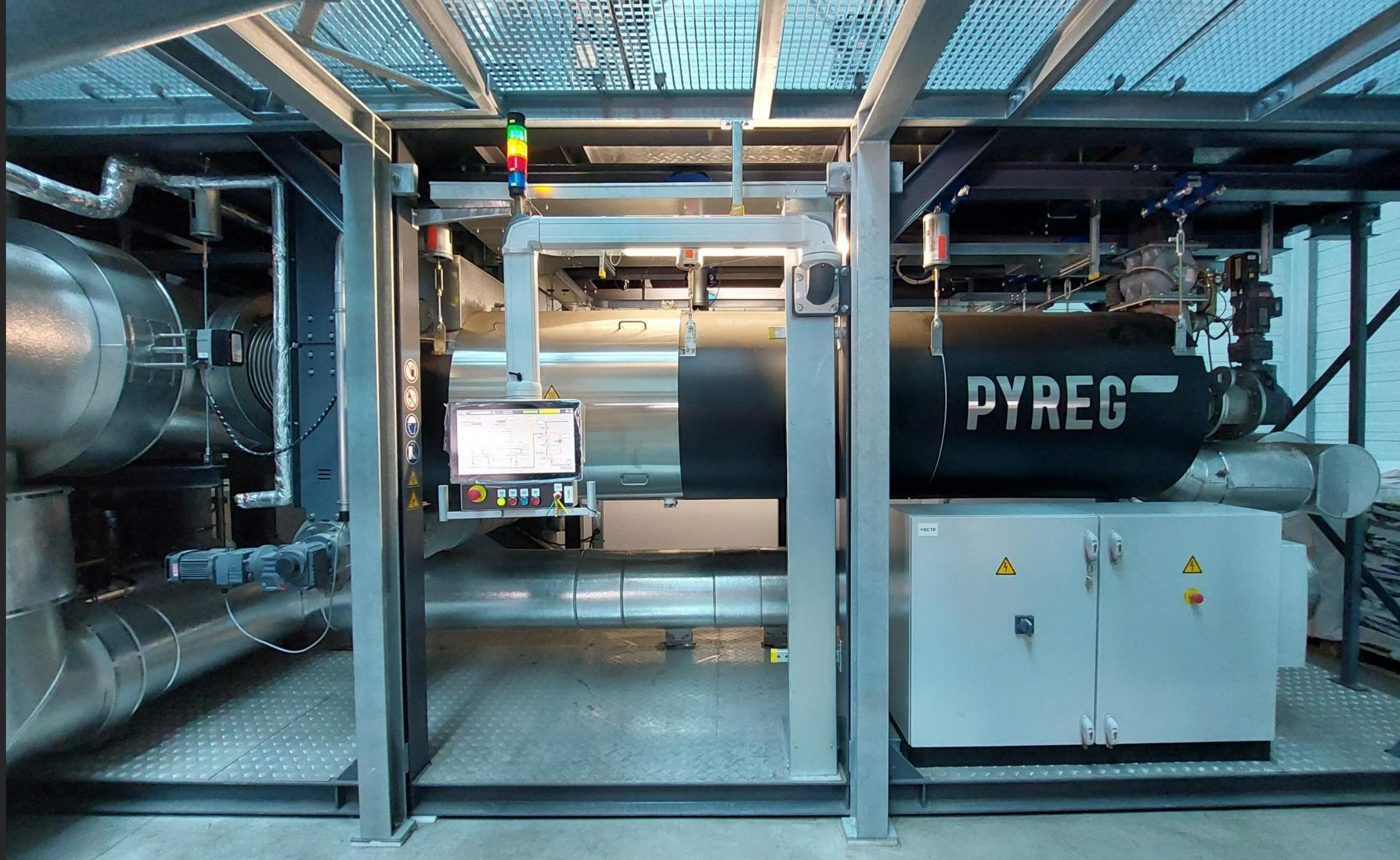


AIREX ENERGY

Stiesdal

SYNCRAFT
Climate Positive Solutions.

PYREG

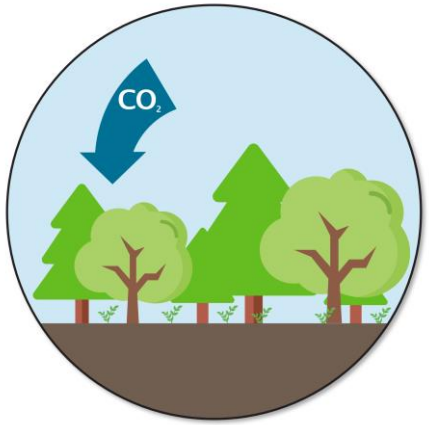


PERPETUAL NEXT

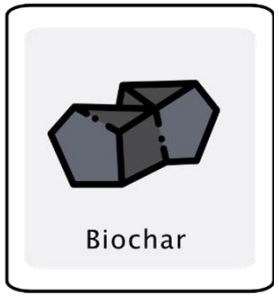
Biochar Carbon Removal (BCR)

capturing carbon, using, and storing it

carbon capture

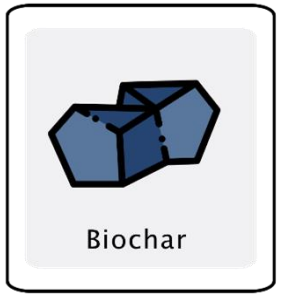


transform biomass into a stable form



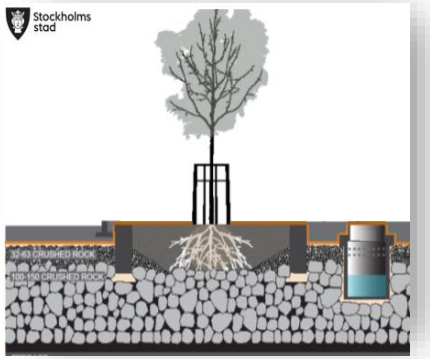
&

tailored to application

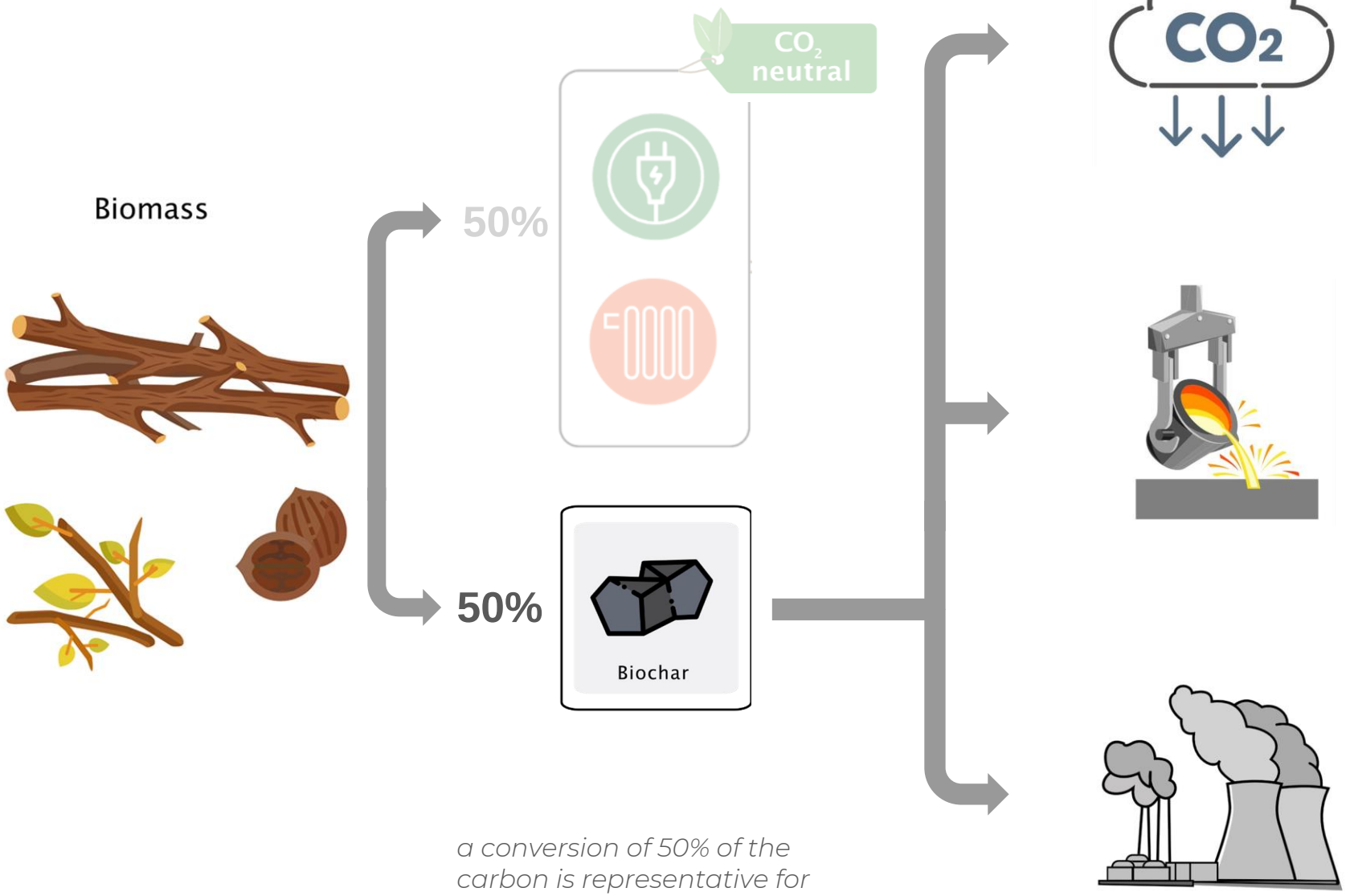


carbon storage

by use of Biochar



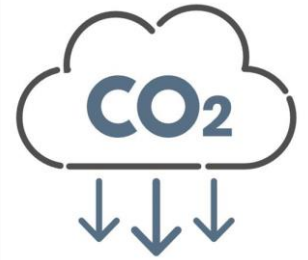
Biomass to carbon & energy and then?



a conversion of 50% of the carbon is representative for plants optimized on biochar yield, not on energy

Carbon preserving application

- Emissions avoided: **0,0 t CO_2**
- Carbon removal: **2,5 – 3,0 t CO_2**



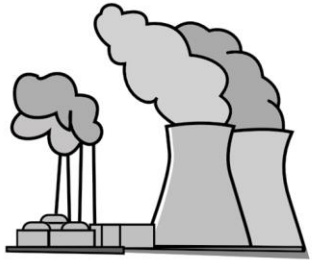
Metallurgy

- Emissions avoided: **2,5 – 3,0 t CO_2**
- Carbon removal: **0,0 t CO_2**

Energy

- Emissions avoided: **< 1,0 t CO_2**
- Carbon removal: **0,0 t CO_2**

t CO_2 per t of Biochar



The problem is with 

C is not a problem

O_2 is not a problem

1 t C pure carbon
= 3,66 t CO_2

dealing with C is more to the point than dealing with CO_2

Tackling the problem at its root means **preventing carbon atoms** from becoming **CO_2-molecules**

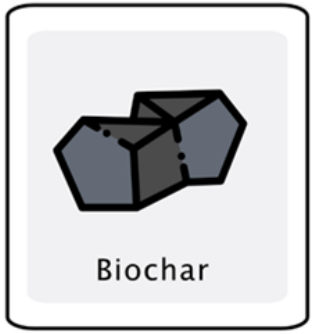
Carbon contents

Biomass

30 - 50%
C in biomass

4,4% C in exhaust gas

0,01% C in atmosphere



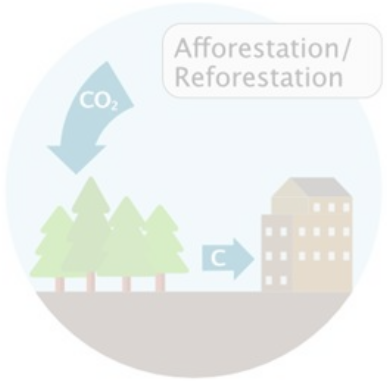
80% C in Biochar

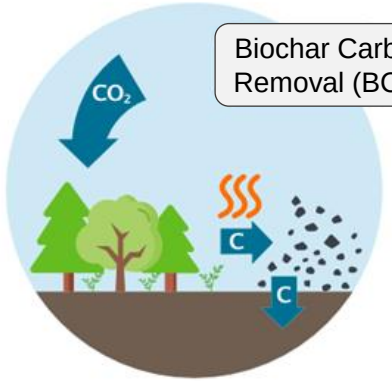
Avoiding combustion prevents **dilution of carbon** by **10x** and up to **4.000x**

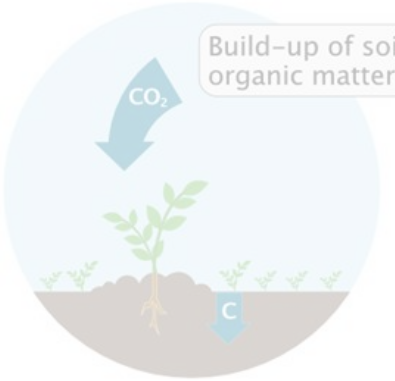
Carbonizing biomass instead **concentrates carbon up by 2x**

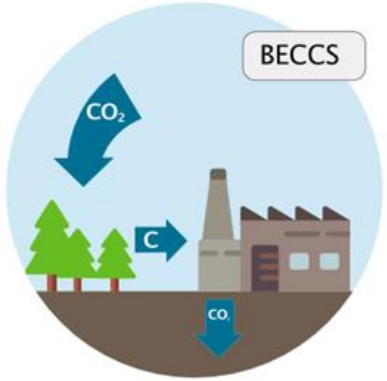
Six highly relevant carbon removal options

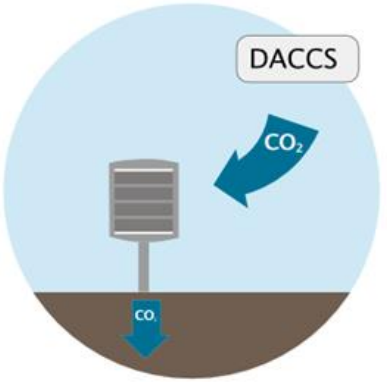
permanent carbon removal



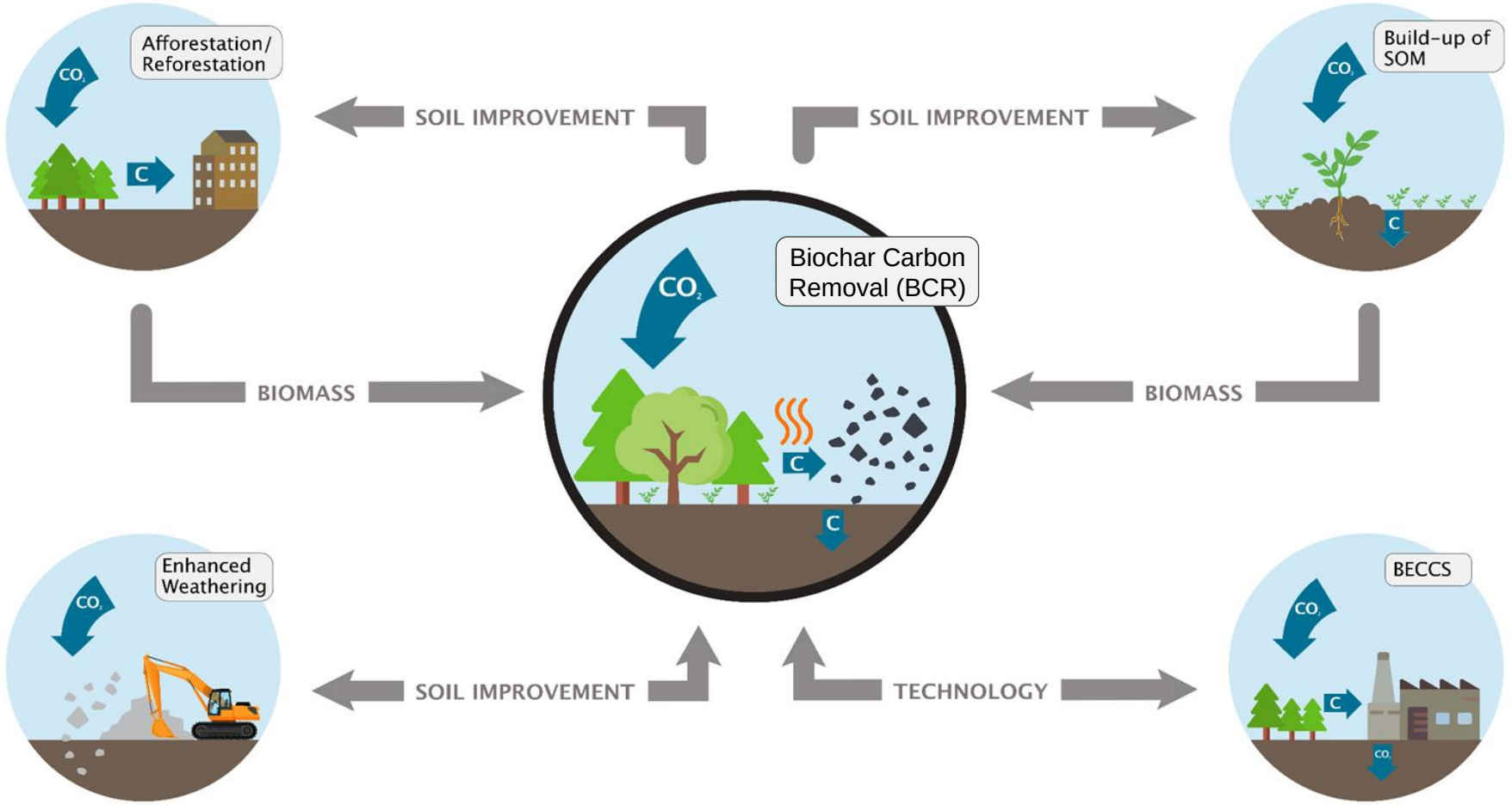








Multiple synergies between different CDR options



Different **CDR technologies** will have different **growth trajectories.** Only a **portfolio approach** can deliver the required amounts of **carbon removal.**

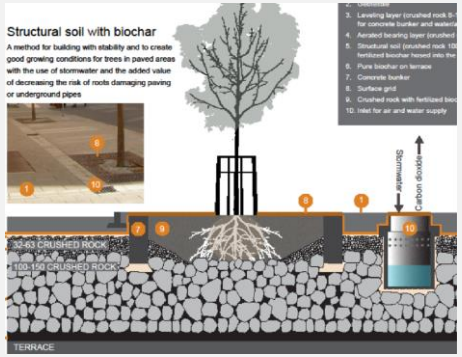
Broad range of biomass suitable for carbonization



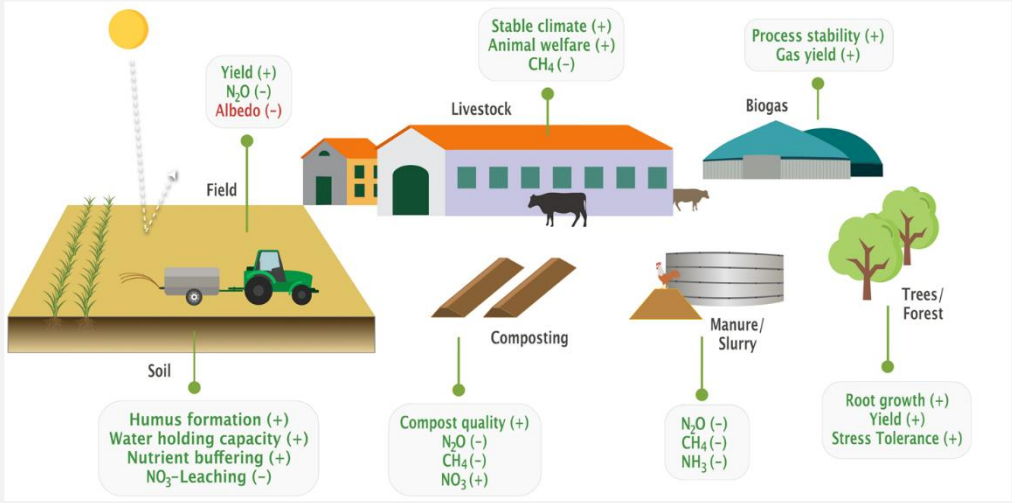



Broad range of applications of Biochar

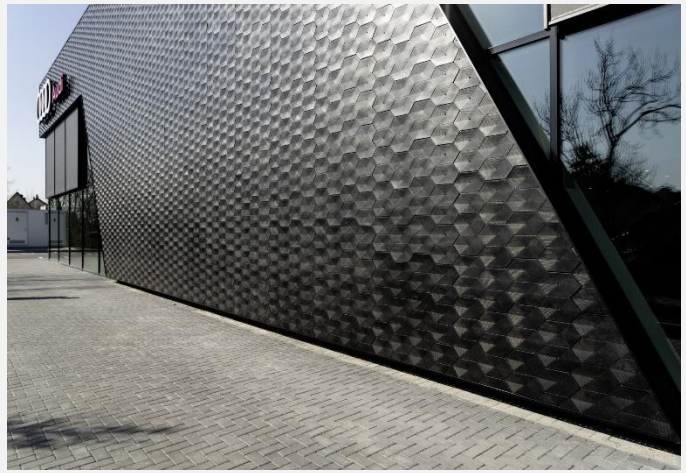
Urban Applications



Agriculture

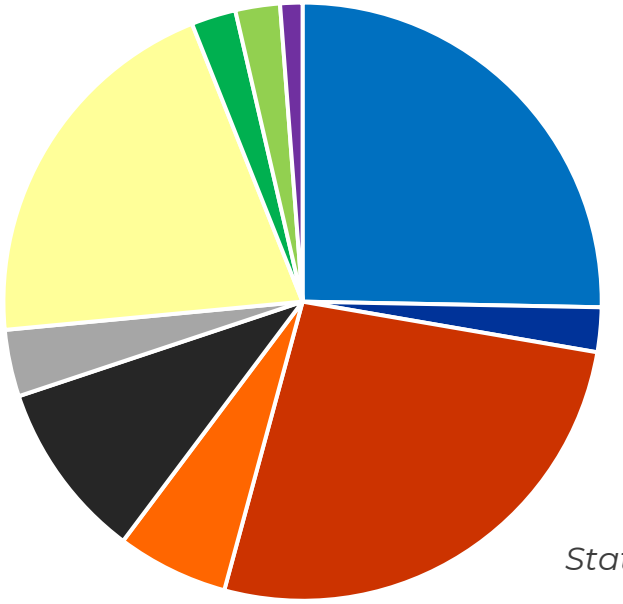


Construction materials




ALPEN KOHLE
AIREX ENERGY
BELLONA
Carbonfuture
CARBON STANDARDS international
CARBUNA
CarStorCon® Technologies
Nature Based Solutions
CIRCULARCARBON
CARBOFEX
Carbon CharStore
carbo culture
eurofins | Umwelt
energie360°
Haffner Energy
Making Hydrogen Super Green
NAWARO ENERGIE
Novocarbo
Norsk Biokullnettverk
PyroCore
EGS
RG H2
Local Renewable Hydrogen
SOLER
L'énergie du bois français
SONNENERDE
Stiesdal
south pole
PERPETUAL NEXT
PYREG
NET ZERO TECHNOLOGY
SYLVA FERTILIS
Skånefrö AB
SÜDWESTDEUTSCHE SALZ WERKE AG
SYNCRAFT®
Climate Positive Solutions.
VOW green metals
VOW
AquaGreen
BISONFOREST
CARBOFORCE
CARBON REMOVAL PARTNERS
CARBOGANIC fibers & fillers
circle carbon
cts CARBON TECHNIK SCHUSTER
DECARBO Engineering
DEMI
carbon collectors
bio inspecta
EUTHENIA ENERGY CARIBBEAN
CARBONLOOP
Pour des énergies carbone négatif
First Climate
RE·CORD
RWZ Raiffeisen
ecoLocked
Evac
EQTEC™
GRK
HolzenergieGUT
IHC INTERHOLCO
made of air
MEVA ENERGY
SUEZ
EnergieWerk Ilg GmbH
energyocean CARBON SINKS
Fraunhofer ISE
MASH MAKES
minus CO2 by carbonauten
NGE
NSR
SAMSUN AVDAN ENERGY
umdaschgroup ventures
XYLERGY
Axel Preuß
BioFlux
BIOENERGIE FRAUENFELD
FAIR'N GREEN
Rainbow Bee Eater
IKB
KWS OKOKRAFT
SKANSKA
Ruhr Lab
SOLVAY

EBI Members by type of business



Status: 28. Feb 2023

- Equipment - Pyrolysis
- Equipment - Other
- Plant Operator
- Plant Operator (planned)
- Biochar Products
- Biochar User
- Biochar Related Services
- R&D Institute
- Not-for-Profit
- Investor

- **Manufacturer of Equipment**, mostly pyrolysis/gasification (25%)
- **Plant Operators** including members that intend to built a plant (33%)
- Members w/o own pyrolysis plant, creating **biochar products** or **trading** or **using** them (14%)
- **Service companies**, most of them in the field of consultancy, certification and CO_2-certificates (20%)

Activities of EBI to support the Biochar industry

Policy

Support/initiate adaptation of legal regulations regarding production & usage of biochar

Market Intelligence

Provide relevant market information for members and for publications

Subject of this report

Communication

Increase the level of awareness of biochar and its commercial and environmental benefits

Industry Standards

Develop & establish standards for a broad set of applications

Outline Market Report

1

Motivation, scope and methodology

2

Biochar manufacturing equipment

3

European Biochar Market 2022/2023

4

Scaling BCR to climate relevance

European Biochar Market Report
2022/2023

Authors and key contributors

- **Hansjörg Lerchenmüller** (EBI) – Lead Author
- **Harald Bier** (EBI)
- **Lea Hettich** (EBI)
- **Mattias Gustafsson** (Ecotopic)
- The **Nordic Biochar Network**
- The **Equipment Manufactures** and **Plant Operators** for Biochar production
- EBI **Policy Working Group**
- And many **other EBI Members, Biochar experts** and **stakeholders**

12. March 2023

Thanks for sponsoring the Market Report 2022/2023

Carbonfuture

south pole

EBI

Carbonfuture

Carbon removal you can trust.

Carbonfuture is your platform for high-quality and impactful carbon removal credits.

EBI

south pole

South Pole helps clients address climate change impacts, while mitigating risk and creating value on their sustainability journeys.

Innovative solutions

An award winning, 17-year history of providing sustainability solutions

Diverse expertise

Based in 37 offices and representations globally, our team of +1200 sustainability advisors, scientists, and engineers are leading experts in their fields

Project developer

Largest developer of climate action projects globally

1 Motivation, scope, and methodology

Motivation

Why we created this market report

- High-quality **market information** is **key** to take the right **decisions** (business, investment, regulatory and political decisions)
- Market information in growing industries is **difficult to gather** and is **often outdated;** standardized reports from **market research firms**, are (i) **expensive** and (ii) have **limited relevance** and (iii) they often **don’t get the complexity**
- We want to share the insight that **Biochar Carbon Removal (BCR)** is a **key solution to mitigate climate change,** is **real today,** and is **scaling very fast**

Scope of the European Biochar Market Report 2022/2023

- We look at **Biochar** production plants **installed in Europe until 2022** and **installations** that will be **commissioned in 2023**
- We look at **carbonized biomass** suitable for **application in soils and materials,** that is produced in
  - **dedicated Biochar production** plants as well as in
  - **charcoal production plants** and **plants for production of carbon for the metallurgic industry** with dedicated production for carbon-preserving applications (counting only the carbon-preserving part)
- Definition of **categories** in terms of production volume

equipment category		method for calculating production capacity
Small	(100 - 199 t)	full Biochar production dedicated to carbon preserving applications
Medium	(200 - 499 t)	
Large	(500 - 1.999 t)	
Very large	(2.000 t - 4.999 t)	individual split btw. (i) BBQ/energy, (ii) metallurgy and (iii) Biochar
Industrial	(≥ 5.000 t)	

Methodology
How we approached this

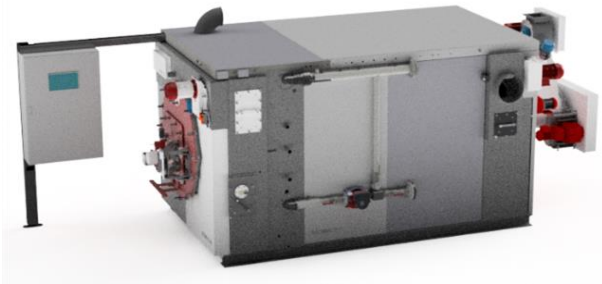
- **Interviews**
  - We gathered information from various stakeholders in the Biochar sector
  - Partially this information was provided on a confidential basis (requires adequate handling)
- **Information from equipment manufacturers**
  - We verified the gathered information with key equipment manufacturers
  - Some equipment manufacturers provided confidential information on projects that are (i) under construction or under contract or (ii) in their planning (requires adequate handling)
- **Internet research**
  - Reference lists from equipment suppliers
  - Published information from biochar producers
  - EBC website
- **Trustful handling of provided information**
  - Confidentially provided information will only be reported in a consolidated way, so that the confidential information cannot be deducted from the report
  - Respecting confidentiality is the basis for collection of data in the future

2 Biochar manufacturing equipment

Equipment manufacturers

Examples for industrial equipment producing Biochar

SYNCRAFT®
Climate Positive Solutions.



Biomacon

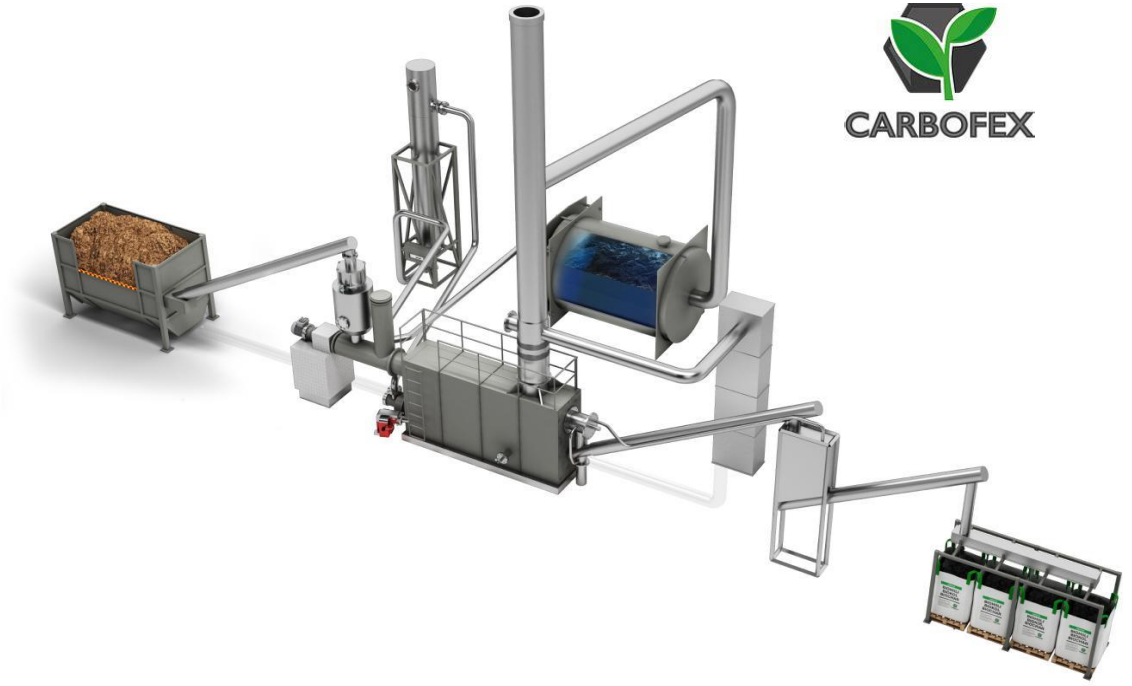
VOW

cts CARBON TECHNIK SCHUSTER

Equipment manufacturers

Examples for industrial equipment producing Biochar

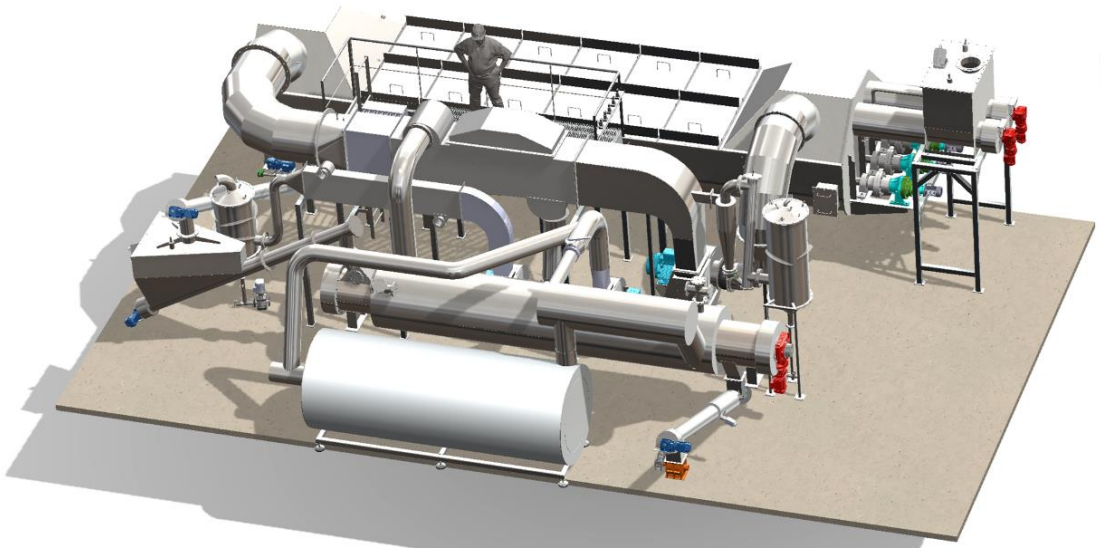
CARBONEX



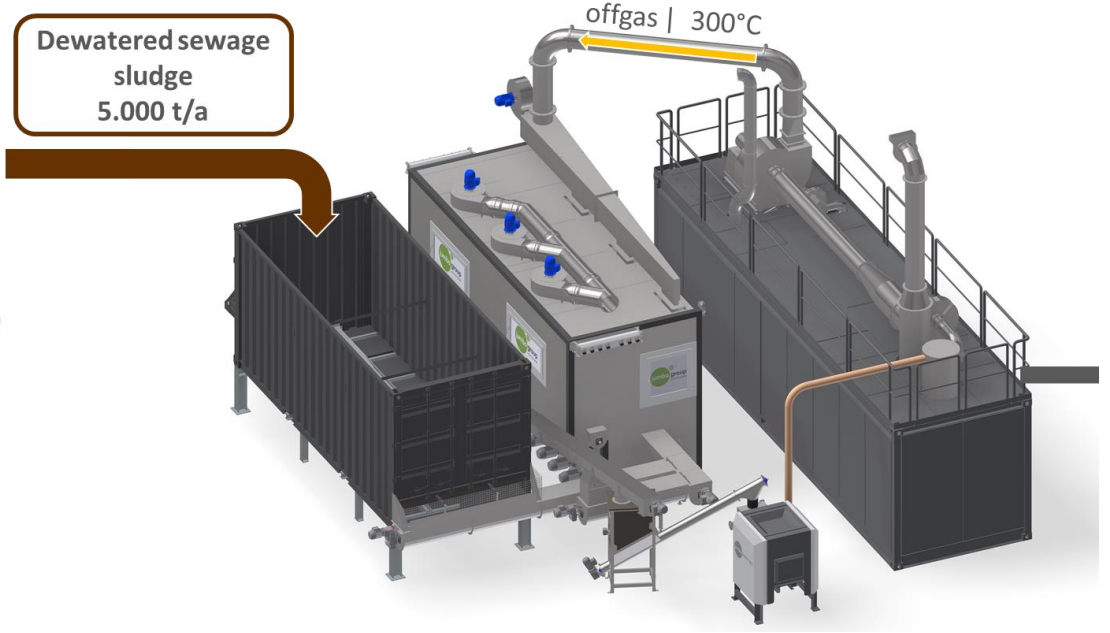
CARBOFEX

Equipment manufacturers

Examples for industrial equipment producing Biochar



AquaGreen



NGE
MATERIAL MORPHING TECHNOLOGY

Equipment manufacturers

Examples for industrial equipment producing Biochar

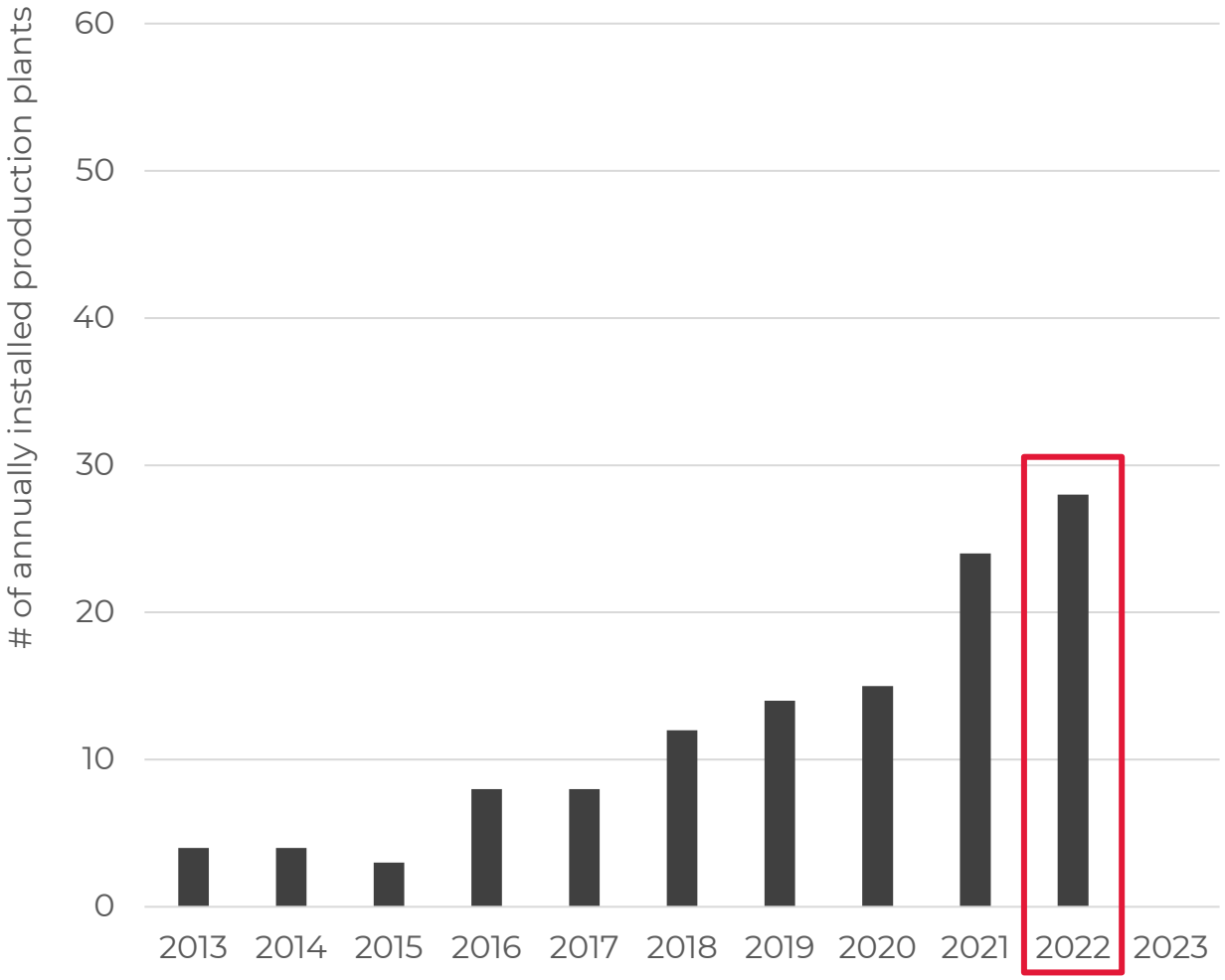
Equipment manufacturers

Examples for industrial equipment producing Biochar

3 European Biochar Market 2022/2023

Biochar market growth

Annually installed Biochar production plants in Europe

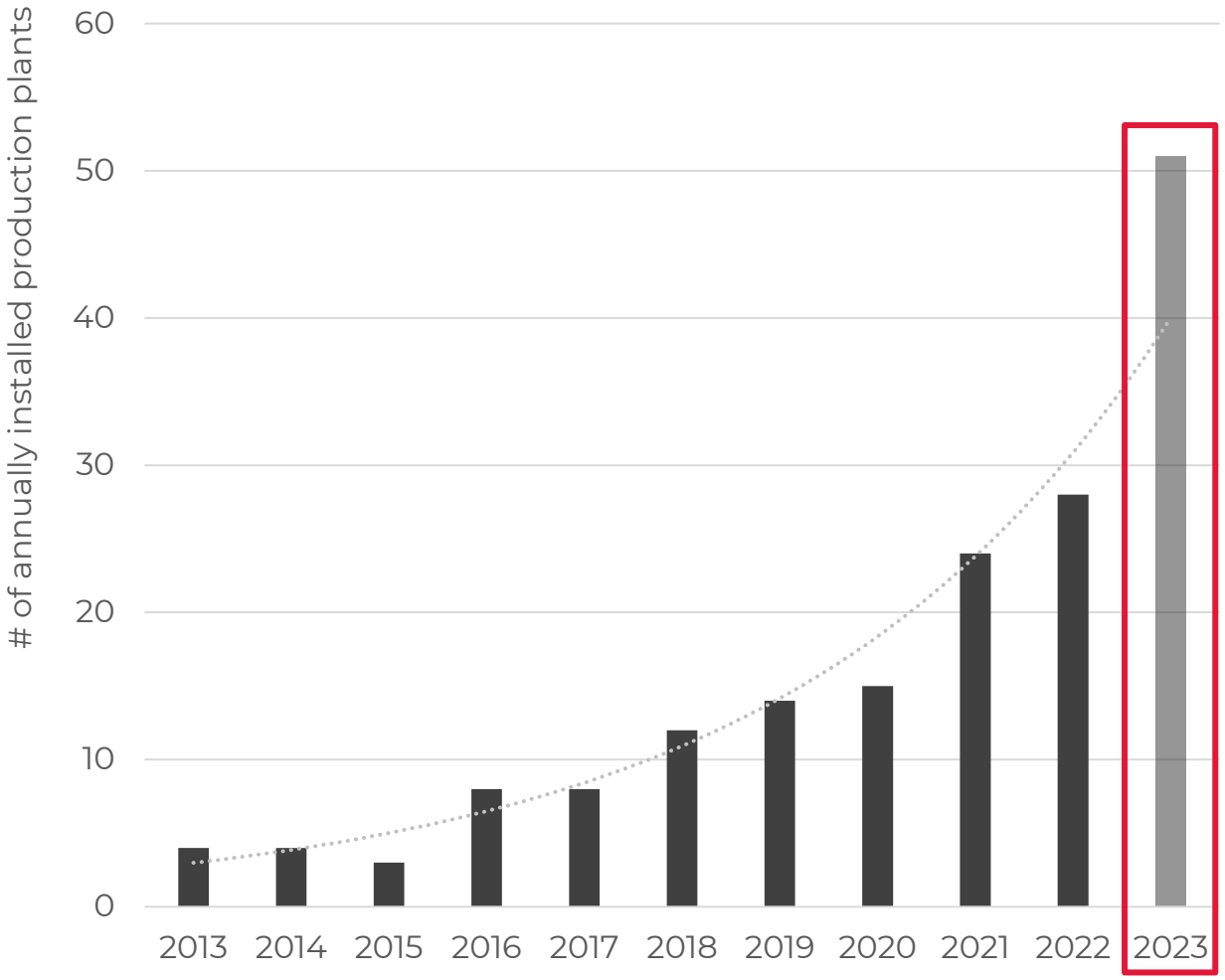


www.biochar-industry.com/market-overview/ © EBI 2023

- **28 Biochar production plants** have been **installed and commissioned** in **2022**
- In **last year's EBI Market Report**, we had **44 projects** on our radar for **2022 completion**
  - For 15 of them commissioning moved to 2023
  - 4 projects slipped even beyond 2023 or have been canceled
  - 3 projects completed in 2022 were previously not on our radar screen

Biochar market growth

Annually installed Biochar production plants in Europe

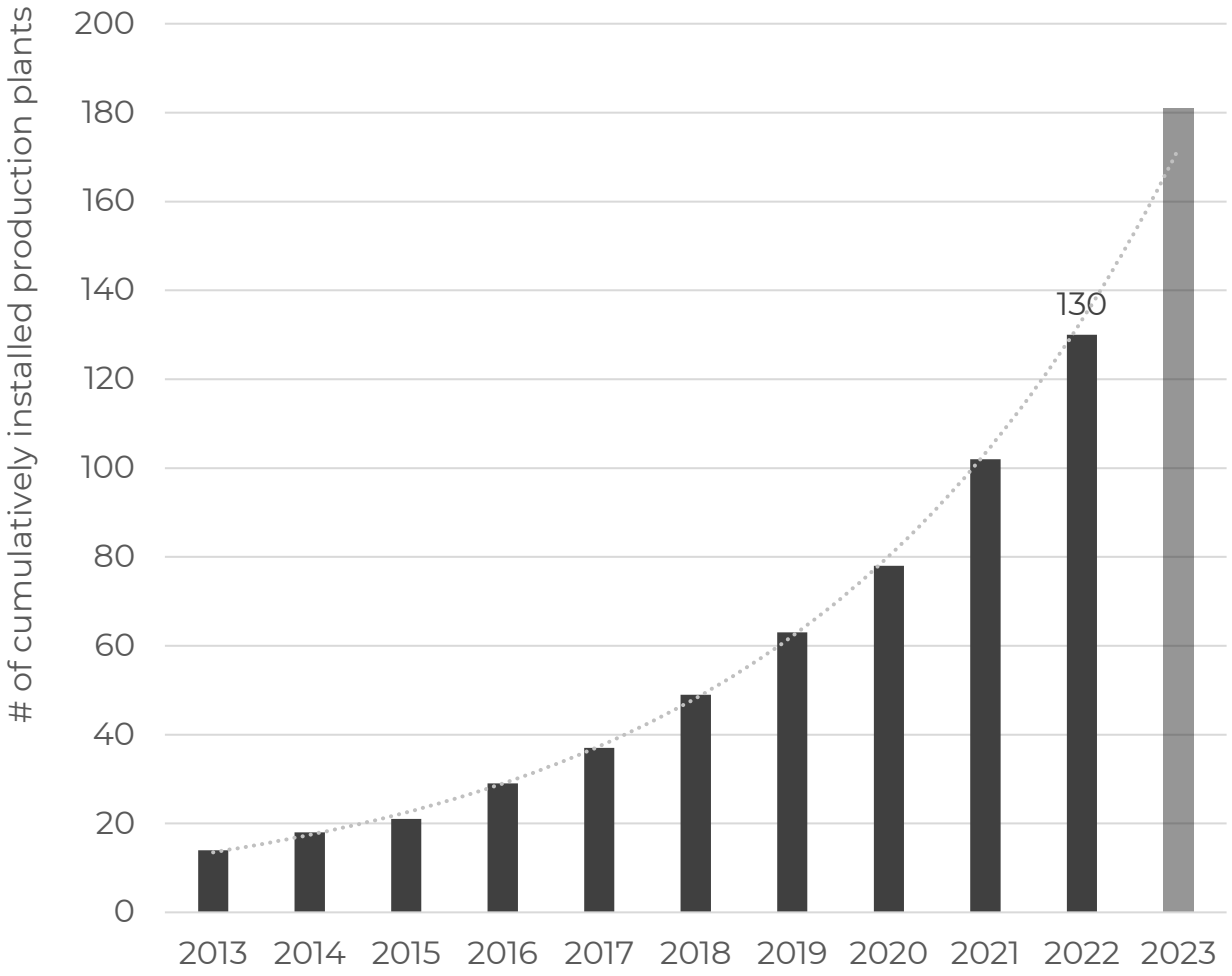


www.biochar-industry.com/market-overview/ © EBI 2023

- EBI is currently aware of **51 projects under construction or under contract** for 2023 commissioning

Biochar market growth

Cumulative number of Biochar production plants in Europe

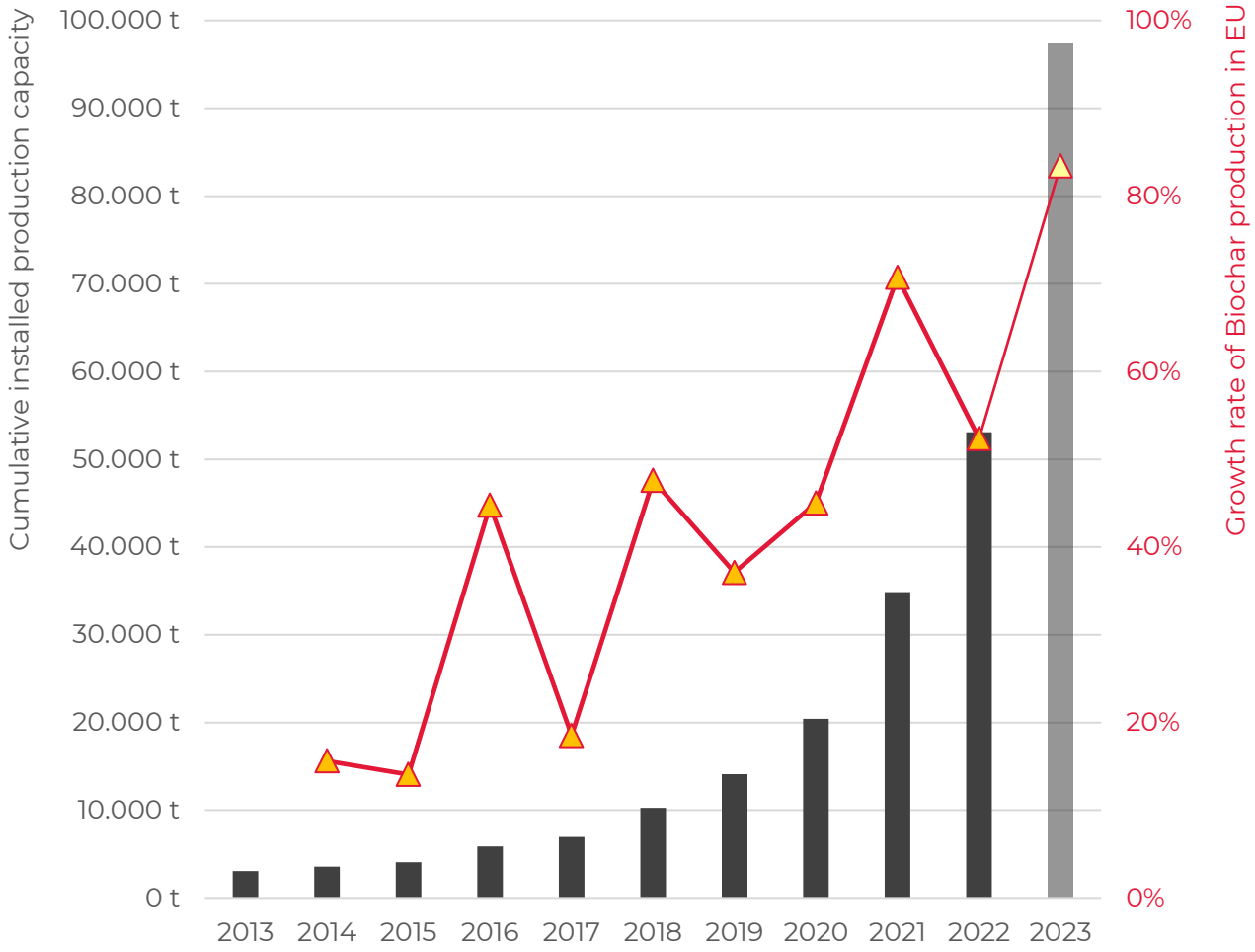


www.biochar-industry.com/market-overview/ © EBI 2023

- By end of **2022, the cumulative number** of production plants in Europe has **grown to 130 installations**
- Until the end of **2023, the cumulative number** of production plants in Europe is **expected to grow to 180 installations**
- Many **further projects** (some of them quite large) are in an **advanced planning and permitting process** for commissioning in **2024**

Biochar market growth and growth rates

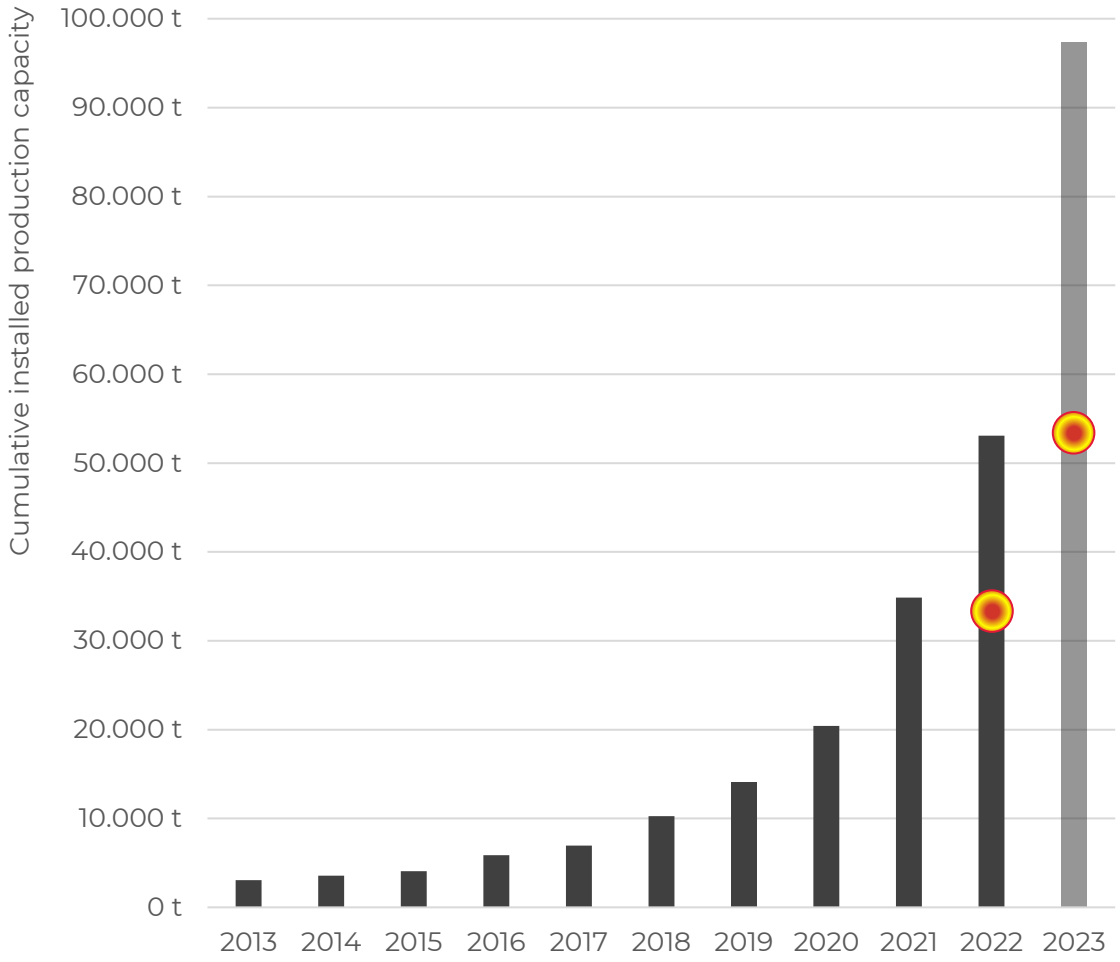
Cumulative Biochar production capacity in Europe



www.biochar-industry.com/market-overview/ © EBI 2023

- Biochar production capacity continues to show **strong growth**. In 2022 it **grew by 52% to 53.000 t** Biochar
- **3y CAGR** was **56%** (2019 - 2022)
- For 2023 we expect **the production capacity** to **grow to > 90.000 t,** equivalent to above **80% growth rate**
- **3y CAGR** is expected to grow to **68%** (2020 - 2023)

From production capacity to actual Biochar production

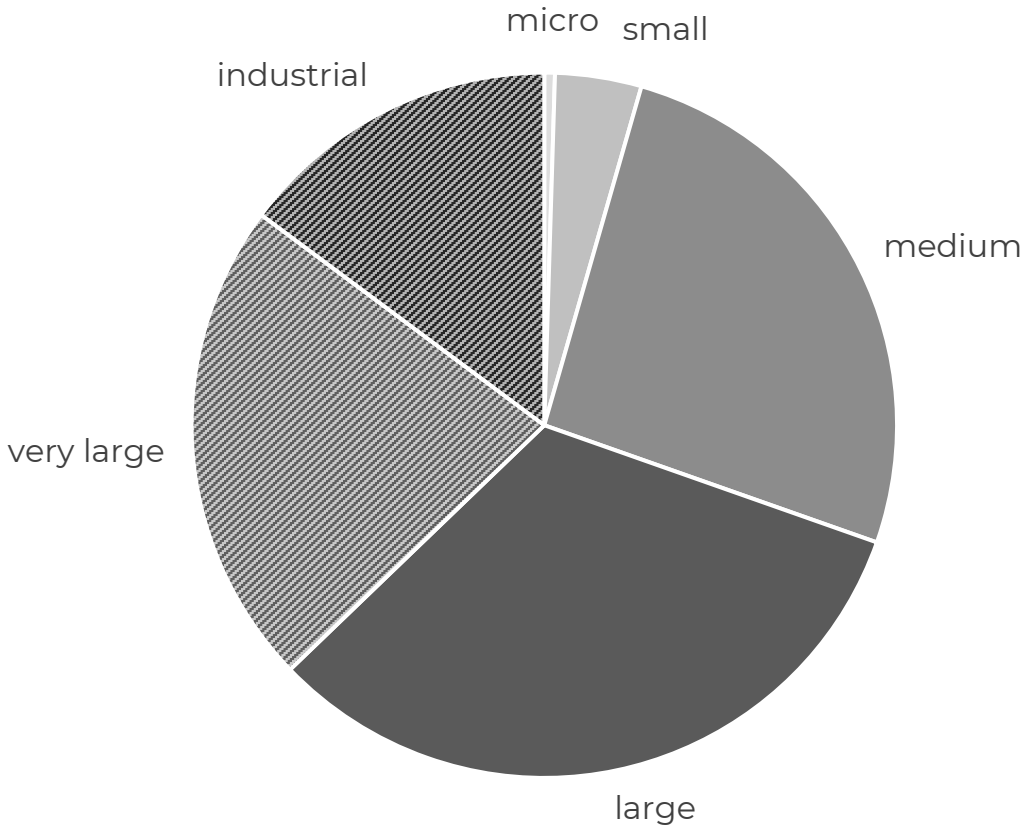


www.biochar-industry.com/market-overview/ © EBI 2023

- Assumptions to calculate **actual Biochar production**
  - 6 months operation and 60% uptime in the commissioning year
  - 12 months operation and 80% uptime in following years
- This leads to **33.500 t of Biochar** production in **2022**, equivalent to more than **90.000 t of CO_{2e}**
- **BCR** is by far today's **most relevant** industrial **carbon removal technology**
- For **2023**, we expect >**50.000 t of Biochar** equivalent to up to **150.000 t of CO_{2e}**

Biochar production by size of equipment

Cumulative Biochar production capacity in Europe end of 2022



- **80%** of the **production 2022 capacity** is in the equipment categories **medium, large** and **very large**
- **very large** and **industrial**, where only part of the production is dedicated to carbon preserving applications, make **37% of the capacity**

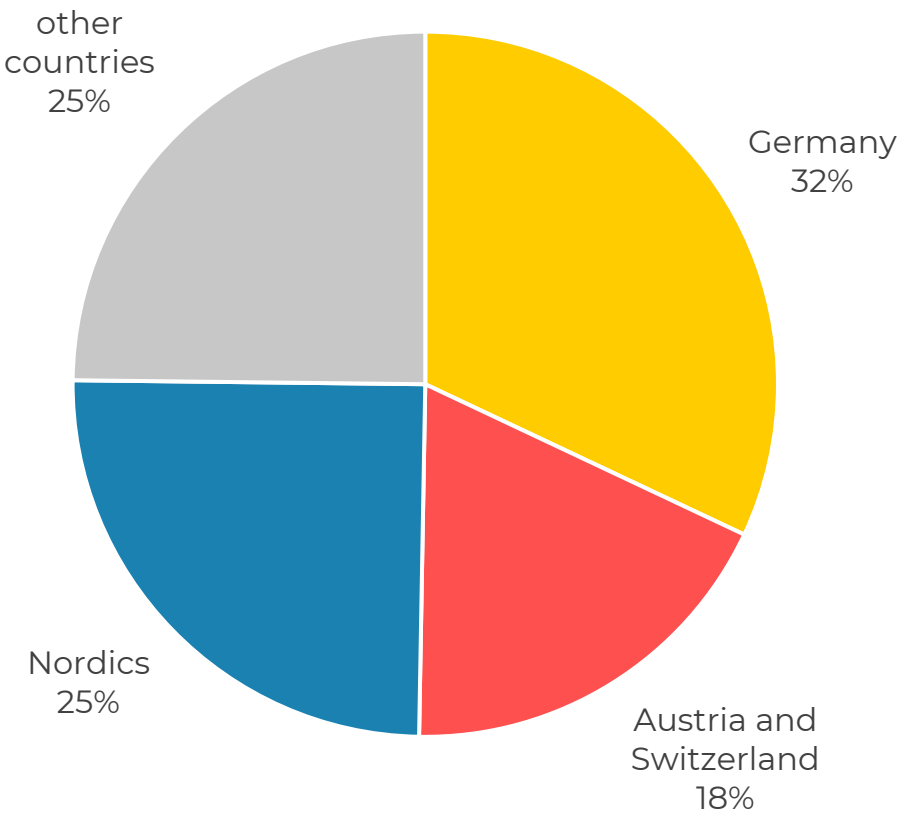
equipment category	
Small	(100 - 199 t)
Medium	(200 - 499 t)
Large	(500 - 1.999 t)
Very large	(2.000 t - 4.999 t)
Industrial	(≥ 5.000 t)

37%

80%

Biochar production by regions/countries

Cumulative Biochar production capacity in Europe end of 2022



- Basis is the cumulative **production capacity** end of **2022**, **53.000 tons**
- About three quarters is distributed among **three dominating regions/countries:**
  - Germany
  - Nordics
  - Austria and Switzerland

Carbon Removal Standards for Biochar Carbon Removal

puro earth

VERRA

Verified Carbon Standard

„others“

ISO 14064

Standards for usage of Biochar as a material and its production

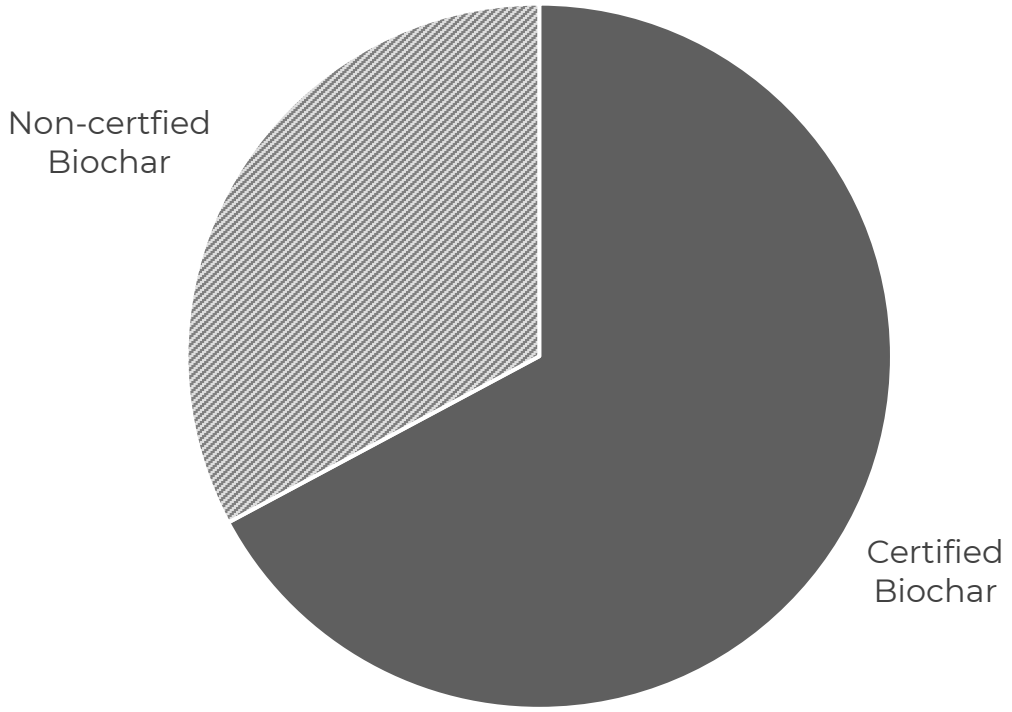
ISO 9001

CERTIFIED BIOCHAR
EBC
EUROPEAN BIOCHAR CERTIFICATE (EBC)

Feed Safety
GMP+
Assurance

QS. Quality scheme for food.
www.q-s.de

Certification of Biochar is becoming more and more relevant



- Certification of the **Biochar material** is becoming **increasingly relevant**
  - The EBC is today by far the most relevant certificate
  - For Biochar application in established markets additionally/ alternatively other certification schemes are required by customers
- From the total production capacity available by **end of 2023,** almost **70%** is product **certified** (in 2018 this was below 50%)

Market observations and trends beyond the general growth

- Today there are at least **ten companies** that have been **operating commercial plants since several years**, with an installed base of **several to many systems,** up 30+ installations
- Beyond the **established equipment manufacturers**, several **new industrial players** are entering the market, some with relevant experience from installations outside Europe
- **Replacement of fossil carbon in metallurgy** is becoming a relevant application for biogenic carbon (*not Carbon Removal*)
- Feedstocks other than woody biomass is becoming more relevant

Market observations and trends beyond the general growth

- **CO_2-Certificates** for **valorisation of the climate service** have become an important commercial element for the industry
- The offtake and use of biochar is increasing in various applications, with the material offering significant added value, but it remains a challenge and requires **political and regulatory support** to develop offtake markets in parallel with increasing production

Summary

- Biochar production **technology is mature** with at least **ten** experienced EU technology providers, from which at least **four** are at **TRL9** level, the others at least **TRL8**
- The European Biochar market **has grown strongly** and will **continue to grow**
  - end of **2022** the **Biochar production capacity** was **53.000 t** and **production of Biochar** was about **33.500 t** (equivalent to over **90.000 t CO_{2e}**)
  - **3y CAGR** was **56%** (2019 - 2022)
  - Until the end of **2023** the **Biochar production capacity in Europe** will grow to **90.000 t** and **production** in **2023** is expected to exceed **50.000 t** (equivalent to almost **150.000 t CO_{2e}**)
- **Biochar** production & **BCR** are “easy” to **scale** to relevant volumes **near term**

3 European Biochar Market 2022/2023
Reference Projects

Criteria for selecting Reference Projects

- The **equipment supplier** has already realized **multiple projects** that are **up and running** with an **operational experience** of **several years** and the equipment has proven to be capable of producing **certified** Biochar
- The Reference Project itself is either **operational** or **in construction** and has a **smart energy utilisation concept**
- We want to show a **representative spilt** on **countries/regions** and **system size**

equipment category	
Small	(100 - 199 t)
Medium	(200 - 499 t)
Large	(500 - 1.999 t)
Very large	(2.000 t - 4.999 t)
Industrial	(≥ 5.000 t)

*For each of the **most relevant equipment categories** we show at least one example*

Auen Pflege Dienst – Flaach

Reference Project (“Small”)

- Customer: **Auen Pflege Dienst AG (CH**)
- Equipment: **Biomacon C400-I**
- Commissioning: **2019**
- Feedstock: **Natural wood (forest and landscape management)**
- Energy utilization: **Feeding** up to **400 kWth** into the **local district heating network** and an **own district heating network for industry**
- Biochar production: up to **360 t/yr of Biochar**

NGE – Offenhausen
Reference Project (“Medium”)

- Customer: **Ökologische Klärschlamm -trocknung Offenhausen GmbH (GER)**
- Equipment: **NGE T:CRACKER_DH 5000 & NGE T:CRACKER_DH 3000**
- Commissioning: **2022**
- Feedstock: **Residual forest wood**
- Energy utilization: **sewage sludge drying**
- Biochar production: overall **500 t/yr**

Nawaro – Perg
Reference Project (“Large”)

- Customer: **NAWARO ENERGIE Betrieb (AT)**
- Equipment: **2 x CW1800-500**
- Commissioning: **2022**
- Feedstock: **Residual forest wood**
- Energy utilization:
  - **11 GWh/yr renewable heat** for the **local district heating network**
  - **7,5 GWh/yr electricity** (8.000 households)
- Biochar production: **1.000 t/yr Biochar**
  up to 3.000 t CO2e

Thyssenkrupp Lippstadt

Reference Project (“Large”)

- Customer: **thyssenkrupp (Germany)**
- Equipment: **PYREG PX1500**
- Commissioning: **2022**
- Feedstock: **Residual forest wood**
- Energy utilization: **Feeding** up to **750 kWth** into the company’s **heating network**
- Biochar production**: 700 t/yr of Biochar** corresponding to **1.500 t CO_2**

Novocarbo

Vow Green Metals – Follum plant

Reference Project (“Industrial”)

- Customer: **Vow Green Metals (NOR)**
- Equipment: **6 x Vow BGR750x6**
- Commissioning: **2024** *(under construction)*
- Feedstock: **Demolition wood**
- Energy utilization:
  50 - 60 GWh/yr renewable heat for the local district heating network
- Biochar: **10.000 t/yr Biochar**
  for Solar Silicon Production
  saving **30.000 t CO_{2e}**

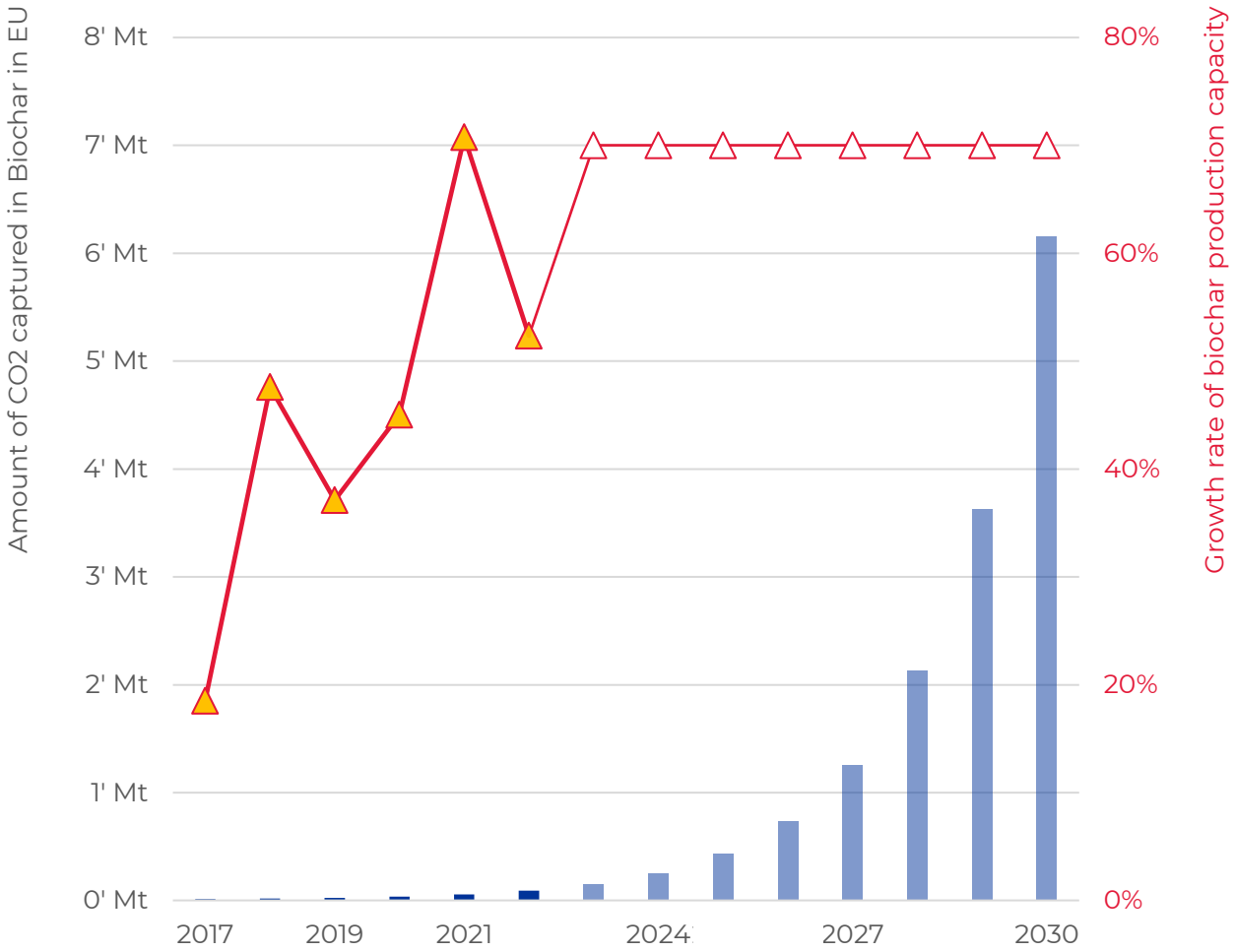
Fårevejle
Reference Project (“Medium”)

- Customer: **Odsherred Utility Company (DK)**
- Equipment: **Hecla® Setores 1.000**
- Commissioning: **in process**
- Feedstock: **Sewage sludge 4.000 t/yr**
- Energy utilization:
  - **sewage sludge drying** without use of external energy
  - **2 GWh/yr excess heat** for the **district heating network**
- Biochar production: **400 t/yr Biochar** with up to 35% carbon used as soil improver under Danish law

4 Scaling BCR to climate relevance

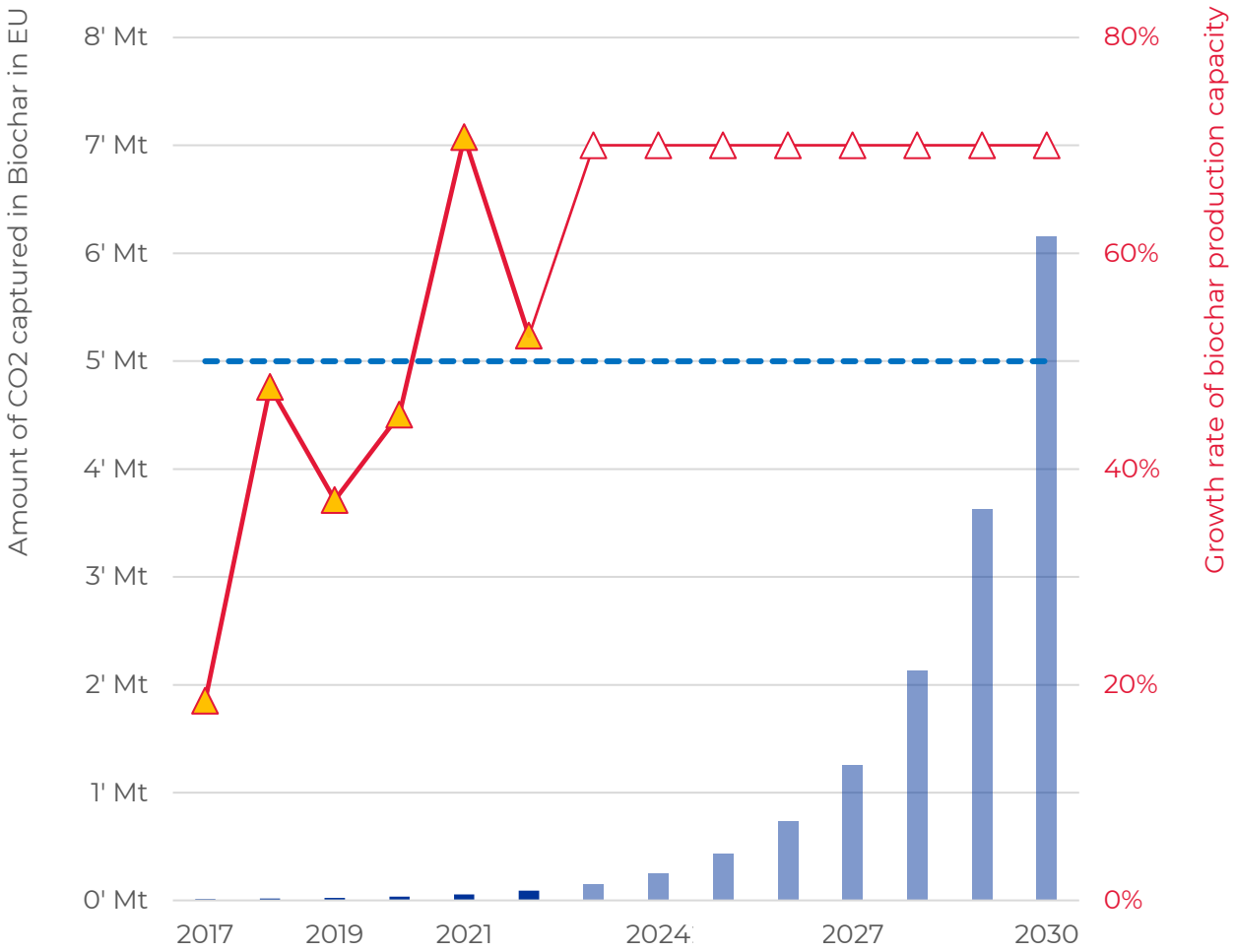
BCR plays a vital role in the **portfolio** of the **Carbon Removal Technologies**

Growing by 70% will bring BCR to 6 megatons by 2030



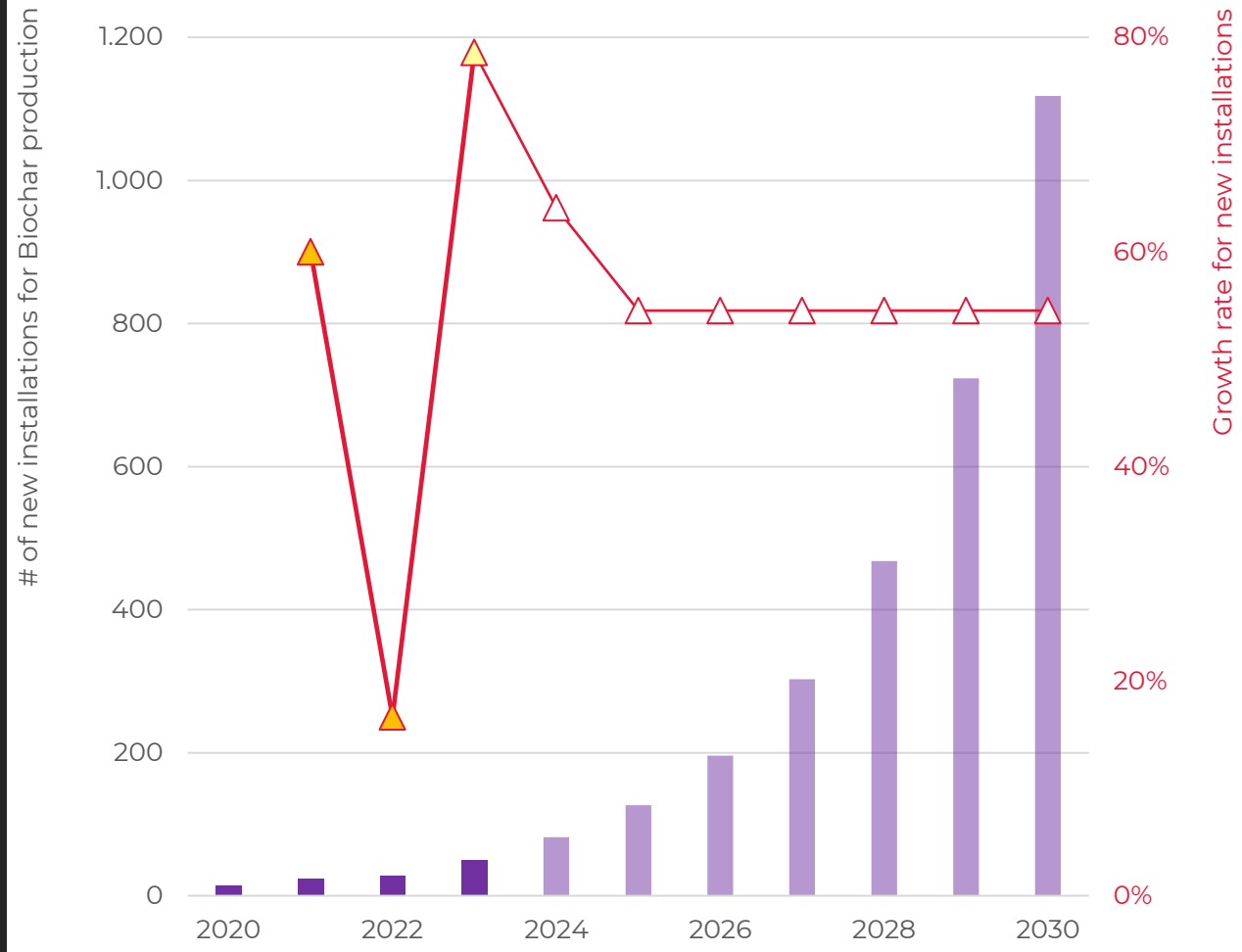
- Starting point is the **historic production** of **Biochar**
- A **conversion rate** of **2,8 t CO_2** per t **Biochar** was used to convert the amount of Biochar produced to **CO_2**
- To extrapolate from 2022/2023 a **growth rate of 70%** was modeled

Growing by 70% will bring BCR to 6 megatons by 2030



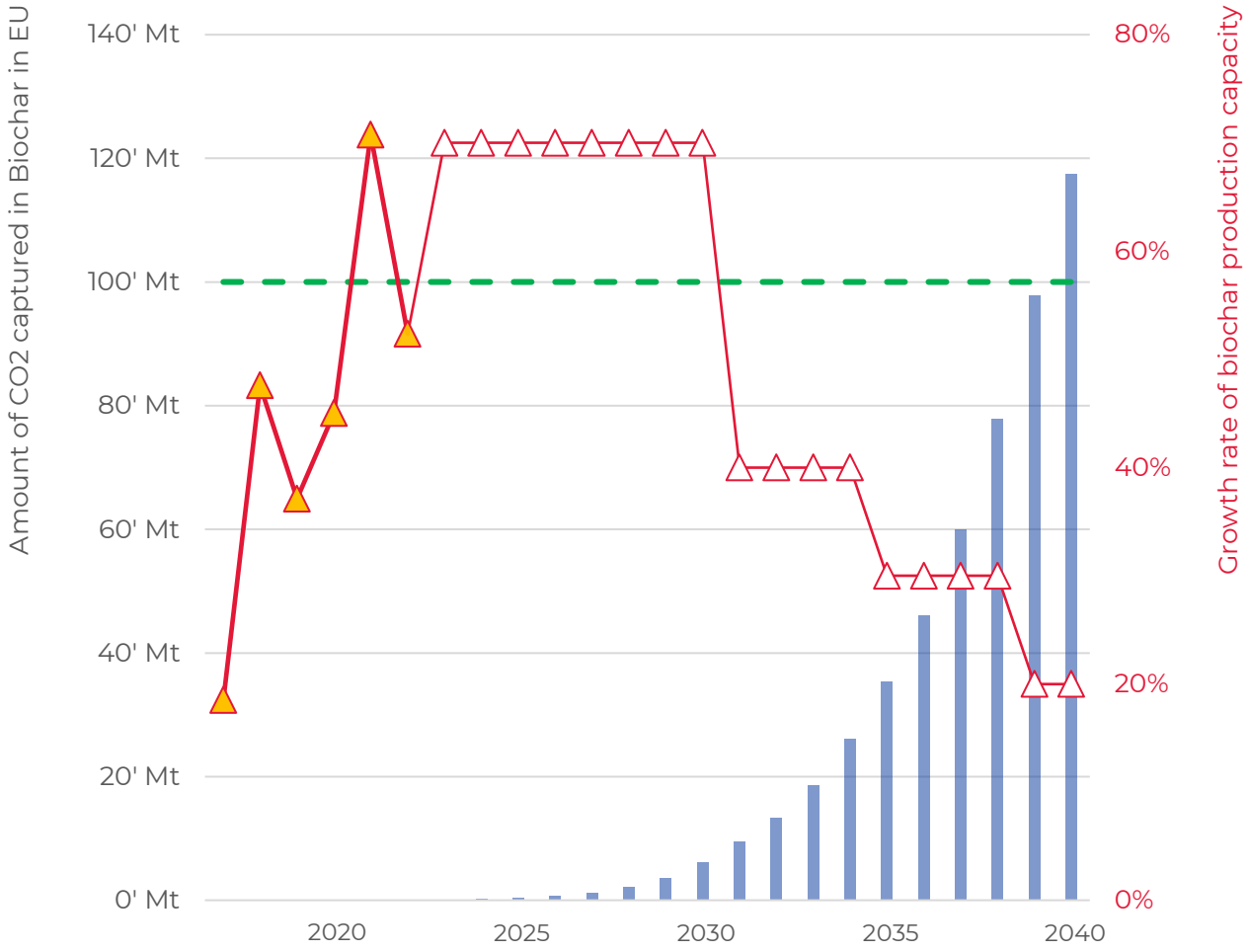
- **Maintaining growth rates** of **70%** until 2030 **is challenging but feasible**
- At 70% growth, **BCR** will sequester **120%** of the **Commission's current target** for industrial CDR

Number of new installations required to meet the 6 megatons



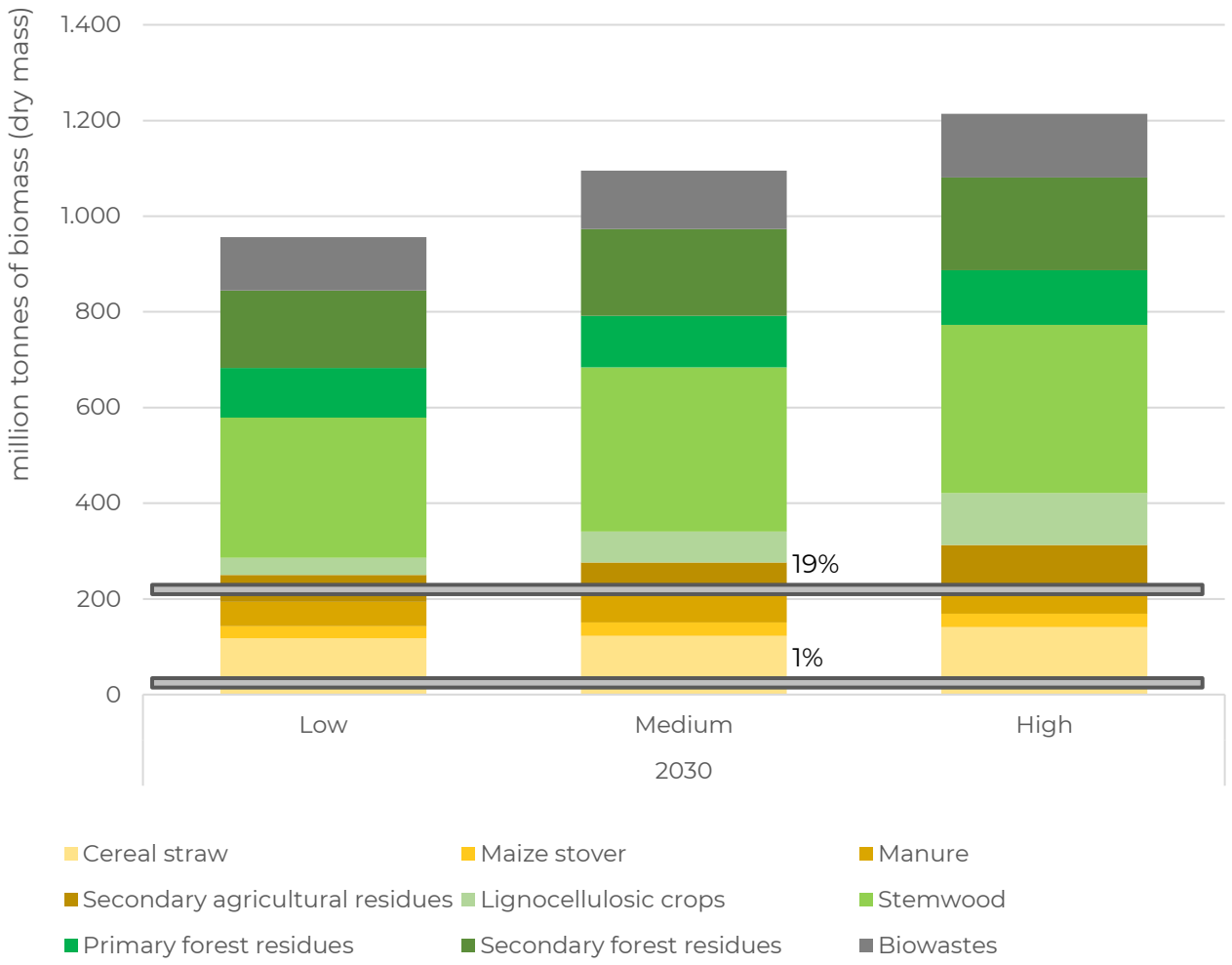
- **New installations** will have to grow to above **1.000 plants** by 2030, **cumulative** installed fleet would then be just over **3.000 plants**
- In comparison: around 143.000 medium-sized combustion plants (1 - 50 MW) are installed in the EU
- Required **growth rate until 2030** for **new installations** will be **55%** (lower than the 70% modeled for production growth rate, as average system size is expected to further grow)

100 megatons of carbon removal by 2040



- Assuming **10 years** of high **growth at 70%** and then declining growth rates would bring BCR to well above **100 Mt** by **2040**
- **Short term** challenge is to **maintain high growth rates for installation** of new plants and find commercially interesting application for the produced Biochar
- **Long term** challenge will be the **availability of biomass** with smart allocation and cascaded use

Smart biomass allocation is key to reach 100 megatons by 2040



Estimated total sustainable biomass potentials (RED II Annex IX A and B) in 2030 and 2050 for all markets (in million dry tonnes) as estimated in this Imperial College London study.

- **Biomass is a limited resource**
  - Smart use of **thermal energy** from the process avoids conflicts over biomass resources
  - **Cascaded use** of biomass with pyrolysis as final step optimizes the use of biomass
  - Pyrolysis permits usage of hardly valorized **residual biomass**
- For the **6 megatons CO_2** projected for BCR by 2030, **1%** of the **biomass** is required
- In order to achieve **100 megatons CO_2** by **2040, 19%** of the **biomass** would be required

BCR is capable of delivering **carbon removal** at **climate relevant** volumes within **15 years**